# Diversification of Energy Sources in Mexico: Closing the Gap Between Objectives and Results in the Electricity Sector

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Abstract

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The Mexican energy reform of December 2013 ended a long history of state-owned energy monopolies in the country, laying the grounds for direct private participation in an attempt to modernize this sector. Favorable political circumstances coupled with the negative effects of stagnation eased the way of the constitutional reform presented by the President, Enrique Peña Nieto, to Congress claiming that through this reform, the Mexican economy would grow around 1 percent by 2018 and 2 percent by 2025.

The "hype" for oil spurred by the reform, was the subject of numerous media reports, academic forums and literature pieces in which every actor had a different opinion regarding who would be the main beneficiary of the "major" money flows that private investment would draw from oil developments, specially because the price for barrel of oil was around 100 dollars at the time. No one anticipated that by the end of 2014 this price would drop dramatically causing the "muteness" of these debates and shifting the government's message from one of prosperity to one of austerity.

This situation, although probably not permanent, gives us a preview of the inevitable: biophysical strains will increasingly tamper oil revenues as technically accessible fuels are depleted. Mexico needs then to pursue the de-carbonization of its economy in order to prevent a major crisis in this regard.

The electricity industry has the potential to become the gateway towards this goal, providing that adequate measures are put in place to spur clean technology development. This not only to satisfy the country's energy demands while contributing to climate change abatement, but also to create an innovation hub that can allow Mexico to compete in international markets exporting its technology around the globe.

Mexico has a great capacity to satisfy its energy requirements through the deployment of renewable technologies. In terms of solar energy, 70% of its territory has Global Horizontal Irradiation Levels greater than 4.5 Kwh/m2; overall wind, geothermal, and hydropower energy potential has been estimated at 87,000MW, 8,000MW, and 53,000MW respectively; there are vast crop yielding lands available to undertake significant biomass generation

efforts; and significant coastlands with considerable wave power that could make marine energy increasingly attractive in the future.

Despite these promising levels, Mexico's electricity matrix is still dominated by fossil fuels. Around 70% of the generation for public service provision is sourced through a combination of fuel oil, diesel, and natural gas, and although it is true that there have been policy efforts in the past aimed at spurring renewable energy deployment, they have mostly fallen to be "catalogues of good intentions" given that they lacked the stringency required to send the adequate price signals to promote an energy transition, as evidenced by the current electricity matrix itself.

Hence, if energy transitional goals are to be pursued in order to access the benefits thereof, policy efforts that address both: technological research and development, and incentives to arouse the market, have to be developed. Task, which shall not be conducted "blindly", but rather guided by best practices, derived from successful policy implementation examples across the world, keeping in mind the legal, economic and political viability of these policy alternatives within the Country.

As such, this dissertation will provide an analysis of the framework that governed the Mexican electricity system previous to the reform, how this system is planned to work after, and the measures that this author believes Mexico should implement in order to advance in its path towards decarbonizing its finances while promoting economic growth, full electrification and climate change abatement, through an energy transition. This in light of internationally identified best practices, and taking into account feasibility considerations of the different policies available to achieve this goal within the Country.

TABLE OF CONTENTS

## 1. The Past

### 1.1. Organizational Structure

Under Mexico's legal framework prior to the constitutional reform of December 2013, the electricity system as a whole belonged to and was controlled exclusively by the Federal Government. Planning and policy making in this sector was, as it is today, an exclusive faculty of the Federal Government in which there is no room for participation by the states. The "Federal Electricity Commission", a state-owned utility, was in charge of conducting all activities of generation, transmission, sales and distribution pertaining to the public service of electricity provision[1]. This was the case until 1992 when, in order to comply with chapter IV of the North America Free Trade Agreement, five activities of the electricity sector where excluded from the concept of "public service" allowing limited private participation in[2]:

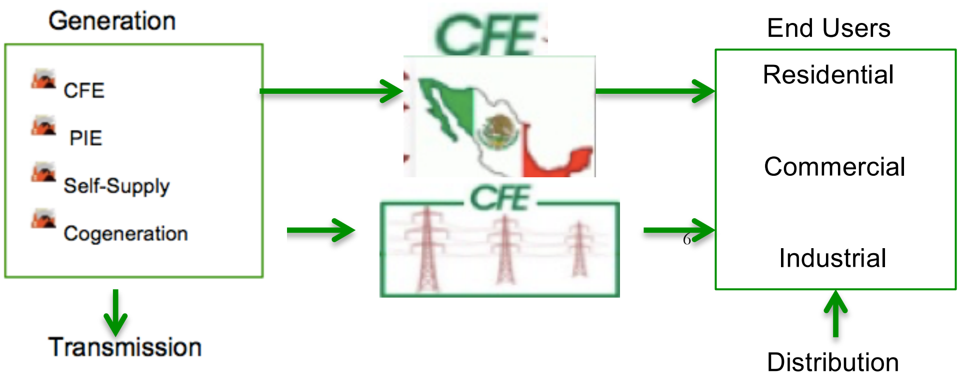
- Generation of electricity for self-supply[3], cogeneration[4] and small power production[5].
- Generation of electricity by independent power producers exclusively for the purpose of selling the output to the Federal Electricity Commission.
- Generation of electricity for export derived from cogeneration, independent production or small power production.
- Import of electricity exclusively for self-consumption.
- Generation of electricity for emergencies that arise from interruptions in the provision of the electric public service.

It is worth noting that in each of the above activities, the generated output that did not serve a self-supply purpose, had to be sold to the Federal Electricity Commission.

The following diagram illustrates the organizational structure of the Mexican Electricity System and the relationship between its participants previous to the reform of December 2013

[1] Title 1, Chapter 1, article 1 of the Law of the Public Service of Electric Energy (Ley del Servicio Público de Energía Eléctrica).
[2] Title 1, Chapter 1, article 3 of the Law of the Public Service of Electric Energy (Ley del Servicio Público de Energía Eléctrica).
[3] Exclusively to satisfy the individual input needs of the generator.
[4] Simultaneous generation of electricity and useful heat.
[5] Production of less than 30 MW of power.

Mexican Electricity System Organization




- CFE (Federal Electricity Commission) generates power with state-owned power plants.
- PIE (Independent power producers) are contracted by CFE to purchase all their output.
- Self-suppliers and cogenerators sell all their surplus power to the CFE.
- CFE transmits and distributes the power.
- CFE conducts sales to every end user

## 1.2. Authorities and Their Main Powers

The authorities in charge of drafting and enforcing the regulatory policy in the electricity sector were the Energy Regulatory Commission[7], the Ministry of Energy[8] and the Ministry of Finance and Public Credit[9].[10]

Although the Energy Regulatory Commission was intended to be an independent agency of the Ministry of Energy, the fact that it lacked budgetary self-sufficiency[11] and relied on presidentially appointed commissioners[12], jeopardized its autonomy.

The Commission had the power to grant and enforce the "Power Generation Permit"[13], the main permit required to build and operate a generation facility in any of the five excluded activities of the "public service" category. This permit required obtaining an environmental, safety and health impact authorization from the Ministry of the Environment and Natural Resources, as well as the opinion of the Federal Electricity Commission regarding the viability of the project, given that the latter had to provide transmission and backup services[14] for the generation facility. In addition to these federal requirements, the project had to obtain all land use and local environmental permits required from the state and municipal authorities. If the use of national waters was

6 This diagram was constructed using information provided by the Law of the Public Service of Electric Energy.
7 Article 2 of the Law of the Energy Regulatory Commission (Ley de la Comisión Reguladora de Energía).
8 Law of the Public Service of Electric Energy (Ley del Servicio Público de Energía Eléctrica), Chapter 1, article 5.
9 Law of Public Service of Electric Energy (Ley del Servicio Público de Energía Eléctrica), Chapter 5, articles 30 and 31.
10 As we will see ahead in this chapter, although some of their responsibilities, organization and main activities have changed, these authorities still govern the electric sector.
11 Title 1, Article 4 of the Regulation of the Law of the Energy Regulatory Commission (Reglamento de la Ley de la Comisión Reguladora de Energía).
12 Title 1, Chapter 2, Article 4 of the Law of the Energy Regulatory Commission (Ley de la Comisión Reguladora de Energía).
13 Title 2, Chapter 6, Article 27 of the Regulation of the Law of the Energy Regulatory Commission (Reglamento de la Ley de la Comisión Reguladora de Energía).
14 If there was an emergency situation in which the generator went offline, the Federal Electricity Commission was responsible to provide enough power to ensure the stability of the grid.

involved[15], there was a need of acquiring the concession or a permit from the National Water Commission.

Apart from granting the generation permit, the Commission was in charge of the next activities in regards to electricity[16]:

- Participating in the tariff setting process.
- Determining the required amount of capital to be provided by local governments and private beneficiaries of the public service provision in order to finance any expansion and modifications required to access electricity services.
- Granting import and export permits.
- Develop a registry of all the entities that conduct any of the activities of the electricity system.
- Undertaking inspections for the supervision of the activities of the electricity system in order to guarantee that they are being conducted following the applicable rules.
- Approving the terms of the Federal Electricity Commission wheeling[17], interconnection[18] and backup supply services[19] (including the issuance of the methodology for the calculation of payment for wheeling services).
- Regulating the development of renewable energy projects, its interconnection to the grid, and the conditions in which its output could be sold to the Federal Electricity Commission.

The Ministry of Energy was the governmental body in charge of conducting the energy policy, setting the agenda for the energy sector and coordinating the efforts of all the agencies involved, to promote the achievement of the set goals[20].

The Federal Electricity Commission conducted, under the Ministry's oversight, and following the applicable rules enacted by the Energy Regulatory Commission, all electricity projects and services related to public service provision (generation, transmission, distribution and sales). It was also in charge of dealing with the output of the permitted private generators, providing, to the extent possible, the required wheeling services, as well as proposing the tariffs for the supply of electricity to the Ministry of Finance and Public Credit[21]. The National Centre for Energy Control, which was included under the Federal Electricity Commission structure, had the responsibility of ensuring reliability of the grid[22].

The Ministry of Finance and Public Credit was in charge of setting the tariffs for electricity supply[23], with the participation of the Ministry of Energy and the Ministry of

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[15] For the purpose of cooling the working fluid before reusing it to produce more electricity in a power plant, or for hydroelectric generation projects seeking to site in this bodies of water.
[16] Title 1, Chapter 1, Article 2 of the Law of the Energy Regulatory Commission (Ley de la Comisión Reguladora de Energía).
[17] Transportation of electricity through transmission lines.
[18] The physical linking of generation facilities with transmission infrastructure.
[19] Spinning and supplemental reserve to compensate for potential generation or transmission outages.
[20] Article 33 of the Organic Law of the Federal Public Administration (Ley Orgánica de la Administración Pública Federal).
[21] Law of the Public Service of Electric Energy (Ley del Servicio Público de Energía Eléctrica), Chapter 2, article 9.
[22] Regulation of the Law of the Public Service of Electric Energy (Reglamento de la Ley del Servicio Público de Energía Eléctrica), Chapter 9, Section 15, article 148.
[23] The Federal Electricity Commission proposed the structure and amount of these tariffs but the Ministry of Finance and Public Credit had the final word in this regard. The tariffs set by this Ministry were the ones that ultimately were charged to consumers of this commodity.

Economy[24]. Apart from this, the Ministry of Finance and Public Credit had the responsibility of authorizing and managing the budget of the Federal Electricity Commission[25].

### 1.3. Interconnection and Transmission

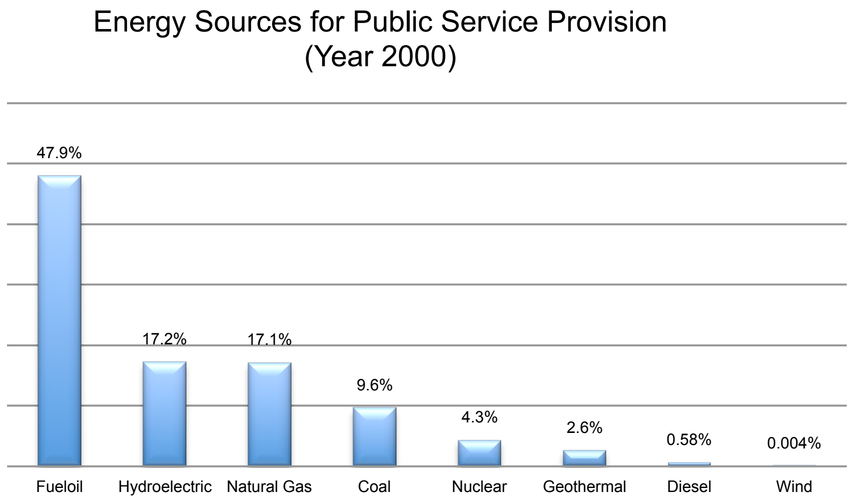
As stated before, the only entity authorized to provide transmission and interconnection services was the Federal Electricity Commission. The holders of a power generation permit could request access to these services, but this petition would only be granted if it was considered "technically viable"[26].

Given the fact that the Federal Electricity Commission had limited resources, only few of the proposed projects were deemed "technically viable". This situation complicated the satisfaction of the growth in electricity demand; therefore, the Ministry of Energy, the Energy Regulatory Commission and the Federal Electricity Commission created a program named "Open Season",[27] the first of which was developed in 2006 in Oaxaca for the incorporation of 2000 MW of wind power to the grid[28]. Later, after the approval of the "Law for the Use of Renewable Energies and the Financing of the Energy Transition", in 2011 the "Open Season" program was expanded for projects in the states of Oaxaca, Tamaulipas, Baja California y Puebla for the incorporation of 4000 MW of wind and hydropower to the grid. The "Open Season" programs consisted in guaranteeing that the payment for the construction of new lines came from the interested permit holders, as the budget of the Federal Electricity Commission was constrained in this regard. These scheme provided for a bidding process that opened up a possibility to advance the start-up date of projects from interested permit holders, under the condition that they had to reinforce the interconnection and transmission infrastructure at their own expense.

### 1.4. Public Service Sources and the Policies That Followed

In the year 2000, nominal energy generation for public service provision in the Mexican Electricity System was conformed as follows:

[24] Regulation of the Law of the Public Service of Electric Energy (Reglamento de la Ley del Servicio Público de Energía Eléctrica), Chapter 6, article 47.
[25] Article 31 of the Organic Law of the Federal Public Administration (Ley Orgánica de la Administración Pública Federal).
[26] Technical viability was mainly dependent on the availability of interconnection facilities.
[27] This program stemmed from a formal resolution by the Energy Regulatory Commission (RESOLUCION Núm. RES/207/2011 Commission Reguladora de Energía).
[28] http://www.cre.gob.mx/documento/2317.pdf




[29]

Since then, Mexican agencies undertook a series of policies aimed at diversifying the sources for electricity generation through the now outdated legal framework. This old framework allowed very little margin to adequately promote an efficient policy and regulatory scheme for the diversification of the energy portfolio, given that the Federal Electricity Commission was the only entity allowed to conduct public service activities and that its resources to do so were limited. This situation constrained this agency to seek the cheapest sources for electricity generation in order to satisfy the ever-growing electricity demand.

Encouragement of combined-cycle gas-fired power plants was one of the agency's priorities at the time, with the goal of achieving higher overall efficiency levels[30] and generating fewer emissions by burning natural gas instead of fuel oil. Therefore the Federal Electricity Commission awarded long-term contracts to Independent Power Producers[31] that generated electricity using this technology. However, over the course of development, these power plants faced some problems; mainly the lack of infrastructure to supply natural gas and the increasing scarcity of this resource, given the fact that the growth in demand for natural gas outpaced its production[32], and that at the moment the infrastructure to import natural gas from the U.S. was limited[33]. Nevertheless, it is worth noting that as more natural gas transportation infrastructure has been developed, imports from the U.S. have been increasing over the years to satisfy Mexico's demand as the next graph showcases.

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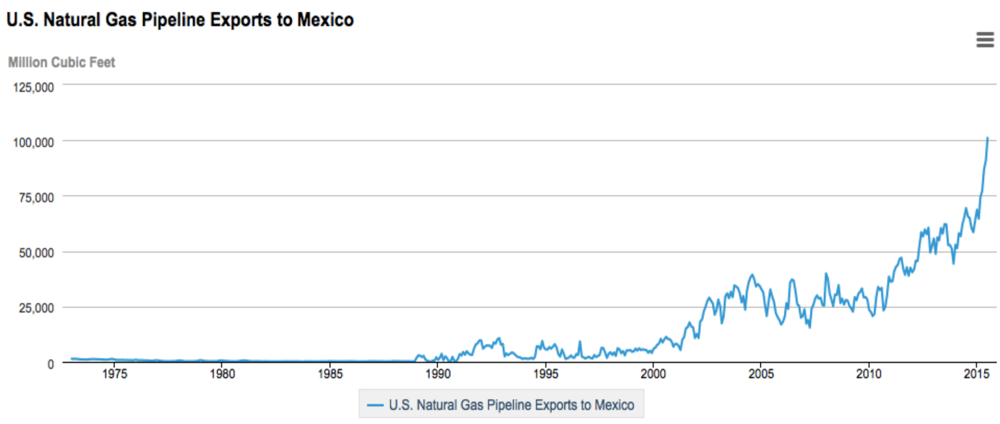
[29] This chart was constructed with information made available by the Mexican Ministry of Energy http://sener.gob.mx/res/PE_y_DT/pub/2012/PSE_2012_2026.pdf (page 92). It is worth noting that public service provision includes all the output sold to the Federal Electricity Commission by the permitted generators; the only sources that are not included in this graph are the ones that were used to generate electricity for self-consumption.

[30] By having two cycles instead of one, these plants take advantage of the heat output derived from the first cycle to generate more work (electricity) by adding the second cycle.

[31] Private generation for the exclusive purpose of selling all the output to the Federal Electricity Commission.

[32] http://www.bloomberg.com/news/2012-09-03/u-s-shale-glut-means-gas-shortage-for-mexican-industry-energy.html

[33] Changes in U.S. Natural Gas Transportation Infraestructure (2004). Energy Information Administration, Office of Oil and Gas, pg 11. Available at: http://www.eia.gov/pub/oil_gas/natural_gas/feature_articles/2005/ngtrans/ngtrans.pdf




[34]

In 2008, the "Law for the Use of Renewable Energies and the Financing of the Energy Transition", was enacted with the goal of promoting the development of renewable energy generation. Apart from incorporating a "Renewable Portfolio Standard"[35], that set a maximum percentage for fossil fuel electricity generation for the years to come (65% by 2024, 60% by 2035, and 50% by 2050)[36]. This law created two main policy instruments to be elaborated by the Ministry of Energy; first a strategy document aimed towards setting the main goals in the path towards reducing reliance on fossil fuels and promoting energy efficiency[37], and second, a program containing specific actions to be taken by the government to achieve these goals.

The strategy document developed in 2009 laid down six main objectives[38]:

- Information Dissemination: Aimed at implementing programs that would allow various groups of society to gain knowledge about the economic and environmental advantages of renewable energy generation, as well as the financial mechanisms available for the development of renewable energy projects.

- Mechanisms for Sustainable Exploitation of Renewable Sources: Aimed at building a national inventory of renewable energy sources and enacting administrative regulations for the development of renewable energy generation taking into consideration the externalities associated with renewable energy projects.

- Infrastructure and Regulation: Aimed at promoting reliance on renewable energy generation in government buildings, promoting the development of the required infrastructure to incorporate renewable generation to the grid, simplifying transmission service charges, and installing renewable energy generation technologies in housing programs of the government throughout the country,

- Research and Technological Development: Aimed at promoting international cooperation in research and development of renewable energy technology, promoting training of human resources to fulfill newly created renewable energy

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[34] U.S. Energy Information Administration. Natural Gas Exports to Mexico. Available at: http://www.eia.gov/dnav/ng/hist/n9132mx2m.htm
[35] A renewable portfolio standard (RPS) is a regulatory mandate to increase production of energy from renewable sources such as wind, solar, biomass and other alternatives to fossil and nuclear electricity generation. It's also known as "renewable electricity standard".
[36] This through the transitory provisions of: the Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).
[37] The reduction of the amount of energy required for the provision of products and services, as well as the curtailment of certain energy intense activities.
[38] This document can be consulted at: http://www.energia.gob.mx/res/0/Estrategia.pdf

projects and establishing collaboration channels with national and local research centers.

- Electrification from Renewable Sources: Aimed at creating mechanisms to electrify disadvantaged communities, allowing them to benefit from renewable energy projects using local resources and training them for the adequate operation and maintenance of these facilities. And, creating a catalogue based on the National Renewable Energy Sources Inventory, focused at analyzing the implementation and performance of renewable energy pilot projects in rural communities to promote their dissemination.

- Promotion and Development: Aimed at the creation of financial schemes for the support of renewable energy generation projects, promoting private investment in fabrication of renewable energy equipment, and proposing guarantee strategies[39] in order to create mechanisms of shared risk that could boost private investment.

The program, enumerated the specific actions to be taken by the government to achieve the energy transition goals established in the strategy document[40]. These actions were mainly:

- Expanding the Open-Season project, an effort between private investors and the government of up to 60 thousand million Mexican pesos, aimed at the development of wind projects that would increase the installed capacity of this technology in order to satisfy 4% of the electricity demand with this resource by 2012.

- A project that took advantage of a 75 million USD donation from the World Bank called Grand Scale Renewable Energy Development Project, which was implemented by granting an incentive of 1.1 US cents per kilowatt-hour delivered from a specific wind power project named "La Ventana III".

- A project of rural electrification named Integral Energy Services, which would provide electricity generation from renewable local sources to 50,000 households in rural communities.

- The creation of a project called "IMPULSA" conducted by the major university and research institute of the country, UNAM, in which federal resources were to be allocated for research focused in renewable generation technologies.

- The implementation of a Solar Water Heating Promotion Program, aimed at adding 600,000 square meters of solar powered water heaters by 2012, for the use in agriculture, construction and residential purposes promoting energy efficiency by substituting the regular fossil fuel heating methods used in these sectors.

- Development of 4 geothermal generation projects conducted entirely by the government through the Federal Electricity Commission, that would constitute an increase of 332 MW of geothermal installed capacity by 2012.

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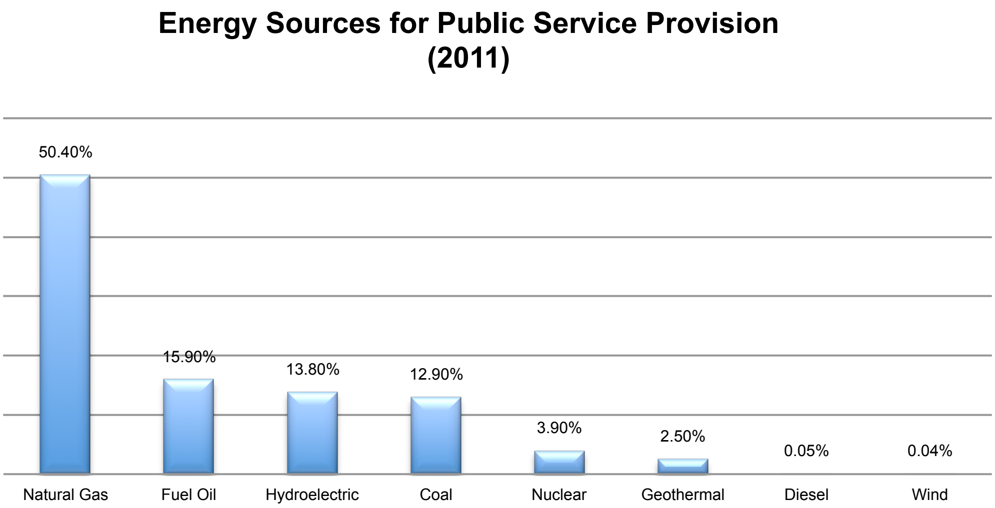
[39] Guarantees can mobilize domestic lending by sharing credit risk. In this scheme the government covers a portion of the outstanding principal thereby reducing what local banks might perceive as high repayment risk associated with some renewable projects.

[40] This program can be consulted at: http://dof.gob.mx/nota_detalle.php?codigo=5101826&fecha=06/08/2009

The problem with these strategies and actions is that there were no enforcement measures imposed by the legislature on the Ministry of Energy to develop the planned programs or to generate other actions that could have increased the speed for the transitional goals set forth by the strategy document. The fact that the government played this dual role of being the policy subject of its own policymaking, while having to balance and conduct all the activities regarding public service provision, condemned these strategies to serve only as a "catalogue of good intentions" that were never fully followed other than on paper. The few successful programs that derived from them, fell short of achieving the goal of energy transition. The proof of this is the next graph, which shows the nominal energy generation for the public service provision in the year 2011.



[41]

This graph suggests that the only policy that proved to be considerably effective was the one that encouraged implementation of combined-cycle gas-fired power plants by independent power generators. This conveys that private entities are more efficient at following policy guidelines than the government itself, given the disincentive in this last case provided by the "judge and party" dichotomy.

Renewable generation only showed development in the activities excluded from the "public service" category, proving once again, the point previously addressed regarding private participation in energy generation. This is evidenced by the next table, which showcases the amount of renewable energy generation permits acquired under the activities excluded from the "public service" category, and the installed capacity that this projects represent, which is roughly 79% more than renewable based installed capacity for public service provision[42].

[41] This chart was constructed with information made available by the Mexican Ministry of Energy http://sener.gob.mx/res/PE_y_DT/pub/2012/PSE_2012_2026.pdf (page 92).

[42] Installed capacity of renewable generation for public service provision at the end of 2011 was 743 MW of Geothermal Energy (10% increase from year 2000), and 12 MW of Wind Energy. This data was calculated using the GWh generation data provided by the Ministry of Energy through http://sener.gob.mx/res/PE_y_DT/pub/2012/PSE_2012_2026.pdf (page 89).

Renewable Generation Permits Under the Activities Excluded From the Public Service Category

| Power generation schemes | Permits | Capacity (MW) | Share in renewable energy installed capacity (%) |
|---|---|---|---|
| Self-supply | 80 | 3224 | 77.1 |
| Independent power producer | 5 | 511 | 12.2 |
| Small power producer | 7 | 80 | 1.9 |
| Co-generation | 32 | 364 | 8.7 |
| Total | 124 | 4179 | 100.0 |

[43]

However it is worth noting that, although clean energy deployment fell short (as the previous figures suggest), a considerable step was taken in terms of clean energy research and development policy, through the establishment of the CONACYT/SENER Sustainability Fund in 2008[44]. The reform to the "Federal Law of Rights" (Ley Federal de Derechos) in this regard, provided for a specific percentage for energy related research and development funds to be allocated directly from "Petroleum Rent"[45][46], through the establishment of three different trust funds that were set to be in charge of promoting energy related research and development activities[47][48]:

1. The CONACYT/SENER Hydrocarbons fund: This trust fund has the goal of promoting research and development activities focused at analyzing the different aspects and implications of exploration, extraction, and refining activities. While also promoting the identification of areas with hydrocarbon potential in Mexico.

2. The Scientific Research and Technological Development Fund of the Mexican Petroleum Institute: This trust fund is in charge of promoting applied research, and deployment of: exploration, extraction, and refining technologies.

3. The CONACYT/SENER Sustainability fund[49]: This trust fund has the goal of promoting research and development activities in the topics of renewable energy, energy efficiency, and diversification of energy sources by engaging universities and research institutes (public and private).

These trust funds were to be managed by their "technical committee"[50], which was in charge of deciding the research and development programs that are to be implemented with the assigned funds[51].

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43 The information contained in this table is from year 2012. Which was made available by PROMEXICO. Self-supply in Renewable Power. Mexico: 2012.
44 Per a Presidential Decree that reformed this law, published in September 14, of 2007.
45 As provided by a Presidential Decree that reformed the Federal Law of Rights (Ley Federal de Derechos), published in September 14, of 2007.
46 The result of multiplying the total dividend by .0015 in 2008, .0030 in 2009, .0040 in 2010, and .0050 in 2011.
47 As provided by a Presidential Decree that reformed the Federal Law of Rights (Ley Federal de Derechos), published in September 14, of 2007.
48 These trust funds remain in operation after the constitutional energy reform of 2013.
49 This trust fund was set to receive 10% of the assigned amount for research and development from the petroleum dividend in 2008, 15% in 2009 and then it will stabilize at 20% by 2010 for future years to come. As provided by a Presidential Decree that reformed the Federal Law of Rights (Ley Federal de Derechos), published in September 14, of 2007.
50 Formed by public servants from the Ministry of Energy and one representative of the National Council of Science and Technology.
51 As provided by section 4, articles 25 and 26 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)

There is no database that allows analyzing the different call for proposals aimed at spurring clean energy research and development efforts that were undertaken by the CONACYT/SENER Sustainability Fund throughout the years. Nevertheless, using electricity patent counts in Mexico[52] as a proxy for clean energy research and development advancement in the electricity field[53], this author has found that electricity technology patents in the 7 years before the establishment of this Fund averaged 8 per year[54], in contrast to an average of 14 per year the following 7 years after the establishment of the Fund, suggesting that the calls for proposal undertaken by the fund had some positive outcome in this regard[55]. Notwithstanding this improvement in electricity technology, patent count in Mexico is still very low. To put things into perspective, the average patent count for electricity related technologies in the U.S. for the period of 2001 to 2014, was 538 patents per year[56].

### 1.5. Reasons that Motivated the Change

In Mexico, the path towards broadening opportunities for private participation in the energy sector has been full of failed attempts. As always, Mexico has had to battle its biggest enemy on the road towards modernization – itself. Overcoming the opposition of a myriad of detractors that use “myths” as arguments to “shake” the citizenship. This has developed in strong political and societal movements, financed by groups of opposing political interests that seek their chance to run the country, in detriment of a steady pace of development for Mexico.

These myths are based in the propagandistic efforts that were carried out by the government in an episode of the Mexican history, during which all the assets of foreign oil companies that operated in Mexico where expropriated in 1938, given their threats to leave the country and take their capital, if the government forced them to sign a collective agreement with the “Petroleum Workers Union of Mexico” which demanded fair working conditions[57]. The rationale advanced by the government then, was that oil and all the energy sources belonged to “all Mexicans” and as such the government entities where the only ones that would exploit them for the sole purpose of benefiting the Nation[58].

This rationale made its way to every history book in the country, and although in the particular circumstances of that time, expropriating oil made sense in order to access petroleum rents that were only benefiting international investors, the current scenario is much different. The fact is that conventional “easy access” oil sources have been mostly depleted, and that the government lacks the required infrastructure and technical capacity

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52 The information about patents is made available by the Mexican Institute of Industrial Property through a recent study in this regard, available at: http://www.impi.gob.mx/ICIFRAS/IMPI_en_CIFRAS_ene-mzo_2015.pdf

53 These numbers are of global electricity technology patents, there is no information publicly available regarding patents specific to “clean” electricity technology advancement, that’s why these numbers have been used as a proxy in this analysis, and not as “hard numbers” that evidence clean energy technology development.

54 During that time there was also an R&D Tax Credit of 30% of any kind of research and development expenditures in place through article 219 of the Federal Income Tax Law, which could have also aided these developments.

55 In 2013, the energy constitutional reform took place which could have also spurred an increase in technological development in the energy field including the electricity sector (electricity patents where unusually high in the year 2013 and 2014, 26 and 17 respectively compared with an average of 11 per year from 2008 to 2013 [still higher than the yearly average before the establishment of the Fund]). An additional note should be made in regards to the fact that the research and development research credit previously described, was abrogated by the end of 2013 which could also explain de drop from 26 patents in 2013 to 17 in 2014.

56 The information about U.S. electricity patents is analyzed by the Mexican Institute of Industrial Property through a recent study in this regard, available at: http://www.impi.gob.mx/ICIFRAS/IMPI_en_CIFRAS_ene-mzo_2015.pdf

57 Herzog (1973). Historia de la Expropiación de las Empresas Petroleras. Instituto Mexicano de Investigaciónes Económicas.

58 Tip. Garrido (1939). La expropiación petrolera en México y sus consecuencias económicas: recopilación de artículos de la prensa Mexicana.

to extract more "entropic"[59] resources as evidenced by the decline in hydrocarbon production in the country[60]. Such a scenario calls for allowing private companies, with better technical knowledge, to extract and exploit energy resources as long as they have a minimum percentage of Mexican participation, and providing that PEMEX (Mexican Petroleum) and CFE (Federal Electricity Commission), keep operating as "National Enterprises"[61].

The "myths" used can be summarized in seven points that gather most of the arguments against reforms that sought private participation in the Mexican energy sector[62]:

- Allowing private participation represents "betraying the nation": the argument for such an affirmation, stems from the belief that the reform would compromise energy security and independence by giving private generators the responsibility of provision of the majority of the electricity supply[63]. This idea is wrong because the stability of the grid depends on a balance between supply and demand, and the rules for the electricity market provide for reserve generation that would be ready to feed the grid in case there is an accident or if a generator decides not to provide the agreed power[64], this will be managed by the National Centre for Energy Control in order to ensure the quality and reliability of the grid. This last case is highly unlikely given that this would result in the generator loosing all the revenue associated with the procured output, and possibly the right to sell its output again[65].

- The reform "weakens" the Federal Electricity Commission and therefore reduces the income it provides to the country's finances[66]: This argument is flawed because the fact that this entity is given a "national enterprise" category means that it will no longer have to be subjected to governmental bureaucracy processes or the analysis of each of its projects[67]. The Federal Electricity Commission actions will only serve the purpose of generating profit, which most likely will result in rational investments that can potentially increase the income this entity gives to the country in the long run.[68]

- The reform "hands" Mexican primary resources[69] to international private parties[70]: this is untrue because the constitution clearly states that all the primary resources

[59] Entropy is the measure of unavailability of a system's thermal energy for conversion into mechanical work.

[60] Oil production fell from 3.83 million barrels of crude a day in 2004, to less than 2.8 million in 2013, raising the possibility of Mexico becoming a net importer by the end of the decade. Production of natural gas declined, since peaking at 59.4 Bcm in 2009 in 2013 it amounted to only 56.6 Bcm (although not a dramatic fall, it is still considerable as overall consumption in the country amounts to a substantial 82.7 Bcm of natural gas, making Mexico a significant importer. As evidenced by the next news article: http://www.gastechnews.com/lng/new-energy-era-for-mexico-as-reforms-become-law/

[61] The role of this "National Enterprises" will be described in detail further as it relates to the Federal Electricity Commission given that electricity is the scope of this study.

[62] These myths are framed towards the electricity sector, as this is the focus of this study.

[63] An example of this argument can be found in an article written by former Federal Congressman from the left wing party "Citizen Movement" (Movimiento Ciudadano), Ricardo Mejía, who voted against the energy reform advancing this as one of the main reasons for his vote. The article is available at: http://www.jornada.unam.mx/2013/09/09/politica/002n1pol

[64] Rule 11 of the Rules of the Electricity Market available at: http://www.dof.gob.mx/nota_detalle.php?codigo=5407715&fecha=08/09/2015

[65] Title 4, Chapter 4, Article 131 of the Electric Industry Law (Ley de la Industria Eléctrica).

[66] As evidenced by the next article that showcases the formal opposition from the senators of the "Democratic Revolution Party" (Partido de la Revolución Democratica) against the establishment of the Federal Electricity Commission and Pemex as "National Productive Enterprises". Article available at: http://www.jornada.unam.mx/2014/05/07/politica/008n1pol

[67] Title 1, article 4 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

[68] The role of the Federal Electricity Commission as a national enterprise will be described in detail further.

[69] Primary resources are all the renewable and non-renewable resources used to generate electricity by virtue of conversion of their energy density to useful work.

[70] This is evidenced by the next article, which showcases this argument being used as one of the main oppositions against the secondary laws of the energy reform by the political leaders of the "Democratic Revolution Party" (Partido de la Revolución Democratica) and their representatives in the Senate and the Federal Congress. Article available at: http://www.jornada.unam.mx/ultimas/2014/07/16/reforma-energetica-acelera-la-desaparicion-de-pemex-y-cfe-cardenas-6162.html

associated with generation are property of the country[71]. Private generators are only allowed to exploit primary resources for the benefit of the nation's electricity sector in return for a profit that stems from the sales of the generated output. These generation activities can only be conducted trough a permit that is granted only after determining the pertinence of the proposed project[72]. It is worth mentioning that all the approved projects are subject to the supervision of the National Centre for Energy Control, the Energy Regulatory Commission and the Ministry of Energy to ensure the integrity of Mexican primary resources[73].

- The reform increases corruption in the sector[74]: the argument behind this statement is that private parties would be compelled to bribe government officials to get their projects approved, which could derive in low quality service and high electricity prices. But, there is nothing that suggests that corruption could increase in the new scheme. The fact that the reform brings more participants to the sector potentially increases accountability derived from the colliding interests between the numerous parties involved. On the other hand, absolute control of the electricity service by the government could encourage the possibility of illicit enrichment through inadequate management of projects given the "judge and party dichotomy" previously described.

- The reform allows fracking[75] activities that are harmful for the environment[76]: Every activity surrounding electricity generation or the exploitation of energy resources involves potential harm to the environment. Rejecting prima facie any activity eliminates the possibility of weighting it against all the potential options for acquiring the desired resource. An adequate framework should incentivize and promote decision-making by allowing every possibility to be discussed in order to reach the most beneficial outcome.

- Electricity tariffs will rise[77]: this argument has no foundation whatsoever; in fact the opposite is true. Allowing generation from multiple sources and establishing a wholesale electricity market is most likely to result in decreasing prices given competition between generators[78].

- Only international businesses will benefit from the business associated with electricity provision[79]: this is not true because the secondary laws that accompany the reform provide for the promotion of the national industry by requiring the Ministry of Economy to enact percentages of compulsory Mexican participation in all the activities of the electricity sector[80].

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71 Article 27 of the Mexican Constitution
72 This permits are granted by the Energy Regulatory Commission.
73 Articles 130, 132, and 136 of the Electric Industry Law (Ley de la Industria Eléctrica).
74 As evidenced by the next article that shows the President of the National Regeneration Movement Party (MORENA) advancing this argument against the energy reform. Article available at: http://www.jornada.unam.mx/2013/07/23/politica/005n1pol
75 A well-stimulation technique in which rock is fractured by a hydraulically pressurized liquid to obtain oil and gas.
76 This argument is evidenced by the next article advanced by the National Regeneration Movement Party (MORENA). Article found at: http://regeneracion.mx/defensa-petroleo/la-reforma-energetica-promueve-ecocidio-con-el-fracking/
77 As evidenced by the next article that showcases the use of this argument by the President of the National Regeneration Movement Party (MORENA). Article available at: http://www.la-verdad.com.mx/reforma-energetica-no-baja-luz-cfe-sube-46245.html
78 Paul L. Joskow (2008). Lessons Learned from Electricity Market Liberalization. Page 11. The Energy Journal. Available at: http://economics.mit.edu/files/2093
79 As evidence by the next article that showcases Andres Manuel Lopez (Two times presidential candidate from a coalition of left wing parties) using this argument against the energy reform. Article available at: http://www.proceso.com.mx/?p=377597
80 Title 2, Chapter 9, Article 90 of the Electric Industry Law (Ley de la Industria Eléctrica).

Although these arguments are phrased taking into consideration the particularities of the reform of December 2013, different manifestations of the same ideas have been used against every attempt to reform the sector over the course of 15 years[81].

The first organized attempt to conduct a structural energy reform was promoted by President Ernesto Zedillo (1994-2000), who in 1999 sent a proposal to the Senate aimed at reforming the constitution to privatize the electricity sector by selling all the assets of the Federal Electricity Commission to private parties. The proposal was rejected in the Senate by an organized opposition from rival parties ("Partido Accion Nacional" and "Partido de la Revolucion Democratica")[82].

After President Zedillo, President Vicente Fox (2000-2006), proposed a reform, motivated mainly in response to an opinion of the Mexican Supreme Court regarding an amendment to the regulation of the "Electric Power Utility Law"[83]. The Court indicated, among other things, that the constitutional grounds for the allowance of private participation in the electricity sector should be clarified, given that the enactment of regulation that allowed private parties to generate electricity for public service "masked" as generation for self-supply and cogeneration, directly violated the constitution which mandated that generation for public service be conducted exclusively by the state. Furthermore, in its opinion, the court invited Congress to consider whether the constitutional provisions regarding the electric power state monopoly have become questionable, given the current economic and political situation of the country. President Fox's reform focused only in the electricity sector aiming at allowing private participation for public service provision without dismantling the Federal Electricity Commission. Although the President managed to get the support of part of the "Revolucionario Institucional" party, the other part allied with the "Partido de la Revolucion Democratica" and prevented the advancement of this reform[84].

The last failed attempt was conducted by President Felipe Calderon (2006-2012) who proposed an integral reform that allowed, among other things, the contracting of PEMEX (Mexican Petrol Agency) with private parties to build and operate new refineries in order to reduce dependence on the import of gasoline. President Calderon had to settle in return with the approval of a really light energy reform that addressed only oil production and exploration by private parties, leaving the electricity sector completely untouched[85].

But nothing serves better to finally overcome the "myths", than the negative effects of stagnation in the energy sector. Oil production fell from 3.83 million barrels of crude a day in 2004, to less than 2.8 million in 2013, raising the possibility of Mexico becoming a net importer by the end of the decade. Production of natural gas declined, since peaking at 59.4 Bcm[86] in 2009. In 2013 it amounted to only 56.6 Bcm, although not a dramatic fall, it is still considerable as overall consumption in the country amounts to a substantial 82.7 Bcm of natural gas, making Mexico a significant importer[87]. The lack of competition in

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[81] An example of this is the next article that summarizes the main arguments against the energy reform proposed by President Calderon in 2008. The main argument advanced is that allowing private participation in the energy sector would only benefit international participants, and hinder the independence of the state energy companies (PEMEX and CFE). Article available at: http://tecamachalco.net/10-razones-por-las-cuales-rechazamos-la-reforma-energetica.html#.VhgA0rcyEvs

[82] As evidenced by the next article that explains these events. http://www.sinembargo.mx/20-06-2013/660436

[83] File 22/2001 of the Mexican Supreme Court of Justice, available at: http://biblio.juridicas.unam.mx/libros/4/1730/7.pdf

[84] As evidenced by the next article that explain these events. http://noroeste.com.mx/publicaciones.php?id=876607

[85] As evidenced by the next article, which summarizes the particularities of Calderon's reform. http://www.cnnexpansion.com/economia/2012/07/03/la-reforma-energetica

[86] Billion Cubic Meters.

[87] http://www.gastechnews.com/lng/new-energy-era-for-mexico-as-reforms-become-law/

electricity generation caused high costs, having tariffs up to 25% more costly than in the US[88]. The Mexican grid growth rate (1.1% a year) could not follow the yearly growth of demand, which is estimated at 4.1% a year[89]. Transmission was being served in 47% by lines that are older than 20 years, with just 8% of the lines being built in the last 5 years[90]. Apart from this, electricity distribution losses were documented at around 15% per year, at almost double of the OCDE standards[91].

The effects of this struggle set the stage for the December 2013 constitutional reform, which after being sent by President Enrique Peña to the Senate, made its way through the legislative process due to the fact that the "Revolucionario Institucional" party exercised the majority in both the Senate and the Federal Congress. This majority gave the "Revolucionario Institucional" party enough leverage to reach agreements with other political forces, finally consolidating the efforts constantly attempted since 1999[92].

## 1. The Present

### 2.1. Organizational Structure

Under the framework established by the constitutional reform of December 2013 and its accompanying secondary laws, the categories of public service are no longer reserved to the Federal Electricity Commission as an agent of the Federal Government[93]. Private parties can conduct generation and sales in an unrestricted access environment[94], following the rules of the market[95]. Although transmission and distribution are still theoretically exclusive faculties of the Federal Government[96], the laws allow contracting with private parties to carry out activities of financing, operation, maintenance and infrastructure development for the provision of these services[97]. The activities of the electricity sector are to be carried through the wholesale electricity market in which all the services associated with generation and provision are to be traded under the management of the National Centre for Energy Control[98], which used to be under the Federal Electricity Commission structure, but has now been granted independence[99]. The Federal Electricity Commission on the other hand, has been transformed into a "National Productive Enterprise", a new category that gives flexibility to this entity and allows it to direct operations as a market participant focused on maximizing income[100].

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88 http://www.wsj.com/articles/SB10001424127887324085304579010993985696728

89 Information provided by the Mexican Presidency through the "Electric Industry Law" decree project, (Page 4). Available at: http://cdn.reformaenergetica.gob.mx/2-ley-de-la-industria-electrica.pdf

90 Information provided by the Mexican Presidency through the "Electric Industry Law" decree project (Page 5). Available at: http://cdn.reformaenergetica.gob.mx/2-ley-de-la-industria-electrica.pdf

91 Information provided by the Mexican Presidency through the "Electric Industry Law" decree project (Page 5). Available at: http://cdn.reformaenergetica.gob.mx/2-ley-de-la-industria-electrica.pdf

92 As evidenced by the next article: http://www.cnnexpansion.com/economia/2013/12/12/diputados-aprueban-reforma-energetica

93 Articles 25, 27, and 28 of the Mexican Constitution.

94 With the exception of nuclear generation and sales which are reserved for the Federal Electricity Commission as an agent of Federal Government, as provided by article 28 of the Mexican Constitution.

95 As long as they acquire the required permits from the Energy Regulatory Commission and sign the "market participant contract" in which they manifest that they will abide by the rules of the market set by this Regulatory Commission, as provided by Title 3, Chapter 1, Article 98 of the Electric Industry Law (Ley de la Industria Eléctrica).

96 There is a strict prohibition to grant licenses or any type of administrative concessions in these areas, although the constitution text allows private parties to conduct these activities by virtue of contract and in the name of the Federal Government, as provided by article 28 of the Mexican Constitution.

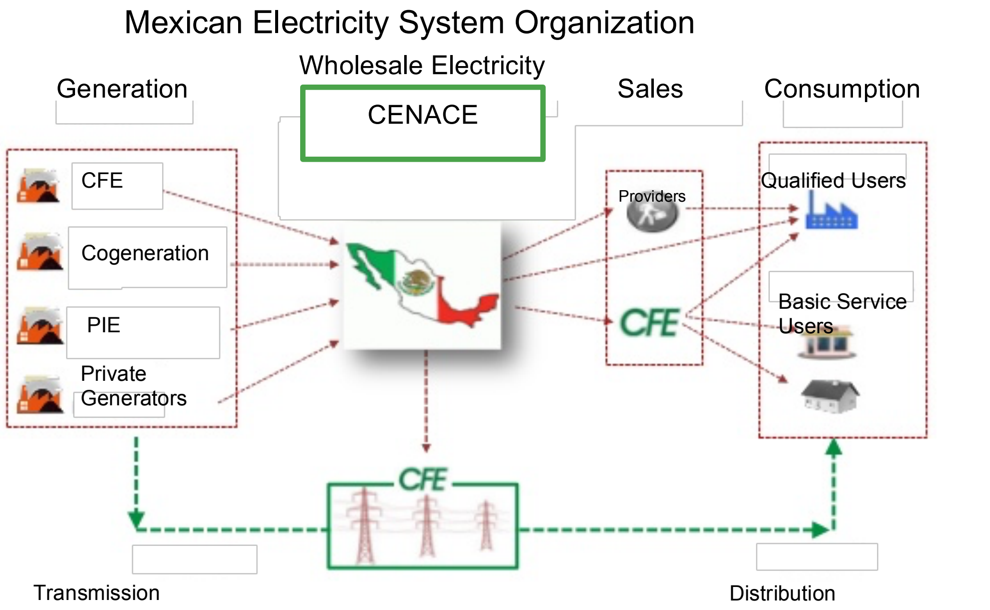
97 Title 4, article 57 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

98 Title 3, Chapter 1, Article 94 of the Electric Industry Law (Ley de la Industria Eléctrica).

99 By establishing it as a public decentralized agency through Title 3, Chapter 2, Article 107 of the Electric Industry Law (Ley de la Industria Eléctrica). It is vested with independence in its decisions and the management of its assigned budget.

100 The role of the Federal Electricity Commission as a National Productive Enterprise will be discussed in detail in a further section.

The following diagram illustrates the organizational structure of the Mexican Electricity System and the relationship between its participants:




- CFE (Federal Electricity Commission) generates using state-owned power plants.
- PIE (Independent power producers) are contracted by CFE which purchases all their output to further conduct dealings with it.
- Cogenerators can participate directly in the market.
- Private Generators participate directly in the wholesale electricity market.
- CENACE (National Centre for Energy Control) operates the wholesale electricity market.
- CFE transmits and distributes all the electricity.
- Qualified Users (users with input requirements over 3MW), can participate directly in the wholesale electricity market to purchase their power.
- Basic Service Users (users with input requirements under 3 MW) are to be serviced by CFE.
- Providers are electricity brokers that sale power to qualified users that do not want to participate directly in the wholesale electricity market, (they compete for these customers with CFE).

## 2.2. Authorities and Their Main Powers

The Ministry of Energy is the government agency in charge of planning and managing the country's energy policy. Given this purpose, the Ministry is required to coordinate the efforts of all the authorities of the electricity sector and provide oversight of all activities within it[102].

The Energy Regulatory Commission is the government agency that concentrates most of the powers regarding the electricity system operation. The laws provide for this agency to be in charge of[103]:

- Permitting within the electricity sector for activities of generation, transmission, distribution and sales.

[101] Source: http://reformas.gob.mx/wp-content/uploads/2014/04/Explicacion_ampliada_de_la_Reforma_Energetica1.pdf page 24
[102] Title 1, Chapter 2, Article 11 of the Electric Industry Law (Ley de la Industria Eléctrica).
[103] Title 1, Chapter 2, Article 12 of the Electric Industry Law (Ley de la Industria Eléctrica).

- Enacting the methodologies to calculate transmission and distribution tariffs.
- Drafting the rules of the wholesale electricity market with the opinion of the Ministry of Energy.
- Supervising the wholesale electricity market activities to ensure its adequate operation.
- Distribution of renewable generation certificates [104] and verification of compliance by the obligated parties.
- Drafting and enacting regulations that promote renewable energy generation, energy efficiency standards, and reliability of the grid, following the policy goals set by the Ministry of Energy in these areas.
- Review the National Centre for Energy Control proposals for the expansion and modernization of transmission and distribution lines.
- Solving disputes that arise between the National Centre for Energy Control and the participants of the wholesale electricity market.
- Providing the terms to ensure legal separation between activities of the electricity sector, in order to prohibit concentration that could potentially develop into market control or pricing manipulation.

The National Centre for Energy Control is established as a "public decentralized agency"[105], and is granted the responsibility of controlling the national electricity system in order to ensure its quality and reliability. This agency is in charge of conducting the operation of the wholesale electricity market providing unrestricted access to all participants, thus having the possibility to contract with private parties that can provide auxiliary services for the achievement of this task[106]. Apart from this, the National Centre for Energy Control has the duty of planning the expansion and modernization of transmission and distribution lines[107], currently there are plans to build the first "smart"[108] transmission line to be named "Direct Current Transmission Line Tehuantepec-Mexico" and following the same scheme, the "Alternate Current Transmission Line Playacar-Chakanaab"[109].

As for the Ministry of Finance and Public Credit, this agency is in charge of setting the tariffs for the provision of basic service[110] in order to warrant price stability for residential and low consumption customers[111].

[104] These certificates represent an amount of electricity that has been generated from renewable sources. The particularities of these certificates will be explained further in this document.
[105] An agency that is formed by virtue of law or presidential decree to provide certain services for which its granted independence in its decisions and the management of its assigned budget. As provided by Title 3, Chapter 2, Article 110 of the Electric Industry Law (Ley de la Industria Eléctrica), CENACE's administration committee and its General Direction have complete autonomy in the decisions and operations of this agency.
[106] Title 2, Chapter 1, Article 15 of the Electric Industry Law (Ley de la Industria Eléctrica).
[107] Title 2, Chapter 1, Article 14 of the Electric Industry Law (Ley de la Industria Eléctrica).
[108] According to the Office of Electricity Delivery and Energy Reliability of the U.S. Department of Energy, smart grids include adding two-way digital communication technology to devices associated with the grid. Each device on the network can be given sensors to gather data (power meters, voltage sensors, fault detectors, etc.), plus two-way digital communication between the device in the field and the utility's network operations center. A key feature of the smart grid is automation technology that lets the controller adjust and control each individual device or millions of devices from a central location. This information can be consulted at: http://energy.gov/oe/services/technology-development/smart-grid
[109] The particularities of these projects can be found at: http://sener.gob.mx/res/index/Proyectos%20y%20Obras%20Transmisi%C3%B3n.pdf
[110] Service provided to customers with input requirements of less than 3 MW.
[111] Title 3, Chapter 6, Article 139 of the Electric Industry Law (Ley de la Industria Eléctrica), and article 33 of the Organic Law of the Federal Public Administration (Ley Orgánica de la Administración Pública Federal).

## 2.3. The Federal Electricity Commission as a "National Productive Enterprise"

The secondary laws that followed the enactment of the reform of December 2013 transformed the Federal Electricity Commission in what is referred to as a "National Productive Enterprise". This entity is granted a special regime drafted with the goal of reducing the Ministry's intervention in the Federal Electricity Commission dealings allowing it to conduct its operations focusing on maximizing its income.

To achieve this goal, the present framework has changed the role of the Federal Government in regards to the Federal Electricity Commission operations. Under the current regime, the Federal Government has gone from being the general manager of the Federal Electricity Commission to become its sole shareholder[112]. The Federal Electricity Commission is therefore, no longer submitted to the "legality principle"[113] in which their activities could only follow what the laws specifically provided. Nowadays this enterprise can conduct its dealings following the decisions of its administration committee and private law stipulations[114].

The administration committee, which is the maximum authority of this entity, is formed by the Minister of Energy (who chairs the committee), the Minister of Finance and Public Credit, three members designated directly by the Federal Government through the President, four "independent" members proposed by the President and approved by the Senate, and one member designated by the employees of the Federal Electricity Commission[115].

Under its special regime, the Federal Electricity Commission is allowed to conduct generation and sales through affiliated companies in which it owns at least 50% of the share capital[116]. As for transmission and distribution services, they have to be provided by entities called "National Productive Subsidiary Companies" which have to be owned and managed in total by the Federal Electricity Commission as an agent of the Federal Government[117]. Despite this, the Federal Electricity Commission has the possibility of contracting with private parties for the conduction of certain activities, pertaining to the provision of transmission and distribution services, mainly: financing, installation, expansion, maintenance and operation[118]. It is worth noting that, as any other market participant, the Federal Electricity Commission is required to have strict legal separation between activities of different nature within the electricity sector[119], by dividing its operations in three "business units" that are to have no interaction with one another, these units are: generation, transmission, and distribution[120].

The Federal Electricity Commission will provide basic electricity service to residential customers, low consuming commercial customers and industrial customers with

[112] Title 1, article 4 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[113] This principle limits the operations of public agencies, which cannot do anything that is not explicitly mandated to them by virtue of law.
[114] Before, this agency was obligated to follow what was specifically mandated in the law regardless of any economic or technical considerations. Nowadays this agency will only be subjected to private law stipulations, as such, it is no longer submitted to the "legality principle" meaning that now this agency can operate freely following only what its administration committee decides, as a private company, with the goal of maximizing profit. Title 1, article 3 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[115] Title 2, article 14 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[116] Title 4, article 57, and article 59 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[117] Title 4, article 57 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[118] Title 4, article 63 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[119] Title 2, article 10 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[120] Chapter 7 Article 11 of the Internal Rules of the Ministry of Energy (Reglamento Interior de la Secretaria de Energía)

input requirements of less than 3 MW of electricity in the first stage of implementation, this 3 MW input demand requirement is programed to be ratchet down throughout a 2-year period until it falls to 1 MW. For the provision of customers whose required input surpasses the 3 MW threshold, the Federal Electricity Commission will have to compete in the wholesale electricity market with other registered providers[121].

The new regime of the Federal Electricity Commission allows for private participation in all of its activities without losing the possibility by the Federal Government of accessing profits that the electricity business provides. This is true given the fact that each year the Federal Electricity Commission is required to hand to the Federal Government a dividend reflective of their financial statements[122], which is determined by the Ministry of Finance and Public Credit[123].

### 2.4. The Wholesale Electricity Market

The wholesale electricity market is where generators, providers, and qualified users converge for the trade of electricity and its ancillary services under the control and supervision of the National Centre for Energy Control.

Only "qualified users" can participate directly in the market to purchase their electricity needs[124]. The main prerequisite to become a qualified user is having an input demand of 3 MW or more[125]. These users are required to register with the Energy Regulatory Commission in order to conduct dealings directly in the wholesale electricity market[126]. They also have the possibility of purchasing their input needs from an independent provider, or the Federal Electricity Commission, if they choose not to participate directly[127].

Generators, providers, and qualified users are allowed to start their dealings only after they sign the "market participant contract" in which they manifest that they will abide by the rules of the market[128] set by the Energy Regulatory Commission, and after they submit a sum of money as a guarantee for the dealings they plan to conduct[129].

In regards to generators, they are also required to undertake a permitting process that requires from them an environmental and social impact assessment containing the analysis of every potential impact and the measures that will be taken to mitigate them. In addition to this, they have to disclose all the details pertaining to the project, mainly, the specifics of the generation activity to be conducted, the geographical area to be occupied, the business plan that will be followed and the plans to access interconnection and transmission services. Moreover, solicitants are required to provide evidence of their technical and financial capabilities to undertake the proposed project. When deciding about

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121 Title 3, Chapter 1, Article 94 of the Electric Industry Law (Ley de la Industria Eléctrica).

122 The Federal Government as sole shareholder receives the profit that it is determined after subtracting all the costs from the revenue amount that this enterprise generates, and all other investment costs according to the plans and projects that the Federal Electricity Commission has for the next 5 years in order to increase its profits. Title 4, Chapter 6, article 99 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad). The companies that work in collaboration with the Federal Electricity Commission through contracts are paid the agreed sums according to its contracts.

123 Title 4, article 98 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

124 Title 4, article 98 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

125 This is provided in the transitory dispositions of the Law of the Electric Industry. The 3 MW input demand requirement is programed to be ratchet down throughout a 2-year period until it falls to 1 MW.

126 Title 2, Chapter 5, Article 59 of the Electric Industry Law (Ley de la Industria Eléctrica).

127 Title 2, Chapter 5, Article 61 of the Electric Industry Law (Ley de la Industria Eléctrica).

128 These rules are available at: http://cenace.gob.mx/Docs/MarcoRegulatorio/ReglasMercado/Bases%20del%20Mercado%20El%C3%A9ctrico%20Acdo%20Sener%20DOF%202015-09-08.pdf

129 Title 3, Chapter 1, Article 98 of the Electric Industry Law (Ley de la Industria Eléctrica).

the pertinence of the proposed project, the Energy Regulatory Commission will analyze the technical viability of the project and the capabilities of the solicitants in order to approve or deny a permit[130].

There are two different mechanisms through which dealings can be conducted in the wholesale electricity market: by virtue of contract between parties with supervision of the National Centre for Energy Control[131], or through the "spot prices" mechanism, in which generators offer their total output to the market, and in turn, independent providers, the Federal Electricity Commission, and qualified users disclose their required demand[132]. Under this last scheme, the National Centre for Energy Control determines short-term spot prices[133] selecting the lower offerings by the generators[134] to supply the required demand.

### 2.5. Transmission and Distribution

Transmitters and distributers are responsible for the national grid, which they are required to manage according to the National Centre for Energy Control instructions and following the general rules set by the Energy Regulatory Commission to ensure quality and reliability of the system[135].

As described before, these services can only be provided through "National Productive Subsidiary Companies" which are owned and managed in total by the Federal Electricity Commission who is able to contract with private parties for the conduct of certain activities[136]. It is worth mentioning that these private parties have joint responsibility in every project they undertake[137], therefore they will be held liable, within the scope of their contract, of any action or inaction that jeopardizes transmission and distribution activities.

Every modernization or expansion project has to be conducted directly by these "National Productive Subsidiary Companies" or its contracted parties, following the instructions set forth by the Ministry of Energy[138] through the "Program for Development of the National Electric System"[139]. Both, transmission and distribution services are considered "high priority"[140], and therefore the construction of the required lines outweighs any property rights of the required land regardless of the recipient[141].

Transmitters and distributers are required to provide these services to any applicant as long as it is technically feasible. In cases where this is not possible given budgetary constraints, solicitors can provide the required resources in order to have access to the needed infrastructure[142].

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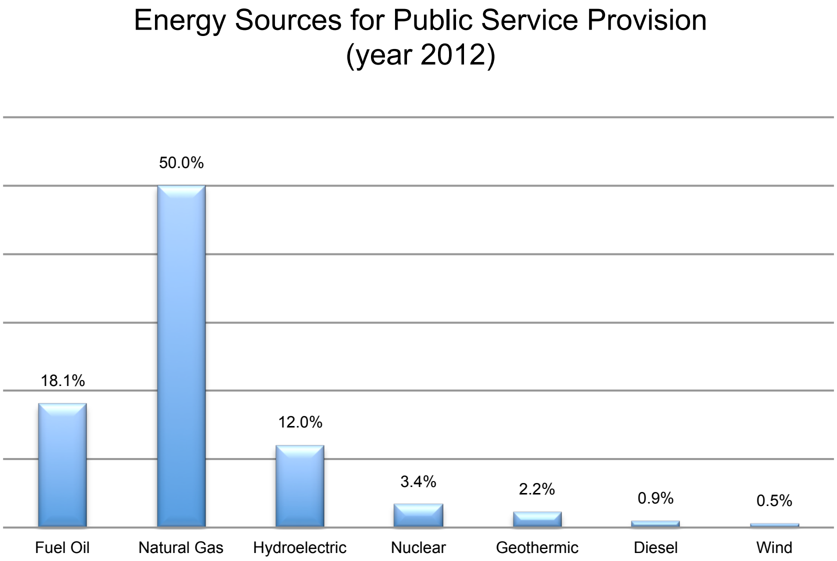
130 Title 4, Chapter 4, Article 130 of the Electric Industry Law (Ley de la Industria Eléctrica).
131 Title 3, Chapter 1, Article 97 of the Electric Industry Law (Ley de la Industria Eléctrica).
132 Title 3, Chapter 1, Article 104 of the Electric Industry Law (Ley de la Industria Eléctrica).
133 The explicit value of the commodity at any given time in the wholesale market.
134 Generators submit their price offers based on all their incurred costs to produce electricity. To prevent cost manipulation, the National Centre for Energy Control reviews all the offers.
135 Title 2, Chapter 3, Article 26 of the Electric Industry Law (Ley de la Industria Eléctrica).
136 Mainly: financing, installation, expansion, maintenance and operation.
137 Title 2, Chapter 3, Article 30 of the Electric Industry Law (Ley de la Industria Eléctrica).
138 Title 2, Chapter 3, Article 29 of the Electric Industry Law (Ley de la Industria Eléctrica).
139 Available at: http://sener.gob.mx/portal/Default_intermedia.aspx?id=3222
140 Title 2, Chapter 3, Article 42 of the Electric Industry Law (Ley de la Industria Eléctrica).
141 For the settlement of controversies that rise regarding this issue the laws provide for a process to assess proper payment in return for the use or expropriation of property.
142 Title 2, Chapter 3, Article 35 of the Electric Industry Law (Ley de la Industria Eléctrica).

2.6. Public Service Sources and First Policy Efforts Towards Diversification

The data available before the Constitutional reform of December 2013 shows that the nominal energy generation for public service provision in the Mexican Electricity System was conformed as follows:



[143]

The secondary energy laws that followed the approval of the initial Constitutional reform provide the grounds for the implementation of policies aimed at diversification of energy sources for electricity generation.

In terms of renewable energy, the laws establish a requirement to acquire tradable "Clean Energy Certificates" to whoever purchases energy in the wholesale electricity market[144]. These certificates represent an amount of electricity that has been generated from renewable sources. Generators that produce clean energy are granted a clean energy certificate for every MWH of output, which they are then able to sell to any interested party through a business transaction[145]. The quantity of certificates that an electricity purchaser[146] holds must be enough to guarantee that a certain percentage, established yearly[147] by the Ministry of energy, has been met[148]. To determine the overall goal, that is, the percentage to be required throughout the year, the Ministry will plot numerous scenarios, a "Business as Usual" reference that allows for an analysis of industry behavior without any changes in the clean energy certificates requirement, plus different scenarios of increments to compare and determine which will be the "optimal"[149] one to achieve the goals traced for renewable energy penetration[150]. The Energy Regulatory Commission is in charge of the "Clean Energy Certificates" allocation and must build and maintain a registry of them.[151]

[143] This chart was constructed with information made available by the Mexican Ministry of Energy http://sener.gob.mx/res/PE_y_DT/pub/2013/Prospectiva_del_Sector_Electrico_2013-2027.pdf (Page 93).
[144] Title 4, Chapter 3, Article 122 of the Electric Industry Law (Ley de la Industria Eléctrica).
[145] Section 2 of the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition" (Lineamientos para el Otorgamiento de Certificados de Energías Limpias y los Requisitos para su Adquisición).
[146] Purchasers of electricity in the wholesale electricity market, mainly, the Federal Electricity Commission and qualified users.
[147] As a transitory measure provided in the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition", the required percentage of acquisition of clean energy for 2016 and 2017 will be zero.
[148] Only the last proprietor of the certificates can account them towards the percentage requirement.
[149] There is no provision that explains what factors will be considered when determining which scenario is "optimal" to achieve the goals.
[150] Section 3 of the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition" (Lineamientos para el Otorgamiento de Certificados de Energías Limpias y los Requisitos para su Adquisición.
[151] Title 4, Chapter 3, Article 126 of the Electric Industry Law (Ley de la Industria Eléctrica).

Given its particular characteristics, a specific geothermal energy law was enacted. This law takes into consideration the fact that geothermal generation involves major investment in 3 main stages: surveying, exploration and exploitation, with each of these stages having particular embedded risks[152]. The higher risks are present in the surveying and exploration stages, which require the commitment of major resources without having any certainty of finding the resource, or that the found resource will have the required characteristics to generate enough output to justify the initial investment[153].

Surveying permits are to be granted to Mexican individuals and private entities constituted under Mexican legal provisions, as long as they have the required technical resources to conduct these activities[154]. The main purpose of this stage is to determine by conducting geological studies, if certain bodies of land contain this resource. With the purpose of promoting surveying activities, the required permit has a special process that takes no longer than 10 days to be granted from the initial date of filing[155]. This permit is granted for an 8-month period, at the end of which the permit holder can expose the evidence gathered to the Ministry in order to be considered for an exploration permit[156].

Exploration permits last three years with the possibility of extending them for three extra years after the first period expires[157]. This stage focuses on analyzing the particular characteristics of geothermic well's contents, in the specific body of land as determined in the surveying stage. The analysis focuses on the generation potential of the wells, and the technical feasibility of conducting a major project. After this works is done, the law provides for the possibility of granting of an exploitation concession to the parties that developed surveying and exploration activities as the main incentive to conduct these risky endeavors[158]. This permit lasts 30 years and can be renewed according to the Ministry's best judgment[159].

As for Research and Development, a policy effort made by the Ministry of Energy in cooperation with the National Council of Sciences and Technology (CONACYT) created a special entity named The Mexican Center of Innovation (CEMIE). This entity constitutes a National project in which resources are being allocated both from the government and from private parties[160] to promote coordination between academic institutions, research centers, companies and organizations. The goal is to develop value chains within the energy sector, promote technology development, and provide specialized training of human resources with the purpose of creating business and employment opportunities[161]. A call for proposals to become a CEMIE was advanced by the National Council of Sciences in collaboration with the Ministry of Energy, which was then answered by many research centers[162] in the country through the submission of strategic plans and

152 Provided throughout Title 1, Chapter 2 of the Law of Geothermal Energy (Ley de Energía Geotérmica).

153 As evidenced by the next article from Bloomberg Energy, which proposes a global fund to de-risk exploration drilling in order to promote geothermal energy development. Article available at: http://about.bnef.com/white-papers/a-global-fund-to-de-risk-exploration-drilling-possibility-or-pipe-dream/

154 Title 1, Chapter 2, Article 8 of the Law of Geothermal Energy (Ley de Energía Geotérmica).

155 Title 1, Chapter 2, Article 9 of the Law of Geothermal Energy (Ley de Energía Geotérmica).

156 Title 1, Chapter 2, Article 10 of the Law of Geothermal Energy (Ley de Energía Geotérmica).

157 Title 1, Chapter 2, Article 17 of the Law of Geothermal Energy (Ley de Energía Geotérmica).

158 Title 1, Chapter 2, Article 21 of the Law of Geothermal Energy (Ley de Energía Geotérmica).

159 Title 1, Chapter 2, Article 26 of the Law of Geothermal Energy (Ley de Energía Geotérmica). So far nothing has been established in regards to the rationale that the ministry will follow when analyzing permit renewals.

160 1,627.8 million pesos from the government and 340.45 million pesos from private investment. As provided by the next report from the Ministry of Energy: http://sustentabilidad.energia.gob.mx/res/CEMIE_General.pdf

161 The particularities of the process and motivation behind the establishment of these centers, can be consulted at: http://sustentabilidad.energia.gob.mx/res/CEMIE_General.pdf

162 These proposals were answered by research centers that grouped numerous education institutions, companies, and different state government agencies.

projects proposals, to be carried out if selected. Finally in February 2014, the winning proposals were selected, and three specialized centers of this nature were created, the Mexican Center of Innovation of Geothermal Energy, the Mexican Center of Innovation of Solar Energy, and the Mexican Center of Innovation of Wind Energy[163]. Each of these centers has been assigned a portion of the overall available budget to carry out their proposed projects, which vary depending on the particular CEMIE[164].

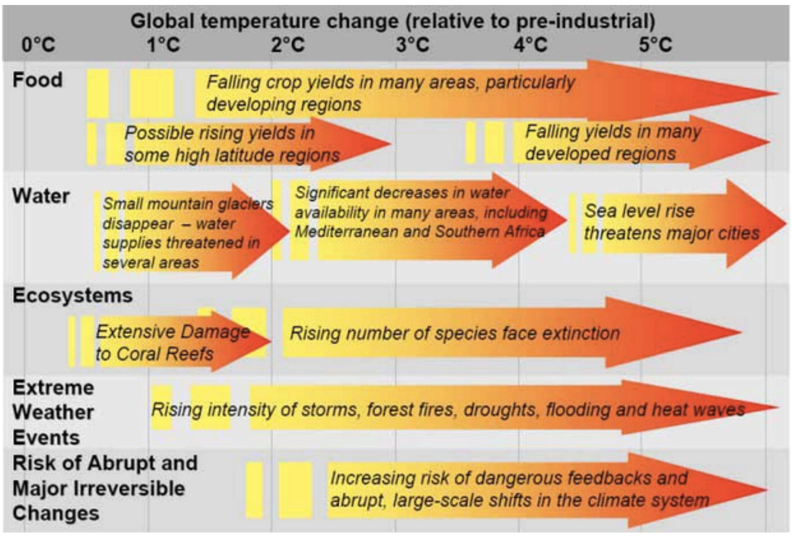
## 2. Opportunities for the Future

### 3.1. Diversification of Electricity Sources to Abate Climate Change and Spur Economic Development.

The Intergovernmental Panel on Climate Change concluded in 2007[165] that climate change is a reality and that there is over 90% probability that it is being caused mainly by human activities, primarily the emission of greenhouse gases[166] and the clearing of natural vegetation.

While there is no agreement on what levels of earth warming could be defined as "dangerous", support has developed towards keeping the rise in global temperature to a maximum of 2 degrees Celsius above pre-industrial levels[167].

As the following diagram suggests, even by containing temperature within these levels, significant adverse impacts would arise:



[168]

[163] http://eleconomista.com.mx/entretenimiento/2014/03/12/energias-renovables-rumbo-mexico
[164] The specific projects of this CEMIEs can be consulted at: http://www.cemiegeo.org/index.php/ProjInvest?id=2 , http://evaluarer.iie.org.mx:8080/cemie/Proyectos , http://sustentabilidad.energia.gob.mx/res/CEMIE_Sol.pdf

[165] IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.
[166] A greenhouse gas is any gaseous compound in the atmosphere that is capable of absorbing infrared radiation thereby trapping and holding heat in the atmosphere.
[167] Copenhagen Accord, 15th session of the Conference of the Parties to the UNFCCC and the 5th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol.
[168] Source: The Stern Review on the Economics of Climate Change, 2006, which can be found at: http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf

Although some communities could engage in pro-active adaptation strategies to cope with some of the impacts derived from a temperature rise of 2 degree Celsius, beyond this threshold, the possibilities of adaptation rapidly decline with an increasing risk on social disruption through health impacts, water shortages and food insecurity[169].

The Intergovernmental Panel on Climate Change estimated the level of atmospheric concentrations of greenhouse gases at which the global temperature would be contained within various ranges and constructed the next table that summarizes this information:

| Category | $CO_2$ concentration at stabilisation (2005 = 379 ppm) [b] | $CO_2$-equivalent concentration at stabilisation including GHGs and aerosols (2005 = 375 ppm)[b] | Peaking year for CO2 emissions[a,c] | Change in global $CO_2$ emissions in 2050 (percent of 2000 emissions) [a,c] | Global average temperature increase above pre-industrial at equilibrium, using 'best estimate' climate sensitivity[d, e] |
|---|---|---|---|---|---|
| | ppm | ppm | year | percent | °C |
| I | 350 – 400 | 445 – 490 | 2000 – 2015 | -85 to -50 | 2.0 – 2.4 |
| II | 400 – 440 | 490 – 535 | 2000 – 2020 | -60 to -30 | 2.4 – 2.8 |
| III | 440 – 485 | 535 – 590 | 2010 – 2030 | -30 to +5 | 2.8 – 3.2 |
| IV | 485 – 570 | 590 – 710 | 2020 – 2060 | +10 to +60 | 3.2 – 4.0 |
| V | 570 – 660 | 710 – 855 | 2050 – 2080 | +25 to +85 | 4.0 – 4.9 |
| VI | 660 – 790 | 855 – 1130 | 2060 – 2090 | +90 to +140 | 4.9 – 6.1 |

[170]

The concentrations are given both in $CO_2$ (Carbon Dioxide) and $CO_2$-equivalents[171]. $CO_2$-equivalents include the combined warming effects of $CO_2$ and non-$CO_2$ greenhouse gases (excluding water vapor), allowing for the expression of greenhouse gases as a single number, which eases the comparison between different bundles of GHGs.

As this table suggests, $CO_2$ is the greenhouse gas of primary concern, because although it does not have the higher warming potential, it is the most concentrated greenhouse gas in the atmosphere given its long life span[172].

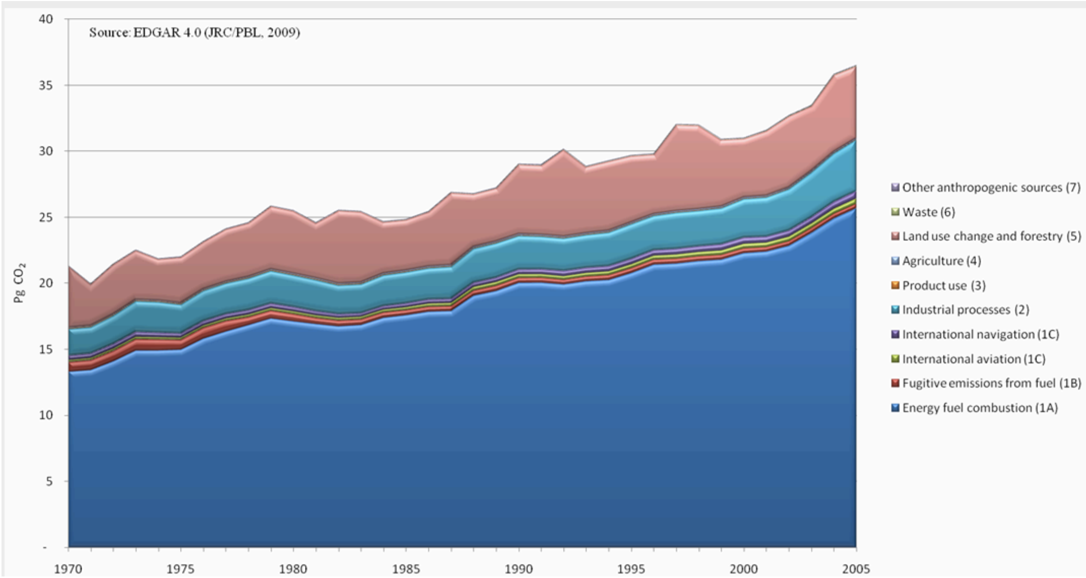
The next graph shows the main sources of Carbon Dioxide emissions in the world.

169 Climate change and human health RISKS AND RESPONSES. World Health Organization, 2003. Available at: http://www.who.int/globalchange/publications/climchange.pdf

170 Source: IPCC Fourth Assessment Report: Climate Change 2007 which can be found at: http://www.ipcc.ch/publications_and_data/ar4/syr/en/mains5-4.html

171 CO2e, or carbon dioxide equivalent, is a standard unit for measuring carbon footprints. It expresses the impact of each different greenhouse gas in terms of the amount of CO2 that would create the same amount of warming. That way, a carbon footprint consisting of lots of different greenhouse gases can be expressed as a single number.

172 Once this gas is emitted it can remain in the atmosphere for over 100 years.




[173]

As we can see the most $CO_2$ intensive human activity is the combustion of fossil fuels for energy purposes. Therefore, a reduction of human emissions of greenhouse gases to the level necessary to stay within the 2 Degree Celsius range cannot happen unless a large percentage of societal energy demands are met by non-fossil fuel sources.

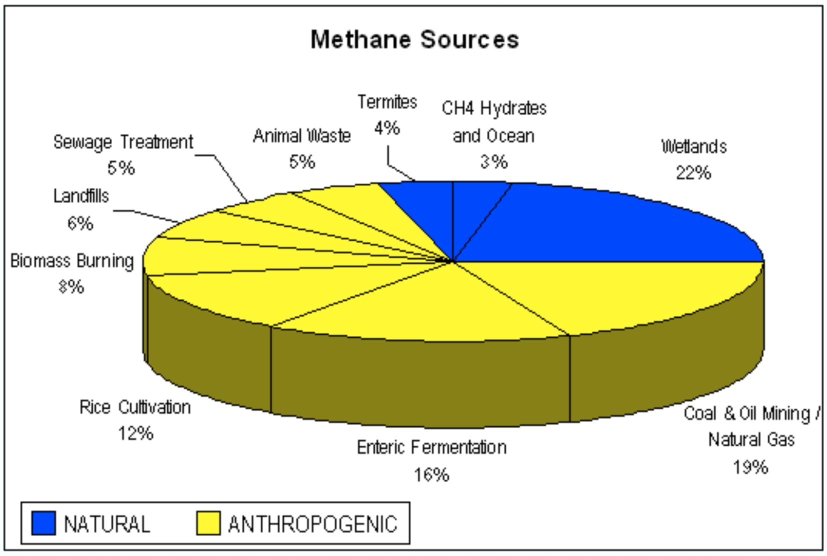
Moreover, methane emissions, which are also associated with the fossil fuel generation industry, should also be acknowledged given that while methane does not stay as long in the atmosphere as carbon dioxide, it is initially far more dangerous to the climate because of how effectively it absorbs heat. In the first two decades after its release, methane is 84 times more potent than carbon dioxide[174]. As such, both types of emissions must be addressed if we want to effectively reduce the impact of climate change.

As the next graph showcases, methane is mainly emitted to the atmosphere through leaks during fossil fuel operations[175], therefore reducing reliance of fossil fuel generation by promoting renewable energy development can be a powerful strategy to mitigate climate change by reducing both $CO_2$ and Methane emissions.

[173] Source: Emission Data Base for Global Atmospheric Research, European Commission, which can be found at: http://edgar.jrc.ec.europa.eu/part_CO2.php

[174] Washington State University. Natural Gas Methane Study. Overview. Available at: https://methane.wsu.edu/program-overview/

[175] Methane Leakage from Natural Gas Production Could Be Higher Than Previously Estimated. Scientific American Blog. Available at: http://blogs.scientificamerican.com/plugged-in/methane-leakage-from-natural-gas-supply-chain-could-be-higher-than-previously-estimated/



[176]

Many renewable energy technologies that can contribute towards decarbonizing the world's economy have been under development in recent years, therefore, although there is no single technology that can replace fossil fuels in their totality, a mix of technologies can allow different countries to meet their own needs[177]. This, given that technologies are already available that, in combination with changes on the demand side (reduced energy usage and improved energy efficiency), give the potential to achieve a 50% greenhouse gas emission reduction by 2050[178].

Given that Mexico relies heavily in fossil fuels for the satisfaction of its energy requirements and that these fuels are a crucial component of Mexico's economy[179], energy related carbon emissions in this country have been growing over the past years[180].

In addition to mitigating climate change and its impacts thereof, promoting the diversification of energy sources make economic sense. This because the deployment of clean technologies has proven to spur economic development through job creation and local economic stimulation. In 2013, 6.5 million people in the world were employed by the renewable energy industry[181]; this industry has a higher potential for job creation than fossil fuels. The next table shows the extent of direct and indirect job creation generated by $1 million in expenditures on alternative energy sources and energy efficiency measures in comparison with fossil fuels in the U.S.

[176] Nasa (2010). Global Methane Inventory. Available at: http://icp.giss.nasa.gov/education/methane/intro/cycle.html
[177] Executive Summary of the World Energy Outlook 2012 which can be found at: http://www.iea.org/publications/freepublications/publication/english.pdf
[178] Fifth Assessment Report (AR5), of the Intergovernmental Panel on Climate Change, which can be found at: http://www.ipcc.ch/.
[179] U.S. Energy Information Administration analysis of Mexico which can be found at: http://www.eia.gov/countries/cab.cfm?fips=mx
[180] According to the most recent available data provided by the United States Energy Information Administration, Mexico's energy related emissions were around 454 million metric tons per year as of 2012. http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90&pid=44&aid=8
[181] Number provided by the International Renewable Energy Agency through: http://www.irena.org/News/Description.aspx?NType=A&mnu=cat&PriMenuID=16&CatID=84&News_ID=360

TABLE 4
**Employment impacts of alternative energy sources**

Job creation per $1 million in output

| Energy source | Direct job creation per $1 million in output (# of jobs) | Indirect job creation per $1 million in output (# of jobs) | Direct and indirect job creation per $1 million in output (# of jobs) | Direct and indirect job creation relative to oil (% difference) |
|---|---|---|---|---|
| **Fossil fuels** | | | | |
| Oil and natural gas | 0.8 | 2.9 | 3.7 | – |
| Coal | 1.9 | 3.0 | 4.9 | +32.4% |
| **Energy efficiency** | | | | |
| Building retrofits | 7.0 | 4.9 | 11.9 | +221.6% |
| Mass transit/freight rail (90% MT, 10% FR) | 11.0 | 4.9 | 15.9 | +329.7% |
| Smart grid | 4.3 | 4.6 | 8.9 | +140.5% |
| **Renewables** | | | | |
| Wind | 4.6 | 4.9 | 9.5 | +156.8% |
| Solar | 5.4 | 4.4 | 9.8 | +164.9% |
| Biomass | 7.4 | 5.0 | 12.4 | +235.1% |

[182]

In terms of local economic stimulation, developing renewable energy projects carries economic benefits to the communities where these projects are sited. The National Renewable Energy Laboratory recently found that wind projects have a county-level annual earnings impact in the U.S. of $5,000 to $43,000 per megawatt of installed wind capacity[183]. As this suggests, the revenue stream provided by renewable energy projects can have a major impact in the quality of life of the people that live in these communities, which can in turn have a positive effect in the overall economy of the country.

Moreover, around 1.5 billion people worldwide live without access to electricity, and without a concerted effort, this number is not likely to drop. Grid extension is often highly costly and not feasible in isolated rural areas, or is unlikely to be accomplished within the medium term in many areas[184]. Diversifying energy sources can promote the advancement of electrification and the satisfaction of demand growth through the deployment of distributive systems that, given the characteristics of the renewable energy sources that power them (mainly solar and wind), can provide for energy access in places that the traditional grids cannot reach given technical constraints[185].

Providing for energy access is fundamental, this, given that expanding access to clean, reliable, and affordable energy services for heating, lighting, communications, and productive uses, has been found to be critical for enabling sustainable development[186]. Well-performing energy systems that provide efficient access to modern forms of energy strengthen opportunities to escape poverty[187]. This circumstance is illustrated by the next graphs, which shows four social indicators as a function of per-capita commercial energy consumption.

[182] Source: The Economic Benefits of Investing in Clean Energy page 28, University of Massachusetts. This report can be found at: http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF

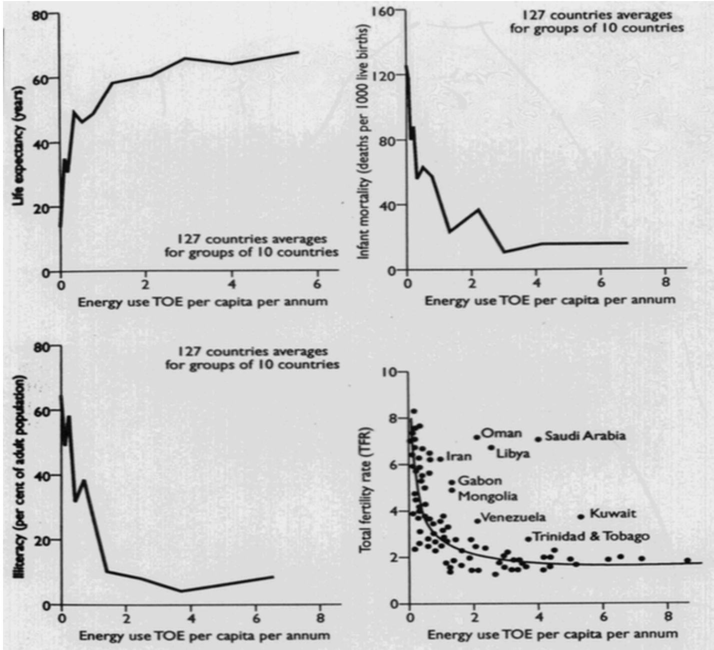
[183] Renewables: Energy You Can Count On page 9, Union of Concerned Scientists. This report can be found at: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/Renewable-Electricity-Standards-Deliver-Economic-Benefits.pdf

[184] United States Agency for International Development. Hybrid Mini-Grids for Rural Electrification: Lessons Learned (page 5). Available at: http://www.ruralelec.org/fileadmin/DATA/Documents/06_Publications/Position_papers/ARE_Mini-grids_-_Full_version.pdf

[185] Energy Access Practitioner Network. Towards Achieving Universal Access by 2030. United Nations, Sustainable Energy For All. Available at: http://www.se4all.org/wp-content/uploads/2013/09/FINAL-ESG-ALL.pdf

[186] Energy Access Practitioner Network. Towards Achieving Universal Access by 2030. United Nations, Sustainable Energy For All. Available at: http://www.se4all.org/wp-content/uploads/2013/09/FINAL-ESG-ALL.pdf

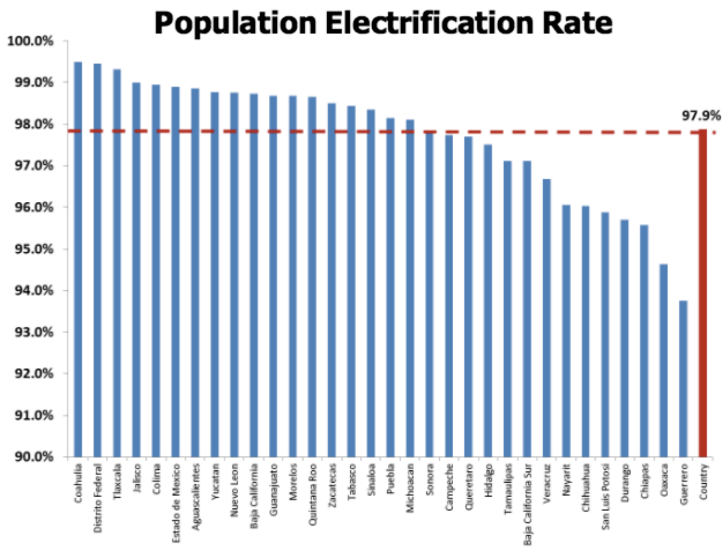
[187] Energy Access Practitioner Network. Towards Achieving Universal Access by 2030. United Nations, Sustainable Energy For All. Available at: http://www.se4all.org/wp-content/uploads/2013/09/FINAL-ESG-ALL.pdf



[188]

This figure showcases that in the majority of countries where commercial energy consumption per capita is below 1 Ton of Oil Equivalent (TOE) per year, illiteracy, infant mortality and total fertility rates are high, while life expectancy is low; and that as commercial energy increases to values above 2 TOE (or higher), social conditions seem to improve considerably.

As the next graphs evidence, although in Mexico average population electrification levels are high, nearly 23% of Mexican communities (which the Federal Electricity Commission has estimated to be equivalent to 130 thousand communities[189]), still lack access to electricity[190].

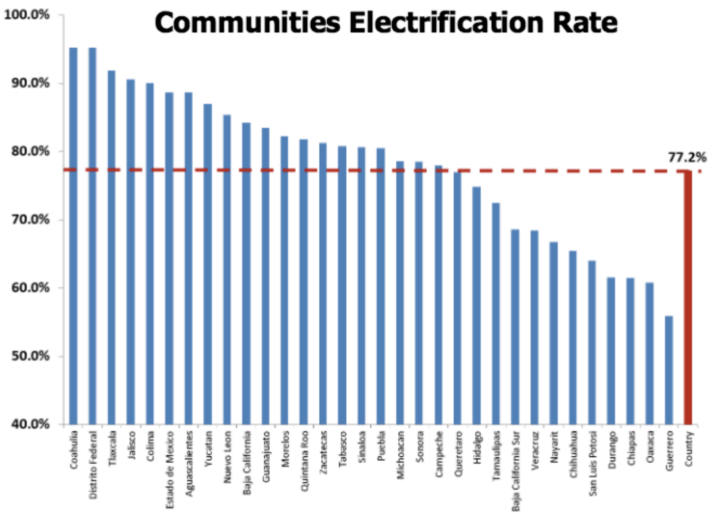



188 Sources: World Energy Council, *Energy for Tomorrow's World,* Kogan Page Ltd. London, UK (1993) and Goldemberg, J, *Energy for a Sustainable World Population*, in Polunin, , and Nazim, M (eds). *Population and Global Security*, United Nations Population Fund (UNFPA), Geneva, Switzerland (1994).

189 Federal Electricity Commission [Comision Federal de Electricidad] (2012). Meeting the Dual Goal of Energy Access and Sustainability – CSP Deployment in Mexico. Available at: http://www.esmap.org/sites/esmap.org/files/CFE_Meeting_dual_goal_Mexico.pdf

190 The most recent information of electrification currently available is that from 2012.

[191]




[192]

The gap between "Population Electrification Rate" and "Communities Electrification Rate" indicates that Communities without access are disperse and sparsely populated. As such, diversifying energy sources can be a powerful tool in the path towards providing basic levels of energy access to ensure acceptable levels of life quality for those Mexicans living in the 130,000 thousand communities that still lack access to electricity. This, by spurring the dissemination and deployment of renewable based technology that can generate electricity without requiring interconnection to the traditional grid.

Apart from these aspects, investing in clean technologies constitutes a great opportunity to decarbonize Mexican finances in order to deter the financial instability that develops whenever oil prices fluctuate[193], this by aiming to become an important manufacturer of renewable generation technology, and to compete in international markets to export technology internationally. Clean energy is gaining relevance all around the world, the United Nations through the Secretary-General Ban Ki-Moon's "High Level Group on Sustainable Energy for All" has established the doubling of the share of renewable energy in the global energy mix as one of its main goals for 2030[194]; and as Carbon Dioxide emissions reach higher concentrations in the atmosphere[195], more international efforts are calling for a steeper decrease in fossil fuel combustion. This is evidenced by the establishment of the *COP21/CMP11 Conference* otherwise known as the *Paris 2015 Convention* aimed at setting a new international agreement on the climate applicable to all countries with the goal of keeping global warming below 2°C in which renewable energy technology deployment is planned to play a major role[196]. The agreement that developed in the *Paris 2015 Convention* has been deemed as a bridge between today's policies and climate-neutrality before the end of the century; it commits 196 countries to work together

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191 Federal Electricity Commission [Comision Federal de Electricidad] (2012). Meeting the Dual Goal of Energy Access and Sustainability – CSP Deployment in Mexico. Available at: http://www.esmap.org/sites/esmap.org/files/CFE_Meeting_dual_goal_Mexico.pdf

192 Federal Electricity Commission [Comision Federal de Electricidad] (2012). Meeting the Dual Goal of Energy Access and Sustainability – CSP Deployment in Mexico. Available at: http://www.esmap.org/sites/esmap.org/files/CFE_Meeting_dual_goal_Mexico.pdf

193 As evidenced by this article that showcases the financial problems faced by Mexico given the current low oil prices. Article available at: http://www.ft.com/cms/s/0/5715257e-7cd3-11e4-b944-00144feabdc0.html#axzz3oT77pZdc

194 Sustainable Energy For All Initiative, The Secretary-General's High-level Group on Sustainable Energy for All found at: http://www.un.org/wcm/content/site/sustainableenergyforall/home/Initiative

195 Currently estimated at 398.82 ppm according to http://co2now.org/

196 Rebecca Williams (2015). Paris 2015: Getting a Global Agreement on Climate Change. Available at: http://www.greenalliance.org.uk/resources/Paris%202015-getting%20a%20global%20agreement%20on%20climate%20change.pdf

to limit global warming. The main details about the agreement are as follow[197]:

Mitigation: reducing emissions

Governments agreed

- A long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels;
- To aim to limit the increase to 1.5°C, since this would significantly reduce risks and the impacts of climate change;
- On the need for global emissions to peak as soon as possible, recognizing that this will take longer for developing countries;
- To undertake rapid reductions thereafter in accordance with the best available science.

Before and during the Paris conference, countries submitted comprehensive national climate action plans (INDCs). These are not yet enough to keep global warming below 2°C, but the agreement traces the way to achieving this target.

Transparency and global stocktake

Governments agreed to

- Come together every 5 years to set more ambitious targets as required by science;
- Report to each other and the public on how well they are doing to implement their targets;
- Track progress towards the long-term goal through a robust transparency and accountability system.

Adaptation

Governments agreed to

- Strengthen societies' ability to deal with the impacts of climate change;
- Provide continued and enhanced international support for adaptation to developing countries.

Loss and damage

The agreement also

- Recognizes the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change;
- Acknowledges the need to cooperate and enhance the understanding, action and support in different areas such as early warning systems, emergency preparedness and risk insurance.

[197] Information provided by the European Commission through: http://ec.europa.eu/clima/policies/international/negotiations/paris/index_en.htm

Support

- The EU and other developed countries will continue to support climate action to reduce emissions and build resilience to climate change impacts in developing countries.
- Other countries are encouraged to provide or continue to provide such support voluntarily.
- Developed countries intend to continue their existing collective goal to mobilize USD 100 billion per year until 2025, when a new collective goal will be set.

The INDC that Mexico advanced consisted of two main components, one for mitigation and another one related to adaptation. In turn, the mitigation portion includes two types of measures: unconditional and conditional. The unconditional set of measures are those that Mexico will implement with its own resources, while the conditional actions are those that Mexico could develop if additional resources and transfer of technology are available through international cooperation[198].

- Unconditional Reductions[199]: Mexico is committed to reduce unconditionally 25% of its Greenhouse Gases and Short Lived Climate Pollutants emissions (below BAU) for the year 2030. This commitment implies a reduction of 22% of GHG and a reduction of 51% of Black Carbon.

  This commitment implies a net emissions peak starting from 2026, decoupling GHG emissions from economic growth: emissions intensity per unit of GDP will reduce by around 40% from 2013 to 2030.

- Conditional Reductions[200]: The 25% reduction commitment expressed above could increase up to a 40% in a conditional manner, subject to a global agreement addressing important topics including international carbon price, carbon border adjustments, technical cooperation, access to low-cost financial resources and technology transfer, all at a scale commensurate to the challenge of global climate change.

  Within the same conditions, GHG reductions could increase up to 36%, and Black Carbon reductions to 70% in 2030.

These emission reductions are relative to a Business as Usual Baseline[201]. In terms of adaptation the priority of these actions are: the protection of communities from adverse impacts of climate change, such as extreme hydro-meteorological events related to global changes in temperature; as well as the increment in the resilience of strategic infrastructure and of the ecosystems that host national biodiversity. In order to reach those priorities Mexico will move towards strengthening the adaptive capacity of at least by 50% the number of municipalities in the category of "most vulnerable", establish early warning

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198 Mexico's Intended Nationally Determined Contribution. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf

199 Mexico's Intended Nationally Determined Contribution. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf

200 Mexico's Intended Nationally Determined Contribution. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf

201 Business As Usual scenario of emission projections based on economic growth in the absence of climate change policies.
2020: 906 MtCO2e (792 GHG and 114 BC/ 127,177 metric tons)
2025: 1013 MtCO2e (888 GHG and 125 BC/ 138,489 metric tons)
2030: 1110 MtCO2e (973GHG and 137BC/ 152,332 metric tons)

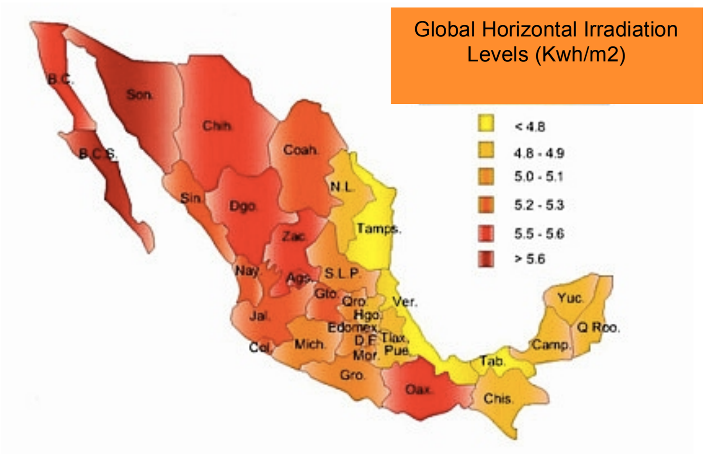
systems and risk management at every level of government and reach a rate of 0% deforestation by the year 2030[202].

There is no detailed information regarding the methods followed to determine the Contributions or their baseline, nevertheless it is advanced that Mexico will support its contributions through a robust national climate change policy that includes, inter alia, the following instruments[203]:

- General Climate Change Law (2012)[204]
- National Strategy on Climate Change, 10-20-40 years (2013)[205]
- Carbon tax (2014).[206]
- National Emissions and Emissions Reductions Registry (2014)[207]
- Energy reform (laws and regulations).

### 3.2. Mexico's Alternative Energy Potential

Mexico has a great potential to satisfy its energy requirements through the deployment of renewable technologies and nuclear power generation. In terms of solar energy, 70% of its territory has Global Horizontal Irradiation levels (GHI)[208] greater than 4.5 Kwh/m2[209]; this is 60% more than Germany's, who leads the world in installed capacity with 36 GW,[210] compared to only .122 GW[211] of Mexico. The next map shows the irradiation levels in the country.

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202 Mexico's Intended Nationally Determined Contribution. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf

203 Mexico's Intended Nationally Determined Contribution. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Mexico/1/MEXICO%20INDC%2003.30.2015.pdf

204 Relevant details of this law are analyzed in Chapter 5.

205 Available at: http://www.semarnat.gob.mx/archivosanteriores/informacionambiental/Documents/06_otras/ENCC.pdf

206 Details of this tax are discussed in Chapters 5 and 7.

207 This registry can be consulted at: http://www.semarnat.gob.mx/temas/cicc/registro-nacional-de-emisiones-rene

208 Global Horizontal Irradiance is the total amount of shortwave radiation received from above by a surface horizontal to the ground. This value includes both Direct Normal Irradiance (the amount of solar radiation received per unit area by a surface that is always held perpendicular to the rays that come in a straight line from the direction of the sun at its current position in the sky), and Diffuse Horizontal Irradiance (the amount of radiation received per unit area by a surface not subject to any shade or shadow that does not arrive on a direct path from the sun, but has been scattered by molecules and particles in the atmosphere and comes equally from all directions).

209 Provided through the Geographic Information System for Renewable Energies in Mexico (SIGER), which can be consulted at: http://sag01.iie.org.mx/evaluarer/CNRegistroSIGER.asp

210 Provided through a report prepared by the German Federal Network Agency, titled Photovoltaic systems : data messages as well as feed-in tariff rates, which can be found at: http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/Photovoltaik/DatenMeldgn_EEG-VergSaetze/DatenMeldgn_EEG-VergSaetze_node.html

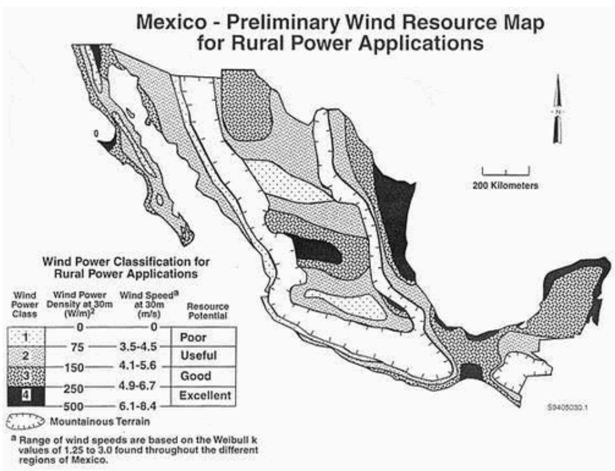
211 "PVPS Annual Report 2013". International Energy Agency.

The next table showcases the status of Solar PV Stations in Mexico by the end of year 2012.

| Station/License | Status | Installed capacity (MW) | Location | Owned by |
|---|---|---|---|---|
| Small and medium scale contracts | In operation | 32.0 | – | Private |
| Private PV central, Santa Rosalia | In operation | 1.0 | Baja Califronia Sur | Public |
| PV project, Durango | To begin operations | 0.5 | Durango | Private |
| PV project (self supply) | Under construction | 3.8 | Agusacalientes | Private |
| PV project (smal producer) | Under construction | 29.8 | Jalisco | Private |
| Pilor PV centrral, Cerro Prieto | Under construction | 5.0 | Baja Califronia Sur | Public |
| Total | | 72.1 | | |

[212]

As for wind power, a study elaborated by the Ministry of Energy shows that the potential for generation in Mexico is around 87,600 MW (without taking into consideration economic feasibility)[213], as of 2013 installed capacity in this country accounted for nearly 2 GW[214]. Wind power generation is dependent on the size of the turbine, the speed of wind and the efficiency of the turbine[215], the next map shows the wind speeds and the potential these speeds have for generating wind power throughout the country.




[216]

As for its installed capacity the next table presents the information regarding the status of wind power stations in Mexico by the end of year 2012.

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[212] Aleman-Nava *et al* (2014). Renewable Energy Research Progress in Mexico: A Review. Elsevier doi:10.1016/j.rser.2014.01.004

[213] Prospectiva Energias Renovables prepared by SENER which can be consulted at: http://www.sener.gob.mx/res/PE_y_DT/pub/2013/Prospectiva_Energias_Renovables_2013-2027.pdf page 28

[214] Provided by a study conducted by the Mexican Eolic Group which can be consulted at: http://www.grupoeolico.com/#!potencial-eolico-mexico/cjg9

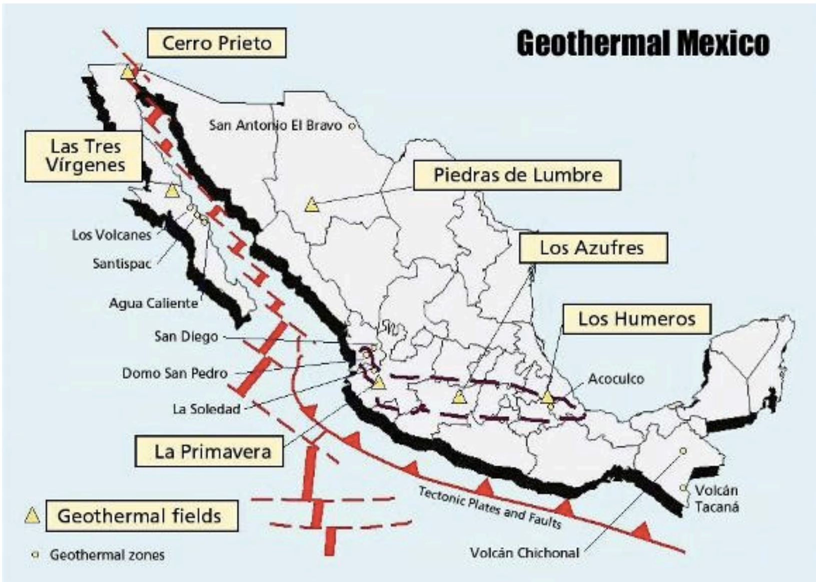
[215] This three factors constitute the wind power equation $P=\frac{1}{2}\rho AV^3$ (P=POWER, ρ= AIR DENSITY, A= AREA SWEPT BY THE TURBINE, and V= WIND SPEED).

[216] *Source: http://www.altestore.com/howto/images/article/Mexico-Wind-Map.jpg*

| Station/License | Status | Installed capacity (MW) | Location | Owned by |
|---|---|---|---|---|
| La Venta | In operation | 84.6 | Oaxaca | Public |
| Guerrero Negro | In operation | 0.6 | Baja California Sur | Public |
| Wind turbine, Cancun | In operation | 1.5 | Quintana Roo | Public |
| – | In operation | 1128.0 | baja California, Chiapas and Oaxaca | Private |
| – | Under construction and about to begin | 2069.0 | Baja California, Nuevo Leon, Oaxaca, San Luis Potosi, Tamaulipas and Veracruz | Private |
| Total | | 3283.7 | | |

[217]

Mexico has an estimated geothermal generation potential of at least 8,000 MW, second in the world only to Indonesia[218]. In regards to installed capacity, Mexico has been doing well in the development of its geothermal resources ranking 4th in the world with a total of 1,017 MW as of 2013[219]. The next map shows the geothermal areas with resources available for exploitation in Mexico:




[220]

The next table showcases the status of geothermal power stations in Mexico by the end of year 2012.

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217 Aleman-Nava *et al* (2014). Renewable Energy Research Progress in Mexico: A Review. Elsevier doi:10.1016/j.rser.2014.01.004

218 Overview Study of Mexico prepared by the Department of Energy of The United States which can be consulted at: http://www.geni.org/globalenergy/library/national_energy_grid/mexico/LatinAmericanPowerGuide.shtml

219 U.S. Embassy in Mexico report regarding renewable energy, which can be consulted at: http://photos.state.gov/libraries/mexico/310329/july2014/2014_07_Renewable%20Energy.pdf

220 Source: http://gis.clas.asu.edu/EnergySources/?index.html

| Station | Status | Installed capacity (MW) | Location |
|---|---|---|---|
| Cerro Prieto (I, II, III, IV) | In operation | 720.0 | Baja California |
| Los Azufres | In operation | 188.0 | Michoacan |
| Los Humeros | In operation | 40.0 | Puebla |
| Tres Virgenes | In operation | 10.0 | Baja California Sur. |
| Cerritos Colorados | Under construction | 75.0 | Jalisco |
| Total | | 1033.0 | |

Mexico can also generate electricity using biomass crops with a zero net release of carbon dioxide, this given that the emissions associated with its combustion accounts to about the same amount that was absorbed by this plants through the photosynthesis process[221]. A biomass crop can be considered carbon neutral, when the releases of biogenic carbon to the atmosphere are being completely offset by removals of CO2 back into growing biomass, as such, as long as the carbon "stock" is stable or increasing and the release of biogenic CO2 resulting from the use of biomass within that cycle does not cause atmospheric CO2 to increase[222], generating electricity through biomass can be an viable alternative when seeking to generate low or zero net carbon electricity. Furthermore, if biomass generation is deployed incorporating carbon capture and sequestration technologies[223] a net reduction of $CO_2$ concentration in the atmosphere can be achieved[224].

Currently biomass power has an installed capacity of 548 MW in operation in Mexico, 40 MW are from biogas and the rest from sugar cane bagasse biomass. Mexico is the third largest country in Latin America and the Caribbean in terms of the cropland area, following Brazil and Argentina according to the *CEPAL Statistical yearbook for Latin America and the Caribbean (2007-2008).* In 2007, the cultivated area was 21.7 million ha with an agricultural production of 270 million tons. There are crops widely cultivated, maize represents 40% of the total cultivated area, whereas sorghum, beans, oats, sugarcane, wheat and barley occupied almost 30% according to *SAGARPA*[225] *Food and Fisheries Information Service (2008)*. The residual biomass generated from these crops currently has diverse uses including animal feed and bedding, mulch, burning to produce energy and finally compost[226]. The next table showcases the status of installed biomass power capacity in the Country by the end of year 2012.

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221 Commonwealth of Massachusetts, Biomass Sustainability and Carbon Policy Study Chapter 6, which can be consulted at: http://www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-chapter6.pdf

222 World Business Council for Sustainable Development. Recommendations on Biomass Carbon Neutrality – Report. Available at: http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=15347&NoSearchContextKey=true

223 Carbon capture and sequestration is the process of capturing waste carbon dioxide (CO2) from large point sources, such as power plants, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation.

224 Carbon Capture and Storage Development Trends from a Techno-Paradigm Perspective. Bobo Zheng and Jiuping Xu. Energies Journal. 2014, *7*, 5221-5250; doi:10.3390/en7085221

225 Mexican Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food.

226 Residual biomass is a better alternative that repurposing food agriculture stocks given that the latter can have negative social impacts.

| | Status | Installed capacity (MW) | Location |
|---|---|---|---|
| Biomass | In operation | 508.0 | Campeche, Chiapas, Colima, Jalisco, Michoacan, Morelos, Nayarit, Oaxaca, Puebla and others |
| | Under construction | 88.0 | Chiapas, Jalisco, Nayarit, Oaxaca and Veracruz |
| Biogas | In operation | 40.0 | Aguascalientes, Chihuahua, Mexico State, Nuevo Leon, Queretaro |
| | Under construction | 5.0 | Guanajuato, Jalisco |
| Total | | 641.0 | |

[227]

In regards to hydroelectric generation, although it has no air quality impacts, construction and operation of hydropower dams can significantly affect natural river systems as well as fish and wildlife populations[228]. This is the reason why in California only projects smaller than 30MW can count towards the satisfaction of the Renewable Portfolio Standard policy[229], therefore it is important to proceed with caution in its implementation. That being said, Mexico's hydropower potential is around 53,000MW and by the end of 2012 it had an installed capacity of 11,775 MW[230] of hydro projects that were below or equal to 30MW, as presented in the next table.

| Station | Status | Installed capacity (MW) | Location | Owned by |
|---|---|---|---|---|
| Hydro≤30 MW | In operation | 287.0 | Chiapas, Chihuahua, State of Mexico, Guerrero, Hidalgo, Jalisco, Michoacan, Nayarit, Oaxaca, Puebla, San Luis Potosi, Sinaloa, Sonora and Veracruz | Public |
| Hydro≤30 MW | Inactive | 11.0 | State of Mexico, Puebla, Queretaro and Veracruz | Public |
| Hydro≤30 MW | In operation | 11169.0 | Chiapas, Coahuila, Guerrero, Hidalgo, Jalisco, Michoacan, Morelos, Nayarit, Oaxaca, Puebla, Sinaloa, Sonora, Tamaulipas and Veracruz | Public |
| Hydro≤30 MW | In operation | 147.0 | Durango, Guanajuato, Guerrero, Jalisco, Puebla and Veracruz | Private |
| Hydro≤30 MW | Under construction | 136.0 | Baja California, Guerrero, Jalisco, Nayarit, Oaxaca and Veracruz | Private |
| Hydro≤30 MW | Inactive | 25.0 | Jalisco, Oaxaca and Puebla | Private |
| Total | | 11775.0 | | |

[231]

Ocean energy has a generation potential in Mexico of 26 GW[232], although this is a significant number; this technology still has many challenges to overcome before it becomes feasible. Issues of disturbance of marine life, the possibilities of threat to

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227 Aleman-Nava *et al* (2014). Renewable Energy Research Progress in Mexico: A Review. Elsevier doi:10.1016/j.rser.2014.01.004

228 Hydroelectricity Review by the Environmental Protection Agency of the United States which can be consulted at: http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html

229 Renewable Portfolio Standard Eligibility Guidebook, prepared by the California Energy Commission, which can be consulted at: http://www.energy.ca.gov/2013publications/CEC-300-2013-005/CEC-300-2013-005-ED7-CMF-REV.pdf page 28

230 PROMEXICO. Renewable energy, Business Intelligence Unit. 2012.

231 Aleman-Nava *et al* (2014). Renewable Energy Research Progress in Mexico: A Review. Elsevier doi:10.1016/j.rser.2014.01.004

232 Provided through a Tidal Energy Report conducted by The Earth's Fund, found at: http://theearthsfund.com/energias-renovables/energia-mareomotriz/

navigation from collisions, and the degradation of scenic ocean front views are some of these obstacles[233].

As for nuclear power generation, even though it is not renewable resource based, it has many advantages that can aid towards climate abatement, while supporting a growth in electrification. The energy density[234] of this resource is around 16,000 times higher than coal[235] and the electricity generated from this fuel has low life-cycle[236] impacts towards the environment[237]. However, nuclear generation poses a number of legitimate concerns, particularly the management of long lifespan radioactive waste and the potential for devastating accidents that have to be taken into consideration when drafting rules for its potential deployment. Mexico has around 22,000 Tons of uranium[238] that can be enriched to produce the required concentration of U 235 to generate electricity[239] and only one nuclear plant in operation in Veracruz that accounts for 1,364 MW of installed capacity[240].

As such, if Mexico's alternative energy potential is to be exploited with the goal of satisfying this Country's energy demand while abating climate change; and, if renewable energy deployment will be pursued as a gateway to economic development by promoting enough technology advancement to allow Mexico to compete in international markets by exporting its technology across the globe; policy efforts that address both, technological research and development, and incentives to arouse the market have to be developed. As the next subchapter will evidence, a harmonic implementation of "technology-push"[241] and "demand-pull"[242] policies, is the best bet when attempting to catalyze a "learning curve effect"[243] capable of decreasing prices of clean energy technologies until they are market competitive with conventional generation technologies.

### 3.3. The importance of "Technology-Push" and "Demand-Pull" Policies to Spur Diversification.

Policy support is fundamental when aiming to spur any type of environmental innovation, with renewable energy technologies being a perfect example[244]. This, given that renewable technologies still require significant Research and Development investments until they can reach market competitiveness, while they also suffer from knowledge spillovers[245].

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233 Ocean Energy Review, California Energy Commission, which can be consulted at: http://www.energy.ca.gov/oceanenergy/

234 Energy density is the amount of energy stored in a unit of mass

235 Energy Density Comparison, Atomic Insight, found at: http://atomicinsights.com/energy-density-comparison/

236 Life-Cycle analysis is a technique to assess environmental impacts associated with all the stages of a product's life from cradle to grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

237 This because although mining uranium has considerable environmental impacts, on a *cradle to grave* comparison with other fuels for energy generation, the overall impact of nuclear energy generation is considerably lower than that of most fuels. This information can be consulted in the Life Cycle Emissions Analysis Report, prepared by the Nuclear Energy Institute, found at: http://www.nei.org/Issues-Policy/Protecting-the-Environment/Life-Cycle-Emissions-Analyses

238 Provided through a study by the Geosciences Department of the National University of Mexico, which findings can be can be consulted through: http://www.diariopresente.com.mx/section/economia/67419/consideran-a-mexico-con-potencial-nuclear/

239 How is uranium enriched? Live Science, found at: http://www.livescience.com/6463-uranium-enriched.html

240 http://www.cnnexpansion.com/obras/2010/01/11/la-nueva-laguna-verde

241 Research and development policies.

242 Policies that promote deployment of technology in the market.

243 The learning curve model is based in the premise that prices decrease with every increase in technology deployment. Each time cumulative volume doubles, costs fall by a constant percentage. A complete explanation of this model can be consulted in a learning curve article provided by Policonomics, found at: http://www.policonomics.com/learning-curve/

244 Kemp, R., 1997. Environmental Policy and Technical Change. A Comparison of the Technological Impact of Policy Instruments. Edward Elgar, Cheltenham.

245 Rennings, K., 2000. Redefining innovation – eco-innovation research and the contribution from ecological economics. Ecological Economics 32, 319–332.

Knowledge spillovers, refer to the issue that arises when several firms can acquire information created by others participants without paying any compensation for that information in a market transaction, and when developers of the information have no effective legal recourse, if other firms utilize information so acquired[246].

Analyzing patent citations[247] can provide evidence of this issue, by showcasing the extent of knowledge flows from renewable technologies to other technologies. A recent study[248] examined citations of patents in eight renewable energy technologies[249] filed in 17 European countries over the 1978-2006 period[250]; and found that most "forward citations"[251] come from patents in the same technology, which exhibits that renewable energy patents often find applications in the same technological fields[252], providing evidence of the high share of intra-technology spillovers[253]. In particular, among renewable technologies, the share of intra-technology spillovers tends to be very high for wind patents (above 80%), medium for solar and storage technologies (around 60%) and low for waste technologies (30%) . This reveals that current innovation in wind, solar and storage depends for a large part on past innovations in these specific technologies, which indicates some form of path-dependency in knowledge creation, and demonstrates how knowledge spillovers accompany the development of renewable energy technologies[254].

Moreover, the fact that, on average, clean-patented inventions receive 43% more citations than dirty inventions[255] in the fields of energy production, automobiles, fuel, and lighting, suggests that clean inventions generate considerably more knowledge spillovers than "dirty" inventions[256]. Hence, stronger public support for Research and Development in renewable energy technologies is warranted to mitigate this issue.

In addition to knowledge spillovers, there is a component of uncertainty in regards to future returns of renewable technology investments[257]. Research has consistently shown that the diffusion of new, economically superior technologies is a gradual process.

The fraction of potential users that has adopted a new technology follows a sigmoid or "S-shaped" path over time (as the next figure suggests), only rising slowly at first, then entering a period of very rapid growth, followed by a slowdown in growth as the technology reaches maturity and most potential adopters have switched[258].

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246 Grossman, G., Helpman, E., 1991. Innovation and Growth in the Global Economy. MIT Press, Cambridge, MA.

247 Using patent data to analyze innovation is helpful given that at the macro-economic level, patent activity over time is linked to the returns to R&D; patent data is comprehensively available; technical characteristics are described in detail; the categories are well documented; and it is possible to track definitions over time. Ricardo J. Caballero & Adam B. Jaffe, 1993. "How High are the Giants' Shoulders: An Empirical Assessment of Knowledge Spillovers and Creative Destruction in a Model of Economic Growth," NBER Working Papers 4370, National Bureau of Economic Research, Inc.

248 Joelle Noailli, Victoria Shestalova. Knowledge Spillovers from Renewable Energy Technologies. Netherlands Bureau for Economic Analysis.

249 Wind, Geothermal, Solar, Marine, Hydroelectric, Biomass, Waste, and Storage.

250 , Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom, Norway, and Switzerland.

251 Forward citations are the citations subsequently received by the patent over time; reflecting the knowledge spillover from this patent to follow-on inventions.

252 Intra-technology spillovers: Both patents of the cited-citing pair are classified into the field of the same technology, i.e. solar patents with solar patents, wind with wind.

253 Both patents of the cited-citing pair are classified into the field of the same technologies.

254 Joelle Noailli, Victoria Shestalova. Knowledge Spillovers from Renewable Energy Technologies. Netherlands Bureau for Economic Analysis.

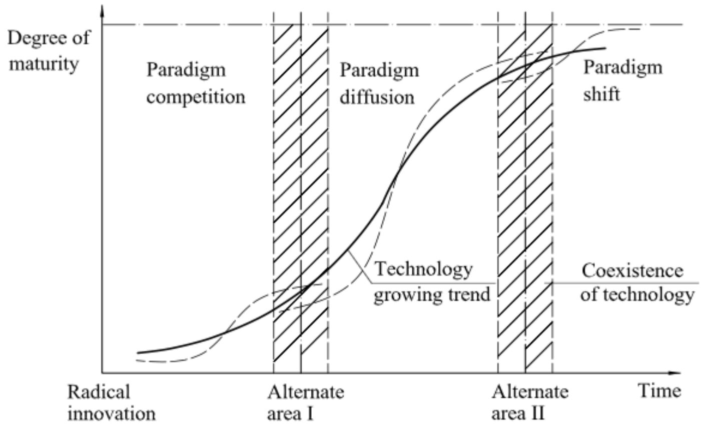
255 The comparison between "clean and dirty inventions" is done by comparing: in energy production, renewables vs. fossil fuel generation; in the automobile industry, electric cars vs. internal combustion engine cars; in regards to fuel, gasoline vs. biofuels; and in lighting, LED vs. incandescent bulbs.

256 Dechezleprêtre, A. R. Martin, M. Mohnen, 2013, Knowledge spillovers from clean and dirty technologies: A patent citation analysis, downloadable at http://personal.lse.ac.uk/dechezle/DMM_sept2013.pdf

257 Peters, M., Schneider, M., Griesshaber, T., Hoffmann, V.H., 2012. The impact of technology-push and demand-pull policies on technical change—does the locus of policies matter? Research Policy, Forthcoming.

258 P.A. Geroski (2000). Models of Technology Diffusion. Elsevier Science B.V.

The Growing Trend of the Technology Paradigm




259

The explanation for this apparent slowness of the technology diffusion process has been a subject of considerable study. Two main forces have been deemed to cause this. First, potential technology adopters are diverse, so that a technology that is generally superior will not be perceived as equally superior by every potential user, and may be in fact deemed inferior in comparison to existing technology for some users for an extended period of time after its introduction[260].

Second, adopting new technologies is a risky undertaking that requires considerable information, both about the generic attributes of the new technology and about the details of its use in the particular application being considered. It takes time for information to spread sufficiently, and this process of diffusion of information limits the application of the technology[261]. Therefore, given these uncertainties present in the technology diffusion process, firms are often not willing to invest in renewable energy technology development, especially when their current investments in conventional energy sources are already widely used and therefore profitable.

A third issue that has to be countered through policy support when aiming to spur diffusion of environmental technology as renewable energy technology, is the fact that the negative external effects present in most environmental issues, i.e. climate change, put these technologies at a disadvantage[262].

The traditional example of a negative environmental externality is helpful to shed light on this issue: a polluter makes decisions based only on the direct cost of and profit opportunity from production and does not consider the indirect costs to those harmed by the pollution. The indirect costs include decreased quality of life; say in the case of a homeowner near a smokestack; higher health care costs; and forgone production opportunities, for example, when pollution harms activities such as tourism. Since the indirect costs are not borne by the producer, and therefore not passed on to the end user of the goods produced by the polluter, the social or total costs of production are larger

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259 Carbon Capture and Storage Development Trends from a Techno-Paradigm Perspective. Bobo Zheng and Jiuping Xu. Energies Journal. 2014, *7*, 5221-5250; doi:10.3390/en7085221

260 Jaffe, Newell, Stavins (2002). Environmental Policy and Technological Change. Environmental and Resource Economics 41-69 (2002)

261 Jaffe, Newell, Stavins (2002). Environmental Policy and Technological Change. Environmental and Resource Economics 41-69 (2002)

262 Peters, M., Schneider, M., Griesshaber, T., Hoffmann, V.H., 2012. The impact of technology-push and demand-pull policies on technical change—does the locus of policies matter? Research Policy, Forthcoming.

than the private costs[263]. Hence, it can be inferred as well, that in regards to renewable technology, as it is the case with most of environmental technologies, there is no clear economic incentive derived from the negative externalities for private companies to undertake production of clean technologies per se.

These three previously described issues can be addressed through "technology-push policies" typically in the form of public research and development investments; and "demand-pull policies", devised as market based instruments[264].

The main argument in favor of "technology-push" is that advances in scientific understanding determine the rate and direction of innovation[265], and as such, mitigating lack of investment in research and development is a "powerful" tool to spur technology diffusion. A highly influential version of this model, the "post-war paradigm"[266], proposed that technological innovation follows a "linear" progression of knowledge from basic science, to applied research, to product development, to commercial products[267].

The effect of "technology-push" policies in technological innovation has been analyzed by several studies, through the assessment of patent counts[268]. These studies have found a positive effect derived from the implementation of these policies, particularly, that public research and development funding has shown the potential to initiate a cycle that can spur innovation, promote price reductions, market growth, and further research and development investments by the industry[269].

Nevertheless, there have been serious critiques to the "technology-push" approach, mainly underpinning the fact that this model's emphasis on a "linear" progression is incompatible with the feedbacks, interactions, and networks of the market, which inevitably affect profitability of innovation[270]. This, given the fact that in innovation, one nearly always deals with the optimization of many demands simultaneously[271].

As such, critiques of the "technology-push" model argue, that successful innovation that can lead to technology dissemination, needs a design that balances the requirements of a new product and its manufacturing processes, the market needs, and the prerequisite to maintain an organization that can continue to support all these activities effectively[272].

If a technological improvement is to have a significant economic impact, it must combine design characteristics that will match with the needs and preferences of users, and it must accomplish these things subject to basic constraints on cost. Commercial success

263 Thomas Helbling (2012). Externalities: Prices do no Capture All Costs. International Monetary Fund. Op Ed
264 Peters, M., Schneider, M., Griesshaber, T., Hoffmann, V.H., 2012. The impact of technology-push and demand-pull policies on technical change—does the locus of policies matter? Research Policy, Forthcoming.
265 Bush, V., 1945. Science the endless frontier: a report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development Report - United States Government Printing Office
266 Established right after the "Manhattan Project" and advanced by Vennevar Bush.
267 Nemet, G., 2009. Demand-pull, Technology-push, and government-led incentives for non-incremental technical change. Research Policy 38 (5), 700–709.
268 Johnstone, N., Has ˇc ic ˇ, I., Popp, D., 2009. Renewable energy policies and technological innovation: evidence based on patent counts. Environmental and Resource Economics 45, 133–155.
269 Industrial dynamism and the creation of a "virtuous cycle" between R&D, market growth and price reduction: The case of photovoltaic power generation (PV) development in Japan. Chichiro Watanabe, Kouji Wakabayashi, Toshinori Miyazawa (2000). Elsevier. doi:10.1016/S0166-4972(99)00146-7
270 Nemet, G., 2009. Demand-pull, Technology-push, and government-led incentives for non-incremental technical change. Research Policy 38 (5), 700–709.
271 Kline, S., Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.
272 Kline, S., Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.

turns on the attainment either of cost levels that are below available substitutes or creation of a superior product at a cost that is at least not prohibitively expensive in comparison with lower performance substitutes[273].

Higher performance is commonly attainable at a higher price. However, to choose the optimal combination of price and performance at which a firm should aim, calls for considerable knowledge of market conditions as well as a high order of business judgment in making decisions with respect to timing. Success requires not only selecting the right cost and performance combination, but also judging just when the timing is right for the product's introduction[274].

Hence, without considering the characteristics of the market, mainly, the price at which users are willing to purchase the technology, or the particular preferences of these users, technology diffusion cannot be guaranteed. Furthermore, a recent study in line with these criticisms[275], referred to the "technology-push" approach as the "over-the-wall model" claiming that viewing the market as a receptacle for the output of scientific research and invention; and holding that an increase in basic and applied research and development should lead to an increase in innovation, assumes that a research and development team knows everything about the users without involving them in the specific product design. "The team simply develops the product and tosses it "over the wall" to users in the belief that there's a need for it, the technology is complete and ready to use, and users are technically skilled enough to use it without help, assumptions that tend to tamper technology dissemination"[276].

In response to these issues, many have argued that it is demand and not "scientific understanding" what drives the rate and direction of innovation. The main proponents behind this theory claim that it is demand what actually steers firms to work on the different problems that tamper technology diffusion[277]; that changes in the prices of conventional sources of energy inevitably affect the demand for innovation"[278]; and, that demand-pull policies[279], aimed at boosting the utilization of technologies, not only lead to diffusion but also induce innovation through the "learning curve effect"[280].

However, recent literature has shown how both policy approaches are not opposite, but in fact, they complement each other and they are actually both necessary to warrant technology development and diffusion, specially in regards to renewable technology development. All because "technology-push" fails to account for market conditions, while "demand-pull" tends to ignore technological capabilities[281].

[273] Kline, S., Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.

[274] Kline, S., Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.

[275] Douthwaite, B. (2002). Enabling Innovation: A Practical Guide to Understanding and Fostering Technological Change. Zed Books, London, England

[276] Douthwaite, B. (2002). Enabling Innovation: A Practical Guide to Understanding and Fostering Technological Change. Zed Books, London, England

[277] Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.

[278] Lichtenberg, F.R., 1986. Energy prices and induced innovation. Research Policy 15 (2), 67–75.

[279] Demand-pull policies include quantity-and price-driven measures that are either neutral or target specific technologies, some examples are: Feed In Tariffs (price-driven), Renewable Portfolio Standards (quantity-driven).

[280] Newell, R.G., Jaffe, A.B., Stavins, R.N., 1999. The induced innovation hypothesis and energy-saving technological change. Quarterly Journal of Economics 114,

[281] Nemet, G., 2009. Demand-pull, Technology-push, and government-led incentives for non-incremental technical change. Research Policy 38 (5), 700–709

As such, "technology-push" instruments facilitate knowledge transfer, and provide direct funding for technological R&D (research and development), improving the perceived cost-benefit ratio of R&D for firms, which in turn alter their routines in favor of explorative activities increasing innovative output[282]. While "demand-pull" instruments, foster innovation and technical change by addressing market factors and facilitating learning-by-doing[283][284], supporting the argument made above that innovation and diffusion are intertwined processes.

The analysis of the different deployment scenarios of solar PV as a function of investment costs[285] provides evidence of this. These advanced PV projections are based both in research and development efforts, and improved designs through niche market applications and feedbacks; where both processes are found to "push" the technologies through ever-wider diffusion as $CO_2$ emission constraints change the relative prices of energy sources and "pull" solar PV and other low carbon technologies into the market, showcasing the necessity and complementarity of "market pull" and 'supply push' policies to yield marked differences in long-term technology outcomes[286].

Moreover, evaluating the impact of "technology-push" and "demand-pull" policies on incremental[287] and non-incremental[288] innovation through econometric analysis and patent count methods in the field of wind energy, has shown how both technology-push and demand-pull policies are required to promote innovation in renewable energy technologies[289]. On the one hand, "technology-push" policies stimulate incremental and non-incremental innovation by providing firms with access to funding and knowledge transfer opportunities through the support of research and development. On the other hand, domestic "demand-pull" policies enable incremental innovation through market deployment by promoting learning[290] during the production of wind turbines; and foster incremental and non-incremental innovation by allowing for experience about turbine reliability characteristics to be gained through iterative turbine design and extensive technology use[291]. Following these findings, the next figure showcases the way that technology development and market deployment interplay with one another.

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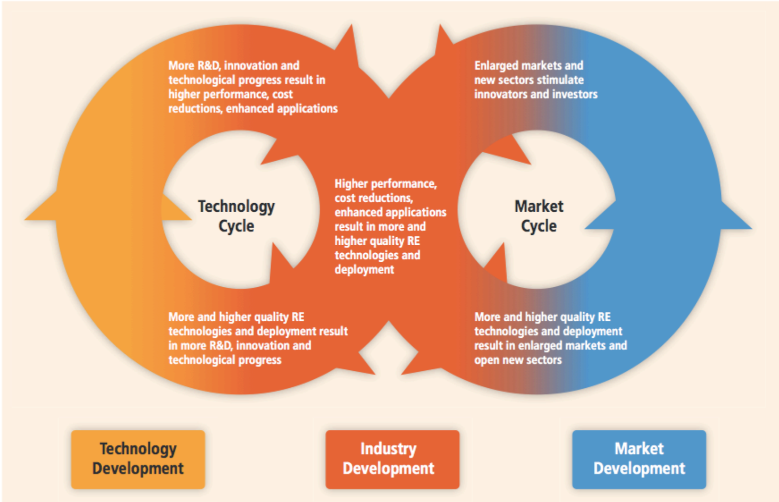
282 Bessen, J., (2008). The Value of Us Patents by Owner and Patent Characteristics. Research Policy 37(5), 932-945.

283 The learning curve effect previously described based in the premise that prices decrease with every increase in technology deployment.
284 Dosi, G., 1988. Sources, Procedures, and Microeconomic Effects of Innovation. Journal of Economic Literature 26(3), 1120-1171.

202 N. Nakicenovic, K. Riahi (2002): *An Assessment of Technological Change Across Selected Energy Scenarios* RR-02-005, International Institute for Applied Systems Analysis, Laxenburg, Austria. Reprinted from a publication by the World Energy Council (WEC) on behalf of the Study Group on Energy Technologies.

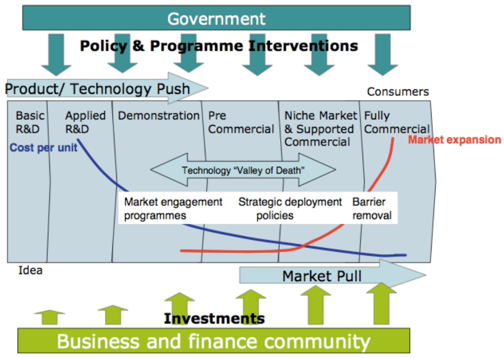
286 Grubler and Wilson (2011). Lessons from the history of technology and global change for the emerging clean technology cluster. World Economic and Social Survey 2011.
287 A series of small improvements to an existing product or product line that usually helps maintain or improve its competitive position over time.
288 Explores new technologies focusing on processes, products or services with unprecedented performance features. Its aimed at creating a dramatic change that transforms existing markets or creates new ones, and as such, it has high uncertainties.
289 Huenteler J. The Impact of Technology Policy on Technical Change: Assessing Alternative Pathways to Competitiveness of Renewable Energy Technologies. RWTH Aachen. 2011.
290 The learning curve effect previously described based in the premise that prices decrease with every increase in technology deployment.
291 Huenteler J. The Impact of Technology Policy on Technical Change: Assessing Alternative Pathways to Competitiveness of Renewable Energy Technologies. RWTH Aachen. 2011.



[292]

These results urge governments to pursue a technology policy strategy that integrates "technology-push" and "demand-pull" policies balancing the two and adjusting them to the degree to which technological R&D requires problem-related information from the use environment[293]. Hence, public economic support in the form of research and development moneys, and some concept demonstration, are to be implemented to spur public domain ideas for others to be able to access them and expand them[294]. Furthermore, governments need to define and enforce regulation that rewards innovation, as 'market pull' is ineffective unless policies that increase the market value of renewable energy technologies are put in place[295]. Spanning the innovation chain, therefore, requires in addition to research and development, a combination of "market engagement programs[296]", "strategic deployment policies"[297], and "barrier removal"[298] (see figure below).

Activities for spanning the innovation chain



[299]

[292] Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Chapter 11 page 889. Available at: http://srren.ipcc-wg3.de/
[293] Huenteler J. The Impact of Technology Policy on Technical Change: Assessing Alternative Pathways to Competitiveness of Renewable Energy Technologies. RWTH Aachen. 2011.
[294] Michael Grubb 2004. Technology Innovation and Climate Change Policy: an overview of issues and options. Keio Journal of Economics.
[295] This to provide market based incentives to underpin the diffusion
of low-carbon technologies, and hence provide signals that innovation in this direction can ultimately expect some reward
[296] Programs designed to move technologies from the domain of
public finance to private sector engagement (i.e. incubators, accelerations programs).
[297] Aimed at supporting the larger scale deployment of emergent technologies (i.e. feed-in-tariffs, renewable portfolio standards).
[298] New technologies face barriers due to the way current markets have become structured to suit incumbent technologies, and incumbents often may not bear their full external costs.
[299] Michael Grubb 2004. Technology Innovation and Climate Change Policy: an overview of issues and options. Keio Journal of Economics.

Considering the fact that both the theoretical and the case study literature agree that successful technological change in renewable energies requires a mix of "technology-push" and "demand-pull" policies to induce innovation and diffusion of renewable energy technologies. Mexico should explore the application of a strong policy agenda aimed at achieving its energy transitional goals through a combination of "supply-push" and "demand-driving" instruments in order to promote technology advancement while incentivizing market deployment of its developed technology. As such, the next chapter will summarize the available "technology-push" and "demand-pull" policy alternatives, in order to provide the reader with a complete scope of the different options available to spur innovation and application of renewable energy technology.

## 4. "Supply-Push" and "Demand-Pull" Policy Alternatives

### 4.1. Supply-Push Policies[300]

#### *4.1.1. Academic R&D Funding*

Investment monies from the government provided to academics for undertaking creative work in a particular field with the intention of making a discovery that can either lead to the development of new products or procedures, or to devise new applications for existing products or procedures[301]. This type of funding is allocated with the purpose of spurring both, basic and applied research by the academia.

Basic research is performed without thought of practical ends; the scientist doing basic research is usually not at all interested in the practical applications of his work, yet the further progress of technological development would eventually stagnate if basic research was neglected given that basic research generates new ideas, principles, and theories, which may not be immediately utilized but nonetheless form the basis of progress by promoting our understanding of the particular field[302]. The function of applied research, on the other hand, is to use knowledge to provide answers with practical application, by promoting the advancement of scientific knowledge required to satisfy specific commercial objectives with respect to products, processes, or services in the renewable energy industry[303]; applied research activities include new product development, product improvement, prototype development, field-testing, process improvement and commercialization of new products.

The continuing importance of academia to the overall R&D effort to overcome the obstacles to innovation discussed in the previous chapter is well accepted[304]. This is especially true for its contributions to the generation of new knowledge through basic research, as evidenced by the fact that since 1998, academia has accounted for more than half of the basic research performed in the United States[305].

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300 As described through Chapter 3 "technology-push" instruments facilitate knowledge transfer, and provide direct funding for technological R&D (research and development), improving the perceived cost-benefit ratio of R&D for firms, which in turn alter their routines in favor of explorative activities increasing innovative output. Nemet, G., 2009. Demand-pull, Technology-push, and government-led incentives for non-incremental technical change. Research Policy 38 (5), 700–709

301 National Science Board (2004). Science and Engineering Indicators. Available at: http://www.nsf.gov/statistics/seind04/c5/c5s1.htm

302 *Vennevar Bush (1945). Science the Endless Frontier.*

303 *Roll-Hansen, Nils (April 2009).* Why the distinction between basic (theoretical) and applied (practical) research is important in the politics of science. *The London School of Economics and Political Science.*

304 As evidenced by chapter 4 of the National Science Board (2004), Science and Engineering Indicators study. Available at: http://www.nsf.gov/statistics/seind04/c5/c5s1.htm

305 National Science Board (2004). Science and Engineering Indicators, Chapter 5. Available at: http://www.nsf.gov/statistics/seind04/c5/c5s1.htm

*4.1.2. Applied R&D and Demonstration Grants*

Funding for research and development and demonstration activities allocated to parties that manifest interest and demonstrate technical capabilities to undertake these efforts. In terms of research and development, these grants are mainly promoted for applied research[306] with the purpose of incentivizing the industry to participate in these activities, given that the industry is the participant with better information in regards to market applications. As an example, in the United States, industry participants represented 65.7% of all applied research efforts in the Country[307] during 2002.

In terms of demonstration activities, these are closely related to applied research as they are focused at moving technology innovations through the product development stages towards commercialization. The purpose of demonstrations activities is to provide developers with the opportunity to convince investors, that their technology will be able to perform in real market conditions and be commercially viable, which is done through controlled deployment of the technology[308].

These grants are bestowed without requiring repayment unless and until technologies and intellectual property have been successfully exploited.

*4.1.3. Incubation Support*

Developing an organization aimed at accelerating and systematizing the process of creating successful enterprises by providing entrepreneurs with a comprehensive and integrated range of support, including: incubator space, business support services, clustering and networking opportunities with the purpose of generating a steady flow of new renewable energy businesses with above average job and wealth creation potential[309].

In general, a business incubator focuses on a range of services designed to help entrepreneurs launch well-managed businesses. This mix of services is generally drawn from: administrative services (photocopying, bookkeeping, etc); business advice services (coaching, counseling, mentoring, training), technical services (technical advice, access to expensive equipment, etc), finance raising, and networking opportunities (between clients, links to wider business community)[310]. The diagram below provides an illustration of the incubation process.

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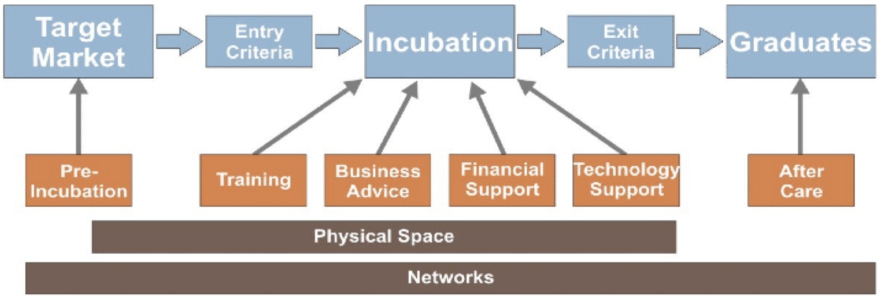
306 The function of applied research, on the other hand, is to use knowledge to provide answers with practical application, by promoting the advancement of scientific knowledge required to satisfy specific commercial objectives with respect to products, processes, or services in the renewable energy industry. *Roll-Hansen, Nils (April 2009).* Why the distinction between basic (theoretical) and applied (practical) research is important in the politics of science. *The London School of Economics and Political Science.*

307 National Science Board (2004). Science and Engineering Indicators, Chapter 4. Available at: http://www.nsf.gov/statistics/seind04/c5/c5s1.htm

308 UNEP (2005). Public Finance Mechanisms to Catalyse Sustainable Energy Sector Growth. United Nations Environment Programme (UNEP), Paris, France. Available at: www.uneptie.org/energy/activities/sefi/pdf/SEFI_PublicFinanceReport.pdf.

309 Definition adapted from "The Business Dictionary" http://www.businessdictionary.com/definition/business-incubator.html

310 Infodev (2010). Global Good Practice in Incubation Policy Development and Implementation. Available at: http://www.infodev.org/infodev-files/resource/InfodevDocuments_834.pdf




311

*4.1.4. Establishment of Public Research Centers*

Providing for the creation of research facilities through government funding with the purpose of promoting research & development, and demonstration activities.

The research activities of these centers are focused at contributing to innovation in codified knowledge (e.g. publications), and in knowledge embodied in technological inventions that are subsequently taken up by innovative business firms. Although there are primarily financed by the government, these centers are encouraged to commercialize the knowledge they generate and seek intellectual property rights protection, such as licensing, with a view to earning incomes[312].

An example of a successful public research center in the United States is the Lawrence Berkeley National Laboratory, founded in 1931, which is supported by the U.S. Department of Energy through its Office of Science, and managed by the University of California Berkeley. The costs of this institute for year 2014 alone were around 785 million dollars, nevertheless it is estimated that its overall impact in the national economy is around 1.6 billion dollars a year, given the revenue associated to the technologies developed by this research center, and their effect in job creation[313].

*4.1.5. Public-Private Research Partnerships*

Implementing mechanisms for collaboration between the public and private sectors to share the risks of investing in research and development activities, with the goal of promoting a more effective response to the rapid transformation of innovation processes and related business needs and strategies, while enhancing the efficiency and cost-effectiveness of technology and innovation policy[314].

In regards to research and development, Public Private Partnerships (PPPs) help governments become more inventive by creating a space outside the government structure that allows innovation to flourish. This partnerships help to inject a broader set of skills and talents, as well as a more diligent and responsive work culture into the government machinery and to create a solid foundation for innovative thinking and creativity; while also helping private companies embrace innovation and bring together new financial resources

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311 Infodev (2010). Global Good Practice in Incubation Policy Development and Implementation. Available at: http://www.infodev.org/infodev-files/resource/InfodevDocuments_834.pdf

312 As provided by "The Innovation Policy Platform" of the OECD available at: https://www.innovationpolicyplatform.org/content/universities-and-public-research-institutes

313 Information provided by this Laboratory through: http://www.lbl.gov/about/

314 OECD 2004. PUBLIC-PRIVATE PARTNERSHIPS FOR RESEARCH AND INNOVATION: AN EVALUATION OF THE DUTCH EXPERIENCE. Available at: http://www.oecd.org/netherlands/25717044.pdf

and business capital to open the door for the creation of new industry clusters, thus ultimately helping to facilitate innovation in increasingly competitive environments[315].

Moreover, this policy helps in the transition from research to commercialization, one of the hardest steps in the innovation chain called: the "valley of death". Many groups, individuals, and companies that have developed promising technologies through the research stages, fail to gather the required resources and to unfold a successful commercialization plan that can "fit" its technology into the market, hence their promising technologies "die-off", that is, they are not accepted by the market and ultimately their funding sources expire. Engaging the private sector can help bridge research innovation and market deployment. By undertaking partnerships with participants that are currently successfully commercializing energy systems in a considerable scale, the government promotes rapid dissemination of technological innovation of the technology developed by the research partnerships[316].

An example of a successful research PPP is the Underwriters Laboratories – U.S. Department of Energy partnership which has shown how public-private research collaboration can inform policy and help innovative companies address risks prior to commercialization. Through various types of collaboration, including extensive research, technical reports, and industry networks (i.e., consultations, technical forums, symposiums and standards committees), this public-private partnership has effectively addressed a number of issues within the energy sector. For instance, as a result of joint efforts on biofuels, UL and its partners have tackled critical deployment issues, including the compatibility of new biofuels with existing infrastructure equipment from the storage of the fuels to the dispensing operations[317].

#### *4.1.6. R&D Prizes*

Established through research and development contests sponsored by the government, in which a monetary reward for the success of a predefined project is set[318]. In this scheme, the sponsor defines the challenge and terms of success and the innovator, in turn, assumes the cost and risks of research and development, while enjoying relative freedom in finding a solution. Anyone can compete and win on a level playing field; the only thing that matters is performance, democratizing with this problem solving[319].

These types of inducement prizes have proved to be increasingly important for incentivizing innovative efforts, in the past they have inspired various scientific and technological breakthroughs, including marine technologies, locomotive engine designs, aeronautical experimentations, and even food preservation solutions[320].

The success of these R&D contest policies in spurring innovations has further invigorated interest in this mechanism. As such, the U.S. National Science Foundation has consistently increased the proportion of its budget that is devoted to sponsoring

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[315] Witters et al. (2012). The Role of Public-Private Partnerships in Driving Innovation. The Global Innovation Index. Available at: http://www.wipo.int/export/sites/www/econ_stat/en/economics/gii/pdf/chapter2.pdf

[316] David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf

[317] As provided through "the Congress Blog" in an article prepared by Gus Schaefer UL's Public Safety Officer and Ombudsman. Available at: http://thehill.com/blogs/congress-blog/economy-a-budget/318805-the-value-of-public-private-partnerships-in-driving-innovation

[318] Qiang Fu et al (2011). Incentivizing R&D: Prize or Subsidies? Elsevier 2011.

[319] Michael Hendrix (2014). The Power of Prizes. U.S. Chamber of Commerce Foundation. Available at: http://www.uschamberfoundation.org/sites/default/files/article/foundation/Power%20of%20Prizes_0.pdf

[320] Qiang Fu et al (2011). Incentivizing R&D: Prize or Subsidies? Elsevier 2011.

inducement prizes[321]. Furthermore, other innovation dependent agencies like the U.S. Department of Defense (DoD), have consistently relied on these type of policies to stimulate private investment in technology, a recent example, was the DoD posting an award of $1 million for a lighter, more wearable power system for military use in 2011[322].

As noted by Jonathan Adler, in the climate change context, traditional government research subsidies are not enough to drive substantial technological innovation. If the goal is to spur enough innovation to make greenhouse (GHG) targets achievable, policymakers should consider the use of technology inducement prizes. Prizes are particularly well suited for the climate policy challenge because the threat of global warming cannot be reduced by any meaningful degree without dramatic technological breakthroughs that enable reductions in atmospheric concentrations of GHGs[323], and traditional innovation tools are inadequate. Patent protection provides a strong incentive to innovate in many areas, but not where there is knowledge spillovers, uncertainty in returns, and negative external effects (as with technology applications that have the capacity to mitigate climate change). Specifically, because the atmosphere is, for all practical purposes, a global, open-access commons, there is no price on GHG emissions, no direct economic incentive to reduce such emissions, and consequently no meaningful market for GHG emission-reducing technologies. Without such a market, there is little economic incentive to pursue patents in this area. Prizes can therefore fill the gap by providing the promise of super competitive returns for the development of climate-protecting innovations[324].

#### *4.1.7. Research Oriented Tax Credits*

Allows investments in research and development to be fully or partially credited from a tax account on a "one to one basis" with the purpose of lowering the cost of these activities and incentivizing private firms to undertake them[325].

Usually this credit is given to private parties that invest in activities defined as "qualified research". In the United States to access the credit, claimed research activities have to undergo a "four-part test" comprised of the next requirements[326]:

> *Permitted Purpose:* The purpose of the activity or project must be to create new or improve existing functionality, performance, reliability, or quality of a business component. A business component is defined as any product, process, technique, invention, formula, or computer software that the taxpayer intends to hold for sale, lease, license, or actual use in the taxpayer's trade or business.
>
> *Elimination of Uncertainty*: the taxpayer must intend to discover information that would eliminate uncertainty concerning the development or improvement of the business component. Uncertainty exists if the information available to the taxpayer does not establish the capability of development or improvement, method of development or

[321] "Innovation Inducement Prizes at the National Science Foundation" (The National Academies Press, Washington, D.C.).
[322] Qiang Fu et al (2011). Incentivizing R&D: Prize or Subsidies? Elsevier 2011.
[323] As analyzed in Chapter 3, energy innovation plays a crucial role in this regard.
[324] Jonathan Adler (2011). Eyes on the Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization. Available at: http://paloaltoprize.com/wp-content/uploads/2014/09/Prizes_EYES_ON_A_CLIMATE_PRIZE_CaseWestern_3_2011.pdf
[325] Mary Moore (2013). Incentivizing U.S. Innovation: Enhancing the R&D Credit. Grant Thornton. Available at: http://www.grantthornton.com/staticfiles/GTCom/Public%20companies%20and%20capital%20markets/RD-Credits-Perspective-May2013-FINAL.pdf
[326] As provided by section 41 of the U.S. Internal Revenue Code.

improvement, or the appropriateness of the business component's design.

*Process of Experimentation:* the taxpayer must undergo a systematic process designed to evaluate one or more alternatives to achieve a result where the capability or the method of achieving that result, or the appropriate design of that result, is uncertain as of the beginning of the taxpayer's research activities. Treasury Regulations define this as broadly as conventional implementation of the scientific method to something as informal a systematic trial and error process.

*Technological in Nature:* the process of experimentation used to discover information must fundamentally rely on principles of the physical or biological sciences, engineering, or computer science. A taxpayer may employ existing technologies and may rely on existing principles of the physical or biological sciences, engineering, or computer science to satisfy this requirement.

Companies that undertake investments in "qualified research" can then deduct up to 20% of their incurred costs from their corporate income taxes.

The R&D tax credit is one of the most studied tax incentives[327]. Taken as a whole, the available research advances that there is substantial evidence to indicate that providing for tax liability reductions has a positive effect of R&D performed. There is tenuous agreement, derived from these studies that, where implemented, the R&D tax credit generally stimulates one dollar of R&D spending for each dollar that it is subtracted from the general tax liability through its application[328].

#### *4.1.8. Research and Development Public Financing*

Research and development public financing allows to allocate capital either through equity financing or concessional rate loans from the government independently, or with matching private investors. This type of financing is aimed at addressing the funding needs of entrepreneurial companies that for reasons of stage of development cannot seek capital from more traditional sources, such as public markets and banks[329]. Equity capital investments are generally made in exchange for shares and possibly an active role in the invested company, and concessional rate loans are advanced at low rates and with repayment obligations that are tied only to the ultimate market success of the developed technology[330]. The main purpose of research and development oriented public financing in renewable energy technologies is focused at increasing innovation by providing the

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[327] Laura Tyson and Greg Linden, "The Corporate R&D Tax Credit and U.S. Innovation and Competitiveness," Center for American Progress, January 6, 2012, 41, http://www.americanprogress.org/issues/tax-reform/report/2012/01/06/10975/the-corporate-rd-tax-credit-and-u-s-innovation-and-competitiveness/.

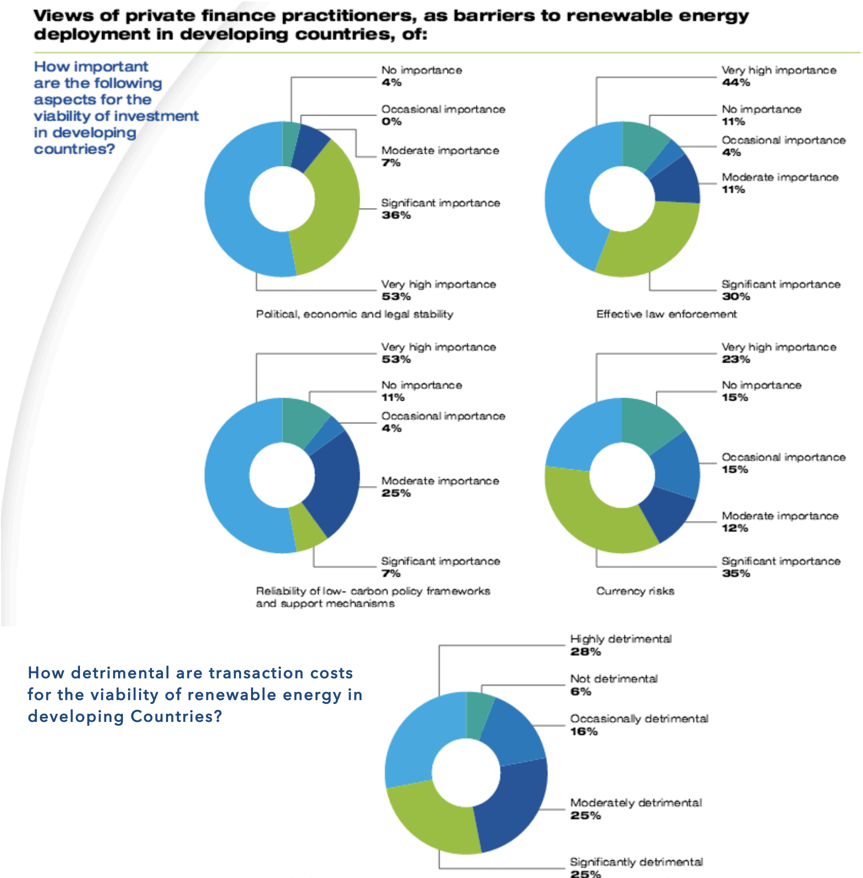
[328] As an example see: Bronwyn Hall and John Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," Research Policy29, no. 4–5 (April 2000): 449–69, doi:10.1016/S0048-7333(99)00085-2.

[329] Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation: An overview of mechanisms being used today to help scale up the climate mitigation markets, with a particular focus on the clean energy sector. United Nations Environment Programme (UNEP), Paris, France. Available at: www.unep.fr/energy/finance/documents/pdf/UNEP_PFM%20_Advance_Draft.pd.

[330] Shally Venugopal and Aman Srivastava (2012). Glossary of Financial Instruments. World Resources Institute. Available at: http://www.wri.org/sites/default/files/pdf/glossary_of_financing_instruments.pdf

required financing to turn promising research into new products and services by virtue of demonstration and early market deployment[331].

For many renewable energy projects the availability of commercial financing is still limited, particularly in developing countries, where the elevated risks posed by weaker institutional capacities frequently inhibit private sector engagement especially in research and development activities[332]. This is evidenced by a study conducted by the United Nations Environment Program, which found that transaction costs; political, economic and legal stability issues; ineffective law enforcement; unreliability of low-carbon support policy frameworks; and currency risks - all of which private finance practitioners associate with developing Countries - considerably impact their willingness to offer financial products for renewable energy in these Countries. Below the figure that summarizes these findings.



[333]

Often the gaps caused by these issues, can be filled only with financial products created through the help of public finance mechanisms, as public venture capital or concessional rate loans, which can help commercial financiers act within a national policy framework, filling gaps and sharing risks where the private sector is initially unwilling or unable to act on its own[334]

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331 Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation: An overview of mechanisms being used today to help scale up the climate mitigation markets, with a particular focus on the clean energy sector. United Nations Environment Programme (UNEP), Paris, France. Available at: www.unep.fr/energy/finance/documents/pdf/UNEP_PFM%20_Advance_Draft.pdf.

332 Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation: An overview of mechanisms being used today to help scale up the climate mitigation markets, with a particular focus on the clean energy sector. United Nations Environment Programme (UNEP), Paris, France. Available at: www.unep.fr/energy/finance/documents/pdf/UNEP_PFM%20_Advance_Draft.pd.

333 United Nations Environmental Program (2012). Financing Renewable Energy in Developing Countries. Available at: http://www.unepfi.org/fileadmin/documents/Financing_Renewable_Energy_in_subSaharan_Africa.pdf

334 Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation: An overview of mechanisms being used today to help scale up the climate mitigation markets, with a particular focus on the clean energy sector. United Nations Environment Programme (UNEP), Paris, France. Available at: www.unep.fr/energy/finance/documents/pdf/UNEP_PFM%20_Advance_Draft.pd.

### 4.2. Demand-Pull Policies[335][336]

#### *4.2.1. Tax Credits (Production or Investment)*

Provides investors or owners with an annual income tax credit (full or partial), based on the amount of money invested in renewable energy infrastructure, or the amount of renewable energy that this investor or owner generates[337].

The Production Tax Credit (PTC) reduces the income tax liability of tax-paying owners/investors of renewable energy projects based on the electrical output (measured in kilowatt-hours, or kWh) of grid-connected renewable energy facilities. While the Investment Tax Credit (ITC) reduces income tax liability for tax-paying owners/investors based on capital investment in renewable energy projects, (the ITC is generally earned when the equipment is placed into service)[338].

An example of an Investment Tax Credit program is the U.S. Solar Investment Tax Credit, a 30 percent federal tax credit for solar systems on residential and commercial properties that is scheduled to remain in effect through December 31, 2016. This tax credit is a dollar-for-dollar reduction in the income taxes that a person or company claiming the credit would otherwise pay to the federal government. The ITC is based on the amount of investment in solar property. Hence, both the commercial and residential ITC are credits equal to 30 percent of the basis that is invested in eligible property that is placed in service before December 31, 2016. Some of the claimed benefits of this program are[339]:

- The ITC has fueled dramatic growth in solar installations. The market certainty provided by a multiple-year extension of the residential and commercial solar ITC has helped annual solar installation grow by over 1,600 percent since the ITC was implemented in 2006 - a compound annual growth rate of 76 percent.
- The ITC has fueled dramatic job creation. Solar employment has grown by 86% in the last four years and is creating jobs at a rate nearly 20 times higher than employment growth in the overall economy.
- The cost of solar for consumers has continued to fall. The existence of the ITC through 2016 provides market certainty for companies to develop long-term investments that drive competition and technological innovation, which in turn, lowers costs for consumers.

As for production tax credits, the landmark example in the United States is the federal production tax credit program implemented to spur wind based electricity generation[340]. Originally enacted in 1992 and expired in 2014, this credit provided a rebate

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335 As explained through Chapter 3, "demand-pull" instruments, foster innovation and technical change by addressing market factors and facilitating learning-by-doing. Bessen, J., (2008). The Value of Us Patents by Owner and Patent Characteristics. Research Policy 37(5), 932-945.

336 Although some of the policies that are analyzed here are similar to some that have been advanced before through the "technology-push" section, their difference stems from the fact that they are directed at tackling a different stage of technological application. "Technology-push" policies are aimed at promoting innovation, while the policies advanced in this section are concerned with the "diffusion" part of the process.

337 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://www.dsireusa.org/

338 Jenna Goodward and Mariana Gonzales (2010).The Bottom Line on Renewable Tax Credits. World Resources Institute. Available at: http://www.wri.org/sites/default/files/pdf/bottom_line_renewable_energy_tax_credits_10-2010.pdf

339 Information provided by the "Solar Energy Industries Association" through: http://www.seia.org/policy/finance-tax/solar-investment-tax-credit

340 Through different periods of its implementation it also covered Geothermal Electric, Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Tidal, Wave, and Ocean Thermal.

of a specific amount for every KWh ($0.023/kWh in 2014) generated by a wind based electricity generation project[341]. Some of its claimed benefits are[342]:

- High levels of job creation, the wind industry currently employs more than 73,000 people in the U.S., with a manufacturing supply chain of more than 500 factories across 43 states.
- Over 70% of U.S. congressional districts have either a wind project or wind-related manufacturing facility, while many have both.
- Wind farms provided economic benefits for surrounding communities through millions of dollars of added tax revenue, which was used to upgrade critical infrastructure such as roads, schools, and emergency services.
- With over 98% of all wind farms on private land, wind energy projects deliver at least $195 million a year in lease payments to landowners.

#### *4.2.2. Tax Reductions or Exemptions (Sales/Property)*

Reductions or exemptions in sales and/or property tax applicable to the purchase of renewable energy technology.

Sales tax incentives typically provide a reduction or exemption from the applicable sales tax for the purchase of a renewable energy system[343]. This type of policy helps to reduce the upfront costs of the installation of distributed systems[344]. In the United States, there are 29 states that offer sales tax exemptions for renewable energy[345]. Arizona, for example, provides a sales tax exemption for the retail sale of solar energy devices and for the installation of solar energy devices by contractors[346]. Colorado exempts from the state's sales and use tax all sales, storage, and use of components used in the production of alternating current electricity from a renewable energy source. The exemption also includes all sales, storage, and use of components used in solar thermal systems[347].

Property tax reductions or exemptions allow businesses and homeowners to exclude the added value of a solar system from the valuation of their property for taxation purposes[348]. An exemption makes it more economically feasible for a taxpayer to install a solar system on a residential or commercial property. Because property taxes are collected locally in the United States[349], some states have granted local taxing authorities the option of allowing a property tax incentive for renewable technology[350]. More than 30 states that offer property tax policies for renewable energy[351]. For example, New Jersey enacted legislation that exempts solar systems from local property taxes if the system is used to

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341 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://www.dsireusa.org/

342 Benefit information provided by "The American Wind Energy Association" through http://awea.files.cms-plus.com/2015%20PTC%20Handout.pdf

343 Particularly solar given its characteristics of easy distributed deployment.

344 Dsire Solar (2012). Dsire Solar Policy Guide page 39. Available at: http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2015/09/Solar-Policy-Guide.pdf

345 Information provided by the Solar Energy Industries Association through: http://www.seia.org/policy/finance-tax/solar-tax-exemptions

346 Information provided by the Arizona Solar Center through: http://www.azsolarcenter.org/economics/incentives/state-tax-credits.html

347 As provided by "Clean Energy Authority" through: http://www.cleanenergyauthority.com/solar-rebates-and-incentives/colorado/sales-tax-exemption-for-renewables/

348 Dsire Solar (2012). Dsire Solar Policy Guide page 34. Available at: http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2015/09/Solar-Policy-Guide.pdf

349 Also in Mexico.

350 Information provided by the Solar Energy Industries Association through: http://www.seia.org/policy/finance-tax/solar-tax-exemptions

351 Dsire Solar (2012). Dsire Solar Policy Guide page 35. Available at: http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2015/09/Solar-Policy-Guide.pdf

meet on-site electricity, heating, cooling, or general energy needs[352]. In Nevada, one of their renewable energy property tax exemptions allows businesses to apply for a property tax abatement of up to 55 percent for up to 20 years for real and personal property used to generate solar[353].

#### *4.2.3. Accelerated Depreciation*

Under these type of policies businesses may recover investments in certain property through depreciation deductions.

Depreciation is an income tax deduction that allows a taxpayer to recover the cost or other basis of certain property. It is an annual allowance for the wear and tear, deterioration, or obsolescence of the property[354]. Because most long-lived assets are depreciated in one way or another for tax purposes, depreciation itself is not a tax incentive provided preferentially to renewable energy projects. If a renewable energy investment accelerated tax depreciation schedule is made available, then it will provide a preferential incentive, due to the time value of money[355][356].

For example, although wind and solar power projects are designed to operate for twenty years or longer, as much as 95% of an investment in a wind or solar project, in the United States, can be depreciated for tax purposes over an accelerated five to six year period, using the 5-year Modified Accelerated Cost-Recovery System ("MACRS") schedule. This MACRS schedule classifies a number of renewable energy technologies as five-year property[357] such property currently includes[358]:

- A variety of solar-electric and solar-thermal technologies
- Fuel cells and micro-turbines
- Geothermal electric
- Direct-use geothermal and geothermal heat pumps
- Small wind (100 kW or less)
- Combined heat and power (CHP)[359]
- Large wind facilities

The ability of these renewable energy projects to accelerate these deductions (compared to the useful life of the project) leads to greater tax savings earlier in time (at the expense of lesser tax savings in later years), which, in turn, increases the benefit and incentive to invest, due to the time value of money[360].

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352 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/3100
353 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/158
354 As provided by the United States Internal Revenue Service through: https://www.irs.gov/Businesses/Small-Businesses-&-Self-Employed/A-Brief-Overview-of-Depreciation
355 The idea that money available at the present time is worth more than the same amount in the future due to its potential earning capacity.
356 Mark Bolinger (2014). An Analysis of the Costs, Benefits, and Implications of Different Approaches to Capture the Value of Renewable Energy Tax Incenctives. Lawrence Berkeley National Laboratory. Available at: http://eetd.lbl.gov/sites/all/files/lbnl-6610e_0.pdf
357 (26 USC § 168(e)(3)(B)(vi)) under the MACRS, which refers to 26 USC § 48(a)(3)(A)
358 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/676
359 Cogeneration facilities.
360 Mark Bolinger (2014). An Analysis of the Costs, Benefits, and Implications of Different Approaches to Capture the Value of Renewable Energy Tax Incenctives. Lawrence Berkeley National Laboratory. Available at: http://eetd.lbl.gov/sites/all/files/lbnl-6610e_0.pdf

### *4.2.4. Direct Investments*

Public finance mechanisms have a twofold objective: to directly mobilize or leverage commercial investment into renewable energy projects, and to indirectly create scaled up and commercially sustainable markets for these technologies[361].

An essential component of all project financings is project equity ("cash equity" or "private equity"), equity is invested by project sponsors as well as other private equity investors. Generally, direct equity investors provide a specified amount of capital in a project in return for a share of the project's future cash flows[362].

Public finance mechanisms can take the form of government funds set up to invest equity in private transactions, termed private equity. A public institution's role in the operation of private equity funds can be either as the fund manager, directly investing in projects or companies, or as a fund of funds, where they pool their money alongside other investors in a private sector managed fund. Either way, the funds can be structured to provide a range of financial products, from venture capital for new technology developments, to early stage equity for project development activities, to late stage equity for projects that are already fully permitted and ready for construction[363].

### *4.2.5. Shared-Risk Financing*

It has been explained, that due to the limited experience, the early stage development of the relevant markets, and the risk-aversion of the players in developing countries, mechanisms that reduce risks of private investors should be developed. This is a task for the public sector, which by sharing credit risk can mobilize domestic lending. Providing for shared loans and guarantees[364] help banks to gain experience with the management of portfolios of renewable energy loans putting them in a better position to evaluate true project risks, addressing with this the perceptions of elevated risk associated with renewable energy projects, and facilitating commercial investment flow to the renewable energy sector[365].

As an example, in the United States, the Obama administration charged the Department of Energy (DOE) Loan Programs Office (LPO) with jump-starting cutting-edge green technology ventures deemed too risky and expensive to attract cash from private investors. LPO administers two separate loan programs: Section 1703 loan guarantees, and Advanced Technology Vehicle Manufacturing (ATVM) loans. Below the descriptions of both as explained by DOE[366]:

- Section 1703 of Title XVII of the Energy Policy Act of 2005 authorizes the U.S. Department of Energy to support innovative clean energy technologies that are typically unable to obtain conventional private financing due to high technology risks.

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[361] Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Chapter 11. Available at: http://srren.ipcc-wg3.de/

[362] Mitz Levin (2012). Renewable Energy Project Finance in the U.S.: 2010-2013 Overview and Future Outlook

[363] Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation: An overview of mechanisms being used today to help scale up the climate mitigation markets, with a particular focus on the clean energy sector. United Nations Environment Programme (UNEP), Paris, France. Available at: www.unep.fr/energy/finance/documents/pdf/UNEP_PFM%20_Advance_Draft.pd.

[364] Guarantees to a private lender that if the company defaults on a loan related to the project, the government will step in to repay the outstanding balance.

[365] KfW Entwicklungsbank (KfW Development Bank) 2005. Financing Renewable Energy: Instruments, Strategies, Practice Approaches. Available at: https://www.kfw-entwicklungsbank.de/Download-Center/PDF-Dokumente-Diskussionsbeitr%C3%A4ge/38_AMD_E.pdf

[366] As provided by LPO through: http://www.energy.gov/lpo/about-us-home

- Advanced Technology Vehicles Manufacturing (ATVM) loans support the development of advanced technology vehicles (ATV) and associated components in the United States. They also meet higher efficiency standards.

The loans and loan guarantees issued by LPO are structured to be fully repaid with interest over the term of the loan. Each project in the portfolio must begin repaying the principal and interest on its loan around the time it reaches completion. As many of LPO's projects reached completion in the past years, project revenues are being used to repay the loans. According to the Department of Energy's report[367] on the performance of its $ 34.4 billion portfolio of investments in loans and guarantees, as of September 2014, that portfolio had a loss rate of 2.28 percent and had made a profit of $30 million.

As stated in the report, this portfolio has helped to fund more than 30 projects comprised of solar power plants, wind farms, and other renewable energy projects which were deemed to produce enough clean energy to power more than 1 million American homes (roughly the size of Chicago), support the manufacturing of more than 8 million fuel-efficient vehicles, avoid carbon pollution equivalent to taking more than 3 million cars off the road," and create or saved 55,000 jobs.

*4.2.6. Capital Grants/Rebates*

Grants (and rebates) assist directly with reducing the upfront investment cost of a generation facility, with the government typically providing a certain level of direct financial support, for example a refund per megawatt of installed capacity or a percentage of total investment, up to a specified limit[368][369]. Capital grants (or rebates) do not require a long-term policy and financial commitment to each specific project, and they can play a significant role in increasing deployment of small, customer-sited projects particularly for emerging renewable technologies[370]. However, they generally require oversight to ensure that certain preconditions are met, that the quality of new generating capacity meets at least a minimum standard, and that effective operation of installed systems is achieved, which can imply additional administrative costs[371].

An example of a capital grant policy is the one provided by the Rhode Island Commerce Corporation (Commerce RI) in the United States, which seeks to fund commercial scale renewable energy projects to generate electricity for onsite consumption[372]. Currently, the Commerce RI provides grants for small-scale solar projects and direct funding for commercial-scale renewable-energy projects made available to all electricity-generating renewable-energy systems greater than 10 kilowatts (kW).

Incentive amounts are as follows:

- $1.15/W For the first 0-50kW

[367] Available at: http://energy.gov/sites/prod/files/2014/11/f19/DOE-LPO-MiniReport_Final%2011%2013%2014_0.pdf
[368] Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Chapter 11. Available at: http://srren.ipcc-wg3.de/
[369] This incentive is different from a tax credit in the sense that it is not tied to the tax liability of an investor, and hence, it is bestowed regardless of it.
[370] Wiser, R., and S. Pickle (2000). Renewable Energy Policy Options for China: Feed In Laws and Renewable Portfolio Standards Compared. Center for Resource Solutions, San Francisco, CA, USA.
[371] Connor, P., V. Bürger, L. Beurskens, K. Ericsson, and C. Egger (2009). Overview of RES-H/RES-C Support Options. D4 of WP2 from the RES-H Policy project. University of Exeter, Exeter, UK. Available at: www.res-h-policy.eu/downloads/RES-H_Policy-Options_(D4)_fi nal.pdf.
[372] Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/5362

- $1.00/W For the 2nd 50kW (Up to 100kW)
- $.85/W For the 3rd 50kW (up to 150kW)
- $.70/W For the 4th 50kW (up to 200kW)
- $.55/W For the 5th 50kW (Up to 250kW)
- $.40/W For all installed capacity over the first 250kW

Commercial Scale Incentive is capped at $350,000 per project.

#### *4.2.7. Public Procurement*

Public authorities are significant energy purchasers through the operation of hospitals, schools, offices, street lighting etc. Such a large market share has a potential for achieving a vital shift on the demand side towards electricity generated from renewable energy sources by mandating a minimum procurement of this type of electricity, and/or requiring the purchase and installation of distributed generation systems[373].

In the United States for example, Maryland's Governor issued an executive order on March 13, 2001 calling for at least 6% of the electricity consumed by state-owned facilities to be generated from "green" energy sources, such as wind, solar, landfill gas, and biomass. Subsequently, in 2009, the state embarked upon an initiative with the University System of Maryland, termed "Clean Energy Horizons," to contract for renewable energy through long-term power purchase agreements with clean energy developers. Furthermore, in December 2009, the Maryland Department of General Services approved four contracts that are anticipated to eventually supply up to 20% of the electricity needs of state agencies and the university system[374].

Following the same rationale, the Obama administration issued an executive order in 2013 re-establishing one of the proclamations from the climate change plans it had issued during that summer, significantly boosting the U.S. federal government's support of renewable energy to supply 20 percent of its energy consumption by 2020 – more than double the previous goal which was set as 7.5 percent[375].

#### *4.2.8. Renewable Portfolio Standards*

Sometimes called renewable electricity standards, renewable portfolio standards (RPS), are a requirement, typically established through legislation, to provide a minimum amount of energy from renewable resources. Often the requirements are defined as a percentage of renewable energy by a given date (e.g., 20% by 2020). Laws or regulation define what technologies are eligible for RPS requirements as well as which utilities are subject to them[376].

In total, 29 U.S. states and Washington DC have adopted some form of mandatory RPS requirement, with most policies enacted during the latter half of the 1990s and 2000s. Roughly 51 GW or two-thirds of all non-hydroelectric renewable capacity additions from 1998 through 2013 occurred in states with active or impending RPS targets, suggesting that

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[373] European Commision DG Environemnt (2011). Green Public Procurement, Technical Background Report. Available at: http://ec.europa.eu/environment/gpp/pdf/tbr/electricity_tbr.pdf

[374] Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/568

[375] The President's Climate Action Plan, June 2013, available at: https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf

[376] National Renewable Energy Laboratory (2014). Renewable Portfolio Standards, Resources and Technical Assistance. Available at: http://www.nrel.gov/docs/gen/fy14/62350.pdf

these policies, alongside other state and federal policies and voluntary renewable energy markets, have played an important role in driving U.S. renewable electricity growth[377].

As an example, in California, the California Public Utilities Commission (CPUC) implements and administers RPS compliance rules and the energy commission certifies eligible renewable resources procured by retail sellers (investor-owned utilities, electricity service providers, and community choice aggregators) that meet statutory requirements, these retail sellers are obligated to procure 50% of their total electricity from renewable energy sources by year 2030. The renewable portfolio standard only admits as renewable energy the one that is generated from Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind, Biomass, Municipal Solid Waste, Landfill Gas, Tidal, Wave, Ocean Thermal, Hydroelectric (less than 30MW), Anaerobic Digestion, and Fuel Cells using Renewable Fuels[378].

#### *4.2.9. Auction Mechanisms*

Renewable energy auctions are quantity-driven support instruments, where the government initially sets the desired capacity to be installed for specific renewable energy technologies, and the interested parties then place their bids in the form of cost per electricity unit i.e., $/kWh, the winning bids are then allocated the projects for that tariff rate over a certain period of time[379].

There are two main alternatives to design the auction process. Under sealed-bid auctions, bidders do not have information on other bids, or, under descending-clock ones where bidders react dynamically to other bids. There are also hybrid auctions where a descending-clock phase allows for price discovery, which will in turn minimize the winner's curse[380] followed by a sealed-bid one, which prevents collusion and induces a high participation rate for small participants[381].

The auction will generally include the potential renewable energy sites, as in the case of wind on-shore in China, where auctions are organized for specific sites. Bidders will submit a price per MWh of electricity produced from every site and include an amount of electricity to be produced annually (the total production does not need to be binding). Although having site-specific bids may reduce the overall efficiency of the system, since it may decrease competition and lose some of the cost- cutting that would be facilitated by a greater flexibility, site-specificity is an important feature in order to reduce uncertainty and to achieve good regional coordination[382].

Once bids are submitted, the auction moves from site-specificity to a general approach: The number of projects awarded is decided generally, not based on the total energy procured or the sites auctioned, but on the total budget available in the overall tender, i.e., bidders do not compete for the energy, but for the money. This mitigates the

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[377] Galen Barbose et al (2015). Costs and Benefits of the Renewable Portfolio Standards in the United States. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032115008229

[378] Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/840

[379] Pablo del Rio et al (2014). Back to the future? Rethinking Auctions for Renewable Energy Support. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114002007

[380] The winner may overpay or be "cursed" in one of two ways: 1) the winning bid exceeds the value of the auctioned asset such that the winner is worse off in absolute terms; or 2) the value of the asset is less than the bidder anticipated, so the bidder may still have a net gain but will be worse off than anticipated

[381] Angeliki Kylili et al (2014). Competitive auction mechanisms for the promotion renewable energy technologies: The case of the 50 MW photovoltaics projects in Cyprus. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114008399

[382] Angeliki Kylili et al (2014). Competitive auction mechanisms for the promotion renewable energy technologies: The case of the 50 MW photovoltaics projects in Cyprus. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114008399

concerns of policy makers regarding the uncertainty about the total costs of renewable energy support, which is very convenient for budgetary purposes but also for allocating that cost to electricity consumers. Bids would then be ordered from cheapest to most expensive, and would be awarded for all sites until the total budget available is gone[383].

#### *4.2.10. Feed-in Tariffs*

Under a feed-in tariff policy, governments set prices (at a premium) for different types of renewable power to compensate producers for the higher cost of producing clean energy. Utilities are then required to purchase power from renewable resources at this price and have the option of either spreading the additional costs across their entire customer base or receiving compensation from the government to recover the incremental costs. Feed-in tariffs thus essentially subsidize renewable energy sources[384].

The three key incentives that this policy offers to renewable energy generators are[385]:

- Guaranteed access to the grid.
- Stable long-term purchase agreements or an arrangement that ensures a revenue stream for a specified period of time.
- Payment levels usually above market price, based on the cost of renewable energy generation.

Typically, feed-in tariffs will specify[386]:

- **Eligible technologies**: FITs in the United States generally include solar PV, but may include other renewable technologies. Other countries' FITs, particularly the German and Danish programs where the policy was tested and developed, initially focused on supporting wind. In U.S. states with an RPS, the FIT-eligible technologies generally overlap or coincide with RPS-eligible technologies: for example, the FIT set by the Los Angeles Department of Water and Power applies to all technologies eligible for the California RPS. The FIT set by Florida's Gainesville Regional Utilities, the first U.S. municipal utility to institute a FIT, applies only to solar PV generators.
- **Rate and contract terms**: Excluding some experimental programs, most U.S. contracts are long term (10-20 years). This assures project owners of a stable long-term revenue stream. Utilities often set rates that depend on project size (smaller projects tend to receive higher rates) and technology (solar PV tends to receive higher rates than other technologies). Rates can also depend on the overall program goal or size limits (e.g., tariffs that decrease as capacity approaches the program ceiling), and utilities or states may revise their tariffs in cases of over- or under-subscription. The City of Palo Alto Utilities CLEAN program initially set its uniform tariff rate for PV based on the utility's avoided cost of providing electricity; however, after low customer interest as a result of the minimal premium, the utility has since raised the tariff rate by more than 15% while reducing the program size.

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383 Angeliki Kylili et al (2014). Competitive auction mechanisms for the promotion renewable energy technologies: The case of the 50 MW photovoltaics projects in Cyprus. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114008399
384 Fan Zhang (2013). How Fit are Feed in Tariffs, Evidence from the European Wind Market. World Bank Policy Research Working Paper. WPS 6376.
385 Gabriela Elizondo et al (2011). Design and Performance of Policy Instruments to Promote the Development of Renewable Energy: Emerging Experience in Selected Developing Countries. The World Bank. Available at: http://siteresources.worldbank.org/EXTENERGY2/Resources/DiscPaper22.pdf
386 As provided by the U.S. Energy Information Administration through: http://www.eia.gov/todayinenergy/detail.cfm?id=11471

- **System size and sector restrictions**: Most U.S. FIT programs have a maximum size for individual projects and may limit participation to certain sectors, like residential customers. The new Dominion Virginia Power Solar Purchase Program, for example, applies only to residential systems up to 20 kilowatts (kW) and commercial systems up to 50 kW in size, while Hawaii's FIT, which applies to all of Hawaii's investor-owned utilities, has a maximum system size ranging from 2,700 kW to 5,000 kW, depending on the island.
- **Program size limitations**: Most U.S. programs designate a cumulative ceiling, set either annually or at the program level, capping the amount of capacity that can take advantage of the tariff. This is an important cost containment mechanism for FIT programs.

### *4.2.11. Net Metering*[387]

Net metering encourages the installation of grid-connected PV generators owned by the consumers of electricity. This policy provides credit to customers with solar PV systems for the full retail value of the electricity their system generates and injects into the grid. Net metering was first introduced in the United States in the 1980s, and now almost all the states include net metering policies in one of the next modalities[388]:

- **Net metering (simple):** There is a measure of the difference between IE (Imported Energy) and EE (Exported Energy) during the billing period (usually one or two months). If IE e EE > 0: the customer-generator must pay the utility for the difference. If IE e EE ≤ 0: the customer-generator receives no compensation.
- **Net metering with buy-back:** if IE e EE < 0 the customer- generator is paid for the excess energy (EE e IE) generated during the billing period, which can be valued below retail rate (typically avoided cost of generation, i.e., wholesale rate or cost to the utility), retail rate, or above retail rate.
- **Net metering with rolling credit:** the banking period extends over a billing period (typically one year). If during a billing period there is excess energy (IE e EE < 0), this value (EE e IE) is used as a credit to reduce the bill in future billing periods.

As an Example, in the state of Virginia in the United States, net-metering law applies to residential generating systems up to 20 kilowatts (kW) in capacity and non-residential systems up to 1000 kW in capacity. This policy combines the "buy-back" and "rolling credit" modalities as it establishes that net excess generation (NEG) is to be carried forward to the next month and at the end of each 12-month period, the customer has the option of carrying forward excess NEG to the next net metering 12-month period or selling the NEG to the utility[389].

387 This policy shall not be confused with the previously described feed in tariff, which provides a guaranteed premium price to the renewable electricity producer and put an obligation on the grid operators to purchase the generated electricity output. Net metering is different in the sense that it allows utility customers to offset some, or all of their electricity use with self produced electricity from distributed systems.
388 Rodolfo Dufo-Lopez et al (2015). A Comparative Assesment of Net Metering and Net Billing Policies, Study Cases for Spain. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S0360544215003254
389 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/40

### *4.2.12. Priority Access and Dispatch*

Priority access means the admittance of an electricity generating installation to the transmission and distribution systems, i.e. the installation gets the permission to build a connection to the grid allowing to actually inject the electricity produced into it. In terms of priority access, renewable energy generators are guaranteed that they will be able to sell and transmit their electricity in accordance with connection rules at all times, whenever the source becomes available. Furthermore, in the event that the electricity from renewable energy sources is integrated into the spot market, guaranteed access ensures that all electricity sold and supported obtains access to the grid, allowing the use of a maximum amount of electricity from renewable energy sources from interconnected installations[390].

Priority dispatch for renewable energy occurs when transmission system operators schedule and dispatch interconnected renewable generation ahead of other generators. Electricity dispatch means that system operators will have to consider those installations with priority dispatch (renewable energy installations in this case), first, when doing the balancing exercise of supply and demand[391].

Priority dispatch for renewable energy resources has been found to make the entire power generation fleet run in a dynamic way by forcing the system operators to adopt flexible system operation routines and to increase transparency in their operational procedures. When combined with priority or guaranteed access, it ensures the optimum development of the grid infrastructure necessary to effectively integrate renewable energy resources[392].

An implementation example of this policy is the German Renewable Energy Sources Act, which mandates that system operators must, as a priority, purchase, transmit and distribute the entire available quantity of electricity from renewable energy sources. However, system operators are allowed to take technical control over installations connected to the grid to curtail renewable generators output of facilities with a capacity of over 100 kW, if all of the following conditions are met[393]:

- The grid would otherwise be overloaded, if curtailment were not to take place;
- The system operator has ensured that the largest possible quantity of electricity from renewable sources is already being purchased;
- The system operator has reported the current situation to the relevant region of the grid system.

In this case, renewable generators are still compensated on the basis of either a negotiated price or, the original price they would have been paid for their output, minus the expenses they saved as a result of the curtailment[394].

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390 Dr. Dörte Fouque et al. Rules on grid access and priority dispatch for renewable energy in Europe. Bekker Buttner Held. Available at: http://www.keepontrack.eu/contents/virtualhelpdeskdocuments/grid-access_7691.pdf

391 As provided by the Clean Energy Solutions Center through: https://cleanenergysolutions.org/cegin/resources/priority-dispatch

392 European Wind Energy Association. Position on Priority Dispatch of Wind Power. Available at: http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA_position_on_priority_dispatch.pdf

393 European Wind Energy Association. Position on Priority Dispatch of Wind Power. Available at: http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA_position_on_priority_dispatch.pdf

394 European Wind Energy Association. Position on Priority Dispatch of Wind Power. Available at: http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA_position_on_priority_dispatch.pdf

## 4.3. Carbon Abating Policies That Can Indirectly Impact Clean Energy Deployment.

*Carbon Taxes* and *Cap and Trade Mechanisms* are two popular market-based policies, established with the purpose of reducing overall carbon emissions in an economy. Although their main goal is not directed at spurring deployment of clean energy technologies per se, it has been recognized that their implementation can potentially result in clean energy technology development. This, given that a significant carbon price established by a *tax* or a *cap*, can grant economic sense to clean energy investments that can substitute carbon-intensive hydrocarbon generation which are made expensive by virtue of the *cap* or *tax*[395]. As such, this dissertation incorporates these policies in the analysis in order to present a complete assessment of the available policies to spur clean energy deployment.

### *4.3.1 Carbon Taxes*

A carbon tax is a fee assessed on the carbon content of fuels. Because of the strict proportionality between fuels' carbon content and their carbon dioxide emissions when burned, a carbon tax is effectively a tax on the carbon dioxide emissions from burning fossil fuels[396].

As explained in Chapter 3, carbon dioxide rises in the atmosphere and remains there, trapping heat re-radiated from Earth's surface and causing climate change. The essence of every fossil fuel is its carbon and hydrogen atoms, the bond between these carbon and hydrogen atoms is the primary source of the heat released in fuel combustion (in efficient combustion, all carbon atoms are converted to $CO_2$)[397].

A carbon tax thus sets a price for carbon dioxide emissions presenting a need for documentation or measurement in order to assess liability and enforce payment[398]. However, administering a carbon tax should be simple; utilizing existing tax collection mechanisms, the tax can be paid far "upstream," i.e., at the point where fuels are extracted from the Earth and put into the stream of commerce, or imported into National markets. Fuel suppliers and processors would pass along the cost of the tax to the extent that market conditions allow[399].

To the extent that carbon is included in a manufactured product such as plastic, but not burned, that carbon is not be taxed. Similarly, to the extent the carbon used to produce energy is permanently sequestered rather than released into the atmosphere the carbon is not taxed, or alternatively, a tax credit can be provided[400].

A study conducted by the U.S. Energy Information Administration in 2013, sheds light on the effect that a *Carbon Tax* can have in the electricity sector. It does this by analyzing several alternative cases in which hypothetical carbon dioxide ($CO_2$) emission fees were imposed on fossil fuel consumers on an economy-wide basis. The fees were set

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395 Lawrence Goulder and Andrew Schein (2013).Carbon Taxes VS. Cap and Trade: A Critical Review. Available at: http://web.stanford.edu/~goulder/Papers/Published%20Papers/Goulder%20and%20Schein%20-%20Carbon%20Taxes%20vs%20Cap%20and%20Trade%20-%20Cl%20Ch%20Economics.pdf

396 Adapted from the information provided by the "Carbon Tax Center" through: http://www.carbontax.org/whats-a-carbon-tax/

397 Adapted from the information provided by the "Carbon Tax Center" through: http://www.carbontax.org/whats-a-carbon-tax/

398 Adapted from the information provided by the "Carbon Tax Center" through: http://www.carbontax.org/whats-a-carbon-tax/

399 Adapted from the information provided by the "Carbon Tax Center" through: http://www.carbontax.org/whats-a-carbon-tax/

400 Adapted from the information provided by the "Carbon Tax Center" through: http://www.carbontax.org/whats-a-carbon-tax/

to start at $10, $15, and $25 per metric ton of $CO_2$ in 2014 and to rise at 5 percent per year thereafter. The key findings of the study were[401]:

- The electricity sector is very responsive to the imposition of $CO_2$ fees. Across the four fee trajectories examined, electricity sector $CO_2$ emissions are between 28 and 60 percent below the 2005 level in 2025 and 35 and 89 percent below the 2005 level in 2040.

- The emissions reductions are achieved through large reductions in coal use offset by increases in natural gas (particularly early on), nuclear and renewable fuel use, as well as by reductions in overall electricity use.

    - With a $CO_2$ fee starting at $10 per metric ton in 2014 and rising 5 percent per year, coal generation is 24 percent below the Reference case level in 2025 and 37 percent below it in 2040, when it accounts for 23 percent of overall electricity generation. In all of the other $CO_2$ fee cases, coal generation falls to 10 percent to 29 percent of total generation by 2025 and, except for one case, less than 10 percent of total generation by 2040.
    - Natural gas-fired generation surges in the early years after a fee is imposed, but tends to return towards or below Reference case levels between 2030 and 2040. In 2025, natural gas-fired generation ranges from 10 percent to 39 percent above the Reference case level in the four $CO_2$ fee cases. However, by 2040 this range falls to between 14 percent below the Reference case level and 5 percent above the Reference case level.
    - Renewable and nuclear generation becomes particularly important over time as large numbers of new plants are brought on line as coal plants retire. In 2025, renewable generation in the $CO_2$ fee cases is between 21 percent and 46 percent above the Reference case level. By 2040 the increase ranges from 41 percent to 71 percent above the Reference case level. Relative to the Reference case, nuclear generation is between 0 percent and 12 percent higher in 2025 and 20 to 105 percent higher in 2040 the $CO_2$ fee cases.

*4.3.2 Cap and Trade*

Cap and trade is a cap on total emissions and the implementation of a system that allows trading to achieve that limit as cost-effectively as possible. Its purpose is to create a market and a price on emissions[402].

The process of its implementation is typically comprised of two main steps. First, the Government sets the limit on overall pollution – that is "the cap", and then, it sells or freely distributes allowances, each representing the right to emit a certain amount of carbon dioxide, the total number adding up to the size of the cap for that year. Allowance recipients are free to trade the allowances among themselves and with other market

[401] Energy Information Administration (2013). Further Sensitivity Analysis of Hypothetical Policies to Limit Energy-Related Carbon Dioxide Emissions. Available at: https://www.eia.gov/forecasts/aeo/supplement/co2/

[402] G. Wagner (2015). Carbon Cap and Trade. Available at: http://www.sciencedirect.com/science/article/pii/B9780123750679000711

participants. That flexibility grants every participant the possibility of choosing how to meet his or her obligation[403].

The cap is typically set to decline over time, ensuring that overall carbon emissions do, too. Assuming that all innovation has been fully anticipated, a declining cap would go hand in hand with increasing allowance prices over time, making carbon emissions increasingly costly[404].

In a well-designed program, the cap's declining path is set well in advance to enable businesses to plan ahead and invest and innovate accordingly. As a result, carbon prices may decline hand in hand with carbon emissions. The carbon allowance price will be as high as necessary and as low as possible to achieve emissions reductions set by the declining cap[405].

An example of this policy is the European Union Emission Trading System (EU ETS), currently the largest emission trading system in the world. Initiated in 2005, the EU ETS puts a cap on the $CO_2$ emissions of the European electric power sector, other heavy industry (e.g., steel, aluminum, cement, pulp and paper), and more recently aviation (flights within Europe). Within the EU ETS, the electric power sector is responsible for about half of the $CO_2$ emissions, while the other industries take up the other half. The EU ETS covers around 45% of total European greenhouse gas emissions. For every ton of $CO_2$ emitted, an allowance has to be surrendered. These allowances can be traded freely on the market, between companies, active in the different sectors under the cap. This way, $CO_2$ emissions are abated where it is cheapest and $CO_2$ emissions are displaced from sectors with cheap abatement possibilities towards sectors with more expensive abatement options. After a trial period running from 2005 to 2007, the second ETS trading period spanned the Kyoto commitment period (2008–2012). The third period currently runs from 2013 till 2020. Allocation of allowances was initially largely for free (until 2012). As from 2013, the major share of allowances is auctioned (at least in the electric power sector)[406].

The ETS sectors undertake an absolute cap on $CO_2$ emissions, declining each year, to reach a 21% reduction in 2020 compared to 2005. The tightness of the cap determines the level of abatement required compared to business as usual (no cap), and hence sets the price of the allowances. With an absolute cap, the demand for allowances is, however, also heavily influenced by external factors. A first example is the economic/financial crisis reigning in Europe from 2008 onwards, clearly having an impact on industrial activity and hence $CO_2$ emissions. Second, also certain policy measures can affect the demand for allowances, e.g., imposing targets for renewable energy, this way pushing carbon free electricity into the system, again reducing the tightness of the cap. These two effects, together with a relatively high inflow of international credits (which can cover part of the emissions under the cap), have led to a surplus of allowances, gradually built up since the second trading period. Allowances are furthermore bankable to subsequent trading periods. The surplus being built up in the second period was then transferred to the third trading period, leading to a surplus of allowances of over 2000 $MtCO_2$ in 2014. Correspondingly, for several years the EUA price has been consistently low, between 4 and 8 EUR/$tCO_2$.

[403] G. Wagner (2015). Carbon Cap and Trade. Available at: http://www.sciencedirect.com/science/article/pii/B9780123750679000711
[404] G. Wagner (2015). Carbon Cap and Trade. Available at: http://www.sciencedirect.com/science/article/pii/B9780123750679000711
[405] G. Wagner (2015). Carbon Cap and Trade. Available at: http://www.sciencedirect.com/science/article/pii/B9780123750679000711
[406] Erik Delaure and Kenneth Van Den Bergh (2016). Carbon Mitigation in the Electric Power Sector Under Cap-and-Trade and Renewable Policies. Available at: http://www.sciencedirect.com/science/article/pii/S0301421516300295

While $CO_2$ emissions are below the cap and hence meet the target set, a current concern in the policy debate is the resulting $CO_2$ price, which is considered too low to serve as a solid signal for low carbon investments deemed crucial for the transition to a low-carbon energy system on the longer term. Despite these current issues, the EU ETS is still considered as Europe's main instrument to reduce carbon emissions[407].

## 5. Feasibility of Policy Alternatives Under the Current Mexican Context

### METHODOLOGY

This portion of the dissertation will analyze the feasibility of the different policy alternatives presented during the previous chapter in light of the current Mexican context in three main respects: legal feasibility, political feasibility, and economic feasibility.

i. In terms of legal feasibility, policy alternatives will be analyzed in view of the current legal framework. In order to be deemed "legally feasible" a policy should not require any changes in the current laws, policies that fall into this category will be assigned a value of "1" for legal feasibility. In turn, policies that do require changes in laws would be deemed not legally feasible under the current framework, and as such they will receive a value of "0" in this category.

ii. Political feasibility of the different policy alternatives will be analyzed through the scope of the goals presented by the President, and the heads of the agencies in charge of energy policy, through media and/or relevant codified documents. This can provide evidence of the objectives of those who currently determine the Country's energy path. Policies that are deemed not be viable in the current political scenario, will receive a value of "0" in terms of political feasibility, in contrast, policies that are in harmony with the current political agenda of the country, will receive a value of "1". Furthermore, an intermediate outcome could develop regarding the political feasibility of a particular policy, this as directly denying its viability through the analyzed instruments, is not the same as disregarding it. The latter could be due to the fact that the particular policy has not been explored, in contrast to a direct denial, which conveys that the particular policy has been already explored and denied. As such, policies that are disregarded but not expressly rejected will receive a value of "0.5" in this category.

iii. Policies deemed economically feasible cannot increase the overall costs for the Federal Government; hence, they have to have the possibility to be financed through the management of currently assigned budgets, or, through the enactment of other policies that can help generate revenue for their implementation. Through this analysis, policies that can be developed without increasing the overall costs for the Federal Government will receive a value of "1", while policies that would increase costs will receive a value of "0".

[407] Erik Delaure and Kenneth Van Den Bergh (2016). Carbon Mitigation in the Electric Power Sector Under Cap-and-Trade and Renewable Policies. Available at: http://www.sciencedirect.com/science/article/pii/S0301421516300295

After these feasibility values have been assigned to every policy alternative, charts that showcase the feasibility levels of each policy will be provided. This, in order to shed light on which "technology-push" and "demand-pull" policies are the most viable in the current context of the Country.

5.1. Technology-Push Policies

*5.1.1. Academic R&D Funding*

**Legal Feasibility:** Currently the laws provide for energy related research and development funds to be allocated directly from the "Petroleum Dividend" that "PEMEX" as a National Productive Enterprise hands to the Federal Government each year[408]. The Ministry of Finance and Public Credit determines the total amount of this "Petroleum Dividend" through the analysis of the financial statements of this enterprise[409], and then it assigns a portion of it[410] to three different trust funds that are in charge of promoting research and development activities[411]:

4. The CONACYT/SENER Hydrocarbons fund[412]: This trust fund has the goal of promoting research and development activities focused at analyzing the different aspects and implications of exploration, extraction, and refining activities. While also promoting the identification of areas with hydrocarbon potential in Mexico.
5. The Scientific Research and Technological Development Fund of the Mexican Petroleum Institute[413]: This trust fund is in charge of promoting applied research, and deployment of: exploration, extraction, and refining technologies.
6. The CONACYT/SENER Sustainability fund[414]: This trust fund has the goal of promoting research and development activities in the topics of renewable energy, energy efficiency, and diversification of energy sources.

These trust funds are managed by their "technical committee"[415], which decides the research and development programs that are to be implemented with the assigned funds[416].

The fact that *Academic R&D funding* can be promoted with a renewable energy focus through the CONACYT/SENER Sustainability fund by virtue of law, if decided by its "technical committee", evidences that there is no need for changes in the current laws to develop and implement this policy; hence, we can grant *Academic R&D funding* a value of "1" for legal feasibility in this study.

**Political Feasibility:** The "National Development Plan"[417] (2013-2018) advanced by the President, establishes that science and technology are innovation pillars for economic and social development. As such, it proposes an increase in government

[408] As provided by title 2, chapter 6, article 97 of the Mexican Petroleums Law (Ley de Petroleos Mexicanos)
[409] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
[410] The result of multiplying the total dividend by .0065
[411] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
[412] This trust fund receives 65% of the assigned amount.
[413] This trust fund receives 15% of the assigned amount.
[414] This trust fund receives 20% of the assigned amount.
[415] Formed by public servants from the Ministry of Energy and one representative of the National Council of Science and Technology.
[416] As provided by section 4, articles 25 and 26 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)
[417] The National Development Plan, is the document that directs the actions of the federal government for any given presidential period, it contains the main goals, strategies and programs to be carried out throughout the period.

investments for research and development activities of up to 1% of the GDP[418]. Which suggests that funding research and development activities is one of the main goals of the President for his period.

Moreover, the "National Energy Strategy" (2013-2027) prepared by the Ministry of Energy, establishes as an objective the promotion of an innovation "chain": *academia-science-technology-innovation* in order to stimulate technological advancement in the energy sector which can in turn spur the Mexican economy[419]. This indicates that the Ministry of Energy recognizes the fundamental role that academia plays in innovation.

In addition to this, recent media appearances both by the President and by the Minister of Energy[420] have disclosed that promoting technological advancement through research and development activities in the energy sector is a directive of the President to be carried out by the Ministry of Energy.

The fact that the goal of spurring technological advancement in the energy sector through the promotion of research and development activities has been advanced not only through media appearances, but also through codified documents as the "National Development Plan" and the "National Energy Strategy" (the latter which specifically refers to the role of academia in this efforts), suggests that the implementation of *Academic R&D funding* is politically feasible in the current Mexican scenario. As such, this policy receives a value of "1" for political feasibility in this study.

**Economic Feasibility:** As explained before, the CONACYT/SENER Sustainability Fund's resources come from the petroleum dividend paid by PEMEX to the Federal Government[421]. The specific yearly amount of resources allocated to this fund is determined by multiplying the petroleum dividend by .0065 and then multiplying that result by .20, which means that the funds for promoting renewable energy, and energy efficiency research and development activities in the Country amounts to .13% of the yearly petroleum dividend[422]. To put things in perspective, in 2010, the sustainability fund received 713 million pesos[423][424] from the "Petroleum Dividend" for renewable energy and energy efficiency research and development activities.

Currently[425] the CONACYT/SENER Sustainability Fund, has 6 different programs in place[426]:

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[418] Objective 3.5 of the National Development Plan (Plan Nacional de Desarrollo), available at: http://pnd.gob.mx/

[419] As provided by the "Strategic Theme #17" of the "National Energy Strategy" document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf

[420] As provided by the next news articles: http://sipse.com/mexico/reforma-energetica-avances-sener-pedro-joaquin-coldwell-141262.html http://eleconomista.com.mx/sociedad/2015/04/13/mexico-comprometido-desarrollo-tecnologico-epn

[421] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

[422] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

[423] The multiplication factor to calculate the portion of the dividend allocated for energy research was set at .0040 in 2010 (as opposed to the current .0065 rate), 20% of which was assigned to the sustainability fund. It is worth noting also that the price for Barrel of Oil during that year was in average $72 dollars.

[424] Number provided by a study prepared by Leonardo Beltran, current Underminister of Energy Transition, this study is available at: http://energiaadebate.com/el-fondo-de-sustentabilidad-energetica-impulso-al-desarrollo-tecnologico/

[425] As of 2015

[426] There is no information regarding the specific amounts allocated to the majority of these programs separately. The only program that indicates specific amounts is the International Cooperation in Geothermal Research and Development program between Mexico and the European Union, which states that both the Mexican government and the European Union would disburse up to 10 million euros each for selected projects. The programs can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica

- Innovation Laboratory for Energy Sustainability: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals for research and development projects regarding energy efficiency, and renewable energy.
- Institutional Strengthening for Energy Sustainability: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals for projects aimed at strengthening the technical capacity of basic and applied renewable energy and energy efficiency research focused facilities.
- Mexican Postdoctoral Projects in Energy Sustainability: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals regarding postdoctoral research projects focused at energy sustainability, with the purpose of incentivizing recent Mexican doctoral graduates to advance research efforts in energy sustainability and develop their technical capabilities while doing so.
- CONACYT-SENER Energy Sustainability Innovate UK 2015-03: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals in regards to energy sustainability projects in collaboration with companies from the United Kingdom.
- International Cooperation in Geothermal Research and Development Between Mexico and the European Union: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals in collaboration with any kind of entities or states of the European Union to undertake research and development activities focused on geothermal energy.
- Postdoctoral Fellowships in Mexico – Energy Sustainability: A call for postdoctoral proposals from foreign or Mexican students that want to conduct energy sustainability postdoctoral research in Mexico.

Without making any judgments in regards to the amounts of the allocated resources for renewable energy research. It is clear that the CONACYT/SENER Sustainability fund could manage its currently assigned resources to fund *Academic R&D* to the desired extent, the only restriction being the budgetary constrains that stem from the funding requirements of other potential research and development policies. Therefore, given that this policy can be implemented without increasing the overall cost for the government, *Academic R&D Funding* has been granted a value of "1" for economic feasibility.

### *5.1.2. R&D and Demonstration Grants*

**Legal Feasibility:** As noted before, the current laws provide for renewable energy research and development programs to be developed and carried out through the CONACYT/SENER Sustainability Fund with its assigned budget, which constitutes .13% of the Petroleum Dividend[427]. The fact that, as *Academic R&D Funding*, *Applied R&D and*

[427] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

*Demonstration Grants* can be promoted with a renewable energy focus through the CONACYT/SENER Sustainability fund by virtue of law, if decided by its "technical committee", evidences that there is no need for changes in the current laws to develop and implement this policy; hence, we can grant *Applied R&D and Demonstration Grants* a value of "1" for legal feasibility in this study.

**Political Feasibility:** The Special Program for the Development of Renewable Energy (2014-2018)[428] prepared by the Ministry of Energy, advances that in order to promote competitiveness and economic development, mechanisms that incentivize industry participation in technological innovation regarding alternative energy sources should be explored and implemented[429]. This suggests that the Ministry of Energy would be in favor of developing policies that promote applied research and development, and technological demonstration activities by the industry.

In addition to this, following the objective advanced by the President through the "National Development Plan" of increasing government investments for research and development activities up to 1% of the GDP[430]. In April 2015, the President exhibited during a National Council of Science and Technology meeting how the investment in research and development activities went from .43% of the GDP in 2012 to .54% in 2014, and expressed that these investments efforts would be furthered more aggressively during the rest of his Presidential period[431].

Moreover, the President has advanced during recent participations in international public events, that there will be promotion of renewable energy focused research and development activities to spur innovation in solar, wind, geothermal and ocean technologies, through mechanisms that promote industry participation and international collaboration[432].

All of this evidences that currently there is political will in Mexico to pursue research and development policies aimed at fostering industry participation in these efforts. As such, *Applied R&D and Demonstration Grants* receives a value of "1" for political feasibility.

**Economic Feasibility:** The CONACYT/SENER Sustainability fund has assigned resources that come from the petroleum dividend paid by PEMEX to the Federal Government[433]. As explained before, the specific yearly amount of resources allocated to this fund is determined by multiplying the petroleum dividend by .0065 and then multiplying that result by .20, this means that the funds for promoting renewable energy, and energy efficiency research and development activities in the Country amount to .13% of the yearly petroleum dividend[434]. The CONACYT/SENER Sustainability fund could

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[428] Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf
[429] Objective #4 of the program.
[430] Objective 3.5 of the National Development Plan (Plan Nacional de Desarrollo), available at: http://pnd.gob.mx/
[431] As provided by the next press release from the National Council for Science and Technology: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/458-preside-enrique-pena-nieto-el-consejo-general-de-investigacion-cientifica-y-desarrollo-tecnologico-e-innovacion
[432] As evidenced by the next news article that showcases the main takeaways of a meeting between the Mexican President and the President of the European Union Council: http://eleconomista.com.mx/entretenimiento/2015/06/14/mexico-ue-mas-colaboracion-investigacion-desarrollo and the following which showcases the main points of the President's joint participation with Gov. Jerry Brown (California) in a bilateral meeting: http://www.animalpolitico.com/2014/08/pena-nieto-y-gobernador-de-california-coinciden-en-fortalecer-la-relacion-bilateral/
[433] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
[434] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

therefore manage its current budget to fund *Applied R&D and Demonstration Grants* by virtue of the decision of its "technical committee", without causing an overall increase in costs for the Federal Government; hence, this policy receives a value of "1" for economic feasibility.

#### *5.1.3. Incubation Support*

**Legal Feasibility:** The Law of Science and Technology directly lists the establishment of incubation programs[435] as one of the allowed activities for "sectorial funds" (as the CONACYT/SENER Sustainability Fund), to promote research and development, within the scope of their goals. As explained before, the current laws provide for renewable energy research and development programs to be developed and carried out through the CONACYT/SENER Sustainability fund with its assigned budget[436]. Hence, developing a program that provides for the creation of an "incubator" can be implemented by virtue of law through the decision of its "technical committee". This allows us to grant a value of "1" for legal feasibility to *Incubation Support*, as its application does not require any changes in current laws.

**Political Feasibility:** the "National Energy Strategy" (2013-2027) prepared by the Ministry of Energy, establishes as an objective the promotion of mechanisms that can "link" research and development activities from the academia and research centers, with deployment of developed technologies by the industry in order to spur the application and dissemination of renewable energy technologies[437].

Furthermore, the Special Program for the Development of Renewable Energy (2014-2018)[438] prepared by the Ministry of Energy, and promulgated by the President, advances throughout the document that the development of "value chains"[439] in the energy sector is of utmost importance in order to transition towards a "knowledge economy"[440] in Mexico.

The fact that *Incubation Support* can aid towards these goals, by providing entrepreneurs that have developed renewable energy technologies with a comprehensive and integrated range of support[441], which accelerates and systematizes the process of creating successful enterprises, and promotes the effective application of the developed technologies. Suggests that currently there is political will to implement this policy in Mexico, as this policy is aimed directly at attaining the goals set by the President and the Ministry of Energy in regards to the creation of "value chains" in the energy sector, and the transition towards a "knowledge economy". For these reasons, *Incubation Support* receives a value of "1" for political feasibility in this study.

**Economic Feasibility:** Given that *Incubation Support* could be implemented by decision of the "technical committee" of the CONACYT/SENER Sustainability Fund[442] through the management of its assigned budget (which amounts to .13% of the Petroleum

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435 As "Unidades de Vinculacion" through Section 4, article 25bis of the Law of Science and Technology (Ley de Ciencia y Tecnologia)
436 As provided by section 4, articles 25 and 26 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)
437 As provided by the "Strategic Theme #15" of the "National Energy Strategy" document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
438 See page 26 of the document available at: http://www.energia.gob.mx/res/planeacion/PEAER%202014.pdf
439 A value chain is a set of activities that a firm operating in a specific industry performs in order to deliver a valuable product or service for the market.
440 The knowledge economy is the use of knowledge to generate tangible and intangible values.
441 Including: incubator space, business support services, and, clustering and networking opportunities.
442 Section 4, article 25 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)

Dividend)[443], without causing an overall increase in costs for the Federal Government; *Incubation Support* receives a value of "1" for economic feasibility.

### *5.1.4. Establishment of Public Research Centers*

**Legal Feasibility:** The current laws provide for renewable energy research and development programs to be carried out through the CONACYT/SENER Sustainability fund with its assigned budget[444]. There is a provision in the Law of Science and Technology fact that refers specifically to the funding of research infrastructure, as a possible program to be developed by sectorial funds as the CONACYT/SENER Sustainability fund[445]. Therefore, given that the establishment of research institutions like Public Research Centers could be implemented without having to change the current laws, *Establishment of Public Research Centers* is given a value of "1" for legal feasibility in this study.

**Political Feasibility:** A recent document prepared by the Ministry of Energy and the CONACYT/SENER Sustainability Fund[446] showcases that the establishment of renewable energy research centers is one of the main priorities of the Ministry of Energy in terms of research and development. This document advances that research centers are basic to promote collaboration between the government, academic institutions and the private sector in research and development activities, which can spur renewable energy innovation, and provide technical preparation to human resources to advance new technology deployment.

Moreover the "Energy Transition Strategy for the Promotion of Clean Fuels and Technologies" document (2014-2018), also prepared by the Ministry of Energy, emphasizes the fundamental role of research centers in renewable energy technological innovation, throughout its " Recommendations Towards the Transition of Technologies and Clean Fuel"[447].

Finally, the fact that three renewable energy based research centers were recently created in February 2014 by the Federal Government through the CONACYT/SENER Sustainability Fund[448], showcases that there is political will to pursue and further develop this policy in the Country. This allows us to conclude that the *Establishment of Public Research Centers* in Mexico is politically feasible, and as such, this policy receives a value of "1" in this category.

**Economic Feasibility:** Given that the CONACYT/SENER Sustainability Fund is allowed to fund research centers as part of its programs to promote renewable energy research and development activities by virtue of law[449]; and, that it is given resources from the "Petroleum Dividend" to do so[450], makes it clear that this policy can be implemented without increasing the overall costs for the Federal Government. The CONACYT/SENER Sustainability fund could manage its current budget to restructure

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443 As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

444 As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

445 Section 4, article 25 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)

446 Available at: http://sustentabilidad.energia.gob.mx/res/CEMIE_General.pdf

447 Available at: *www.dof.gob.mx/nota_to_doc.php?codnota=5376675*

448 As evidenced by this press release of the National Council of Science and Technology: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/312-formalizacion-de-los-convenios-de-asignacion-de-recursos-para-tres-centros-mexicanos-de-innovacion-en-energias-renovables-cemie-s

449 Section 4, article 25 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)

450 As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

the recently formed research centers[451], or could direct more resources towards the creation of new ones. This allows us to give a value of "1" to *Establishment of Public Research Centers* in regards to its economic feasibility.

### *5.1.5. Public-Private Research Partnerships*

**Legal Feasibility:** The Law of "Public-Private Associations" advances that these types of partnerships are to be promoted for the purpose of undertaking applied research and innovation activities[452]. This law provides for the creation of a "Public-Private Fund" that is to be managed by CONACYT[453] with the purpose of:

- Creating public-private research centers.
- Investing in research infrastructure.
- Constituting public-private technological research companies.
- Financing public-private technological research programs.
- Developing public-private research programs aimed at advancing the technical preparation of human resources.

The Fund was assigned a budget of one billion pesos in 2014[454], however it is not yet in operation. This, given that its technical committee has not been established, and that, as this fund will provide financial products, it requires contracting with a Development Bank for its operations[455], because in Mexico only Universal Banking Institutions and Development Banks[456] can directly administer financial products[457].

Nevertheless, the fact that the laws currently provide for these types of associations with the purpose of undertaking applied research and technological innovation activities, and that the adequate steps are being followed for the "Public-Private" Fund to be able to begin operations, allows us to grant a value of "1" to *Public-Private Research Partnerships* for legal feasibility, as its implementation does not require any changes in current laws.

**Political Feasibility:** The Special Program for the Development of Renewable Energy (2014-2018)[458] prepared by the Ministry of Energy, and promulgated by the President, advances throughout the document, that it is fundamental to promote public-private collaborations in research and development to spur innovation in the energy sector. Furthermore, the "National Energy Strategy" (2013-2027) establishes as an objective the construction of a "link" between the academia, the government and the industry for the development of renewable energy technologies[459]. This suggests that both the President and the Ministry of Energy are in favor of promoting these types of partnerships, with the purpose of undertaking research and development activities.

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451 CEMIE Eolico, Solar y Geotermico - As provided by this press release of the National Council of Science and Technology: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/312-formalizacion-de-los-convenios-de-asignacion-de-recursos-para-tres-centros-mexicanos-de-innovacion-en-energias-renovables-cemie-s
452 Article 3 of the "Public-Private Associations Law" (Ley de Asociaciones Publico Privadas)
453 National Council for Science and Technology.
454 As provided by the constitution document of this fund available at: http://www.conacyt.mx/index.php/sesiones-de-la-junta-de-gobierno/comision-asesora/44a-sesion-comision-asesora/8006-7-constitucion-fondo-conacyt-publico-privado/file
455 As of November 11, of 2015, there is no indication that these steps have been fulfilled.
456 Public entities in charge of implementing and managing financial products for the Federal Government.
457 Title 1 article 2 of the Law of Credit Institutions (Ley de Instituciones de Credito).
458 See pages 46 and 47 of the document available at: http://www.energia.gob.mx/res/planeacion/PEAER%202014.pdf
459 As provided by the "Strategic Theme #15" of the "National Energy Strategy" document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf

In addition to this, during a recent conference, representatives from the Industry, Federal Congress, Sate Governors and Educational Institutions agreed to establish an "innovation" alliance between government, academia and private parties. This, acknowledging that public-private associations are basic to develop the required innovative advances necessary to spur economic growth in the country[460].

The combination of these factors allows us to conclude that currently *Public-Private Research Partnerships* are politically feasible in the Country, and as such this policy receives a value of "1" in this regard.

**Economic Feasibility:** The fact that the "Public-Private" Fund of CONACYT has been assigned one billion pesos for its initial stage, and that these funds are planned to be complemented by resources from private parties[461][462], allows us to conclude that the implementation of *Public-Private Research Partnerships* will not cause an overall increase in costs for the Federal Government. This, as renewable energy focused *Public-Private Research Partnerships* can be implemented by this Fund through the management of its already assigned budget; reason for which this policy receives a value of "1" for economic feasibility.

*5.1.6. R&D Prizes*

**Legal Feasibility:** As explained before, the current laws provide for renewable energy research and development programs to be developed and carried out through the CONACYT/SENER Sustainability fund by decision of its "technical committee"[463]. As such, *R&D Prizes* programs can be promoted with a renewable energy focus through the CONACYT/SENER Sustainability fund by virtue of law, which showcases that there is no need for changes in the current laws to develop and implement this policy. Hence, *R&D Prizes* receives a value of "1" for legal feasibility in this study.

**Political Feasibility:** In 2014, the Ministry of Energy through the CONACYT/SENER Sustainability Fund, and the Inter-American Development Bank (IDB) developed in collaboration an R&D prize program that granted up to 200,000 US dollars for research activities to winning proposals focused at renewable energy, energy efficiency and biofuels[464]. Although this program ended on January 2015, the fact that this type of policy has been used before to promote renewable energy focused research and development activities during this Presidential period, suggests that currently this policy is politically feasible in the Country[465].

In addition to this, the President has advanced during recent participations in international public events that there will be promotion of renewable energy focused

[460] As provided by the next press release form CONACYT: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/371-a-propuesta-del-conacyt-los-sectores-publico-y-privado-acuerdan-una-alianza-en-favor-de-la-innovacion
[461] The amounts provided by private parties will depend on the specific programs developed.
[462] As provided by the constitution document of this fund available at: http://www.conacyt.mx/index.php/sesiones-de-la-junta-de-gobierno/comision-asesora/44a-sesion-comision-asesora/8006-7-constitucion-fondo-conacyt-publico-privado/file
[463] Which constitutes .13% of the Petroleum Dividend, as provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
[464] Information regarding this program is found through: http://www.iadb.org/es/noticias/anuncios/2014-10-27/convocatoria-2014-innovacion-energetica-en-mexico,10949.html
[465] This program ended not because support faded, but simply because since its inception it had a limited amount of resources to give away (2.2 million dollars in total), and hence a limit for the reception of proposals and the announcement of the winners for the disbursement to proceed was put in place. This can be analyzed through: http://www.iadb.org/es/noticias/anuncios/2014-10-27/convocatoria-2014-innovacion-energetica-en-mexico,10949.html

research and development activities to spur innovation in renewable energy technologies[466]. Moreover, both the Special Program for the Development of Renewable Energy (2014-2018)[467], as well as the "National Energy Strategy" (2013-2027)[468] provide for the implementation of government programs to promote renewable energy research. This further supports the finding that research and development programs as *R&D Prizes* are currently politically feasible policy in Mexico, hence this study grants this policy a value of "1" in this regard.

**Economic Feasibility:** As it has done before[469], the "technical committee" of the CONACYT/SENER Sustainability fund could manage its currently assigned resources to fund more *R&D Prize* programs to the desired extent[470], the only restriction being the budgetary constrains that stem from the funding requirements of other potential research and development policies. Therefore, given that this policy can be implemented through the application of its already assigned resources without increasing the overall cost for the Federal Government, *R&D Prizes* has been granted a value of "1" for economic feasibility.

*5.1.7. Research Oriented Tax Credits*

**Legal Feasibility:** Until the end of 2013, the "Income Tax Law"[471] provided for a tax credit of up to 30% of any kind of research and development expenditures[472], however, in December 11, 2013 that provision was abrogated. Currently there are no research oriented tax credits, instead the laws provide for a narrow tax deduction[473] of up to 35% of the expenditures made specifically for the purchase of equipment and machinery destined to technological innovation[474]. In order to "revive" the original tax credit, or to provide for a new kind of tax credit focused at promoting research and development activities specific to renewable energy technology, changes to the Income Tax Law would have to be approved by the Senate and the Federal Congress. Hence, given that establishing *Research Oriented Tax Credits* would require changes in the current laws, this policy is deemed not legally feasible and therefore it is assigned a value of "0" in this regard.

**Political Feasibility:** When presenting the Fiscal Reform that was approved on December 2013, the President advanced that the main goal of this reform was increasing revenue by eliminating "privileges"[475]. Under this rationale, the elimination of several incentives (including the innovation tax credit[476]), and the increase in tax percentages to higher earners[477], would draw 240 million pesos extra (1.4% of the GDP of 2013) during future years to the government. This reform gained additional relevance when the price of oil dropped by the end of 2014 (from around 100 dollars per barrel to 47 dollars[478]) and the

466 As evidenced by the next news article that showcases the main takeaways of a meeting between the Mexican President and the President of the European Union Council: http://eleconomista.com.mx/entretenimiento/2015/06/14/mexico-ue-mas-colaboracion-investigacion-desarrollo and the following which showcases the main points of the President's joint participation with Gov. Jerry Brown (California) in a bilateral meeting: http://www.animalpolitico.com/2014/08/pena-nieto-y-gobernador-de-california-coinciden-en-fortalecer-la-relacion-bilateral/
467 Available at: http://www.energia.gob.mx/res/planeacion/PEAER%202014.pdf
468 Available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
469 Through previously described R&D prize collaboration program between the Fund and the IBD of 2014.
470 Section 4, articles 25 and 26 of the Law of Science and Technology (Ley de Ciencia y Tecnologia).
471 Ley del Impuesto Sobre la Renta
472 Article 219 of the Income Tax Law. Abrogated in December 11, 2013.
473 Deductions are deemed to be in general less beneficial than credits, this given that a tax deduction only reduces taxable income while a credit directly "wipes out" any tax liability on a "one for one" basis, see: http://sunbridgesolar.com/why-a-solar-tax-credit-beats-all-of-your-tax-deductions/
474 Article 35 of the Federal Income Tax Law, (Ley del Impuesto Sobre la Renta) Consulted in 11/09/2015.
475 As provided by the next news article: http://www.excelsior.com.mx/nacional/2013/09/09/917770
476 Tax credit of up to 30% of any kind of research and development expenditures.
477 To see the main points of these reform consult: http://mexico.cnn.com/nacional/2013/10/31/cuales-son-los-nuevos-impuestos-que-pagaras-en-2014
478 To see the trends in oil prices look at: http://www.oil-price.net/

Federal Government, through the Ministry of Finance and Public Credit, advanced that the fiscal reform would serve as a "buffer" for the price drop of oil, by containing revenue levels trough the increases in tax and the elimination of incentives[479].

Since then, both the President and the Minister of Finance and Public Credit have praised the "success" of the reform in helping to reduce the dependence on oil revenue[480][481]. However, given the sluggish economic growth levels of the Country in 2015[482], the proposal of the "Economic Packet" for 2016[483] incorporates a few changes to the "Income Tax Law" with the hope of incentivizing investment and promoting economic growth.

In terms of investments in equipment and machinery for research and development the tax deduction previously situated at 35%[484], is "temporarily" set at 95% for the years 2016 and 2017[485]. Although this higher deduction percentage is compelling, the fact that it is only temporal[486], and that it only applies to investments in equipment and machinery implies that it success in incentivizing research investments would be very limited[487].

Given that, *Research Oriented Tax Credits* were eliminated through the Fiscal Reform of 2013, and that the proposal of the "Economic Packet" of 2016 "sticks" with deductions limited to investments in equipment and machinery for the years 2016 and 2017, suggests that *Research Oriented Tax Credits* are not politically viable in this Presidential period; hence this policy receives a value of "0" for Political Feasibility.

**Economic Feasibility:** The fact that this policy allows investments in research and development to be fully or partially credited from a tax account on a "one to one basis" implies that, through its application, the Federal Government would forfeit revenue that would have otherwise collected. As such, this policy is deemed to increase the overall costs for the Government as the cost of implementing this policy would be equal to the amount that it fails to collect through the application of the credit; therefore *Research Oriented Tax Credits* is assigned a value of "0" for economic feasibility.

#### *5.1.8. Research and Development Public Financing*

**Legal Feasibility:** According to the current laws, in Mexico only two types of institutions can directly provide and administer credit and banking services[488]: Universal Banking Institutions[489] and Development Banks[490]. The CONACYT/SENER Sustainability fund by virtue of its attributions as a "sectorial fund"[491] is allowed to develop any type of financial products (including venture capital and high risk loans products) to spur

479 As evidenced by the next news article: http://www.cnnexpansion.com/economia/2015/09/09/los-impuestos-salvaran-las-finanzas-publicas-en-2016
480 Although not within the topic of this study, this statement is very questionable.
481 As evidenced through the next news article: http://www.jornada.unam.mx/ultimas/2015/06/09/cayo-dependencia-del-petroleo-en-finanzas-publicas-shcp-7391.html
482 The OECD situates it at 2.3%, see: http://huellas.mx/nacional/2015/11/09/ocde-recorta-expectativas-de-crecimiento-economico-en-mexico/
483 Available at: http://www.shcp.gob.mx/ApartadosHaciendaParaTodos/ppef2016/index.html
484 Article 35 of the Federal Income Tax Law, (Ley del Impuesto Sobre la Renta) Consulted in 11/09/2015.
485 This has been embedded into the Federal Income Tax Law, in Article 3 of the "Temporal Validity Provisions" section.
486 Uncertainty in Tax policy has been found to deter investment and tamper economic growth. Tom Giovanneti (2015). How Tax Uncertainty Harms Economic Growth: Agricultural Investment and Section 179. Institute for Policy Innovation. Available at: http://www.ipi.org/ipi_issues/detail/how-tax-uncertainty-harms-economic-growth-agricultural-investment-and-section-179
487 There are many more expenditures through the Research and Development process which can, in some cases be more burdensome that those in equipment, see: http://www.entrepreneurial-insights.com/rd-research-and-development-overview-process/
488 Title 1 article 2 of the Law of Credit Institutions (Ley de Instituciones de Credito).
489 Commercial and/or investment banks.
490 Public entities in charge of implementing and managing financial products for the Federal Government.
491 Section 4, articles 25 and 25Bis of the Law of Science and Technology (Ley de Ciencia y Tecnologia.)

innovation in renewable energy and energy efficiency. However, given that only Universal Banking Institutions and Development Banks can manage financial products directly, the Fund has signed a contract[492] with the "National Works and Public Services Bank" (BANOBRAS), through which the latter is required to implement the financial products that the Fund develops.

Hence, the fact that the laws currently provide for the possibility of creating financial products with the goal of promoting research and development activities in energy sustainability, and, that there is a signed contract in place with BANOBRAS for their implementation, allows us to grant a value of "1" for legal feasibility to *Research and Development Public Financing*, as the development of these types of instruments would not require changes in the current laws.

**Political Feasibility:** The Special Program for the Development of Renewable Energy (2014-2018)[493] prepared by the Ministry of Energy, advances that in order to promote competitiveness and economic development through the energy sector, mechanisms that mobilize investments in renewable energy research and development, should be explored and implemented[494].

In addition to this, the "National Development Plan"[495] (2013-2018) advanced by the President proposes an increase in government investments for research and development activities of up to 1% of the GDP[496]; investments in public financing mechanisms could account towards this research and development Presidential goal, and therefore its implementation could be viable during this period.

Furthermore, the fact that recently the Ministers of Energy, Economy and Finance and Public Credit, have presented three energy[497] funds that have been developed with the purpose of mobilizing investment in the energy sector, and that these funds provide specifically for research oriented public financing mechanisms[498], showcase the openness of the Federal Government in using research and development public financing mechanisms as a viable policy in the energy sector.

This allows us to conclude that currently there is political will in Mexico to pursue *Research and Development Public Financing* policies aimed at addressing the funding needs of entrepreneurial companies and institutions, that for reasons of stage of development cannot seek capital from more traditional sources[499]. As such, *Research and Development Public Financing* receives a value of "1" for political feasibility in this study.

**Economic Feasibility:** As noted before, the "technical committee" of the CONACYT/SENER Sustainability fund has liberty in deciding which programs to implement with its assigned resources. Providing for public financing mechanisms, within the limits of its budget, is one of the faculties attributed to this fund by the Law of Science and Technology, as such, this policy could be implemented by the CONACYT/SENER Sustainability fund by managing its current resources, without an overall increase in costs

[492] Available at: http://sustentabilidad.energia.gob.mx/res/Contrato%20de%20Fideicomiso%202138.pdf
[493] Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf
[494] Objective #4 of the program, available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf
[495] The National Development Plan, is the document that directs the actions of the federal government for any given presidential period, it contains the main goals, strategies and programs to be carried out throughout the period.
[496] Objective 3.5 of the National Development Plan (Plan Nacional de Desarrollo), available at: http://pnd.gob.mx/
[497] These three funds are focused on the hydrocarbons sector.
[498] As evidenced by the next news article: http://www.milenio.com/negocios/Presenta-gobierno-fondos-energia-economia-financiera-Banobras-Nafin_0_382761755.html
[499] Such as public markets and banks.

for the Federal Government[500]. Moreover, these public-financing mechanisms can be implemented with repayment obligations tied to the ultimate market success of the developed technology[501], which can in turn provide an additional source of revenue for the promotion of renewable energy. For these reasons, *Research and Development Public Financing* receives a value of "1" for economic feasibility.

### 5.2. Demand-Pull Policies

#### *5.2.1. Tax Credits (Production or Investment)*

**Legal Feasibility:** Currently there are no renewable energy focused investment or production *Tax Credit* provisions in the laws[502]. Any attempt to incorporate *Tax Credits* to the legal framework would require changes to the "Income Tax Law"; hence, this policy is given a value of "0" for Legal Feasibility in this study, as its application would require undertaking a legislative process.

**Political Feasibility:** Neither the Special Program for the Development of Renewable Energy (2014-2018)[503], nor the "National Energy Strategy" (2013-2027)[504] document, refer to *Tax Credits* as a policy to be explored, in fact, the term is not even mentioned in these instruments.

Furthermore, as explained before, when presenting the Fiscal Reform of 2013, the President advanced that the main goal of this reform, was increasing revenue by eliminating "privileges"[505], reason for which there were several eliminations of tax incentives like the innovation tax credit[506]. Since then, the President and the Minister of Finance and Public Credit have praised the "success" of the reform in helping to reduce the dependence on oil revenue[507] by containing the negative effects of the oil price drop[508] in the public finances[509]. This suggests that the current "low incentives - higher collection" fiscal path will continue to be followed during the rest of this Presidential period.

In addition to this, the President recently presented to congress the "Economic Packet" for 2016, which contains no renewable energy *Tax Credits*, or any indication that this credits can be pursued in the near future. Hence, the fact that there is complete muteness about this policy option both throughout the relevant codified documents and in the discourse of the President or the relevant Ministers[510]; and that a similar "innovation tax credit" was already eliminated during this presidential period, showcase that currently there is no political feasibility for this policy. As such, *Tax Credits* is assigned a value of "0" in this regard.

**Economic Feasibility:** This policy reduces income tax liability for tax-paying owners/investors based on capital investment in renewable energy projects, or electricity production from these projects, This implies that through its application, the Federal

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500 Section 4, articles 25 and 25Bis of the Law of Science and Technology (Ley de Ciencia y Tecnologia.)
501 Tim Parker (2012). Small Business Financing: Debt or Equity? Investopedia. Available at: http://www.investopedia.com/financial-edge/1112/small-business-financing-debt-or-equity.aspx
502 Up unitl November 2015.
503 Available at: http://www.energia.gob.mx/res/planeacion/PEAER%202014.pdf
504 Available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
505 As provided by the next news article: http://www.excelsior.com.mx/nacional/2013/09/09/917770
506 Tax credit of up to 30% of any kind of research and development expenditures.
507 As evidenced through the next news article: http://www.jornada.unam.mx/ultimas/2015/06/09/cayo-dependencia-del-petroleo-en-finanzas-publicas-shcp-7391.html
508 From around 100 dollars per barrel to 47 dollars, to see the trends in oil prices look at: http://www.oil-price.net/
509 Although not within the topic of this study, this statement is very questionable.
510 Minister of Finance and Public Credit and Minister of Energy.

Government would forfeit tax revenue that would have otherwise collected. As such, this policy is deemed to increase the overall costs for the Government as the cost of implementing this policy would be equal to the amount that it fails to collect through the application of the credit; therefore *Tax Credits* is assigned a value of "0" for economic feasibility.

#### *5.2.2. Tax Reductions or Exemptions (Sales/Property)*

**Legal Feasibility:** Currently there are no reductions or exemptions in the Added Value Tax Law (Ley del Impuesto al Valor Agregado)[511], attributed to the purchase of renewable energy systems.

As for property taxes, in Mexico these are one of the few taxes that are left for municipalities to decide and implement. There are 2,454 municipalities in Mexico and information about their management of property tax provisions is very limited. The only provision found in relation to renewable energy property tax incentives is one available in Mexico City that allows a reduction of 25% of property tax liability to businesses that install renewable generation equipment with the the potential to reduce pollution[512].

The fact that there are no reductions or exemptions in the Added Value Tax Law attributed to the purchase of renewable energy systems, and, that the recently presented "Economic Packet" for 2016 contains no renewable energy incentives in the Added Value Tax Law, evidences that if sales tax reductions or exceptions are to be implemented they would require changes in the current laws. Therefore, this policy is assigned a value of "0" for legal feasibility.

In regards to property tax reductions or exceptions, given that there is not enough information to assess legal feasibility in each of the 2,454 municipalities in Mexico, this study refrains from giving this policy a set value, and instead deems its legal feasibility as "undetermined".

**Political Feasibility:** Just as with *Tax Credits,* neither the Special Program for the Development of Renewable Energy (2014-2018)[513], nor the "National Energy Strategy" (2013-2027)[514] document refer to *Tax Reductions or Exemptions* as a policy to be explored[515].

The Fiscal Reform of 2013, had the main goal of increasing revenue by eliminating "privileges"[516], reason for which there were several eliminations of tax incentives like the innovation tax credit[517], and also increases to the Added Value Tax[518]. Following the rationale that the added revenue provided by this reform corrected for the low prices of oil, in September 2015, the "Economic Packet" for 2016 was presented with no proposals of significant changes to the current Added Value Tax Law. This "packet" contains no provisions in favor of exemptions or reductions for the purchase of renewable energy equipment.

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511 Mexican "sales tax law", in Mexico Sales Tax provisions are Federal.
512 Article 277 of the Fiscal Code of Mexico City.
513 Available at: http://www.energia.gob.mx/res/planeacion/PEAER%202014.pdf
514 Available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
515 The term is not even mentioned in these instruments.
516 As provided by the next news article: http://www.excelsior.com.mx/nacional/2013/09/09/917770
517 Tax credit of up to 30% of any kind of research and development expenditures.
518 Particularly an increase in this tax in border cities (from 11% to 16%), and the elimination of exemptions and reductions previously available.

The fact that there is no dialogue about this policy option throughout the relevant codified documents, nor in the discourse of the President or the relevant Ministers[519], and that the President advanced as the main goal of the Fiscal Reform of 2013, increasing revenue by eliminating "privileges"[520] which was followed by increases to the Added Value Tax[521]. Showcases that currently this policy is politically unfeasible, hence, *Tax Reductions or Exemptions* is assigned a value of "0" in this regard.

As for property tax reductions or exemptions, analyzing political feasibility in the 2,454 municipalities is unviable, and as such, this study refrains from giving this policy a set value, instead deeming its politically feasibility: "undetermined".

**Economic Feasibility:** This policy reduces tax liability for individuals that purchase and install renewable energy equipment, this implies that, through its application, the Government would forfeit tax revenue that would have otherwise collected. As such, this policy is deemed to increase the overall costs for the Government as the cost of implementing this policy would be equal to the amount that it fails to collect through the application of the exemption or reduction in sales or property taxes. Therefore *Tax Reductions or Exemptions* is assigned a value of "0" for economic feasibility.

### *5.2.3. Accelerated Depreciation*

**Legal Feasibility:** The "Income Tax Law" currently allows for the accelerated depreciation[522] of renewable energy generation systems of up to a 100% of the purchase costs in the tax year that they are acquired[523], this, providing that these systems operate for at least 5 years[524]. Hence, the fact that the current laws provide for *Accelerated Depreciation* allows us to grant a value of "1" for legal feasibility to this policy, as its application does not require undertaking a legislative process.

**Political Feasibility:** This policy was included in the fiscal reform of 2013, and it was further acclaimed as one of the instruments that would aid in promoting investment in the Country, during the presentation of the "Economic Packet" for 2016[525]. This implies that this policy is politically feasible in the Country as it is already operating during the current regime. As such *Accelerated Depreciation* receives a value of "1" in this regard.

**Economic Feasibility:** Given that most long-lived assets are depreciated in one way or another for tax purposes, depreciation itself does not pose an added cost to the Federal Government, as it only incorporates a different schedule for this deductions to take place. Even if there was an argument to be made based on the time value of money[526], to claim that depreciation causes added costs, the fact that this policy is already operating implies that the potential costs of its application are already taking place, and hence any considerations in regards to its implementation would not pose an increase in overall cost

[519] Minister of Finance and Public Credit and Minister of Energy.

[520] As provided by the next news article: http://www.excelsior.com.mx/nacional/2013/09/09/917770

[521] Particularly an increase in this tax in border cities (from 11% to 16%), and the elimination of exemptions and reductions previously available.

[522] As explained before, accelerated depreciation is an annual allowance for the wear and tear, deterioration, or obsolescence of the property. Because most long-lived assets are depreciated in one way or another for tax purposes, depreciation itself is not a tax incentive provided preferentially to renewable energy projects. If a renewable energy investment accelerated tax depreciation schedule is made available, then it will provide a preferential incentive, due to the time value of money.

[523] Article 34 of the Federal Income Tax Law, (Ley del Impuesto Sobre la Renta).

[524] In case these systems operate for a shorter period of time, then the taxpayer would have to readjust and pay according to the normal depreciation schedule provided in the law.

[525] Available at: http://www.shcp.gob.mx/ApartadosHaciendaParaTodos/ppef2016/index.html

[526] The idea that money available at the present time is worth more than the same amount in the future due to its potential earning capacity

for the Federal Government. Therefore, *Accelerated Depreciation* receives a value of "1" for economic feasibility.

### *5.2.4. Direct Investments*

**Legal Feasibility:** Currently the Federal Government can only participate in energy generation projects through the Federal Electricity Commission as a "National Productive Enterprise". As a result of the secondary laws that accompanied the energy reform of December 2013, the Federal Government went from being the general manager of the Federal Electricity Commission to become its sole shareholder[527], which means that the Federal Electricity Commission is no longer submitted to the "legality principle"[528] in which their activities could only follow what the laws specifically provided. Nowadays this enterprise can conduct its dealings following the decisions of its administration committee and private law stipulations[529].

The fact that the Federal Electricity Commission has been granted independence, and that as such, their investment decisions are to be taken solely via its administration committee by virtue of law[530], means that direct investments in renewable energy by the Federal Government are dependent on the decision of the administration committee of this enterprise.

If this policy is to be implemented as a mandate to the Federal Electricity Commission to directly invest in renewable energy generation projects, changes to the current laws to submit the administration committee to set activities provided by law, and a mandate for direct investments in renewable energy projects have to be undertaken. However, given that there is no impediment in the laws for this type of investments by the Federal Electricity Commission through the decision of its administration committee, this policy receives a value of "1" for legal feasibility as its application would not require any changes in current laws. Nevertheless it is worth noting that the fact that there is no legal mandate for undertaking these types of investments, gives an important degree of uncertainty in regards to its implementation.

**Political Feasibility:** Recently the Director of the Federal Electricity Commission has announced that this "National Productive Enterprise" will invest 4,800 million dollars in 15 renewable energy projects that would represent 2,700 megawatts of installed capacity in upcoming years[531]. Following this announcement, the Director has signed agreements with "Acciona" (A Spanish Multinational) for the development of collaborative renewable energy projects (particularly wind, photovoltaic and hydroelectric)[532], and with "Grupo Salinas" (A Mexican company) for the deployment of a geothermal power plant in the state of Nayarit[533].

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[527] Title 1, article 4 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

[528] This principle limits the operations of public agencies, which cannot do anything that is not explicitly mandated to them by virtue of law.

[529] Before, this agency was obligated to follow what was specifically mandated in the law regardless of any economic or technical considerations. Nowadays this agency will only be subjected to private law stipulations, as such, it is no longer submitted to the "legality principle" meaning that now this agency can operate freely following only what its administration committee decides, as a private company, with the goal of maximizing profit. Title 1, article 3 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

[530] Title 1, articles 5, 6, and 7 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

[531] As provided by the next news article: http://eleconomista.com.mx/industrias/2015/03/05/cfe-invertira-4800-mdd-energias-renovables

[532] As provided by the next news article: http://www.energias-renovables.com/articulo/acciona-y-la-cfe-firman-acuerdo-para-20151019

[533] As provided by the next news article: http://www.forbes.com.mx/grupo-salinas-obtiene-concesion-para-proyecto-de-energia-geotermica/

Given that the Federal Government can only participate in energy generation projects through the Federal Electricity Commission as a "National Productive Enterprise", the only authority that can decide to implement *Direct Investments* in renewable energy projects is the administration committee of the commission. The fact that its Director has recently announced *Direct Investments* in renewable energy projects, and that steps are being followed in this direction (evidenced by the signature of agreements aimed at developing renewable energy projects with CFE's investment), allows us to grant a value of "1" for political feasibility to this policy.

**Economic Feasibility:** As explained before, the Federal Electricity Commission manages its own budget, with which it can invest in the electricity generation projects that its administration committee decides. Undertaking *Direct Investments* in renewable energy generation projects, therefore, poses no increases in costs to the Federal Government, as the resources used for the application of this policy, come directly from the Federal Electricity Commission's budget. As such, this policy receives a value of "1" for economic feasibility in this study.

*5.2.5. Shared-Risk Financing*

**Legal Feasibility:** *Shared-Risk Financing* could be implemented by virtue of law through the "Shared Risk Trust Fund" (Fideicomiso de Riesgo Compartido), which was established by presidential decree in 1981 with the goal of promoting land productivity and technology diffusion[534]. This trust fund currently has as one of its goals: the promotion of renewable energy through the implementation of shared risk mechanisms[535]. However, given that this trust fund is under the Ministry of Agriculture, Livestock, Rural Developments, Fisheries and Food (SAGARPA), most of its programs are focused on agriculture and rural development[536], not in renewable energy deployment per se.

As explained before, in Mexico only two types of institutions can directly administer financial products[537]: Universal Banking Institutions[538] and Development Banks[539]. Reason for which, this Trust Fund, has signed a contract with "Rural Financier" (Financiera Rural)[540], to implement and administer the financial products that the Fund develops.

Even though currently the majority of the programs developed by this Trust Fund are focused at agricultural and rural development, *Shared-Risk Financing* can be implemented with a renewable energy focus through this "Shared Risk Trust Fund" by virtue of law. As such, this policy receives a value of "1" for legal feasibility in this study, given that it can be implemented without undertaking a legislative process.

**Political Feasibility:** The Special Program for the Development of Renewable Energy (2014-2018)[541] prepared by the Ministry of Energy and promulgated by the

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534 Information provided by the Ministry of Agriculture, Livestock, Rural Developments, Fisheries and Food (SAGARPA) through: http://www.sagarpa.gob.mx/quienesomos/datosabiertos/firco/Paginas/default.aspx

535 As provided by information provided by the Trust Fund through: http://www.firco.gob.mx/firco/Paginas/Quienes-Somos.aspx based on article 2 of the Presidential Decree that regulates this trust fund (2004), available at: http://www.firco.gob.mx/POTTtransparencia/Documents/Lineamientos/DecretoFirco2004.pdf

536 Out of the four programs that are available as of November of 2015, only one covers renewable energy systems and only for its use in agriculture, livestock or fishing activities. See: http://www.firco.gob.mx/componentes_2015/Paginas/Componente_de_Bioenergia_y_Sustentabilidad_2015.aspx

537 Title 1 article 2 of the Law of Credit Institutions (Ley de Instituciones de Credito).

538 Commercial and/or investment banks.

539 Public entities in charge of implementing and managing financial products for the Federal Government.

540 A Mexican Development Bank.

541 Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf

President, establishes as an objective the development of collaborative financial mechanisms between Mexican Development Banks and private banks, to promote renewable energy deployment[542]. Moreover, the "National Energy Strategy" (2013-2027) document[543], highlights throughout its Strategy #10: "Diversifying and Optimizing the Generation Matrix", the importance of creating financial mechanisms aimed at promoting renewable energy development and mitigating risk aversion in the industry. *Shared-Risk Financing* can achieve the latter by mobilizing domestic lending to help banks gain experience with the management of portfolios of renewable energy, facilitating commercial investment flow to this sector through risk sharing.

The fact that the relevant energy policy documents of the country prepared by the Ministry of Energy and promulgated by the President, refer directly to *Shared-Risk Financing* as a policy to explore and implement to promote renewable energy deployment, implies that this policy is politically feasible in the current Mexican scenario. Hence *Shared-Risk Financing* receives a value of "1" in this regard.

**Economic Feasibility:** The budget of the "Shared Risk Trust Fund" is primarily composed of resources directly assigned from the "Federal Expense Budget"[544], for the development of its programs[545]. Given that this Fund is in charge of promoting renewable energy through the implementation of shared risk mechanisms[546] by virtue of law, it could manage its currently assigned resources to fund *Shared-Risk Financing* programs focused at the deployment of renewable energy generation projects through the decision of its "technical committee". The only restriction to this being the budgetary constrains that stem from the funding requirements of other potential programs. Therefore, given that this policy can be implemented without increasing the overall cost for the government, *Shared-Risk Financing* has been granted a value of "1" for economic feasibility.

### *5.2.6. Capital Grants/Rebates*

**Legal Feasibility:** The "Law for the Use of Renewable Energies and the Financing of the Energy Transition" (enacted in 2008), created the "Fund for Energy Transition and Sustainable Energy Exploitation"[547]. This Fund has as a main objective: developing programs to incentivize the deployment of renewable energy technologies[548] for which it has entered into an agreement with the "National Works and Public Services Bank"[549] (BANOBRAS), so the latter can implement the financial products that this Fund develops. However, this fund has no programs currently in operation[550].

However, the fact that *Capital Grants/Rebates* programs focused at renewable energy deployment could be developed and implemented through this Fund by virtue of law, allows us to grant this policy a value of "1" for legal feasibility, as its application would not require any changes in current laws.

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542 Objective 2.4.2 of the Plan.
543 Document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
544 Prepared by the executive branch and approved by Federal Congress.
545 Article 1 of the Presidential Decree that regulated this trust fund (2004), available at: http://www.firco.gob.mx/POTTtransparencia/Documents/Lineamientos/DecretoFirco2004.pdf
546 As provided by information provided by the Trust Fund through: http://www.firco.gob.mx/firco/Paginas/Quienes-Somos.aspx based on article 2 of the Presidential Decree that regulates this trust fund (2004), available at: http://www.firco.gob.mx/POTTtransparencia/Documents/Lineamientos/DecretoFirco2004.pdf
547 Article 27 of the Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley Para el Aprovechamiento Sustentable de las Energias Renovables y el Financiamiento de la Transicion Energetica).
548 As provided by its rules of operation available at: http://www.dof.gob.mx/nota_detalle.php?codigo=5331192&fecha=30/01/2014
549 A Mexican Development Bank.
550 No programs as of November 20, 2015. Available programs are disclosed at: http://fotease.energia.gob.mx/portal/DefaultF.aspx?id=2806

**Political Feasibility:** As analyzed before, both the Special Program for the Development of Renewable Energy (2014-2018)[551], and the "National Energy Strategy" (2013-2027) document[552] highlight the importance of developing incentives to promote deployment of renewable energy generation technologies. In doing so, both of these documents enumerate policies that could be explored as tools to achieve this goal. Nonetheless, there is no indication or reference throughout these documents that could suggest that *Capital Grants/Rebates* is a policy that the Federal Government seeks to explore for this purpose.

Moreover, after reviewing several media participations of both the President and the Minister of Energy in regards to the topic of renewable energy incentives, there was no mention whatsoever of policies aimed at providing monetary assistance bestowed by the government to renewable generation projects with no repayment obligations.

Since failing to acknowledge a policy is not the same as directly denying its viability, an intermediate value will be assigned to *Capital Grants/Rebates*. This given that the Federal Government could be disregarding this policy because it has yet to explore it, in contrast to a direct denial, which would convey that the particular policy has been already analyzed and denied. Therefore, *Capital Grants/Rebates* receives a value of "0.5" for political feasibility.

**Economic Feasibility:** According to the rules of operation of the "Fund for Energy Transition and Sustainable Energy Exploitation", this Fund's resources come directly from the budget of the Ministry of Energy[553]. The amounts destined to this Fund are disclosed through the "Federal Expense Budget" which in 2015 amounted to 430,000,000 pesos[554] (570,000,000 pesos less than in 2014[555]).

Nowadays, the "Federal Expense Budget" for 2016[556] does not refer to this Fund directly, and as such, the amounts that will be destined for it (if any), are not in the public domain yet. Hence, whether this policy is economically feasible or not, will depend on the assignation of resources to this fund in 2016 and future years. If the Fund were to be assigned resources to develop programs, in theory this policy would be economically feasible to the extent that its implementation costs are covered through the application of the assigned budget. If the Fund were not assigned resources for 2016 and future years, then this policy would not be economically feasible. As such, given that we currently lack complete information to determine the economic feasibility of this policy, this study refrains from giving it a set value, and instead deems its economic feasibility as "undetermined".

#### *5.2.7. Public Procurement*

**Legal Feasibility:** The "Law for the Use of Renewable Energies and the Financing of the Energy Transition" (enacted in 2008), was modified in 2013 to include a provision that establishes the obligation to direct public resources to the promotion of renewable

551 Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf
552 Document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
553 As provided by its rules of operation available at: http://www.dof.gob.mx/nota_detalle.php?codigo=5331192&fecha=30/01/2014
554 Federal Expense Budget 2015: http://www.diputados.gob.mx/LeyesBiblio/pdf/PEF_2015.pdf
555 In 2014, this fund received 1,000,000,000 pesos, as provided by the funding report of this Fund available at: http://fotease.energia.gob.mx/portal/DefaultF.aspx?id=2804
556 Available at: http://www.ppef.hacienda.gob.mx/work/models/PPEF/2016/docs/paquete/Proyecto_Decreto.pdf

electricity procurement by Federal Public Administration buildings and facilities[557][558]. Hence, *Public Procurement* can be pursued based in this legal provision, and therefore its application does not require any changes in current laws. For this reason this policy is granted a value of "1" for legal feasibility.

**Political Feasibility:** Following the establishment of the legal provision previously described, the Ministry of Energy is currently developing a program named "Clean Energy in the Federal Public Administration". This program has the purpose of promoting the installation of renewable energy generation equipment in buildings and facilities from the Federal Public Administration[559]. According to the Ministry, the goal of this program is deploying 2.4 MW of overall installed renewable based capacity that can provide clean and independent electricity supply to these buildings and facilities[560].

The fact that during the current Presidential period the "Law for the Use of Renewable Energies and the Financing of the Energy Transition" was modified to include public procurement of renewable energy, and that the Ministry is currently designing a program to implement this policy, implies that *Public Procurement* is currently politically feasible in the Country. As such *Public Procurement* receives a value of "1" in this regard.

**Economic Feasibility:** Currently there is no indication in regards to where the funds for the implementation of the "Clean Energy in the Federal Public Administration" program will come from. The program could be implemented either through the "Fund for Energy Transition and Sustainable Energy Exploitation", through a newly created Fund for this purpose, or, as a mandate to the different organizations of the Federal Public Administration to undertake it with its own assigned resources.

Regardless of the source of the required funds or the institution in charge of implementing the program, purchasing and installing distributed generation systems will present upfront investment costs to the Federal Government. Nevertheless, by allowing self-generation of electricity, these systems could reduce the procurement requirements of these buildings and facilities. Hence, electricity savings will offset the costs of the system over time, which at some point can even result on negative costs when the breaking point between investment and savings is reached[561]. Therefore, given that the implementation of this policy does not cause an overall cost increase for the Federal Government if analyzed in the scope of the lifetime of the system, this policy is assigned a value of "1" for economic feasibility.

#### *5.2.8. Renewable Portfolio Standards*

**Legal Feasibility:** Currently the laws provide for a Renewable Portfolio Standard type of policy by setting a maximum percentage for fossil fuel electricity generation for the years to come (65% by 2024, 60% by 2035, and 50% by 2050)[562]. The "Clean Energy Certificates Program" supports the implementation of this policy[563][564]. As explained in

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557 Taking into consideration economic, technical and geographical viability issues.
558 As provided by the next presidential decree: http://www.dof.gob.mx/nota_detalle.php?codigo=5301692&fecha=07/06/2013
559 As disclosed by the Ministry through: http://www.energia.gob.mx/portal/Default.aspx?id=2936
560 As disclosed by the Ministry through: http://www.energia.gob.mx/portal/Default.aspx?id=2936
561 This Simple Payback time which represents the amount of time it will take to recover the initial investment in energy savings, can be calculated dividing initial installed cost by the annual energy cost savings (which will depend on resource availability in the specific installation).
562 This through the transitory provisions of: the Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).
563 A Renewable Energy Credit (REC) program. RECs are usually implemented to provide a measurable and verifiable metric for compliance with renewable portfolio standards.

Chapter 2, through this program clean energy generators are granted a certificate for every MWH of output, which they are then able to sell to any interested party through a business transaction[565]. The quantity of certificates that an electricity purchaser[566] holds must be enough to guarantee that a certain percentage, established yearly[567] by the Ministry of Energy, has been met[568].

Hence, the fact that a Renewable Portfolio Standard policy is directly set in the laws, and that further mechanisms for compliance have been established in the form of the "Clean Energy Certificates", allows us to grant this policy a value of "1" for legal feasibility, as its implementation requires no changes in the current framework.

**Political Feasibility:** The "Clean Energy Certificates Program" was introduced through the secondary laws that accompanied the energy reform of December of 2013. The rationale advanced for its development, was that through the implementation of this mechanism, the Renewable Portfolio Standard goals set forth by the "Law for the Use of Renewable Energies and the Financing of the Energy Transition" would be attained[569]. Since then, this policy has been constantly held as the driving force of the energy transition in Mexico, both by the President and the Minister of Energy[570]. Given these reasons, and the fact that this "Clean Energy Certificates Program" is scheduled to start operating this upcoming year (2016)[571], this policy is deemed politically feasible in the current Mexican scenario. As such *Renewable Portfolio Standards* receives a value of "1" in this regard.

**Economic Feasibility:** Through the "Clean Energy Certificates Program" the Government sets the required percentage of renewable based electricity that the direct participants of the wholesale electricity market[572] are required to procure in order to comply with the Renewable Portfolio Standard. This poses no additional costs for the Federal Government as the costs are borne by the purchasers of electricity.

It is true though that this policy could in fact cause an increase in customer rates if utilities transfer their added costs (these costs will be marginal unless the RPS percentage is set very high[573]). If this happens the Federal Government might want to implement a subsidy for low-income population[574], which could in turn cause an overall increase in costs for the Federal Government. However, the fact that this policy is already set to operate implies that the costs (if any) are ready to take place, hence, this policy can be deemed "de facto" economically feasible. Reason for which, *Renewable Portfolio Standards* receives a value of "1"in this regard.

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564 Title 4, Chapter 3, Article 122 of the Electric Industry Law (Ley de la Industria Eléctrica).
565 Section 2 of the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition" (Lineamientos para el Otorgamiento de Certificados de Energías Limpias y los Requisitos para su Adquisición.
566 Purchasers of electricity in the wholesale electricity market, mainly, the Federal Electricity Commission and qualified users.
567 As a transitory measure provided in the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition", the required percentage of acquisition of clean energy for 2016 and 2017 will be zero.
568 Only the last proprietor of the certificates can account them towards the percentage requirement.
569 As provided by the next article that reproduces the details of the official proposal of the reform: http://www.adnpolitico.com/gobierno/2013/08/12/documento-integro-iniciativa-de-reforma-energetica-de-pena
570 As provided by the next news articles: http://www.radioformula.com.mx/notas.asp?Idn=548750&idFC=2015 http://www.radioformula.com.mx/notas.asp?Idn=505320&idFC=2015
571 As a transitory measure provided in the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition", the required percentage of acquisition of clean energy for 2016 and 2017 will be zero.
572 Mainly the Federal Electricity Commission and qualified users.
573 As an example, in New York there is a 30% by 2015 RPS, which cost on average $2.87 for the whole year to the average residential consumer in 2007. Information provided by the government of the New York State through: http://www.nyserda.ny.gov/All-Programs/Programs/Main-Tier/FAQs#funded
574 Depending on the impact.

*5.2.9. Auction Mechanisms*

**Legal Feasibility:** Renewable energy auctions, just like Renewable Portfolio Standards, are quantity-driven support instruments. Both of these policies have the same goal: achieving a minimum share of capacity from renewable sources; their difference lies in the way that they are set to reach it.

As noted before, through renewable energy auctions the government initially sets the desired capacity to be installed for specific renewable energy technologies, and the interested parties then place their bids in the form of cost per electricity unit i.e., $/kWh, the winning bids are then allocated the projects for that tariff rate over a certain period of time[575]. Renewable Portfolio Standards, on the other hand, set a mandate for the satisfaction of energy demand with a set "quota" of renewable based generation[576].

These policies are just two ways of reaching the same goal, but, given that its instrumentation calls for different processes, they could be mutually exclusive. The government can either freely allow renewable energy quotas to be reached through tradable certificates, or can auction specific capacity to be satisfied by a particular resource, but not both at the same time for every renewable resource, as one would render the other inoperable.

There is an argument to be made about renewable auction mechanisms complementing Renewable Portfolio Standards in regards to a particular resource that the Government seeks to promote as a priority (i.e. having a general RPS of 20% and then auctioning several MW of solar generation with the goal of taking advantage of high solar irradiation levels in a geographic area). In this case the driving quantity policy would be the RPS and the renewable auction mechanism would be supporting solar deployment within it.

The fact that currently a Renewable Portfolio Standard is set in law through the implementation of the "Clean Energy Certificates" program as the "quantity-driven" policy to implement, requires either changing the laws to establish *Auction Mechanisms* as the general quantity based driving policy, or undertaking a legislative process to incorporate the possibility of implementing *Auction Mechanisms* to complement the available RPS policy. Both cases imply changing the current legal framework, which renders *Auction Mechanisms* legally unfeasible in terms of this study; hence, this policy receives a value of "0" on this regard.

**Political Feasibility:** Although in the Special Program for the Development of Renewable Energy (2014-2018)[577], there is a paragraph that talks about designing auction mechanisms for renewable energy deployment, the "National Energy Strategy" (2013-2027) document[578] contains no indication about undertaking renewable auction mechanisms.

In addition to this, after reviewing several media participations of both the President and the Minister of Energy in regards to the topic of promoting renewable

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[575] Pablo del Rio et al (2014). Back to the future? Rethinking Auctions for Renewable Energy Support. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114002007

[576] National Renewable Energy Laboratory (2014). Renewable Portfolio Standards, Resources and Technical Assistance. Available at: http://www.nrel.gov/docs/gen/fy14/62350.pdf

[577] See Page 42 of document, available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf

[578] Document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf

energy deployment, there was no mention whatsoever of renewable auction mechanisms per se. Withal, there are no efforts currently being undertaken to incorporate the possibility of developing *Auction Mechanisms* to aid the "Clean Energy Certificates" program in the current laws.

Since failing to acknowledge a policy is not the same as directly denying its viability, an intermediate value will be assigned to *Auction Mechanisms*. This given that the Federal Government could be disregarding this policy because it has yet to explore it, in contrast to a direct denial, which would convey that the particular policy has been already analyzed and denied. As such, *Auction Mechanisms* receives a value of "0.5" for political feasibility.

**Economic Feasibility:** The cost of implementing this policy would be dependent on the particular auction and the amount of the winning bids, therefore, whether these auctions will increase electricity costs for consumers to the extent of requiring the implementation of a subsidy if bore by them, will depend on these specifics. If, however, the required resources for the implementation of this policy were to come from a direct payment by the government, then its implementation would present an overall increase in costs for the Federal Government in the amount of this payment. As such, given that cost information (which would most likely determine the source of the funds), is very case specific, this study refrains from giving this policy a set value, and instead deems its economic feasibility as "undetermined".

### *5.2.10. Feed-in Tariffs*

**Legal Feasibility:** Although congress has chosen to speak directly through law in regards to the implementation of policies that address the electricity system as a whole (as evidenced by the previously described "Clean Energy Certificates"), the broad scope that has been given to the "Fund for Energy Transition and Sustainable Energy Exploitation"[579] by the 'Law for the Use of Renewable Energies and the Financing of the Energy Transition", could provide the legal basis to implement a Feed-In-Tariff. Without focusing at the resource requirements or implementation issues that this policy would pose[580], and only zeroing in on whether this policy can be implemented without requiring changes in the current laws, the fact that the objective of the Fund is developing programs to incentivize the deployment of renewable energy technologies[581], and that a Feed-In-Tariff is a policy aimed at achieving this goal, gives legal basis to its potential implementation through this Fund. Hence, this policy is given a value of "1" for legal feasibility in this study.

**Political Feasibility:** Neither the Special Program for the Development of Renewable Energy (2014-2018)[582], nor the "National Energy Strategy" (2013-2027) document[583] discuss setting electricity prices at a premium for renewable power to compensate producers for the higher cost of producing clean energy, as an alternative to be explored for the promotion of renewable energy technology deployment.

Furthermore, after reviewing several media participations of both the President and the Minister of Energy in regards to the topic of spurring renewable energy deployment, it

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579 Article 27 of the Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley Para el Aprovechamiento Sustentable de las Energias Renovables y el Financiamiento de la Transicion Energetica).

580 Implementation consideration will be discussed in the next chapter.

581 As provided by its rules of operation available at: http://www.dof.gob.mx/nota_detalle.php?codigo=5331192&fecha=30/01/2014

582 Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf

583 Document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf

is clear that this discussion is dominated by the implementation of the "Clean Energy Certificates"[584]. The latter, is acclaimed as the "backbone" policy for renewable energy deployment that will almost "singlehandedly" allow the Country to reach the goals set in the 'Law for the Use of Renewable Energies and the Financing of the Energy Transition". There is no mention whatsoever by the President or the Minister of Energy of the potential implementation of price-driven policies to aid in these the goals.

Given that, as we have analyzed before, failing to acknowledge a policy is not the same as directly denying its viability, an intermediate value will be assigned to *Feed-in Tariffs*. This because the Federal Government could be disregarding this policy since it has yet to analyze it, in contrast to a direct denial, which would convey that the particular policy has been already explored and denied. As such, *Feed-in Tariffs* receives a value of "0.5" for political feasibility.

**Economic Feasibility:** *Feed-in Tariffs* can be funded by spreading its additional costs through the customer base (e.g., Germany); using tax revenue to finance a direct payment by the government (e.g., the Netherlands); or through a combination of both (e.g., Spain)[585]. In any of these cases the implementation of this policy would represent added costs for the Federal Government.

If this policy were to be financed using tax revenue to provide a direct payment by the government, income that is currently used to finance other government programs would have to be directed to this policy which implies added costs for the Federal Government as well. If costs were spread through the customer base, subsidies would have to be put in place given the amount of "low-income" population in Mexico, and the fact that ensuring energy access is basic for development[586]this would cause an overall increase in costs in the amount of the subsidy required. Therefore given that the implementation of this policy would cause an overall increase in costs for the Federal Government, *Feed-in Tariffs* is assigned a value of "0" for economic feasibility.

#### *5.2.11. Net Metering*

**Legal Feasibility:** Currently the laws provide for the possibility of installing distributed systems and interconnect them to the grid to provide self-supply generation with the possibility of procuring any extra electricity required from the grid[587]. There is, however, no indication about providing payments for the electricity that these systems generate and send to the grid when the output its not used for self-supply.

Residential and low consuming commercial customers are to be serviced by the Federal Electricity Commission[588], which has been granted independence in their operations. Therefore, the decision of paying for the electricity sent to the grid by distributed systems would lie on the Federal Electricity Commission itself.

Currently the commission does not provide for a payment in return for the electricity injected by distributed systems into the grid, instead, they implement what is

[584] As provided by the next news articles: http://www.radioformula.com.mx/notas.asp?Idn=548750&idFC=2015 http://www.radioformula.com.mx/notas.asp?Idn=505320&idFC=2015
[585] NREL (2010). A policy Makers Guide to Feed-In-Tariff Policy Design. Available at: http://www.nrel.gov/docs/fy10osti/44849.pdf
[586] As analyzed in chapter 3 of this Study.
[587] Title 2, Chapter 4, Article 47 of the Electric Industry Law (Ley de la Industria Eléctrica).
[588] Customers with input requirements of less than 3 MW of electricity in the first stage of implementation. This 3 MW input demand requirement is programed to be ratchet down throughout a 2-year period until it falls to 1 MW.

known as "Net metering with rolling credit"[589]. Through this application, the banking period extends over a billing period (typically one year), and if during a billing period there is excess energy (IE [imported energy] e EE [exported energy] < 0), this value (EE e IE) is used as a credit to reduce the bill in future billing periods.

If this policy is to be implemented as a mandate to the Federal Electricity Commission to continue its "Net metering with rolling credit" approach or even to expand this to the preferred "Net metering with buy-back"[590] policy, changes to the current laws to submit the administration committee to set activities provided by law, and a mandate for the implementation of *Net Metering* have to be undertaken.

However, given that there is no impediment in the laws for the application of these type of policies by the Federal Electricity Commission, *Net Metering* receives a value of "1" for legal feasibility as its implementation would not require, per se, any changes in current laws. Nevertheless it is worth noting that, the fact that there is no legal mandate for undertaking this policy, gives an important degree of uncertainty in regards to its implementation. Moreover, given that a "buyback" net metering policy approach would present additional costs to the Federal Electricity Commission in the form of a payment that it would have to make to the owners of these systems, it is highly unlikely that this "for profit" enterprise would willingly offer it.

**Political Feasibility:** The Federal Electricity Commission has announced recently through its director, that this enterprise will start selling solar panels to customer that whish to generate their own electricity through these distributed systems[591]. While promoting this decision from customers, the Director of the Federal Electricity Commission has began to explain the numerous benefits in different media appearances, advancing the current "Net metering with rolling credit" policy as one of them[592].

Given that the Federal Electricity Commission is the only one that could implement this policy for residential and low input consumers as it is currently their sole provider, the fact that its Director has advanced the "Net metering with rolling credit" approach as one of the benefits that should incentivize people to purchase panels from them, suggests that this policy is currently politically feasible in the Country, at least in its rolling credit form[593]. Hence, *Net Metering* receives a value of "1" for political feasibility in this study.

**Economic Feasibility:** As noted before, the Federal Electricity Commission manages its own budget, with which it can make any investments or advance any policies that its administration committee decides. Undertaking *Net Metering* for consumers that install distributed generation systems, therefore poses no increases in costs to the Federal Government, as the potential resources[594] needed for its application would come directly from the Federal Electricity Commission's budget. As such, this policy receives a value of "1" for economic feasibility in this study.

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[589] As provided by CFE's interconnection contract available at: http://www.cfe.gob.mx/ConoceCFE/Desarrollo_Sustentable/Lists/Energia%20renovable/Attachments/3/CONTRATODEINTERCONEXIONPEQUE%C3%91AESCALA.pdf

[590] If IE e EE < 0 the customer- generator is paid for the excess energy (EE e IE) generated during the billing period, which can be valued below retail rate (typically avoided cost of generation, i.e., wholesale rate or cost to the utility), retail rate, or above retail rate invest in renewable energy generation projects.

[591] See: http://www.oem.com.mx/elsoldemexico/notas/n3759248.htm

[592] See http://www.oem.com.mx/elsoldepuebla/notas/n3736793.htm

[593] The benefits and downsides of this approach against a "buyback" scheme, will be explained in the next chapter in light of other country success examples.

It is worth noting that, if a "Net metering with buy-back" approach is taken instead of the "Net-metering with rolling-credit" currently in place; or if "buy-back" is incorporated for a specific type of consumers, the costs for the Federal Electricity Commission might rise. In this case, the Commission might cover these cost-increases directly through its budget[595], or it might instead be compelled to spread the added costs within electricity consumers. If the latter approach is undertaken, the Federal Government might want to implement a subsidy for low-income population[596], which could in turn cause an overall increase in costs for the Government.

However, this policy is already operating in its "rolling-credit form"; "a buy-back" approach might or might not be applied, and if it is in fact implemented, the cost increase could be undertaken by the Commission in its discretion. These facts, constrain potential cost increases for the Federal Government to a very limited set of specific circumstances in which a subsidy would have to be put in place. Hence, this author believes that this policy should only be deemed economic unfeasible if the special set of circumstances that would require a subsidy develop, and up until they do.

*5.2.12. Priority Access and Dispatch*

**Legal Feasibility:** In terms of access, the laws establish that transmitters are required to provide these services to any applicant as long as it is technically feasible. In cases where this is not possible given budgetary constraints, solicitors can provide the required resources in order to have access to the needed infrastructure[597].

When applying for a generation permit, solicitors have to disclose all the details pertaining to the project, mainly: the specifics of the generation activity to be conducted, the geographical area to be occupied, the business plan that will be followed and the plans to access interconnection and transmission services[598]. When deciding about the pertinence of the proposed project, the Energy Regulatory Commission will analyze the technical viability of the project and the capabilities of the solicitants in order to approve or deny a permit[599].

Hence, access is unrestricted but dependent on the technical capabilities of transmitters, and on whether generators for which there is no available infrastructure are willing to invest on the required interconnection facilities.

In terms of dispatch, it is worth reinstating that there are two different mechanisms through which dealings can be conducted in the wholesale electricity market: by virtue of contract between parties with supervision of the National Centre for Energy Control[600], or through the "spot prices" mechanism, in which generators offer their total output to the market, and in turn, independent providers, the Federal Electricity Commission, and qualified users disclose their required demand[601]. Under this last scheme, the National Centre for Energy Control determines short-term spot prices[602] selecting the lower

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595 The added resources that the Commission will receive for the sales of distributed systems that is programmed to undertake could provide enough income to offset the costs of implementing the "Net metering with buy-back" policy.
596 Depending on the impact.
597 Title 2, Chapter 3, Article 35 of the Electric Industry Law (Ley de la Industria Eléctrica).
598 Title 4, Chapter 4, Article 130 of the Electric Industry Law (Ley de la Industria Eléctrica).
599 Title 4, Chapter 4, Article 130 of the Electric Industry Law (Ley de la Industria Eléctrica).
600 Title 3, Chapter 1, Article 97 of the Electric Industry Law (Ley de la Industria Eléctrica).
601 Title 3, Chapter 1, Article 104 of the Electric Industry Law (Ley de la Industria Eléctrica).
602 The explicit value of the commodity at any given time in the wholesale market.

offerings by the generators[603] to supply the required demand. Dispatch will depend then, on the specific dealings conducted through the wholesale electricity market in accordance to the current legal framework, and therefore, there is no priority given to any generators per se.

As such, if priority access and dispatch aimed at favoring renewable energy generation projects is to be implemented, changes to the current laws would be required to establish this prelation. Given these reasons, *Priority Access and Dispatch* is assigned a value of "0" for legal feasibility in this study.

**Political Feasibility:** Neither the Special Program for the Development of Renewable Energy (2014-2018)[604], nor the "National Energy Strategy" (2013-2027) document[605] discuss *Priority Access and Dispatch* for renewable energy generation projects as a policy to be explored.

In addition to this, after reviewing several media participations of both the President and the Minister of Energy in regards to the topic of promoting renewable energy deployment, there was no mention whatsoever of *Priority Access and Dispatch*. Furthermore, there are no efforts currently being undertaken to incorporate the possibility of instrumenting *Priority Access and Dispatch* in the current laws.

Given that although there is no indication that this policy is currently being pursued, its application during this Presidential period has not been ruled-out. This conveys that the policy might not have been explored yet, as opposed to a direct denial, which would imply that the policy was already analyzed and rejected. As such *Priority Access and Dispatch* receives a value of "0.5" for political feasibility.

**Economic Feasibility:** The implementation of this policy would only affect which facilities get dispatched first into the grid after granting interconnection access to generators. Providing that the National Centre for Energy Control should dispatch interconnected renewable energy generation facilities first, poses no increase in overall costs to the Federal Government, and as such this policy receives a value of "1" for economic feasibility.

The only caveat to this is that there could be an argument to be made in regards to this policy causing an overall increase in electricity prices, if the electricity that these facilities produce is in general costlier than other options. In this case a subsidy from the Federal Government might need to be implemented to ensure energy access for low-income customers. However, this would depend on the specific effects of this policy's application, which cannot be determined until it is actually operating.

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603 Generators submit their price offers based on all their incurred costs to produce electricity. To prevent cost manipulation, the National Centre for Energy Control reviews all the offers.

604 Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf

605 Document available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf

5.3. Carbon Abating Policies That Can Indirectly Impact Clean Energy Deployment.

*5.3.1. Carbon Taxes*

**Legal Feasibility:** Currently the "Special Production and Services Tax Law" provides for a *Carbon Tax* set at MXN$39.80 (US$3.50) per tCO2-e of fossil fuels[606]. This tax, which covers fossil fuel sales and imports by manufacturers, producers, and importers, is not a tax on the full carbon content of fuels, but rather on the additional amount of emissions that would be generated if the particular fossil fuel were used instead of natural gas (natural gas therefore is not subject to the carbon tax). The tax rate is capped at 3% of the sales price of the fuel.[607]

Hence, the fact that a *Carbon Tax* policy is directly set in the laws and currently operating, allows us to grant this policy a value of "1" for legal feasibility.

**Political Feasibility:** In April 2012, Mexico's Congress passed the General Climate Change Law, which was signed into law in June 2012. The law set the target for a 30% reduction in emissions, below business as usual, by 2020 and a 50% reduction below 2000 levels by 2050[608].

The current administration has the task of implementing the mandates of the General Climate Change Law of 2012. Following this, the updated "National Climate Change Strategy" document[609] and Second Special Program on Climate Change (2014-18)[610] were published in June 2013 and April 2014 respectively. These outlined the government's contribution towards the General Climate Change Law targets, which were set to be guided by the next five objectives:

- Objective 1: Reduce the vulnerability of the population and productive sectors by increasing resilience through strategic infrastructure.
- Objective 2: Sustainably conserve, restore and manage ecosystems through mitigation and adaptation to climate change, so as to protect environmental services.
- Objective 3: Reduce greenhouse gas emissions to transition into and develop a competitive economy with low-emissions.
- Objective 4: Reduce emissions of short-lived climate pollutants, which improve health and wellbeing.
- Objective 5: Consolidate national climate policy through the use of effective policy instruments and through coordinative efforts with state entities; societies, municipalities and legislative authorities.

Hence, in October 2013, in coherence with objectives 3 and 5, President Enrique Peña Nieto put forward plans for a *Carbon Tax* on fossil fuel production as part of the fiscal reform package of that year, which was further approved by Congress and its now contained in the "Special Production and Services Tax Law". The fact that this Carbon Tax was proposed by the President and further approved by Congress evidences that this policy

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606 The Law provide for the possibility of modifying the amount of the tax on a yearly basis. The Ministry of Finance and Public Credit is in charge of publishing the potential changes in the Official Federal Gazette.
607 Article 2 of the "Special Production and Services Tax Law" (Ley del Impuesto Especial Sobre Produccion y Servicios).
608 Article 2 of the transitory provisions of the "Climate Change General Law" (Ley General de Cambio Climatico)
609 Available at: http://www.semarnat.gob.mx/archivosanteriores/informacionambiental/Documents/06_otras/ENCC.pdf
610 Available at: http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/PPD02/DO3301.pdf

is currently politically feasible in the Country, as it is already operating after being endorsed by both the Executive and the legislative branches of Government. As such, this policy receives a value of "1" in this regard.

**Economic Feasibility:** The implementation costs of this policy for the Federal Government as it stands are already being undertaken, and as such, this study will grant this policy a value of "1" for Economic Feasibility. Nevertheless, it is worth noting that if the tax rate were to be increased in order to allow Mexico to reap the full benefits of its implementation, and spur the energy transition through it, significant cost increases in the system could develop that can be ultimately transferred to electricity consumers. The study conducted by the Energy Information Administration (previously analyzed in Chapter 4) found that the change in the generation mix and emission fees in the $CO_2$ fee cases leads to higher electricity prices. Within the parameters of the study, in 2025 electricity prices are 12 percent to 34 percent higher than in the Reference case, while in 2040 they are 14 percent to 28 percent higher[611]. This highlights the potential necessity of implementing a subsidy for low-income population[612], which could in turn cause an overall increase in costs for the Federal Government.

*5.3.2 Cap and Trade*

**Legal Feasibility:** Currently the laws in Mexico do not provide for a *Cap-and-Trade* system. The "General Climate Change Law" sets a target for a 30% reduction in emissions, below business as usual, by 2020 and a 50% reduction below 2000 levels by 2050[613], but does not advance the possibility of implementing a mandatory cap-and-trade system to reach it. There is however a provision in this law regarding the possibility of constructing a "voluntary" emission trading market, allowing those interested in participating in it to carry out transactions that can be linked with emissions trading in other Countries, or that can be utilized in international carbon markets[614].

Nevertheless voluntary carbon markets differ from *Cap-and-Trade* mechanisms given that they function outside of a compliance market and they lack a mandatory "cap". Therefore, compared to compliance markets, trading volumes in voluntary markets tend to be much smaller because only credit buyers willing to purchase create demand, whereas in a *Cap-and-Trade* system, a regulatory instrument creates it[615].

Therefore, as a *Cap-and-Trade* mechanism is currently not provided by law, any attempt to incorporate it to the legal framework would require changes to the "General Climate change Law"; hence, this policy is given a value of "0" for Legal Feasibility in this study, as its application would require undertaking a legislative process.

**Political Feasibility:** Although neither the "National Climate Change Strategy" document (2013)[616], nor the and Special Program on Climate Change (2014-18)[617] discuss setting a mandatory limit on emissions and establishing a market with tradable certificates to comply with it. Recent participations by both the President and the Minister of the

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611 Energy Information Administration (2013). Further Sensitivity Analysis of Hypothetical Policies to Limit Energy-Related Carbon Dioxide Emissions. Available at: https://www.eia.gov/forecasts/aeo/supplement/co2/
612 Depending on the impact.
613 Article 2 of the transitory provisions of the "Climate Change General Law" (Ley General de Cambio Climatico).
614 Article 94 of the "Climate Change General Law" (Ley General de Cambio Climatico).
615 Adapted from information provided by the "Stockholm Environment Institute" through: http://www.co2offsetresearch.org/policy/MandatoryVsVoluntary.html
616 Available at: http://www.semarnat.gob.mx/archivosanteriores/informacionambiental/Documents/06_otras/ENCC.pdf
617 Available at: http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/PPD02/DO3301.pdf

Environment in regards to the topic of carbon markets clearly convey that this policy option is gaining political momentum. This as they both have advanced that Mexico will explore the potential implementation of a carbon market similar to Quebec's *Cap-and-Trade* mechanism for which both Mexico and Quebec have signed a collaboration agreement that provides for information sharing and probable establishment of a partnership to undertake "linkage"[618] strategies[619]. As such, given that political feasibility is being analyzed in regards to the will showcased by the Federal Government for the implementation of the different policies, *Cap-and-Trade* receives a value of "1" for political feasibility. This given that although *Cap-and-Trade* was not being considered as a viable policy in previous years, since 2015 steps that evidence political will from the President and its Cabinet in favor of its implementation have been undertaken.

**Economic Feasibility:** The implementation costs of this policy can be derived from the same rationale used in regards to the Carbon Tax policy. In fact the previously cited study from the Energy Information Administration (EIA) found that the results in *Cap-and-Trade* cases targeting a 50 percent electricity sector emissions reduction by 2040 are most similar to carbon tax cases with a starting level of $10 in 2014 - the change in the generation mix spurred by such a mechanism leads to higher electricity prices[620]. This highlights the potential necessity of implementing a subsidy for low-income population[621], which could in turn cause an overall increase in costs for the Federal Government in the amount of the subsidy. However, it is worth noting that the electricity price increases, and therefore the cost of the subsidy (if needed) would be dependent on the specific cap. There have been cases where the cap is set high enough that allowances are priced very cheap and hence the *Cap-and-Trade* policy is effectively not causing price increases[622]. As such, given that the potential requirement of setting a subsidy would depend on the specific design characteristics of the policy, this study refrains from giving *Cap-and-Trade* a set value, and instead deems its economic feasibility as "undetermined".

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618 Linking carbon markets, thus allowing compliance in both Countries by presenting allowances of either Mexico or Quebec.

619 As evidenced by the next news articles: http://www.zocalo.com.mx/seccion/articulo/acuerdan-mexico-y-quebec-fortalecer-cooperacion-en-cambio-climatico-1444693 http://www.rcinet.ca/es/2015/10/13/mexico-interesado-en-el-mercado-de-carbono-de-quebec/

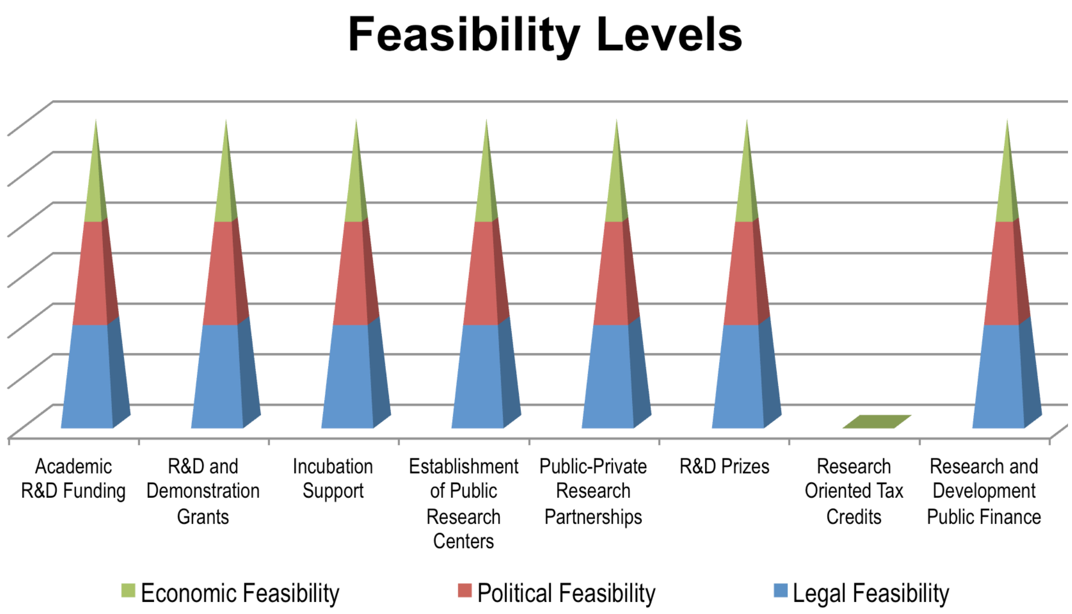
620 Energy Information Administration (2013). Further Sensitivity Analysis of Hypothetical Policies to Limit Energy-Related Carbon Dioxide Emissions. Available at: https://www.eia.gov/forecasts/aeo/supplement/co2/

621 Depending on the impact.

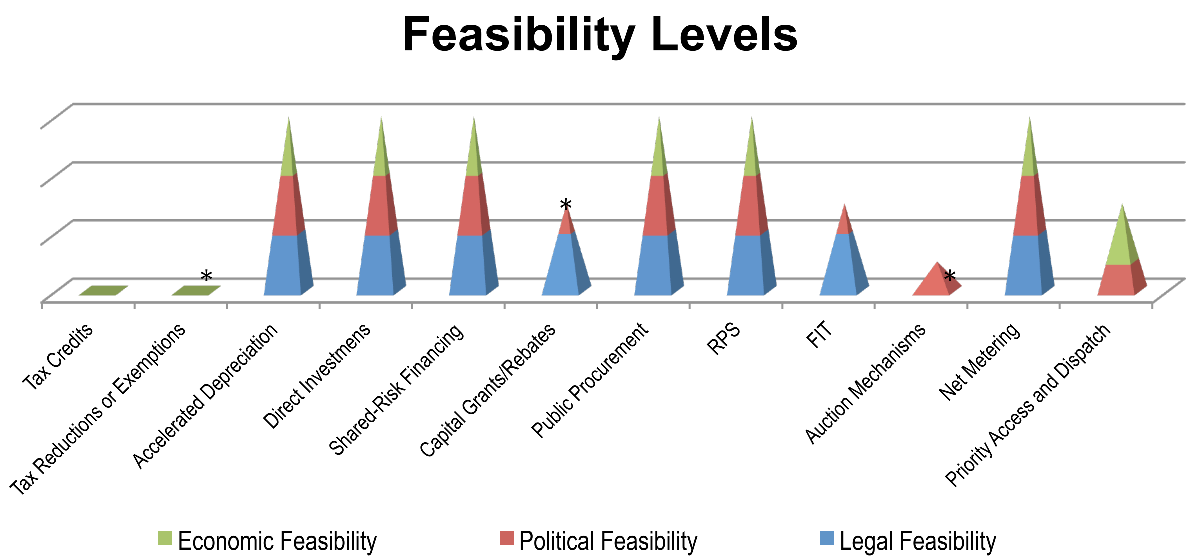
622 In California, where a mixture of a market-based mechanism and complementary policies has been deployed, the fact that allowances are being traded at almost the established price floor, showcases how mitigation efforts are being driven mainly by complementary policies that aren't reflected in the carbon market price as compliance with them is required an independent of the carbon market. See: http://calcarbondash.org/

5.4 Feasibility Charts

a. Supply-Push Policies

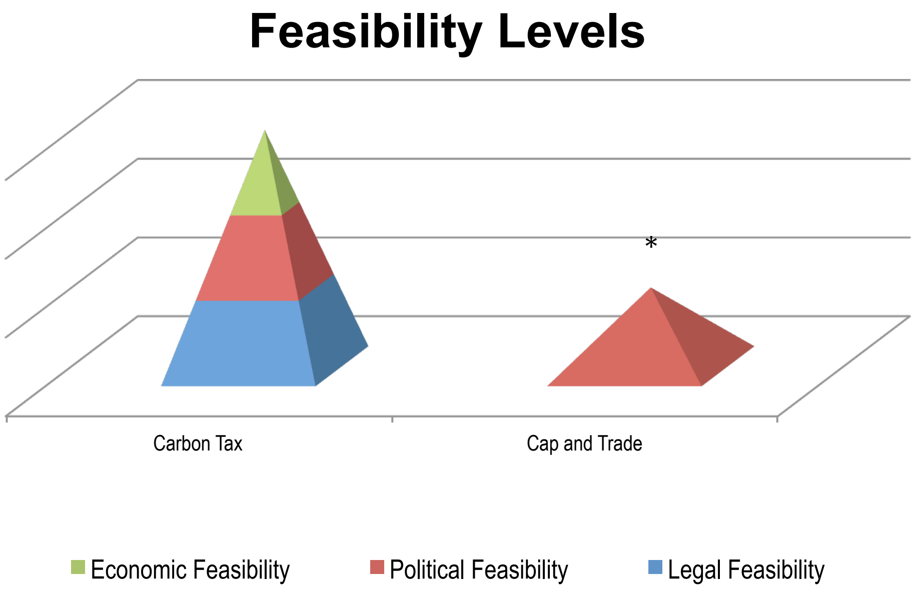



b. Demand-Pull Policies




* Policies with this symbol have undetermined feasibility levels in one or more categories

c. Carbon Abating Policies




5.5 Key Findings and Concluding Remarks

In this chapter we have analyzed the current legal, political and economic feasibility levels in Mexico for the different policies available to spur innovation and application of renewable energy technologies – directly and indirectly. Through it we have found that:

- Most "technology-push" policies are currently feasible given the structure of the CONACYT/SENER Sustainability Fund, which has the legal basis for developing and implementing renewable focused research and development policies using its already assigned resources. Furthermore, the National Development Plan and the relevant documents that contain the Country's energy agenda[623] showcase that spurring innovation in alternative energy technologies is one of the main directives of this Presidential period[624].
- In regards to "demand-pull" policies, there are few efforts already in place, some in queue to start operating, and others that aren't currently scheduled, but that are feasible under the current Mexican scenario. This gives this Country a solid base that can be furthered to close the gap between deployment objectives and results.
- With reference to "market-based carbon abating policies" although Mexico has taken steps in this regard trough the implementation of a Carbon Tax. Its design characteristics seem questionable, as it stands, with regards to its ability to reach the goals set forth by the General Law of Climate Change, and indirectly spur renewable energy deployment.

623 National Energy Strategy and Special Program for the Development of Renewable Energy.
624 The only caveat being the application of policies that tamper the Federal Government's tax revenue (Tax Breaks), which is currently not politically feasible for reasons discussed through the study.

For these three main key findings, the caveat is the same: in the past we have seen how policies aimed at spurring renewable energy have been programed to operate, and how they have fallen to serve only as "catalogues of good intentions". Hence, the utmost importance of discussing and analyzing implementation and design considerations of those policies that were deemed feasible, with the goal of increasing their likelihood of success in attaining the energy transitional goals.

As such, the next chapters will be aimed at analyzing the implementation examples of the U.S. and other Countries that have undertaken similar policy efforts to the ones chosen as feasible for Mexico, in a successful manner. Drawing conclusions about the proper design of these policies, while disclosing the differences and similarities that these Countries might have with Mexico in regards to factors that might affect the outcomes of policy implementation.

## 6. Policy Design Considerations in Light of Other Country Examples - "Technology-Push"

As explained through Chapter 3, innovation is a key driver in the path towards energy transition, as technological development enhances the portfolio of energy options available, and further contributes in reducing their costs[625].

Governments have an important role in this regard: creating an attractive environment for research and development through the implementation of "supply-push" policy instruments[626]. In order to be efficient in the approach taken towards this purpose, policy makers must allow for a coherent strategy when making choices. The levels of available funding often determine government's ability to act, and in Mexico this funding is constrained to the amounts provided by "PEMEX" through the "Petroleum Dividend"[627] directed to the CONACYT/SENER Sustainability Fund[628], by virtue of law[629]. Hence, a clearly established vision of what the Government aims to achieve, is the crucial first step, in regards to research and development.

There is extensive literature pertaining to the goals that research and development policy should be aimed to achieve. The consensus is that this type of policy efforts should focus on building competence and human capital, promoting the creation and sharing of knowledge, and improving knowledge diffusion by establishing collaborative networks[630]. Each one of the "supply-push" policies deemed feasible in Mexico through chapter 5, are indeed focused at attaining one or more of these three broad goals, however, whether these policies are successful in achieving them or not, will depend on the specifics of their design.

Hence, this Chapter will focus on analyzing the implementation examples from other Countries that have undertaken similar "supply-push" policy efforts to the ones

[625] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[626] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[627] The Ministry of Finance and Public Credit determines the total amount of this "Petroleum Dividend" through the analysis of the financial statements of this enterprise. As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
[628] This fund receives 20% of the result of multiplying the yearly "petroleum dividend" by .0065, as provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
[629] As provided by title 2, chapter 6, article 97 of the Mexican Petroleums Law (Ley de Petroleos Mexicanos)
[630] International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

chosen as feasible for Mexico, in a "successful"[631] manner. Drawing conclusions about proper policy design, while disclosing the differences and similarities that these Countries might have with Mexico in regards to factors that might affect the outcomes of policy implementation[632].

The selection of the design characteristics that will be highlighted as "key" for policy goal attainment during the study, will be done in light of 6 respects that have found to be fundamental in research and development policy making, by the International Energy Agency[633]:

- *Strategy and Priority Setting:* R&D policies should have clear priorities and quantifiable objectives.

- *Stable Government R&D Support:* There is no set level of funding with which a country must comply for a particular policy, or an amount it must meet; the requirement is rather evidence of adequate, stable and predictable funding in the different implemented policies, that is coherent with the objectives.

- *R&D Governance:* Managers should have proven scientific and administrative capacities. In addition, the organizational structure of the governance bodies should balance independence against accountability.

- *Effective Evaluation and Monitoring:* Monitoring and performance evaluation tools need to be established for measuring the performance of R&D policies and programs. Moreover, selection processes for incentive allocation should promote transparency and fairness.

- *Strong Collaborative Approach:* Successful R&D policy should address the interests of the many stakeholders involved; bridging them to accelerate the development of a particular technology. Collaboration, transparency and networking are vital to effectively utilizing the limited RD&D resources available.

- *Strategic International Collaboration:* Governments can benefit from developing national strategies for international R&D collaborations. To promote access to facilities and expertise; and improved competitiveness by spreading the costs and risks of R&D.

It is worth noting that as there is no such thing as "perfect policy-making", it is likely that there will be policy examples that do not address all of these "good practices", but still achieve successful results. These situations shall be treated as opportunities to

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631 Examples will be selected following successful implementation criteria, which will be showcased within the scope of each individual example with respect to the specific results that these policies have achieved.

632 The choice of examples that are analyzed through this Chapter might seem biased based on the fact that they are selected out of efforts conducted by developed countries – Mainly the U.S. Nevertheless, it is worth noting that an important factor when selecting case studies undoubtedly was information availability, as the purpose of this analysis is to shed light on different approaches that can be used when developing successful R&D policy in light of the characteristics that have been deemed fundamental by extensive research efforts, which can only be done if information about those aspects is available (after a thorough research effort, this author has realized that it is rare to find developing Countries fully providing information regarding the specific details of their clean energy policies) . Moreover, it is important to keep in mind that the purpose of the study is not to frantically search for Countries that can be deemed very much similar to Mexico (which is always a relative categorization), undertaking those policies that have been chosen as feasible for this Country, but rather to find mature examples of strong policy making that has reaped successful results; this, in order to be able to provide policy design lessons for Mexico.

633 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

further include these practices in the Mexican versions of these policies, with the goal of furthering results even beyond those showcased through the different examples.

### 6.1. Academic R&D Funding

R&D Academic Funding programs tend to be structured to address one of the three main goals of policy aimed at spurring technological innovation: promoting the creation and sharing of knowledge[634].

In the U.S., the National Science Foundation undertakes the efforts focused at clean energy R&D Academic Research Funding[635] through different calls for proposals. To cite an example: the "Energy for Sustainability" program (currently operating), supports fundamental engineering research for the sustainable production of electricity and fuels[636]. Topics in this proposal include:

- Biomass Conversion, Biofuels & Bioenergy.
- Photovoltaic (PV) Solar Energy.
- Advanced Batteries for Transportation and Renewable Energy Storage.

The success of this policy is evidenced by the vast amounts of scientific publications in scientific and engineering journals than the financed research projects have promoted. From this call for proposals alone, more than 190 academic research projects have been financed which has led to more than 200 publications in several different journals. This evidences the success of this policy in promoting the goal of creation and sharing of knowledge[637].

As explained before, by virtue of law, in Mexico renewable energy research is carried out through the CONACYT/SENER Sustainability Fund[638]. The NSF and CONACYT share many similarities, which make the selection of NSF academic research programs as a case study to analyze, pertinent. Both are nationally run and funded institutes focused at conducting research and advising their respective governments in regards to innovation, science and technology[639]. Both have freedom in deciding which projects to undertake, and how to develop and fund them even though their approaches to do so might be different[640]. Moreover, both have registered national researchers, which are useful

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634 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

635 Although there are several clean energy research programs in the Country, they tend to be geared towards different participants (industry, local governments and academia indistinctively) – this can be analyzed by browsing the different research and development opportunities sponsored by the Federal Government through the Department of Energy, an example of this can be found at the Federal Business Opportunities website through: https://www.fbo.gov/index?s=opportunity&mode=form&id=ad1f92ce9c8df1dc297005aac290f7e2&tab=core&_cview=0. The NSF is specifically focused to academic research and development programs in every aspect of sciences and engineering including clean energy technology.

636 National Science Foundation, "Energy for Sustainability" program details, available at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026

637 Detailed information of all the awards granted under this call for proposals, and the publications derived from them can be found at: http://www.nsf.gov/awardsearch/advancedSearchResult?WT.si_n=ClickedAbstractsRecentAwards&WT.si_x=1&WT.si_cs=1&WT.z_pims_id=501026&ProgEleCode=7644&BooleanElement=Any&BooleanRef=Any&ActiveAwards=true&#results

638 As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

639 Provided by information contained in the Mexican Expenditure Project of 2016 through: http://www.ppef.hacienda.gob.mx/work/models/PPEF/2016/docs/38/r38_epr.pdf . And NSF through: http://www.nsf.gov/about/index.jsp

640 In terms of clean energy, this fact is provided by the collaboration agreement between SENER and CONACYT, available at: http://sustentabilidad.energia.gob.mx/res/Convenio%20de%20Colaboracion%20SENER-Conacyt.pdf. And the NSF through: http://www.nsf.gov/about/index.jsp

to develop merit review systems for award allocations in order to promote fairness in the selection of projects[641].

The CONACYT/SENER Sustainability Fund has 6 different programs in place[642], none of which are focused directly at academic research. The only two programs that are somewhat related to this type of research are the Post-Doctoral programs, however they are only accessible by recent doctoral graduates, which considerably restricts the pool of academics that can access funds to conduct clean energy research in the Country.

Hence the first lesson derived from NSF's implementation of their academic research program, would be expanding the access of current academic research programs in Mexico to allow proposals from undergraduate and graduate students, as well as educators - both as individuals or in groups. This could be done either by enacting a new call for projects that addresses these individuals, or submitting an addendum to the postdoctoral program to provide for the inclusion of these participants.

In terms of *Strategy and Priority Setting*, the NSF establishes through its call for proposals the objectives of each particular program, for instance, in the example that we are currently analyzing, the "Energy for Sustainability" program clearly advances the objective of promoting engineering research that enables innovative processes for the sustainable production of electricity and fuels; and further specifies that acceptable proposals should be environmentally benign, reduce greenhouse gas production, and utilize renewable resources[643]. Moreover, the "Energy Sustainability" call for proposals distinctly advances the focus of renewable energy research that is to be funded, by directly describing the different technologies in which they are seeking proposals within each of the renewable energy topics of the program[644]. This practice is not currently undertaken by the CONACYT/SENER Sustainability Fund, nationally focused call for proposals for R&D activities advance vague objectives, which do not allow zooming in on the specifics of what they are looking for through the different programs (below the description of the available program objectives, which provides evidence for this statement). The CONACYT/SENER Sustainability Fund, has 4 domestic programs in place[645]; their objectives are advanced as follow:

- <u>Innovation Laboratory for Energy Sustainability:</u> A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals for research and development projects regarding energy efficiency, and renewable energy.
- <u>Institutional Strengthening for Energy Sustainability:</u> A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals for projects aimed at strengthening the technical capacity of basic and applied renewable energy and energy efficiency research focused facilities.

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641 An explanation of a "Merit Review System" and its role in award allocation will be advanced further under the *Effective Evaluation* section.

642 Innovation Laboratory for Energy Sustainability, Institutional Strengthening for Energy Sustainability, Mexican Postdoctoral Projects in Energy Sustainability, CONACYT-SENER Energy Sustainability Innovate UK 2015-03, International Cooperation in Geothermal Research and Development Between Mexico and the European Union, Postdoctoral Fellowships in Mexico – Energy Sustainability.

643 National Science Foundation, "Energy for Sustainability" program details, available at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026

644 These specifics can be consulted at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026

645 The programs and their details can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica

- Mexican Postdoctoral Projects in Energy Sustainability: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals regarding postdoctoral research projects focused at energy sustainability, with the purpose of incentivizing recent Mexican doctoral graduates to advance research efforts in energy sustainability and develop their technical capabilities while doing so.
- Postdoctoral Fellowships in Mexico – Energy Sustainability: A call for postdoctoral proposals from foreign or Mexican students that want to conduct energy sustainability postdoctoral research in Mexico.

Hence, Mexico should learn from the example of the NSF and clarify objectives in the different call for proposals of the CONACYT/SENER Sustainability Fund with the goal of preventing confusion and maximizing efficiency[646].

With regards to the issue of *Stable Government R&D Support,* the NSF does not establish the specific lifetime of all incentive programs as it is the case in the "Energy for Sustainability" program, however it does provide a clear window during which proposals will be accepted per year[647]. This is one instance in which a Mexican equivalent program could improve the current design of the policy example we are currently analyzing. The CONACYT/SENER Sustainability Fund programs do not contain provisions that specify the lifetime duration of the particular incentive program, nor windows of acceptance of proposals, as they stand, call for proposals are just deemed open until specified otherwise[648]. Hence, Mexico should learn from the lessons compiled by international well-established research efforts as the one by the International Energy Agency, and send the adequate signals to stakeholders by advancing a specific lifetime for government support in this regard[649]. This, as it has been found that stakeholders will be looking for concrete and long-term policy support that promotes the stated objectives of the particular program in order to react[650].

Pertaining to *R&D Governance*, NSFs leadership has two major components: a director who oversees the staff and who is responsible for program creation and administration, merit review, planning, budget and day-to-day operations; and a 24-member National Science Board of eminent individuals that meets six times a year to establish the overall policies of the foundation. The director and all Board members serve six-year terms. Each of them, as well as the NSF deputy director, is appointed by the President of the United States and confirmed by the U.S. Senate[651].

NSF is organized into the following seven divisions that support science and engineering research and education programs: Biological Sciences, Computer and Information Science and Engineering, Engineering, Geosciences, Mathematical and Physical Sciences, Social, Behavioral and Economic Sciences, and Education and Human

646 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

647 National Science Foundation, "Energy for Sustainability" program details, available at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026

648 The specifics of CONACYT/SENER Sustainability can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica

649 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

650 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

651 The specifics of the National Science Foundation organizational structure can be consulted at: http://www.nsf.gov/about/index.jsp

Resources. Each is headed by an assistant director, which is an expert in the field, and is further subdivided into categories like materials research, ocean sciences and behavioral and cognitive sciences. Other sections of NSF are devoted to financial management, award processing and monitoring, legal affairs, outreach and other functions. The Office of the Inspector General examines the foundation's work and reports to Congress[652].

Mexico's CONACYT has a similar governance structure than NSF, it has a General Director with adjunct directorships, however, these directorships are not divided by sciences but by the activities they are in charge of undertaking. These are: scientific development, technological development and innovation, fellowships, research centers, regional development, planning and international cooperation. Just as in NSF, other sections are devoted to legal issues, communication, and finances; The CONACYT also has an Internal Organ of Control in charge of conducting monitoring activities, and detecting and preventing fraud, waste, and abuse within the CONACYT or by individuals that receive funding[653].

As opposed to the way that NSF enacts calls for proposals through its directorates within the areas of their respective specialization[654]. The CONACYT relies on the formation of specific Funds with different Mexican Federal agencies, local governments, or international institutions in order to develop focused R&D incentive programs[655]. In terms of clean energy, as analyzed in Chapter 4, these programs are carried out through the "CONACYT/SENER Sustainability Fund with resources that come from the "Petroleum Rent". This Fund is managed by its "technical committee" which decides what programs to undertake, and it is formed by three representatives of SENER, one of CONACYT, one of the Federal Electricity Commission, one of the Energy Efficiency Commission and two representatives from the academia or the scientific community[656]. This Fund hence, currently has a diverse governance body; however, there are no indications in regards of how the selection of these representatives is conducted.

Apart from the Board Members, and the General and Deputy Directors, which are appointed by the President and confirmed by the U.S. Senate, NSF divisions are composed of a committee appointed directly by the Board of Members[657]. These committees consist of no less than five individuals, who may or may not be members of the board, and which are to serve in the committees for 2 years, and shall elect its own chairman from among its constituents and prescribe its own rules of procedure[658]. By browsing the profiles of the different division Directors it is clear that they are highly qualified in their field[659], therefore, we can conclude that NSFs appointment process is reaching the results deemed fundamental for clean energy research and development policy: Managers have proven scientific and administrative capacities. Mexico has been recently deemed the most corrupt Country of the OCDE[660], and as such transparency[661] and rule following in the selection

[652] The specifics of the National Science Foundation organizational structure can be consulted at: http://www.nsf.gov/about/index.jsp
[653] As provided by the Organizational Manual of the National Council of Science and Technology (CONACYT).
[654] The process is explained by NSF through: http://www.nsf.gov/about/how.jsp
[655] The explanation of how the CONACYT develops focused R&D incentive programs through different funds can be consulted at: http://www.conacyt.mx/index.php/fondos-y-apoyos
[656] As provided by the collaboration agreement between SENER and CONACYT, available at: http://sustentabilidad.energia.gob.mx/res/Convenio%20de%20Colaboracion%20SENER-Conacyt.pdf
[657] PUBLIC LAW 507- 81ST CONGRESS, CHAPTER 171-2D SESSION, S. 247.
[658] PUBLIC LAW 507- 81ST CONGRESS, CHAPTER 171-2D SESSION, S. 247.
[659] To provide an example, the profile of the Director of the division of Astronomical Sciences can be found here: https://www.nsf.gov/news/news_summ.jsp?cntn_id=116331
[660] As provided by the next news article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde
[661] There is no publicly available information regarding who the representatives currently managing the technical committee of the Sustainability Fund are.

process of the representatives of the CONACYT/SENER Sustainability Fund should be deem fundamental. Hence, establishing rules for selection, and making the processes available to consult by the public, should be pursued.

In regards to *Effective Evaluation*, to ensure that proposals are evaluated in a fair, competitive, transparent and in-depth manner, NSF uses a rigorous system of merit review. Nearly every proposal is evaluated by a minimum of three independent reviewers consisting of scientists, engineers and educators who do not work at NSF or for the institution that employs the proposing researchers. NSF selects the reviewers from among the national pool of experts in each field and their evaluations are confidential[662].

The NSF program officer reviews the proposal and analyzes the input received from the external reviewers. After scientific, technical and programmatic review and consideration of appropriate factors, the program officer makes an "award" or "decline" recommendation to the division director. Final programmatic approval for a proposal is generally completed at NSF's division level. A principal investigator (PI) whose proposal for NSF support has been declined will receive information and an explanation of the reason(s) for declination, along with copies of the reviews considered in making the decision. If that explanation does not satisfy the PI, he/she may request additional information from the cognizant NSF program officer or division director.

If the program officer makes an award recommendation and the division director concurs, the recommendation is submitted to NSF's Division of Grants and Agreements (DGA) for award processing. A DGA officer reviews the recommendation from the program division/office for business, financial and policy implications, and the processing and issuance of a grant or cooperative agreement. DGA generally makes awards to academic institutions within 30 days after the program division/office makes its recommendation.

Currently the method for selection of awardees of the different programs undertaken by the CONACYT/SENER Sustainability Fund is lacking transparency. There is an evaluation commission[663] in charge of selecting the awardees established by the "operation rules" of the Fund, however, the selection processes this commission will follow are set as self-imposed and variable[664]. The commission is allowed to devise its own selection processes, which could be changed from time to time, and from project to project, as long as they reach decisions that demonstrate that technical, scientific and innovative viability of proposals has been analyzed, as deemed by the technical committee of the Fund[665]. Therefore the NSF merit review and assignation process can provide an example that can be employed by Mexico in order to comply with the *Effective Evaluation* ingredient of successful clean energy R&D policy making in a transparent way. Mexico can explore the incorporation a "merit review system" where independent reviewers consisting of scientists, engineers and educators who do not work at CONACYT, or for the institution that employ the proposing researchers, should evaluate every proposal. CONACYT already has a catalogue of experts in mostly every research field through its

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662 The specifics of the "merit review system" are provided by the National Science Foundation and can be consulted at: http://www.nsf.gov/about/how.jsp

663 Composed by the technical secretary of the Fund, three researchers appointed together by CONACYT and SENER, and one representative of SENER. As provided by the rules of operation of the CONACYT/SENER Sustainability Fund, available at: http://www.conacyt.gob.mx/siicyt/index.php/reglas-fondos-sectoriales/47--8/file

664 See the rules of operation of the CONACYT/SENER Sustainability Fund, available at: http://www.conacyt.gob.mx/siicyt/index.php/reglas-fondos-sectoriales/47--8/file

665 See the rules of operation of the CONACYT/SENER Sustainability Fund, available at: http://www.conacyt.gob.mx/siicyt/index.php/reglas-fondos-sectoriales/47--8/file

National Researcher System (Sistema Nacional de Investigadores), incentivizing these researchers to participate in this process could prove to be very useful to increase transparency and fairness in the award assignation process[666].

*Monitoring* in the NSF is conducted by the Office of the Inspector General[667], which examines the foundation's work and reports two times per year to Congress. This Office is in charge of promoting effectiveness in administering the Foundation's programs; detecting and preventing fraud, waste, and abuse within the NSF or by individuals that receive NSF funding; and identifying and helping to resolve cases of misconduct in science[668]. As explained before, the CONACYT also has an Internal Organ of Control in charge of conducting monitoring activities, and detecting and preventing fraud, waste, and abuse within the CONACYT or by individuals that receive funding[669], however, there is no requirement that compels this organ to publicly report its findings and activities. As such, the NSF example can shed light on a possible mechanism to improve transparency in its undertakings by providing for public reports to congress and making them readily available online.

In regards to *Strong Collaborative Approach*, in NSFs programs this is encouraged by the incorporation of scientists, engineers and educators as independent reviewers from among the national pool of experts in each field, but also through the implementation of GOALI (Grant Opportunities for Academic Liaison with Industry). GOALI is a category of eligible applicants (beyond undergraduate and graduate students, and educators in general) for the award programs of the NSF[670], aimed at the development of innovative collaborative industry-university educational programs, and direct transfer of new knowledge between academe and industry. This categorization is made available for[671]:

- Faculty, postdoctoral fellows, and students focused at conducting research and gain experience in an industrial setting;
- Industrial scientists and engineers to bring industry's perspective and integrative skills to academia; and
- Interdisciplinary university-industry teams to conduct research projects.

As previously analyzed, the CONACYT/SENER Sustainability Fund currently does allow for private participants to access certain incentives through proposals, but it does not have any collaborative mechanisms in place to promote access to grants by research partnerships between industry and academia. The NSF provides an example of a possible mechanism to implement in order to promote this when developing an Academic R&D program, through GOALI. Mexico can learn from this example and seek the establishment of specific eligibility criteria that promotes this type of collaborations, in order to promote bridging the interests of industry with academic research to accelerate technological development[672].

Furthermore, NSF promotes *International Collaboration* by welcoming proposals from U.S. participants that involve collaboration and cooperation with counterparts from other

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666 Details of this System are provided by CONACYT and can be found at: http://www.conacyt.gob.mx/index.php/el-conacyt/sistema-nacional-de-investigadores
667 Established in 1989, in compliance with the Inspector General Act of 1978, as amended.
668 As provided by NSFs Office of the Inspector General semiannual report to congress (March 2015). Available at: http://www.nsf.gov/pubs/2015/oig15002/oig15002.pdf
669 As provided by the Organizational Manual of the National Council of Science and Technology (CONACYT).
670 As an example, the "Energy for Sustainability" program is available for proposals by GOALI eligible participants.
671 As provided by Program Solicitation NSF 12-513, available at: http://www.nsf.gov/pubs/2012/nsf12513/nsf12513.htm
672 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

nations. The NSF finances the U.S. participants on a collaborative project, while international partners are to be supported directly by their own funding sources[673]. Proposers interested in international collaborations should address the following aspects in their proposals, as applicable[674]:

- Anticipated mutual benefits to the collaborating partners, as evidenced in true intellectual collaboration with complementary responsibilities and contributions,
- Benefits to be realized from the expertise and specialized skills of the collaborators,
- Any unique facilities, sites and/or resources available through the international collaboration, and
- Whether active research engagement of students and early-career researchers at the international site would occur.

Currently the CONACYT/SENER Sustainability Fund promotes *International Collaboration* through the establishment of bilateral collaborative agreement with different Countries, which is available on a per program basis and not across all call for proposals as the NSF's approach. Proof of this are the two calls for proposals available that promote collaboration with the United Kingdom and the European Union in different regards:

- CONACYT-SENER Energy Sustainability Innovate UK 2015-03: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals in regards to energy sustainability projects in collaboration with companies from the United Kingdom.
- International Cooperation in Geothermal Research and Development Between Mexico and the European Union: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals in collaboration with any kind of entities or states of the European Union to undertake research and development activities focused on geothermal energy.

Hence it is important to follow this practice also when developing Academic R&D programs in order to promote collaborative research proposals, which can enable access across expertise; and improved competitiveness by spreading the costs and risks of R&D between Mexico and other nations[675].

In terms of the differences between the U.S. NSF and Mexico's CONACYT beyond those advanced through this analysis, although the U.S. NSF has more resources[676], administrative costs between Mexico and the U.S. differ considerably[677]; the allocated funds for CONACYT have proven to be administratively sufficient to develop and run the programs that have been undertaken since is inception in 1999[678]. Furthermore, it is worth noting that on top of CONACYT's operational budget, many programs are financed through other sources - which as we analyzed, is the case of clean energy research related

673 As provided by the National Science Foundation through: https://www.nsf.gov/mps/dmr/international.jsp

674 As provided by the National Science Foundation through: https://www.nsf.gov/mps/dmr/international.jsp

675 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

676 The NSF has an annual budget of $7.2 billion (fiscal year 2014), while CONACYT has 27,356.5 Million Pesos.

677 Cost of living comparison can serve to shed light on the cost difference between the two Countries. A comparison in this regard is available at: http://www.numbeo.com/cost-of-living/compare_countries_result.jsp?country1=Mexico&country2=United+States

678 As evidenced by the success cases provided in the annual reports of the CONACYT available at: http://www.conacyt.gob.mx/siicyt/index.php/indicadores-cientificos-y-tecnologicos

programs for which funding comes from the petroleum dividend paid by PEMEX to the Federal Government[679].

### 6.2. R&D and Demonstration Grants

Just as R&D Academic Funding, R&D and Demonstration Grants are also focused at spurring technological innovation by promoting creation and sharing of knowledge[680]. However, this policy is mostly concerned with the development of projects involving an innovation operated at or near full scale in realistic environments to show the viability of its applications in its path towards commercialization – that is, this policy is aimed at promoting the transition of technology from the lab to the market[681].

The Canadian Clean Energy Fund addresses this "bottleneck" by directing government funds towards applied research and demonstration efforts through its "Clean Energy Fund". This fund was established in 2009, with the objective of supporting research and development of the new, cutting-edge energy technologies, essential for reducing greenhouse gas (GHG) and other air emissions in energy production, transmission, distribution and use[682].

The success of this policy in promoting the goal of creation and sharing of knowledge is evidenced by the fact that the projects financed by this Fund contributed to the publication of 84 peer-reviewed articles in scientific journals; 86 technical reports, 58 client reports; 171 presentations at national and international conferences, workshops and symposia; over 500 months of training and developing of highly qualified personnel – students and postdoctoral fellows and; the creation and revision of 11 Canadian codes and standards in the three year span during which this program operated[683]. Some examples of projects that operated through this Fund are:

- In support of the deployment of marine renewable energy systems, a preliminary review of site characterization requirements and methodology at a number of sites with high wave and tidal energy potential was completed, and a best practices document developed. This was the first attempt to summarize the range of geological and geophysical information that is required for characterizing the seabed and identifying geo-hazards at a marine renewable energy site.

- A project aimed at advancing the design, development and fabrication of the next generation combined building-integrated solar electric and thermal power generating technologies and systems, and their integration in net- or near-zero energy high performance buildings, which led to the publication of a Technology Assessment Report that, inter alia, provided an overview of the barriers to the market uptake of the PV-T technology in Canada. These findings will help to orient future R&D on this technology and remove the barriers to its market uptake.

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[679] As provided by title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

[680] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

[681] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

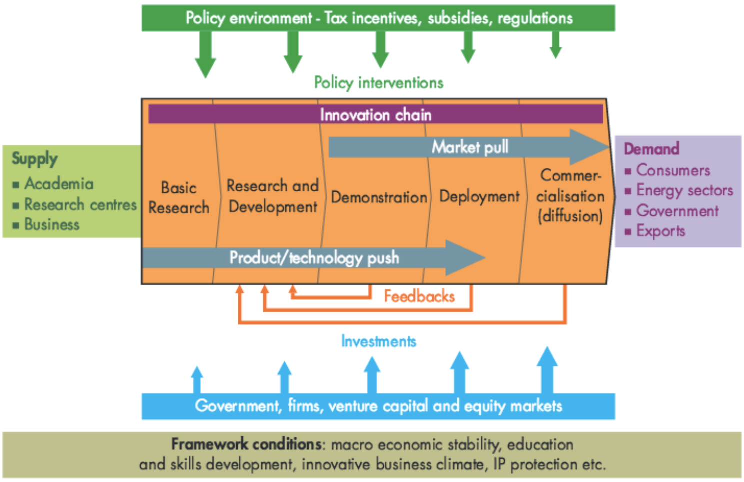
[682] Office of Energy (2014). Clean Energy Fund Summary Report. Available at: http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/files/pdf/CLEAN-ENERGY-FUND-ENG-FINAL-may-29.pdf

[683] Office of Energy (2014). Clean Energy Fund Summary Report. Available at: http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/files/pdf/CLEAN-ENERGY-FUND-ENG-FINAL-may-29.pdf

- A full process simulation was undertaken for capture of $CO_2$ from a 600 MW coal-fired power plant. The study was a full simulation at 12 combinations of feed and vacuum pressures. For the optimum feed pressure the overall capture cost was $25.6US/ton $CO_2$ captured at a purity of 99% and 90% recovery. The energy demand was 40.4% of a 600 MW coal fired plant.

Both, Canada and Mexico have significant hydrocarbon reserves, which have resulted in the dominant participation of these resources in their respective energy mixes[684]. This is a core similarity given that clean energy research programs in Canada (as the clean Energy Fund) have been established with the goal of breaking the traditional paradigm of hydrocarbon reliance in this Country[685], which Mexican energy leaders have claimed as one of the main goals of the energy Constitutional Reform[686]. This makes the selection of the Clean Energy Fund's R&D and Demonstration Grants program as a case study to analyze, suitable, given that this program represents an example that was viable to operate in a Country with a history of hydrocarbon reliance[687] just as Mexico.

None of the domestic programs currently in operation by the CONACYT/SENER Sustainability Fund focuses solely at this fundamental stage for technological innovation. The "Innovation Laboratory for Energy Sustainability program" currently available, has as one of its purposes promoting applied research - but it mentions it vaguely together with "scientific research", "technology adoption", and "technology development"[688][689]. Hence, the first lesson to derive from the Canadian example is the importance of undertaking a program with a strong applied research and demonstration component, recognizing its role as a key transitional stage in the innovation chain (see figure below).




[684] Details of the Mexican energy mix were advanced throughout Chapters 1 and 2. The Canadian energy mix can be consulted at the Energy Information Administration Site: https://www.eia.gov/beta/international/analysis.cfm?iso=CAN

[685] As provided by the evaluation report of the Clean Energy Fund conducted by the Departmental Evaluation Committee of NRCan, which can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0

[686] As provided by the next article that reproduces the details of the official proposal of the reform: http://www.adnpolitico.com/gobierno/2013/08/12/documento-integro-iniciativa-de-reforma-energetica-de-pena

[687] Robert Bott (2004). Evolution of Canada's Oil and Gas Industry. Canadian Center for Energy Innovation. Available at: http://www.energybc.ca/cache/oil/www.centreforenergy.com/shopping/uploads/122.pdf

[688] Provided by the call for proposals of this program available at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-05-sustentabilidad-energetica/9711-bases-de-convocatoria-2013-05/file

[689] Detailed information regarding the different projects that have been financed through this call for proposals is lacking, however CONACYT discloses the titles of the projects and the names of the institutions that have carried them out through: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-05-sustentabilidad-energetica

In terms of *Strategy and Priority Setting*, the Clean Energy Fund establishes as its objectives promoting simulation, energy mapping, techno-economic and regulatory studies, technology development up to the demonstration pilot project, and proof-of-concept field trial phase activities, focused at four priority technology areas:

- Renewable and Clean Energy (with sub-components in renewable energy, bioenergy and integration in the built environment);
- Environmental Challenges Facing Oil Sands Production (given the vast Oil Sands resource that Canada has);
- Carbon Dioxide (CO2) Capture and Storage; and
- Hydrogen and Fuel Cells

With regards to renewable energy, projects in this component addressed the integration, at the community level, of renewable and clean energy, defined as wind, marine, low head hydro (less than 15m), solar thermal, low-enthalpy heat to produce power from geothermal and industrial sources, solar photovoltaic, biomass and biogas. It included Smart Grid concepts using information gathered automatically, such as supply and demand information, to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. Projects were to be focused on the examination of systems for the increased integration and deployment of renewable and clean energy into both the power grid and the built environment; hence, priority was placed on the investigation of a full system approach that would maximize renewable energy deployment

As analyzed before, clear objective setting is not a practice currently undertaken by the CONACYT/SENER Sustainability Fund, its call for papers advance vague objectives, which do not allow zooming in on the specifics of what they are looking for through the different programs. Hence, if Mexico is to pursue this policy, it is important to submit an addendum to the "Innovation Laboratory for Energy Sustainability program", or to develop a new program that clearly advances what counts as applied research and demonstration, as in the Canadian example. Furthermore, defining the scope of the technologies that are to be funded in order to abate confusion by prospective applicants should be pursued as well. In the Clean Energy Fund example, "clean energy" was defined as: wind, marine, low head hydro (less than 15m), solar thermal, low-enthalpy heat to produce power from geothermal and industrial sources, solar photovoltaic, biomass and biogas, Mexico could further include Nuclear as we have seen through chapter 3 that this resource has the potential of generating high amounts of $CO_2$-free energy at the point source[690].

With regards to the issue of *Stable Government R&D Support,* the Clean Energy Fund did not establish a specific lifetime of the program; moreover, it dramatically reduced its investment from the $1 billion (Canadian Dollars) initially announced, to $205 million in Budget 2010[691]. The CONACYT/SENER Sustainability Fund programs do not advance fixed lifetimes either, as they stand, call for proposals are just deemed open until specified otherwise[692]. Hence, Mexico should learn from the lessons compiled by international well-

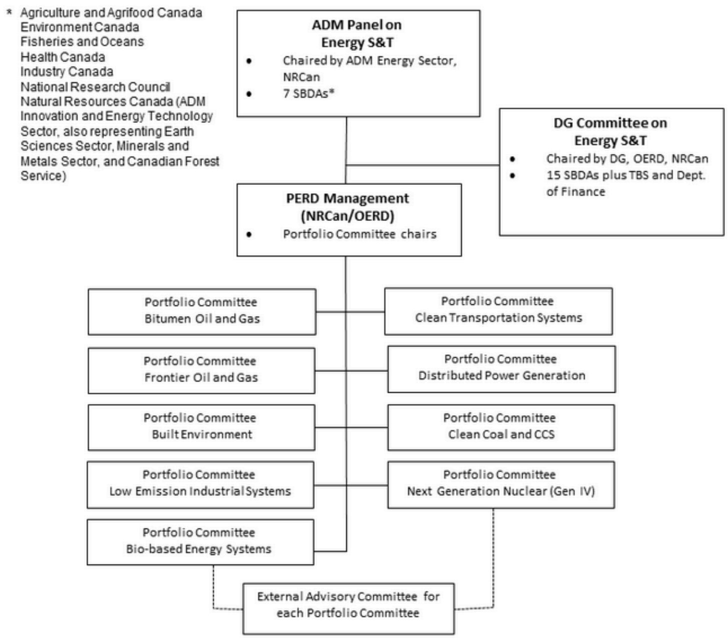
[690] In this regard considerations about nuclear waste and safety should be analyzed.

[691] Information provided by Natural Resources Canada through : http://www.nrcan.gc.ca/energy/funding/current-funding-programs/17905

[692] The specifics of CONACYT/SENER Sustainability can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica

established research efforts as the one by the International Energy Agency, and send the adequate signals to stakeholders by advancing a specific lifetime for government support in this regard with set amounts for each of its programs, which can in turn improve the current design of the policy example we are currently analyzing. This, as it has been found that stakeholders will be looking for concrete and long-term policy support that promotes the stated objectives of the particular program in order to react[693].

Pertaining to *R&D Governance*, the Clean Energy Fund was managed through the Office of Energy Research and Development (OERD); the governance structure of the program is showcased by the next figure[694].




The highest body in the Clean Energy Fund project selection and oversight is the Assistant Deputy Ministers Panel. The ADM Panel was formed to provide guidance and advice to Natural Resources Canada (NRCan) on the management and governance of energy research programs, including the Clean Energy Fund. This panel is comprised of departments and agencies with major capacities in energy R&D[695].

The governance structure of the Clean Energy Fund, and the technical committee of the CONACYT/SENER Sustainability Fund, both incorporate representatives from governmental agencies. As we analyzed before, the technical committee of the CONACYT/SENER Sustainability Fund is formed by three representatives of SENER, one of CONACYT, one of the Federal Electricity Commission, one of the Energy Efficiency Commission and two representatives from the academia or the scientific community[696]; while the governance structure of the Clean Energy Fund, has representatives from: Agriculture and Agri-Food Canada, Environment Canada, Fisheries

[693] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[694] As provided by the evaluation report of the Clean Energy Fund conducted by the Departmental Evaluation Committee of NRCan, which can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0
[695] As provided by the evaluation report of the Clean Energy Fund conducted by the Departmental Evaluation Committee of NRCan, which can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0
[696] As provided by the collaboration agreement between SENER and CONACYT, available at: http://sustentabilidad.energia.gob.mx/res/Convenio%20de%20Colaboracion%20SENER-Conacyt.pdf

and Oceans Canada, Industry Canada, National Research Council, Natural Resources Canada, and Public Works and Services Canada. In this regard it is worth noting that the fact that the Sustainability Fund has representatives from the academia and/or the scientific community, can pose an advantage over the governance structure of the Clean Energy Fund pertaining to the technical analysis of the programs. However, the fact that the Assistant Deputy Ministers of 7 agencies manage the Clean Energy Fund, all of which have focus on topics that are closely related to energy (food, water, and the environment), gives the possibility of having a systematic scope in the analysis of the implementation of these applied research and demonstration projects[697]. Hence, exploring the possibility of incorporating representatives from those relevant agencies that are closely related to energy, in the technical committee of the CONACYT/SENER Sustainability Fund should be pursued[698][699].

Being managed by the Assistant Deputy Ministers of the agencies previously described, the Clean Energy Fund increases the likelihood of ensuring that the qualities deemed fundamental for clean energy research and development policy in terms of governance are met, given the characteristics of those that currently occupy those positions[700]. It is true that not because someone is appointed Assistant Deputy Minister it is automatically conferred scientific and administrative capacity, however, from the analysis of the profiles of current Assistant Deputy Ministers in Canada, it is clear that they are individuals highly qualified in their field with proven administrative experience[701].

As advanced before, Mexico has been recently deemed the most corrupt Country of the OCDE[702], and as such transparency and rule following in the selection process of the representatives of the CONACYT/SENER Sustainability Fund should be deem fundamental. As we analyzed before, there are no indications in regards of how the selection of the representatives of the CONACYT/SENER Sustainability Fund is conducted nor who are the representatives operating its technical committee. The Clean Energy Fund example sheds light on the possibility of directly appointing high-level officials of relevant agencies to promote adequate governance, by tying the responsibility of being part of the panel to a specific governmental position, not by "pinpointing" them. Nevertheless it is worth noting that this is done in a transparent manner in a Country where this high level officials have proven qualifications; Mexico could explore this path towards attaining *R&D Governance* goals, or establish a clear selection process with rules to follow as envisioned through the Academic R&D analysis[703], whatever the process chosen it is important to keep the *R&D Governance* goals in mind when establishing it, and promote transparency in its undertaking.

In regards to *Effective Evaluation*, the ADM Panel was in charge of advising the Deputy Minister of NRCan, as to which demonstration projects should be approved. The

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[697] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

[698] If its decided that this is to be done, it can be done by submitting an addendum to the collaboration agreement between SENER and CONACYT, the current version is available at: http://sustentabilidad.energia.gob.mx/res/Convenio%20de%20Colaboracion%20SENER-Conacyt.pdf

[699] This *R&D Governance* lesson will not be replicated in the analysis of each policy example, however, it should be implied that it applies across the board.

[700] Managers should have proven scientific and administrative capacities as provided by the International Energy Agency study.

[701] To provide an example the profile of the Assistant Deputy Minister of the Environment can be consulted here: https://www.ec.gc.ca/default.asp?lang=En&n=BC5E38F9-1

[702] As provided by the next news article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde

[703] It is worth noting that an appointment selection process similar to the one undertaken in Canada would not be sufficient for those representatives that are to come from the scientific community and the academia, as this will go beyond establishing being part of the fund as a responsibility of a certain governmental position, direct appointment from a random pool of scientist and academics can derive in opaque selections that could be motivated by the intention of ensuring control over these representatives.

portfolio committees[704] were responsible for reviewing all proposals received and approving funding of less than $5 million for R&D projects. Projects of $5 million and above were approved by a sub-set of the interdepartmental ADM Panel on Energy S&T (representatives from NRCan, Environment Canada, Industry Canada, and the National Research Council)[705]. There is no detailed information about the specifics of the Clean Energy Fund selection process, other than an explanation providing that projects were funded and managed under the terms of memoranda of understanding (MOUs )[706] between NRCan-OERD and participating departments - the MOUs are said to have outlined roles and responsibilities, funding arrangements and reporting requirements[707].

Such a method poses issues of transparency, and fairness, which in a Country as Mexico, can serve to mask corruption in the processes. Therefore this is another instance in which a Mexican equivalent can surpass the design quality of this policy example by devising a transparent and effective selection method[708]. One option would be implementing the previously analyzed "merit review system"[709]- providing for a process enriched by the considerations of experts in the field from the National Researcher System (Sistema Nacional de Investigadores), and the communication with the applicants in regards to the basis for the decisions reached.

The Departmental Evaluation Committee conducts *Monitoring* in NRCan[710]. The planning process is intended to produce a five-year evaluation plan designed to achieve evaluation coverage of all ongoing grants and contributions programs, and direct non-grants and contributions program spending as appropriate to the department. However, as this program lasted less than five years, its evaluation was conducted at its end in 2013[711]. The evaluations conducted by this committee focus on the following issues and questions:

- **Relevance**
  - Is there an ongoing need for each of the program components?
  - Are the program components consistent with government priorities and NRCan strategic outcomes?
  - Is there a legitimate, appropriate and necessary role for the federal government in the program area of activities for all components? Is NRCan's role appropriate in the context of the role of others?
- **Performance (Effectiveness)**

[704] As evidenced by the figure above, these committees are subdivisions of the Program of Energy Research and Development by area of specialization: Bitumen Oil & Gas, Frontier Oil & Gas, Clean Transportation Systems, Distributed Power Generation, Clean Coal and CCS, Next Generation Nuclear, Built Environment, Low Emission Industrial System, Bio-Based Energy System. These "portfolio committees" are formed by the relevant governmental agencies regarding the topic of specialization, which may develop collaborations with the private sector, provincial and municipal governments, international organizations, and academia for the assignation of the research and development resources they are allocated to manage. As provided by the evaluation report of the Clean Energy Fund conducted by the Departmental Evaluation Committee of NRCan, which can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0

[705] As provided by the evaluation report of the Clean Energy Fund conducted by the Departmental Evaluation Committee of NRCan, which can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0

[706] These instruments generally set out commitments or undertakings between agencies and organizations to work towards a common goal.

[707] As provided by the evaluation report of the Clean Energy Fund conducted by the Departmental Evaluation Committee of NRCan, which can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0

[708] As analyzed before, currently there is no indication in regards of how the method for selection of awardees of the different programs is undertaken by the CONACYT/SENER Sustainability Fund, there is an evaluation commission in charge of selecting the awardees established by the "operation rules" of the Fund, however, the selection processes this commission will follow are set as self-imposed, that is: the commission is allowed to devise its own selection processes, and transparency is lacking in regards to how this processes are being undertaken

[709] Previously analyzed during the "Academic Research R&D Section of this chapter.

[710] This committee is part of the organizational structure of NRCan.

[711] This evaluation report is made available to the public by NRCan, it can be consulted at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0

- o Building on the existing work and accomplishments from other similar initiatives, to what extent have the program components achieved their outcomes?
  - o Have there been any unintended outcomes from each component (positive or negative)?
- **Performance (Efficiency and Economy)**
  - o What are the internal and external factors that have facilitated or hindered the achievement of the intended outcomes for each component?
  - o Are the program activities within each component the most economic and efficient means of making progress towards the intended outcomes?

As explained before, the CONACYT also has an Internal Organ of Control in charge of monitoring activities, and detecting and preventing fraud, waste, and abuse within the CONACYT or by individuals that receive funding[712], however, there is no requirement that compels this organ to publicly report its processes and findings, or to follow a certain method when conducting its evaluations. As such, the NRCan example can shed light on a possible mechanism to perform R&D program evaluations to measure their performance through the analysis of key questions aimed at unveiling the effectiveness, efficiency and relevance of the implemented program.

In regards to *Strong Collaborative Approach*, the Clean Energy Fund does not provide for specific mechanisms to promote it. Eligible recipients included for-profit and not-for-profit organizations legally incorporated or registered in Canada, corporations, industry associations, research associations, academic institutions, and provincial, territorial and regional and municipal governments and their departments and agencies, but there was no collaboration scheme to promote bridging the interests of industry and the research community to accelerate technological development. Just as the Clean Energy Fund, the CONACYT/SENER Sustainability Fund currently does allow for private participants to access incentives through proposals, but it also lacks specific collaborative mechanisms in place to promote access to grants by research partnerships between industry, academia, and other participants (non-profits, etc)[713]. Hence, the previously described NSF GOALI categorization could also gain relevance when designing applied research and demonstration programs in order to promote these types of collaborations.

The Clean Energy Fund had no *International Collaboration* component. But oddly enough, even though there is no national program that is directed specifically at applied research and demonstration in Mexico, the CONACYT/SENER Sustainability Fund has two international programs both of which are in fact are solely focused at these activities:

- CONACYT-SENER Energy Sustainability Innovate UK 2015-03[714]: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals in regards

[712] As provided by the Organizational Manual of the National Council of Science and Technology (CONACYT).
[713] In the terms of reference of this program, there is a provision that advances that "more value will be given to collaborative proposals" however the eligibility provisions do not reflect that fact, nor is there any collaborative mechanism established to promote associations between industry and researchers. Terms of reference of this program can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-05-sustentabilidad-energetica/9710-terminos-de-referencia-2013-05/file
[714] The terms of reference of this program are provided by CONACYT through: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica/conacyt-sener-sustentabilidad-energetica-innovate-uk-2015-03/10295-terminos-de-referencia-54/file

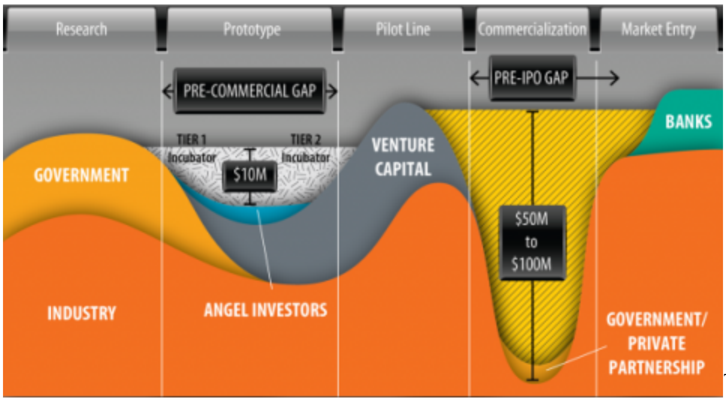
to applied research and demonstration energy sustainability projects in collaboration with companies from the United Kingdom.

- International Cooperation in Geothermal Research and Development Between Mexico and the European Union[715]: A call for projects to any public or private research institution registered in the National Registry of Scientific and Technologic Institutions, to submit proposals in collaboration with any kind of entities or states of the European Union to undertake applied research and demonstration activities focused on geothermal energy.

Hence it is important to continue to follow this practice in regards to applied research and demonstration, and further apply it when designing other R&D programs in order to promote access across expertise; and improved competitiveness by spreading the costs and risks of R&D between Mexico and other nations[716].

### 6.3. Incubation Support

Incubation Support programs tend to be structured to address two of the three main goals of policy aimed at spurring technological innovation: promoting the creation and sharing of knowledge, and improving knowledge diffusion by establishing collaborative networks[717]. These programs are focused at addressing two known funding gaps: those that occur at the prototype commercialization stage and those at the commercial scale-up stage. The next figure represents these gaps.



[718]

The U.S. Sun Shot's Incubator program provides early-stage assistance in the form of direct monetary awards, to help startup companies "jump" technological barriers to commercialization while encouraging private sector investment with the purpose of benefiting the solar market to achieve the 2020 SunShot goal (drive down the cost of solar electricity to $0.06 per kilowatt-hour or $1 per watt not including incentives) with innovative ideas[719]. Its success is evidenced by the fact that, since the program was launched in 2007, $138 million in government funds has leveraged more than $3 billion in venture capital and private equity investment, demonstrating a ratio of nearly $22 in

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715 The terms of reference of this program are provided by CONACYT through: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica/convocatoria-2015-04-cooperacion-internacional-en-investigacion-y-desarrollo-entre-mexico-y-la-union-europea-en-energia-geotermica/10375-terminos-de-referencia-62/file

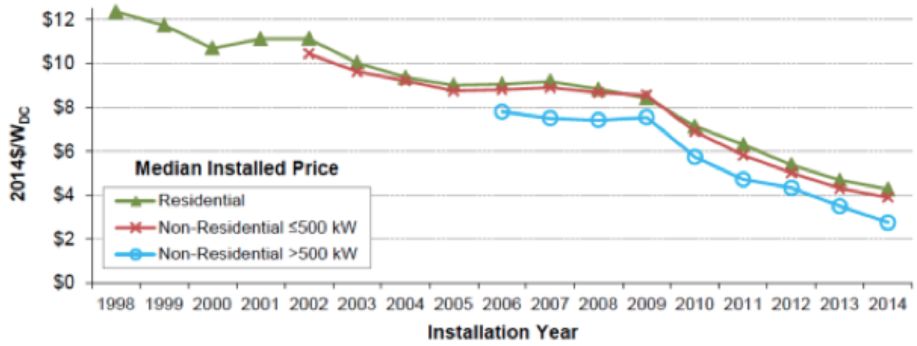
716 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

717 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

718 Source: U.S. Department of Energy, through: http://energy.gov/eere/sunshot/technology-market

719 Information provided by the U.S. Department of Energy through: http://energy.gov/eere/sunshot/sunshot-incubator-program

subsequent private sector support for every $1 of Federal support[720]. Moreover, although it cannot be fully attributed solely to this program, it is true than since its inception, the price of solar in the U.S. has been declining steeply (see figure below).



[721]

None of the programs currently in operation by the CONACYT/SENER Sustainability Fund is focused at tackling the barriers that innovative technologies confront when seeking commercialization[722]. As explained before, transitioning from research to commercialization is one of the hardest steps in the innovation chain, reason for which this stage has acquired the epithet "valley of death" as many groups, individuals, and companies that have developed promising technologies through the research stages, fail to gather the required resources and to unfold a successful commercialization plan that can "fit" its technology into the market, hence their promising technologies "die-off" - they are not accepted by the market and ultimately their funding sources expire[723]. As such, the first lesson to derive from the Sun Shot Incubator Program is the importance of developing a government run scheme to ensure that innovators with promising technology have the required support to bring their laboratory successes into the market.

In terms of *Strategy and Priority Setting*, the Sun Shot Program establishes as its objectives: to shorten the time between laboratory-scale proof of concept and prototype development and accelerate the process for companies to transition pre-commercial prototypes through the pilot stage into full-scale manufacture. With this purpose, funding is directed to all the technological components of solar electricity systems:

- Photovoltaic (PV) technologies
- Concentrating solar power (CSP) technologies
- Power electronics
- Balance-of-system (BOS) hardware
- Balance-of-system non-hardware (Soft Costs).

Using a five-tiered approach when directing funding, to address both hardware, and non-hardware development stages towards full commercialization.

*For Hardware Development*

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720 Information provided by the U.S. Department of Energy through: http://energy.gov/eere/sunshot/sunshot-incubator-program

721 Galen Barbose (2015). The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States, Summary Report. Available at: https://emp.lbl.gov/sites/all/files/lbnl-188238_presentation.pdf

722 CONACYTs programs and their details can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica

723 Jessie Jenkins and Sara Mansur (2011). Bridging the Clean Energy Valleys of Death. Available at: http://thebreakthrough.org/blog/Valleys_of_Death.pdf

- Tier 0 is to accelerate the transition from a proof-of-concept of all critical components to an early stage functional prototype
- Tier 1 is to accelerate the transition of early stage functional prototype to manufacturing and commercially relevant prototype made in the laboratory.
- Tier 2 is to develop the manufacturing processes and equipment to move from fully developed lab prototype to pilot-scale production.

*For Non Hardware Development*

- Tier 1S is to accelerate the transition of proof-of-concept or business plan to alpha capability[724] and early customer trials.
- Tier 2S is to transition alpha capability through beta launch [725] and full commercialization.

As analyzed before, clear objective setting and promoting specificity in the funding targets are not practices currently undertaken by the CONACYT/SENER Sustainability Fund, its call for papers advance vague objectives, which do not allow zooming in on the specifics of what they are looking for through the different programs, nor do they address milestones that are to be reached to achieve those vague objectives. Hence, if Mexico is to pursue this policy, it is important to consider developing a new program that clearly addresses the barriers promising technology faces when transitioning to the market while engaging in clear goal setting, and devising milestones towards its accomplishment. The Sun Shot example sheds light on a viable approach to promote this, following the rationale that the main obstacle for market adoption of solar technologies is their price, the Sun Shot initiative set as a goal reducing the cost of solar electricity. Further it takes a systematic approach to funding by directing it to different "tiers", each of which address a different key stage in hardware and non-hardware development, touching on every stage of solar technology, which is key for its advancement into the market[726].

With regards to the issue of *Stable Government R&D Support,* the Sun Shot initiative does not establish the specific lifetime of the program; rather it sets a general goal with a year component, which implies that support will be provided until the goal is attained[727]. However, the specific support provided over the years has been very variable, oscillating from 6 million dollars, all the way to 45 million dollars depending on the year[728], one reason for this, is that U.S. funding is uncertain because of variations in appropriations by Congress[729].

This is one instance in which a Mexican equivalent program could improve the current design of the policy example we are currently analyzing. The CONACYT/SENER Sustainability Fund programs do not contain provisions that specify the lifetime duration of particular incentive program, as they stand, call for proposals are just deemed open until specified otherwise [730]. Hence, Mexico should learn from the lessons compiled by international well-established research efforts as the one by the International Energy Agency, and send the adequate signals to stakeholders by advancing a specific lifetime for

[724] Second phase of software testing in which a sampling of the intended audience tries the product out.
[725] Information provided by the U.S. Department of Energy through: http://energy.gov/eere/sunshot/sunshot-incubator-program
[726] Information provided by the U.S. Department of Energy through: http://energy.gov/eere/sunshot/sunshot-incubator-program
[727] Achieving $0.06 per kilowatt hour (kWh) for the total installed cost of solar energy systems by the year 2020.
[728] Yearly advanced budgets can be consulted at: http://energy.gov/eere/sunshot/sunshot-incubator-program
[729] John H. Aldrich, Brad T. Gomez and Jennifer L. Merolla (2006). Follow the Money: Models of Congressional Governance and the Appropriations Process. Available at: http://myweb.fsu.edu/bgomez/Aldrich-Gomez-Merolla_Follow%20the%20Money.pdf
[730] The specifics of CONACYT/SENER Sustainability can be consulted at: http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica

government support in this regard, with fixed amounts[731]. This is hard to do with the current configuration of funding for clean energy research in the Country, where the amounts allocated for this research are derived from a yearly percentage of the petroleum dividend and therefore they inevitably vary depending on petroleum sales[732], consequently, exploring the possibility of setting specific amounts for clean energy research instead, should be pursued.

Pertaining to *R&D Governance*, the Sun Shot Incubator program is managed through the Office of Solar Energy Technologies, which is under the Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy[733].

This poses a great difference with the governance structure that such a program would have in Mexico, as we have analyzed that energy sustainability R&D programs as this one are only to be undertaken by the CONACYT/SENER Sustainability Fund, by virtue of law. Being part of the Department of Energy, the Office of Solar Energy Technologies is subject to operate according to the instructions of those Officials that head higher bodies. This might be positive in terms of ensuring coherency of the programs with national energy policy managed by the Department of Energy, however coherency can also be promoted through representation of the energy agencies in the governance bodies of R&D programs. The CONACYT/SENER Sustainability Fund takes the latter approach, as we have analyzed, it is formed by three representatives of SENER, one of CONACYT, one of the Federal Electricity Commission, one of the Energy Efficiency Commission and two representatives from the academia or the scientific community[734]. This might be a more suitable model for a Country with high corruption levels as Mexico, given that, at least in theory, having technical representatives from the scientific and academic communities implies that decisions can have a certain higher degree of transparency as they are not taken solely by government officials behind walls.

As we discussed through the analysis of the Clean Energy Fund example, incorporating high level officials of relevant agencies in the management of R&D programs may increase the likelihood of compliance with the qualities deemed fundamental for clean energy research and development policy in terms of governance[735] (depending on the profiles of the individuals that tend occupy those positions in a particular Country). This seem to be the case with the management structure of the Incubator program of the U.S. Department of Energy, as through the analysis of the profiles of the current managers of the Office of Solar Energy Technologies, it is clear that they are highly qualified individuals in their field, with proven administrative experience[736].

As advanced before, Mexico has been recently deemed the most corrupt Country of the OCDE[737], and as such transparency and rule following in the selection process of the representatives of the CONACYT/SENER Sustainability Fund should be deem fundamental. There are no indications in regards of how the selection of the

[731] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

[732] As provided by title 2, chapter 6, article 97 of the Mexican Petroleums Law (Ley de Petroleos Mexicanos), and, title 5, chapter 1, article 88 of the Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)

[733] The organizational structure of the Department of energy can be consulted at: http://energy.gov/leadership/organization-chart

[734] As provided by the collaboration agreement between SENER and CONACYT, available at: http://sustentabilidad.energia.gob.mx/res/Convenio%20de%20Colaboracion%20SENER-Conacyt.pdf

[735] Managers should have proven scientific and administrative capacities as provided by the International Energy Agency study.

[736] To provide an example the profile of the Director of the Office of Solar Energy Technologies be consulted here: http://energy.gov/eere/sunshot/leadership

[737] As provided by the next news article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde

representatives of the CONACYT/SENER Sustainability Fund is conducted nor who are the representatives operating its technical committee. The Sun Shot Initiative example sheds light on the same possibility than the Clean Energy Fund example: directly appointing high-level officials of relevant agencies to promote adequate governance, by tying the responsibility of managing R&D programs to a specific governmental position (in a panel, committee, or through the standard organizational structure of an office. Nevertheless it is worth noting that this is done in a transparent manner in the U.S. and Canada, where these high level officials have proven qualifications. Mexico could explore this path towards attaining *R&D Governance* goals, or establish a clear selection process with rules to follow as envisioned through the Academic R&D analysis, whatever the process chosen it is important to keep the *R&D Governance* goals in mind when establishing it, and promote transparency in its undertaking.

In regards to *Effective Evaluation*, the evaluation proposal process for the Sun Shot Incubator program follows the next steps:

1. Starts with the submission of a letter of intent to apply by interested parties with a brief description of the proposal and why it is innovative.
2. The Department of Energy (DOE) then holds a round of webinars to answer questions of applicants before the deadline for submission of the concept paper arrives[738].
3. After submission, DOE will evaluate each compliant Concept Paper[739] and will make a decision in regards to those projects that can advance to the next stage.
4. The next step is the submission of a full application with detailed information on the proposed project, including, among other items, an in-depth discussion of the proposed project or solution and a detailed budget. Reviews on full applications will be made available to applicants, which will have a brief opportunity to review these comments and prepare a short Reply. Once DOE completes its review of full applications and replies to reviewer comments, certain applicants will be invited to participate with DOE in pre-selection conference calls so that DOE may learn more about the proposed project.
5. Once DOE completes its pre-selection conference calls, DOE identifies a subset of applicants, which it would like to invite to present their project through a webinar, at the Applicant's facility, or at a DOE facility. The presentation will provide DOE with the opportunity to learn more about the proposed project.
6. DOE will then carefully consider all of the information obtained through the application process (e.g., Full Applications, reviewer comments, Replies to Reviewer Comments, and information obtained through pre-selection conference calls and meetings and presentations) and evaluate each full application based on the criteria provided by the Funding Opportunity Announcement, which is readily available for all prospective applicants in advance, and will proceed to make a decision in regards to which projects will be funded[740].

Such a detailed method implicitly promotes transparency and fairness in the decisions through open communication with applicants, while also incentivizing technical capacity of the selected projects by submitting applicants to set requirements that entail

[738] The Concept Paper describes the essence and novelty of the proposed project/solution and its capability to meet or exceed the Technical Performance Target, which can be consulted through the Funding Opportunity Number DE FOA-0000651

[739] Based on specific criteria and program policy factors in Sections V.A.1 and V.B.1. Applicants will be notified of DOE's determination, as described in the Funding Opportunity Announcement, which can be consulted through the Funding Opportunity Number DE-FOA-0000651

[740] Provided by the Funding Opportunity Number DE-FOA-0000651

extensively "mapping" the proposed project. An interesting option for the CONACYT/SENER Sustainability Fund when restructuring their selection methods might be combining Sun Shot's staggered process with NSFs "merit review system" - providing for an exhaustive process enriched by the considerations of experts in the field from the National Researcher System (Sistema Nacional de Investigadores). Using a merit review system to evaluate which projects to fund would inevitably take time and money, however, in a Country with high corruption levels as Mexico, implementing stringent award assignation methods is of utmost importance in order to be able to meet program goals, as risking corruption interference to avoid paying administrative costs can render programs a failure by deriving in non-optimal allocations, and potentially fund leakage[741].

Just as the NSF, with regards to *Monitoring*, the U.S. Department of Energy, has an Office of the Inspector General, which is in charge of strengthening the integrity, economy, and efficiency of the Department's programs and operations by conducting audits, processing complaints and evaluating the performance of the department's endeavors, reporting its activities to Congress two times per year[742]. As explained before, the CONACYT also has an Internal Organ of Control in charge of conducting monitoring activities, and detecting and preventing fraud, waste, and abuse within the CONACYT or by individuals that receive funding[743], however, there is no requirement that compels this organ to publicly report its findings and activities. As such, the DOE example can shed light on a possible mechanism to improve transparency in its undertakings by providing for public reports to Congress and making them readily available online.

Pertaining to project monitoring, Sun Shot's Incubator program relies on a "self reporting" mechanism to assess performance of sponsored projects, following the next requirements:

- Technical progress reports have to be submitted by awardees on a quarterly basis;
- Monthly status calls.
- Financial status reports submitted on a quarterly basis;
- Scientific/technical conference papers and proceedings must be submitted to DOE;
- Reporting on lobbying activities relating to the project;
- Annual indirect cost proposals;
- Annual audits of for-profit recipients;
- Annual property inventories;
- Closeout reporting, such as final scientific/technical report, final invention and patent report, and final property report; and
- Subject invention utilization reporting.

A Mexican equivalent of this program could rely on this "self-reporting" method for ongoing projects, and perhaps it could be enriched with the previously analyzed evaluation methods of the Clean Energy Fund, once projects conclude.

741 Ritva Reinikka and Jakob Svennson (2004). Explaining Leakage of Public Funds. The World Bank. Available at: http://www1.worldbank.org/publicsector/decentralization/Feb2004Course/Background%20materials/Reinikka2.pdf
742 The data base of these reports can be consulted at: http://energy.gov/ig/listings/semiannual-reports-congress
743 As provided by the Organizational Manual of the National Council of Science and Technology (CONACYT).

In regards to *Strong Collaborative Approach*, Sun Shot's Incubator does not provide for specific mechanisms to promote it. Eligibility, is provided only to startup businesses, and Project Teams led by startup businesses with less than 500 employees that satisfy a cost-sharing requirements by submitting a plan that reflects that they will incur at least in 60% of expenditures under the project[744]. However, there is no mechanism in place to promote collaborations between industry, academia and other research participants in this program. This is an instance where a Mexican equivalent could surpass the example we are currently analyzing by establishing a collaborative mechanism, perhaps a modified "GOALI" type of categorization aimed at promoting participation by startups composed of industry and academic researchers and non-profit organizations could be implemented to promote this. Nevertheless, analyzing Sun Shot's eligibility provisions provides the opportunity to derive a lesson in regards to the use of cost sharing as means to promote productivity of participants and the value of their proposals. Hence, the latter should be explored when devising an Incubator program in Mexico.

The Sun Shot Incubator program has no *International Collaboration* component; foreign entities, whether for-profit or otherwise, are not eligible to apply for funding under this program, only those subsidiaries or affiliates incorporated in the United States can be deemed eligible. As explained before, the CONACYT/SENER Sustainability Fund promotes this type of collaboration through the establishment of bilateral agreement with different Countries, which is available on a per program basis and not across all call for proposals[745].

Hence it is important to follow this practice also when developing an Incubator program in order to promote collaborative proposals, which can enable access across expertise; and improved competitiveness by spreading the costs and risks between Mexico and other nations[746].

Beyond what has already been advanced regarding differences between the U.S. and Mexico in terms of the implementation of such a program. The capacities of the United States in terms of resources for R&D policy surpass considerably those of Mexico. The Sun Shot program alone has been granted $138 million in government funds[747], while in Mexico the whole amount for renewable energy and energy efficiency research related programs totals an average of 713 million pesos yearly (around 39 million dollars)[748]. This difference in resource capacity would inevitably translate in a lesser amount of project funding for a potential Incubator program. Nevertheless, implementing this program should be explored given its relevance to aid towards crossing "the valley of death" and achieving commercialization. Given this issue of limited funds, Mexico will need to focus its investments; which technologies receive funding, for which stages and how much, is to

[744] The rationale for this stems from the fact that cost sharing has been recognized as a signal of the potential productivity of the recipients of funding and the value of their proposals. If the recipient is willing to make a commitment to the project, he/she must be confident of the project reaping future rewards, which increases the likelihood of mindful spending of the provided award. Robert Poulton (2008). The Role of Cost-Sharing as a Signal of Quality in the Federal Funding of Academic Research: an Application to the National Science Foundation.

[745] Proof of this, are the two previously analyzed calls for proposals available, which promote collaboration with the United Kingdom and the European Union.

[746] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

[747] Information provided by the U.S. Department of Energy through: http://energy.gov/eere/sunshot/sunshot-incubator-program

[748] Number provided by a study prepared by Leonardo Beltran, current Underminister of Energy Transition, this study is available at: http://energiaadebate.com/el-fondo-de-sustentabilidad-energetica-impulso-al-desarrollo-tecnologico/

be determined then through analytically structured processes relying on available data regarding which technologies can be more commercially viable in the Country[749].

The characteristics of the applicants can differ as well. The United States has been funding this kind of research for a while now, and as such, the stage of technological development in regards to clean energy in this Country can be found to be very different than Mexico's. In addition, disparity in the monetary power of applicants can also be an issue worth discussing in terms of devising a cost-sharing mechanism.

Both of these circumstances are sort of a "chicken and egg" problem, which poses the question, what developed first? Technical and monetary capacity of clean energy entrepreneurs, or policy aimed at promoting technical and monetary capacity. However, in a field as clean energy affected by knowledge spillovers, uncertainty in returns, and negative external effects[750], it is hard to think that these previously mentioned capacities appeared first. Therefore, if the reader allows the metaphor, investment needs to be directed in this type of "technology-to-market" programs if Mexico is to ever have its own entrepreneurial clean energy "chickens".

### 6.4 Establishment of Public Research Centers

The research activities of these centers are focused at contributing to innovation in codified knowledge (e.g. publications), and in knowledge embodied in technological inventions that are subsequently taken up by innovative business firms through collaborative networks; depending on the specific responsibilities they are attributed, they can also provide the opportunity to aid in building competence and human capital[751]. Although there are primarily financed by the government, these centers are encouraged to commercialize the knowledge they generate and seek intellectual property rights protection, such as licensing, with a view to earning incomes[752].

The U.S. National Renewable Energy Laboratory is the only Federal laboratory dedicated to the research, development, commercialization, and deployment of renewable energy and energy efficiency technologies in this Country. Its success is evidenced by the fact that since it started operating in 1977, this Center has won 58 R&D 100 Awards[753] (widely recognized as the "Oscars of Invention"[754]); has earned patent rights in over 450 different applications and technologies regarding renewable electricity conversion and delivery systems, renewable fuels formulation and delivery, efficient and integrated energy systems, and strategic energy analysis[755]; and has participated in over 14,000 energy related publications[756].

Mexico is already undertaking efforts in regards to establishing Public Research Centers, in 2014 the Ministry of Energy in cooperation with the National Council of

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749 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
750 Previously analyzed in chapter 3.
751 As provided by "The Innovation Policy Platform" of the OECD available at: https://www.innovationpolicyplatform.org/content/universities-and-public-research-institutes
752 As provided by "The Innovation Policy Platform" of the OECD available at: https://www.innovationpolicyplatform.org/content/universities-and-public-research-institutes
753 An average of 1.5 yearly
754 Detailed information about the R&D 100 awards is provided by the R&D Magazine through: http://www.rd100awards.com/
755 Information about all the patents that NREL holds can be consulted at: http://techportal.eere.energy.gov/search.xhtml?action=presetSearch&labID=10
756 NRELs publications can be browsed at: http://www.nrel.gov/research/publications.html

Sciences and Technology (CONACYT) created three special entities named Mexican Centers of Innovation (CEMIEs)[757]. These entities constitute a National project in which resources are being allocated both from the government and from private parties[758] to promote coordination between academic institutions, companies and organizations. The goal is to develop value chains within the energy sector, promote technology development, and provide specialized training of human resources with the purpose of creating business and employment opportunities[759].

Even though Mexico is already advancing in this policy, comparing the CEMIEs with more mature examples as the National Renewable Energy Laboratory of the U.S. (NREL) can provide implementation lessons. In terms of *Strategy and Priority Setting*, NREL's general goal is "a clean energy future," and its approach to energy involves the relationship among four key systems: fuel production, transportation, built environment, and electricity generation and delivery[760].

Research and Development at the NREL involves 13 areas of focus for innovation in efficient and renewable energies with the goal of putting these technologies into the marketplace for the use by households and businesses[761]:

- **Advanced Vehicles & Fuels Research** aims at making more fuel-efficient technologies by testing and analyzing current technologies in order to reduce oil dependency and reduce emissions. This research also looks at removing technical barriers to make hybrid, electric, and fuel cell vehicles more available. The NREL has worked closely with major car manufacturers such as General Motors and Ford to create economically competitive vehicles.
- **Biomass Research** studies biological material such as trees and agricultural crops to produce fuels to create electric power, heat or fuel. Biomass conversion technologies are developed in the most cost-effective and environmentally friendly manner.
- **Buildings Research** looks at reducing the large amount of energy used by structures. This research helps develop technologies to manage building energy use and effectively implement renewable energy capabilities.
- **Department of Defense (DoD) Energy Programs** are supported by the NREL with the goal of advancing the implementation of DoD's clean energy initiatives, reducing costs, minimizing risks in the field, and attaining energy security.
- **Electricity Integration Research** focuses on ways for renewable energy technologies to be integrated into electrical grid planning and operations. This NREL division focuses on both distributed and transmission grid integration. The former deals with solar photovoltaic implementation, distributed wind, and vehicle-to-grid technologies; the latter with wind and large-scale solar power systems.
- **International Activities** covers the NREL's global initiatives—undertaken in collaboration with foreign governments and technical institutions—that address

757 Three different centers where created initially, each focused on different renewable energy technologies: CEMIE-eolico (wind), CEMIE-sol (sun), CEMIE-geo (geothermal).

758 1,627.8 million pesos from the government and 340.45 million pesos from private investment. As provided by the next report from the Ministry of Energy: http://sustentabilidad.energia.gob.mx/res/CEMIE_General.pdf

759 The particularities of the process and motivation behind the establishment of these centers, can be consulted at: http://sustentabilidad.energia.gob.mx/res/CEMIE_General.pdf

760 NREL (2002). National Renewable Energy Laboratory, 25 years of excellence report. Available at: http://www.nrel.gov/docs/gen/fy02/30845.pdf

761 Detailed information about all the programs currently underway in the 13 areas of focus can be found at: http://www.nrel.gov/research/

three strategic objectives: economic development, energy security, and environmental protection.

- **Solar Research** at the NREL delves into two major branches of solar energy: photovoltaics (also known as solar electric systems), and solar thermal systems:
    - **Concentrating Solar Power Research** looks at solar power plant and solar thermal technologies to create large scale and advanced solar energy cost effective in the market.
    - **Photovoltaic Research** looks at limiting the nation's use of fossil fuels by preparing alternative options and increase photovoltaic models and systems that are cost effective and efficient.
- **Technology Deployment** involves the NREL's support of various federal agencies, including the DOE, DoD, and others by providing technical and project assistance, training, and resources to help meet and exceed energy and environmental targets.
- **Energy Analysis** looks at market, private and government relations, along with renewable energy developments, to create applicable policy recommendations. Research in this area takes a cost-benefit analysis of current and new technologies to understand environmental, economical, and security impacts.
- **Geothermal Technologies** aims at converting geothermal energy into heat and electricity. This area is also concerned with drilling technologies and exploration and management of power plants.
- **Hydrogen and Fuel Cells Research** is focused on hydrogen production, storage, validity, and standardization. The goal is to help industry transport and use hydrogen and fuel cells in the safest and most cost effective way in order to compete with more traditional methods such as coal and oil.
- **Weatherization and Intergovernmental Program** provides technical assistance, grants, and information resources to states, local governments, community agencies, utilities, Indian tribes, and overseas U.S. territories for their energy programs.
- **Wind Research** aims at using this natural power to fuel many systems and make wind energy technologies more competitive against conventional energy methods. Focus is now on making low-wind turbine technology more cost-effective. The research and development is conducted in the National Wind Technology Center, built in 1993.

The CONACYT/SENER Sustainability Fund takes a different approach towards goal setting and the strategy to reaching them. Instead of consolidating all the different topics on a sole Federal Research Center as NREL, different Centers that focus on set technologies have been deployed in Mexico. The first of which are: the Mexican Center of Innovation of Geothermal Energy, the Mexican Center of Innovation of Solar Energy, and the Mexican Center of Innovation of Wind Energy. Their objectives are generically the same: consolidating and producing knowledge about geothermal, solar and wind energies, fostering synergies to guide the activities of innovation, scientific research and technological development, as well as promoting specialized training of human resources, in order to contribute to the generation of economic value and strengthening of the geothermal, solar and wind industries[762]. Nevertheless, it is worth mentioning that just as

[762] The objectives of these CEMIEs can be consulted at: http://www.cemiegeo.org/index.php/ProjInvest?id=2 , http://evaluarer.iie.org.mx:8080/cemie/Proyectos , http://sustentabilidad.energia.gob.mx/res/CEMIE_Sol.pdf

NREL, in terms of strategies, these Centers do in fact advance specific projects to be conducted in the path towards attaining its general goals[763].

With regards to the issue of *Stable Government R&D Support*, NREL's funding budget varies yearly (from 2002 to 2014 it oscillated between $201 million dollars all the way to $536 million[764]), the majority of it comes from the Office of Energy Efficiency and Renewable Energy of the Department of Energy (DOE)[765]. In terms of certainty in the amounts, this is one instance in which the Mexican equivalent CEMIE program surpasses the current design of the NRELs example as each CEMIE has been assigned a fixed budget for a period of 4 years for the undertaking of their specific projects[766]. However a note can be made in regards to the period of years that CEMIEs are set to operate, as good practice dictates that once areas have been targeted, governments should estimate long-term investment requirements and mechanisms necessary to bring technologies to commercialization[767]. Therefore exploring the possibility of extending the term that these centers are set to operate should be pursued.

Pertaining to *R&D Governance*, NREL is a government-owned, contractor-operated facility, which is currently managed for the DOE by the Alliance for Sustainable Energy, LLC, a partnership between Battelle Memorial Institute and MRIGlobal (Midwest Research Institute) through a five year contract, which since 2008, it has been renewed once[768]. NRELs governance structure is privately determined by the Alliance for Sustainable Energy, LLC, and so as the individuals that head the positions[769]. Mexico follows a very similar approach in this regard, CEMIEs are also government-owned but privately operated by those research institutes that got selected through a call for proposals undertaken by the CONACYT/SENER Sustainability Fund[770]. Nevertheless, the government structure of the CEMIEs is set by the call for proposals, but just as in the NREL example is the proposers themselves who select the individuals that head the positions[771].

There is currently no specific mandate in order to obligate these Centers to appoint individuals with proven qualifications, however, both the Mexican and U.S. Research Center examples seem to be achieving the desired characteristics in terms of governance, as they both employ individuals with scientific and administrative expertise for these positions[772]. Perhaps, given that Mexico has been recently deemed the most corrupt Country of the OCED[773], incorporating a provision in the different terms of reference of

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763 The specific projects of these CEMIEs can be consulted at: http://www.cemiegeo.org/index.php/ProjInvest?id=2 , http://evaluarer.iie.org.mx:8080/cemie/Proyectos , http://sustentabilidad.energia.gob.mx/res/CEMIE_Sol.pdf

764 Information regarding yearly budgets can be consulted at: http://www.nrel.gov/about/funding-history.html

765 As provided by the yearly Congressional Budget Requests, 2016's can be consulted at: http://energy.gov/sites/prod/files/2015/02/f19/FY2016BudgetinBrief.pdf

766 Information provided by CONACYT through the next press release: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/312-formalizacion-de-los-convenios-de-asignacion-de-recursos-para-tres-centros-mexicanos-de-innovacion-en-energias-renovables-cemie-s

767 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

768 As provided by the next press release by NREL: http://www.nrel.gov/news/press/2012/2002

769 Information regarding leadership structure of NREL is provided by the Alliance for Sustainable Energy through: http://www.allianceforsustainableenergy.org/leadership.html

770 As provided by the CEMIE-sol terms of reference of the call for proposals available at: http://www.conacyt.gob.mx/index.php/convocatorias-conacyt/convocatorias-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-cerradas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-02-1/9754-terminos-de-referencia-2013-02-cemie-sol/file

771 Leadership structures of these CEMIEs can be consulted at: http://www.cemiegeo.org/index.php/ProjInvest?id=2 , http://evaluarer.iie.org.mx:8080/cemie/Proyectos , http://sustentabilidad.energia.gob.mx/res/CEMIE_Sol.pdf

772 The profiles of people that compose their governance structures can be found for the CEMIEs at: http://www.cemiegeo.org/index.php/ProjInvest?id=2 , http://evaluarer.iie.org.mx:8080/cemie/Proyectos , http://sustentabilidad.energia.gob.mx/res/CEMIE_Sol.pdf
And for NREL at: http://www.allianceforsustainableenergy.org/leadership.html

future proposals for CEMIEs to ensure that those individuals that occupy key positions in the governance structure have proven expertise, can be explored as a means to guarantee that *R&D Governance* goals are met, without leaving it to chance.

In regards to *Effective Evaluation*, there is little to be drawn from the NREL example in terms of the selection of consortiums to run Public Research programs. Since its inception, this laboratory has been managed by MRIGlobal (Midwest Research Institute) [774], which in 2008 joined forces with the Battelle Memorial Institute, but there is no information regarding what was the selection process to choose MRIGlobal (Midwest Research Institute) in 1977. There is also no information regarding the process followed to reestablish the five year plans over the course of the existence of this laboratory, decisions have been accompanied by press releases that focus on the successes of the laboratory as a means to justify the extensions[775]. This is an instance where the Mexican equivalent CEMIE program can surpass the quality of the design characteristics of the example we are currently analyzing.

Although there is information available regarding the specifics of the call for proposals for the constitution of the CEMIEs, there are no indications pertaining to the evaluation methods practiced to reach decisions regarding the research centers that are to be vested with the CEMIE categorization for the implementation of this policy. Notwithstanding this fact, the research centers chosen for the development of each of the CEMIEs currently in operation, seem to be coherent with the goals they are set to achieve, as they are renowned institutions with experience in electricity related research topics in the Country, the Renewable Energies Institute of the National Autonomous University of Mexico is vested with the CEMIE-sol categorization; the Electric Research Institute is vested with the CEMIE-eolico categorization; and the Higher Education and Scientific Research Institute of Ensenada is vested with the CEMIE-geo categorization. Nevertheless, transparency and rule following in the selection process of the additional institutes that are to be established as Public Research Centers in Mexico should be pursued in order to promote the attainment of *Effective Evaluation* in the implementation of this policy.

With regards to *Monitoring*, as we analyzed before, the U.S. Department of Energy, has an Office of the Inspector General, which is in charge of strengthening the integrity, economy, and efficiency of the Department's programs and operations by conducting audits, processing complaints and evaluating the performance of the department's endeavors, reporting its activities to Congress two times per year[776]; this Office is charge of evaluating and auditing the activities of NREL as well[777]. CONACYT also has an Internal Organ of Control in charge of conducting monitoring activities, and detecting and preventing fraud, waste, and abuse within the CONACYT or by individuals or consortiums that receive funding as the CEMIEs[778], however, there is no requirement that compels this organ to publicly report its findings and activities. As such, the DOE example can shed light on a possible mechanism to improve transparency in its undertakings by providing for public reports to Congress and making them readily available online.

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[773] As provided by the next news article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde

[774] NREL (2002). National Renewable Energy Laboratory, 25 years of excellence report. Available at: http://www.nrel.gov/docs/gen/fy02/30845.pdf

[775] Press release by NREL available at: http://www.nrel.gov/news/press/2012/2002

[776] The data base of these reports can be consulted at: http://energy.gov/ig/listings/semiannual-reports-congress

[777] The detailed report of the last audit conducted to NREL can be found at: http://energy.gov/ig/downloads/audit-report-wr-b-99-05

[778] As provided by the Organizational Manual of the National Council of Science and Technology (CONACYT).

Pertaining to specific project monitoring there is no information regarding NREL's activities in these regard, however the Mexican CEMIE program does address this by requiring consortiums to self-report technical and financial project advancements twice a year, moreover it requires that an external accounting firm audits the financial information provided by the consortiums[779]. Perhaps this monitoring mechanism can be enriched with the evaluation methods of the Clean Energy Fund (previously analyzed), once the four-year period assigned to these CEMIEs concludes; this, in order to analyze performance of the different programs undertaken by these research centers.

In terms of *Strong Collaborative Approach*, NREL has 4 different mechanisms available to partner with the private sector and non-profit organizations:

> **Technology Partnership Agreement:** Through technology partnership agreements, NREL provides partners with technical support to help commercialize and deploy energy technologies and products. The partner provides the necessary resources and covers NRELs costs of providing technical services.
>
> **Cooperative Research and Development Agreement (CRADA):** a research and development partnership between NREL and an outside company. This type of agreement protects the intellectual property of both NREL and the outside company, and allows the investing company the right to exclusive field-of-use license for any inventions that come out of the CRADA.
>
> **Work-for-Others agreement:** NREL uses a work-for-others (WFO) agreement when a partner seeks technical services to complete a research project but does not intend to perform joint research. The partner provides NREL with the necessary resources and fully covers the costs of the work to be performed.
>
> **Technology Licensing Agreement:** NREL offers licensing for many of its technologies related to energy efficiency and renewable energy development. Licensing of NREL's intellectual property is available to businesses of any size

The CEMIEs of the CONACYT/SENER Sustainability Fund currently are required to be formed at least by one university or academic institution (public or private), and one public or private enterprise, which promotes academia-industry associations. However, there are no specific mechanisms established to promote future work with other public or private participants beyond those that conform the Center, beyond a vague requirement to address "potential future collaborations with different sectors" as part of their proposals[780]. The analysis of the NREL example hence, provides the opportunity of deriving a lesson in the form of the different mechanisms that can be further incorporated in the design of the CEMIE program in Mexico with the purpose of incentivizing a *Strong Collaborative Approach* with the added benefit of profit generation.

NREL also promotes *International Collaboration* through its four partnership mechanisms; currently it has bilateral agreements with over 50 countries including

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779 As provided by the Terms of Reference of the CEMIE call for proposals available at: http://www.conacyt.gob.mx/index.php/convocatorias-conacyt/convocatorias-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-cerradas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-02-1/9754-terminos-de-referencia-2013-02-cemie-sol/file

780 As provided by the Terms of Reference of the CEMIE call for proposals available at: http://www.conacyt.gob.mx/index.php/convocatorias-conacyt/convocatorias-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-cerradas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-02-1/9754-terminos-de-referencia-2013-02-cemie-sol/file

Mexico[781]. In Mexico, the *International Collaboration* component is vaguely addressed in the same provision that advances "potential future collaborations with different sectors" as a part of their proposal, but again it lacks the requirement of specifically advancing mechanisms to undertake this. Just as with *Strong Collaborative Approach* NRELs example sheds light on the opportunity of establishing mechanisms that can promote *International Collaboration* while also incorporating the possibility of generating profit.

### 6.5. Public-Private Research Partnerships

These partnerships embody a mechanism for collaboration between the public and private sectors to share the risks of investing in research and development activities, with the goal of promoting a more effective response to the rapid transformation of innovation processes and related business needs and strategies, while enhancing the efficiency and cost-effectiveness of technology and innovation policy[782]. Hence, they address two of the three main goals of policy aimed at spurring technological innovation: promoting the creation and sharing of knowledge, and improving knowledge diffusion by establishing collaborative networks[783].

A widely cited example of this type of partnerships in the U.S. is the "Partnership for a New Generation of Vehicles (PNGV)"[784]. The Clinton Administration and three major US automakers launched it in 1993 with the goal of advancing the development of energy efficient vehicles. Its success is evidenced by the fact that it increased the profile of advanced technology opportunities; It developed in technological breakthroughs (a prime example is the nickel-metal hydride battery designed for hybrid vehicle applications)[785]; and it led to better working relationships between the federal government and automakers, while also indirectly leading to technology advancement by inspiring more aggressive investments by European and Japanese automakers that, in turn, through a boomerang effect, inspired US automakers to do likewise; reasons for which, it has come to be seen as a model[786].

As analyzed in chapter 5, Mexico has acknowledged the importance of public-private research partnerships in energy innovation through codified documents and speeches of those who run the energy agencies in the Country. However, there is so far, no program that directly identifies a set innovation goal and establishes a public-private research partnership to achieve it. Although the terms of reference of the CEMIE allows for a private component, the fact that private parties, if they actually participate in them, they are to do so not in direct collaboration with the government, but in alliance with research institutes that may or may not be public[787], renders this policy different that one

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[781] NREL supports implementation of a bilateral agreement between the DOE Office of Energy Efficiency and Renewable Energy and the Secretaría de Energía of Mexico for the improved use of modern wind energy mapping and modeling methods as well as design and testing of advanced wind turbines. NREL supports implementation of the EC-LEDS work agreement between the U.S. government and the Government of Mexico through work with the Instituto Nacional de Ecologia (INE) to increase capacity to update and modify current abatement cost models and to develop Mexico-specific data on abatement options; help advance economic modeling capacity; and develop INE's capacity to plan LEDS implementation. More information available at: http://www.nrel.gov/international/bilateral_partnerships.html#mexico

[782] OECD 2004. PUBLIC-PRIVATE PARTNERSHIPS FOR RESEARCH AND INNOVATION: AN EVALUATION OF THE DUTCH EXPERIENCE. Available at: http://www.oecd.org/netherlands/25717044.pdf

[783] International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

[784] Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

[785] David Garman (2014). Public-Private Partnerships in Vehicle Technologies. American Energy Innovation Council. Available at: http://americanenergyinnovation.org/wp-content/uploads/2014/04/Case-Vehicle-Technology-Partnerships.pdf

[786] Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

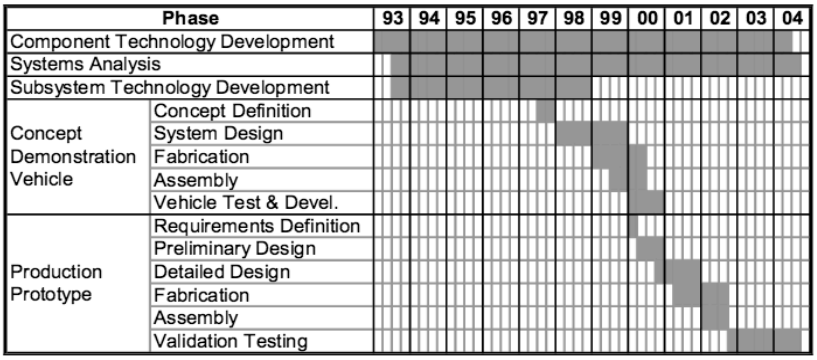
[787] As provided by the CEMIE-sol terms of reference of the call for proposals available at: http://www.conacyt.gob.mx/index.php/convocatorias-conacyt/convocatorias-conacyt/convocatorias-fondos-sectoriales-

that focuses at specifically constructing government-industry R&D partnerships to advance in the attainment of specific clean energy technology goals[788]. Hence, analyzing the example of PNGV can provide policy design lessons that can advise a Mexican implementation of government-industry R&D partnerships in the path towards attaining energy transitional goals.

In terms of *Strategy and Priority Setting*, PNGV's set a deadline for a specific, focused, measurable stretch goal that was publicly visible, was judged to be important by government, and was believed to have the potential to motivate substantial industry support[789]:

- Develop a vehicle with up to three times the fuel economy of 1993 conventional, mid-sized sedans, while achieving improved recyclability and maintaining comparable performance, utility, safety and cost of ownership[790].

And in the path towards attaining it, PNGV devised a specific timeline:




The process began with a focus on the consideration of components, subsystems and systems analysis; candidate technologies were then assessed for their relative likelihood of attaining the goals of PNGV by 2004. In 1997, efforts were directed towards identifying the most promising candidate technologies and teams started to design integrated systems of components; activities that would culminate in the interim goal of concept demonstration vehicles by the year 2000[791]. The final phase would focus at the final production prototype vehicles to be completed by 2004[792]. The plan called for design and production of prototype vehicles by each of the "Big Three" (General Motors Corporation, Ford Motor Company, and Chrysler Corporation) separately, since prototyping requires the full application of technical processes and equipment that tend to be proprietary[793].

constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-cerradas-sener-conacyt-sustentabilidad-energetica/convocatoria-2013-02-1/9754-terminos-de-referencia-2013-02-cemie-sol/file

788 See the "pros" of this type of partnerships advanced at the end of this Chapter to understand the value of this configuration. Reduction of administrative costs, promotion of a social benefit oriented research agenda, and the potential for leveraging private capital are a few examples of the benefits of these partnerships.

789 National Research Council (2001). *Review of the Research Program of the Partnership for a New Generation of Vehicles. Available at: http://www.nap.edu/read/10180/chapter/1*

790 Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

791 David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf

792 The purpose of production prototypes is to demonstrate the performance of the functional attributes of the prototype vehicles, as well as manufacturing feasibility.

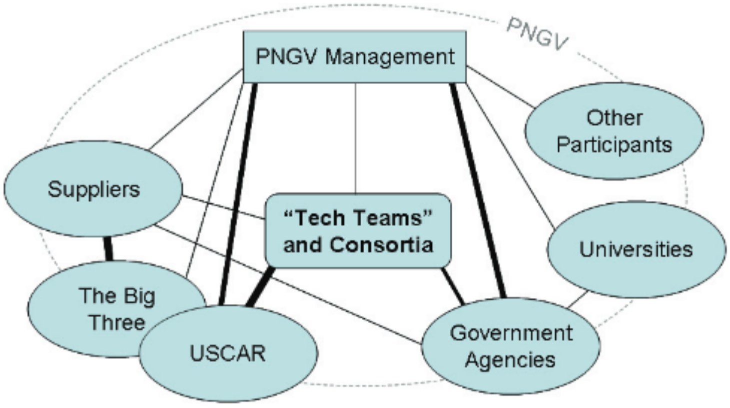
793 David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf

A public-private partnership program with clean energy focus could be developed, by virtue of law, through the CONACYT/SENER Sustainability Fund[794]. This Fund could advance a call for proposals that envisions as eligible candidates strong private energy companies that are to be partnered up, through this program, with the different relevant agencies according to the specific technological goals set in Mexico. If it is decided that this policy is to be undertaken, it is important to keep in mind the lesson derived from PNGVs example which resonates with what has been deemed as a fundamental component of clean energy R&D policy by the International Energy Agency: advance a specific quantifiable goal and setting a schedule to achieve[795]. In Mexico this goal could be developed through an analysis conducted by the technical committee of the CONACYT/SENER Sustainability Fund, with collaboration of the registered experts of the National Researcher Registry.

With regards to the issue of *Stable Government R&D Support,* funding for PNGV was not to be provided through a formal budget at any specific agency; instead funding would flow through a large array of "contracts, subcontracts, understandings, and cooperative research and development agreements as well as shared research arrangements". PNGV's Federal "budget" would comprise a collection of separately funded efforts that would be coordinated to work towards the PNGV objectives[796]. PNGV is generally said to have started with a budget of about $300 million per year, though accounting this would prove difficult. Costs were to be split evenly between government and industry, but the government paid a larger share of the costs of longer-term or riskier research, and industry participants took on most of the production costs in the later stages of the Partnership[797]. This goes against what has been identified as fundamental in terms of government funding in R&D programs by the International Energy Agency, and hence, a Mexican equivalent program should improve the policy design of PNGV in this regard by providing evidence of adequate, stable and predictable funding that is coherent with the objectives[798].

Pertaining to *R&D Governance*, the Partnership included government and industry members, with participation of industrial suppliers and universities. The next figure evidences how these components interacted together[799].

[794] As provided by section 4, articles 25 and 26 of the Law of Science and Technology (Ley de Ciencia y Tecnologia)
[795] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[796] U.S. Council for Automotive Research (1996). PNGV Technical Accomplishments.
[797] David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf
[798] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[799] Robert M. Chapman (1998). The Machine That Could: PNGV, A Government-Industry Partnership. Available at: https://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR1011.pdf




The PNGV program was managed through its "Operational Steering Group". From the government side it was conformed by the Undersecretary for Technology of the Department of Commerce, and senior officials from the Department of Commerce (DOC), the Department of Energy (DOE), the Department of the Interior (DOI), the Department of Transportation (DOT), the Environmental Protection Agency (EPA), the National Science Foundation (NSF), the Office of the Vice President, the Office of Science and Technology (OSTP), the Office of Management and Budget (OMB), the National Economic Council (NEC), the Council for Environmental Quality (CEQ), the Department of Defense (DOD), and the National Aeronautics and Space Administration (NASA). From the industry by the Vice Presidents of Daimler Chrysler, Ford and General Motors; the chair of the Steering Group would rotate between the industry and the government[800].

Such a robust representation in PNGV governance structure by high-level officials from both the relevant Federal agencies and the industry implies that R&D goals for Governance, ensuring technical and administrative capacity by individuals, were met. A Mexican equivalent program could follow this rationale by requiring through the terms of reference of the CONACYT/SENER Sustainability Fund call for proposals, that the governing body of such a partnership should be composed by high level officials of the relevant agencies (which will vary depending the specific technological goal, but most likely will include the Ministry of Energy, the Ministry of the Environment, the Ministry of Economy, and representatives of the CONACYT), and executive officers of the companies that are to participate in the industry side.

A note should be made in regards to the fact that the suggestions advanced so far regarding the possibility of incorporating senior government officials in the management structures of the different programs discussed, could raise the question of whether these officials have the time and capacity to serve in multiple management committees at the same time. However, as explained through the Clean Energy Fund analysis, if this avenue is to be pursued, directly appointing high-level officials of relevant agencies to promote adequate governance should be done by tying the responsibility of being part of the panel to a specific governmental position after a careful analysis, and not by simply "pinpointing"

800 U.S. General Accounting Office (2000). Results of U.S.-Industry Partnership to Develop a New Generation of Vehicles, Report to Congress, available at: https://books.google.com/books?id=fAJspw3l3aMC&pg=PA8&lpg=PA8&dq=operational+steering+group+PNGV&source=bl&ots=UcaW-HGMqV&sig=H1laVJucu1foHEt-1fzwYflZLGw&hl=en&sa=X&ved=0ahUKEwiW4Jfl0JPLAhUEKGMKHc2LCgoQ6AEIJjAE#v=onepage&q=operational%20steering%20group%20PNGV&f=false

them. Hence, the determination of which senior officials will serve in which management committees should be done through a transparent selection process that considers time, capacities, and expertise of the different high-level officials of the agencies in question.

In regards to *Effective Evaluation and Monitoring*, it was agreed when developing the PNGV program that some form of independent peer review would be required to provide an independent assessment of progress to goals, program plan, and schedule. Hence, the National Research Council was selected to provide this review on a yearly basis[801].

In 1994, NRC formed a standing committee to provide these ongoing evaluations, a rather uncommon practice in Washington DC, but recognizing the uniqueness and high profile of this program, six annual reports were published from 1994 to 2000[802]. The positive effect of the NRC committee's efforts was to keep PNGV in the public eye and hold government and industry managers accountable, much more so than is common for large government programs, this high level of scrutiny was effective in increasing the transparency of the program planning, and encouraging industry teams to stay productively engaged[803]. However, there was also a negative effect of this continuing stream of relatively benign criticism by limiting the debate about its true costs and benefits to the information provided by the PNGV, and by implicitly endorsing the goals and design of the program[804]. The latter given that the NRC committee interpreted its mission narrowly by taking as given the vision, goals, and schedules for the PNGV program that had been enunciated by the president and agreed to by USCAR (the entity representing the three automakers)[805 806].

A Mexican equivalent could derive a lesson from PNGVs example in this regard, by moving towards forming an independent evaluation committee within CONACYT, and incorporating provisions of transparency and public reporting to ensure impartial scrutiny. However, in regards to the method to follow when performing the particular evaluation, the criteria used by the Clean Energy Fund to formulate the performance analysis of the set program[807], can shed light on an opportunity to surpass the design of the PNGVs evaluation committee methodology, by going beyond goals established by signatory parties and promoting a debate about the true costs and benefits attained by the project at its different stages.

There is no information regarding the selection process followed to determine which companies were to participate in PNGV, however the choice of partners (General Motors Corporation, Ford Motor Company, and Chrysler Corporation) entails that established automotive enterprises where targeted. In any automotive R&D program, one must engage the automakers to ensure compatibility of component technologies and to

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801 U.S. General Accounting Office (2000). Results of U.S.-Industry Partnership to Develop a New Generation of Vehicles, Report to Congress, available at: https://books.google.com/books?id=fAJspw3l3aMC&pg=PA8&lpg=PA8&dq=operational+steering+group+PNGV&source=bl&ots=UcaW-HGMqV&sig=H1laVJucu1foHEt-1fzwYflZLGw&hl=en&sa=X&ved=0ahUKEwiW4JfI0JPLAhUEKGMKHc2LCgoQ6AEIJjAE#v=onepage&q=operational%20steering%20group%20PNGV&f=false

802 Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

803 Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

804 Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

805 The "United States Council for Automotive Research" (USCAR), an organization that houses the various consortia and other cooperative efforts of the automotive industry was formed by the "Big Three" in 1992 to provide a setting for the coordination of joint projects.

806 Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

807 Previously analyzed on section 6.2 of this Chapter.

oversee packaging, especially when production prototypes are to be built, and also because they are the ultimate users of the technologies[808]. This is a key lesson to keep in mind when developing a clean energy equivalent in Mexico; partnership is to be sought with those participants that are currently successfully commercializing clean energy technology components in a considerable scale, in order to promote rapid dissemination of technological innovation. To this point a note could be made in regards to the fact that Mexico currently does not have such high level participants in the clean energy industry as the "Big Three" in the U.S. automotive sector. There are however clean energy companies that although they are certainly not in the size of the "Big Three", they could participate in a clean energy public-private program with the goal of providing a fast dissemination route for the developed technological advancements[809].

With respect to *Strong Collaborative Approach*, given the nature of this public-private partnership program, collaboration with industry was promoted through its inception; but beyond the automotive industry, PNGV incorporated also suppliers, which provided components and assemblies to the auto manufacturers, and universities primarily through their ongoing research interactions for and with government agencies and laboratories. This provides an example of a possible mechanism to promote collaborations in a Mexican equivalent program with the purpose of bridging the interests of industry and the research community to accelerate technological development.

The PNGV had no *International Collaboration* component; however it has been found that it also motivated investments directed at the goals of the program by companies that were not part of it. When PNGV was unveiled, foreign automakers in Europe and Japan quickly accelerated their efforts. Many executives in European and Japanese companies readily concede that PNGV was clearly seen as a threat, and was the catalyst for increased investment in advanced propulsion technology in their companies[810]. Perhaps this can be a learning point for Mexico to enhance its policy design as compared to PNGVs, by considering the incorporation of international participants in addition to those from the national industry in the public-private research partnerships, this, in order to promote access across expertise; and improved competitiveness by spreading the costs and risks between Mexico and other nations[811].

### 6.6. R&D Prizes

As explained before, these types of inducement prizes have proved to be increasingly important for incentivizing innovative efforts. In the past they have inspired various scientific and technological breakthroughs, including marine technologies, locomotive engine designs, aeronautical experimentations, and even food preservation solutions[812]. In the field of clean energy innovation they can be directed towards the goals of: creation and sharing of knowledge, and improving knowledge diffusion by establishing

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808 David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf

809 An example of this can be GeckoLogic which sales photovoltaic technology in Mexico DF, Tijuana, Ensenada, Valle de Guadalupe, Guadajalara, Monterrey, Villa Hermosa, Merida, Sonora, Puerto Vallarta, Puebla, San Jose del Cabo, La Paz, Culiacán, Hermosillo, Mexicali, Cancun, Tabasco, Veracruz, Ciudad Obregón, Veracruz, San Luis Potosí, León, Chihuahua, Distrito Federal, Ecatepec, Juárez, Zapopan, Nezahualcóyotl. More information available at: http://www.geckologicmexico.com/nuestra_compania/empresa-paneles-solares-Mexico.html

810 Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf

811 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

812 Qiang Fu et al (2011). Incentivizing R&D: Prize or Subsidies? Elsevier 2011.

collaborative networks[813].

Given that the purpose of this section is to advice the Mexican Government on the adequate implementation of policies by analyzing successful cases in other Countries. For R&D Prizes, this author has selected to shed light on the case of the "Progressive Insurance Automotive X PRIZE (PIAXP)[814]". This, given that although it is not directly a Government run program, the department of energy has sponsored it as it is a referent of a successful implementation of an R&D prize program[815], from which Mexico can derive lessons to develop a potential Government run equivalent.

The success of PIAXP is evidenced by the fact that the goals of the program were reached - "building viable, super fuel-efficient vehicles in each category[816]" - and that it spurred substantial R&D activities through the efforts of the registered teams; more than 100 teams registered for the competition, and despite the long odds of winning, more than 40 teams incurred the expense of fielding vehicles[817]. The winners were[818]:

- **Edison2 LLC**, based in Charlottesville, Va., won the $5 million mainstream class with its Very Light Car. This forward-looking, truly aerodynamic vehicle weighs less than 750 pounds and boasts a drag coefficient that is half of what is considered the best today. In the competition, the Very Light Car achieved just more than 100 MPGe and passed all safety and emissions criteria- made even more remarkable with the knowledge that the car runs on E85 ethanol.
- **Li-ion Motors**, based in Mooresville, N.C., won the $2.5 million alternative side-by-side class with its Wave II vehicle. This battery electric urban car was built on a lightweight aluminum chassis and includes a highly efficient battery package and aerodynamic features that enabled it to achieve 187 MPGe in on-track testing.
- **X-Tracer**, based in Uster, Switzerland, won the $2.5 million alternative tandem class with its E-Tracer 7009 vehicle. The E-Tracer features two stabilizer wheels that automatically drop at low speeds or during sharp turns. It includes room for two in-line passengers and weekend baggage, and held the record high for efficiency in the competition, coming in at 197 MPGe.

There is no R&D Prize Program currently in operation to incentivize clean energy in Mexico. Hence, the first lesson to derive from the PIAXP example is the potential that prize programs can have to incentivize the formation of a large population of potential problem solvers aimed at a single R&D innovation goal, and willingness on the part of participants to bear some of the costs and risks of developing technology[819].

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[813] International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

[814] Based on the successful ANSARI X prize that was launched in 1996, rewarding the first private space vehicle to launch a reusable manned spaceship into space twice in 2 weeks, which motivated 26 teams to spend over $100 million of private investment. The winners of ANSARI X were able to take their winning vehicle (SpaceShipOne), from the Ansari X PRIZE and move it forward into commercialization through a $250 million commitment from Sir Richard Branson to create Virgin Galactic. Jonathan Adler (2011). Eyes on the Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization. Available at: http://paloaltoprize.com/wp-content/uploads/2014/09/Prizes_EYES_ON_A_CLIMATE_PRIZE_CaseWestern_3_2011.pdf

[815] As evidenced by this press release: http://auto.xprize.org/news-events/press-release/55-million-in-funding-from-us-doe-to-further-goals-of-competition

[816] Two categories: one "Mainstream" focused at developing a four-seater, and an Alternative Class focused at developing two two-seaters vehicles (one with tandem seating and one with traditional side-by-side seating).

[817] Alan Maccormack et al. (2013). Spurring Innovation Through Competition. MIT Management Review, available at: http://sloanreview.mit.edu/article/spurring-innovation-through-competitions/

[818] Information provided by the Huffington Post through: http://www.huffingtonpost.com/peter-diamandis/congratulations-to-the-wi_b_718840.html

[819] Jonathan Bays et al (2009). Using Prizes to Spur Innovation. McKinsey 7 Company, available at: http://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/using-prizes-to-spur-innovation

In terms of *Strategy and Priority Setting*, the claimed purpose of the PIAXP was to provide incentives to teams from around the world for them to focus on a single goal: "building viable, super fuel-efficient vehicles that give people more car choices and make a difference in their lives"[820]. The initial prize proposal called for two divisions – Mainstream and Alternative – with the same requirements for fuel economy and emissions in each division, but different design constraints[821]. It awarded $5 million per division to the team with the fastest vehicle with fuel efficiency in excess of 100 miles-per-gallon equivalent (MPGe) around a course[822]. Qualification was given by providing a "Letter of Intent", and the contest had a "Design Judging" Stage in which teams that provided "credible, initial plans for a production capable vehicle or product that could meet the performance criteria of the prize" would advance to the first of two "dramatic long-distance" races – a Qualification Race which, if successfully completed (and after crash test results) would provide admission into a Final Race[823].

As analyzed before, clear goal and strategy setting are not practices currently undertaken by the CONACYT/SENER Sustainability Fund, its programs advance vague objectives, which do not allow zooming in on the specifics of what they are looking for through them, nor do they address milestones that are to be reached to achieve those vague objectives. Hence, if Mexico is to pursue this policy, it is important to consider undertaking clear objective setting, embodied in a quantifiable technological innovation goal that it is to be reached by participants in order to access the prize, with complete information about the steps that are to be followed in their path towards accessing it.

With regards to the issue of *Stable R&D Support,* the empirical reality of the PIAXP program is that it neither attempted to balance the costs and benefits of participation, nor did it try to value the potential social benefits of a prize solution[824]. Peter Diamandis[825], was guided by history in setting the first X PRIZE at $10 M, he was inspired by the large sums of the Orteig Prize, the $25,000 reward that inspired Charles Lindbergh to venture across the Atlantic in his aircraft, the Spirit of St. Louis, in 1927 to become the first aviator to fly non-stop from New York to Paris. With objectives of gathering attention and building the reputation of participants and organizers, the prize hosts emphasized the ability of a prize of a large magnitude to generate interest[826]. The amount of the prize was stable, as it was never modified throughout the contest[827].

This is one instance in which a Mexican equivalent program could improve the current design of the policy example we are currently analyzing. A CONACYT/SENER Sustainability Fund R&D prize could follow Peter Diamandis' approach in term of offering a large sum to motivate participation, but in setting the specific amount it can follow a rationale that balances the costs and benefits of the potential participants, in order to seek the maximization of the marginal benefits of such a program, by incentivizing high participation at the lowest cost. Once the amount is set, it should be never modified

820 Information provided by the X-PRIZE foundation through: http://auto.xprize.org/about/overview
821 Progressive Automotive XPRIZE Competition Guidelines accessible at: http://auto.xprize.org/about/guidelines
822 Progressive Automotive XPRIZE Competition Guidelines accessible at: http://auto.xprize.org/about/guidelines
823 Progressive Automotive XPRIZE Competition Guidelines accessible at: http://auto.xprize.org/about/guidelines
824 Fiona Murray et al.(2012). Grand Innovation Prizes: A Theoretical, Normative, and Empirical Evaluation. Available at: http://mitsloan.mit.edu/shared/ods/documents/Murray_2012_GrandInnovation.pdf&PubID=5446
825 Founder and Chairman of the X PRIZE Foundation
826 Fiona Murray et al.(2012). Grand Innovation Prizes: A Theoretical, Normative, and Empirical Evaluation. Available at: http://mitsloan.mit.edu/shared/ods/documents/Murray_2012_GrandInnovation.pdf&PubID=5446
827 Fiona Murray et al.(2012). Grand Innovation Prizes: A Theoretical, Normative, and Empirical Evaluation. Available at: http://mitsloan.mit.edu/shared/ods/documents/Murray_2012_GrandInnovation.pdf&PubID=5446

throughout the contest, as it has been found that stakeholders will be looking for concrete and stable monetary support in order to react[828].

In terms of resource availability, the resources of the CONACYT/SENER Sustainability Fund have found to be limited, as analyzed throughout this Chapter, therefore setting a large sum prize might be deemed challenging. However, sponsorship can be sought from enterprises that want to be associated publicly with the cause[829], this in order to raise the prize sum to the required extent to promote meaningful participation at the lowest possible cost, based on the results of the cost-benefit analysis.

Pertaining to *R&D Governance*, the PIAXP was managed by its Prize Administration Advisory Board, which incorporated experts from the industry, academia, non-profits, and a former DOE Assistant Secretary of Energy Efficiency and Renewable Energy[830]. The PIAXP provides no information regarding the selection process for their governance body, nevertheless it is clear that this program achieves *R&D Governance* goals as the experts that compose the advisory board are highly qualified individuals in their field with proven administrative experience[831].

As advanced before, Mexico has been recently deemed the most corrupt Country of the OCED[832], and as such transparency and rule following in the selection process of the representatives of the governance body should be pursued in order to ensure that this body can ultimately be deemed "conflict-free" and qualified. A transparent selection process can be established through the terms of reference of the potential R&D Prize program, which can incorporate the lessons from the PIAXP example in this regard, by promoting that this body gets formed by expert representatives of the academia, the industry, non- profits, and perhaps high level officials of the current energy agencies; all of these in equal numbers so there are no incentives to form groups to manipulate decisions.

In regards to *Effective Evaluation*, in terms of being accepted for participation in the contest, PIAXP used low barriers to qualify in order to maximize participation[833]. Nevertheless in terms of the characteristics that the models needed to have in order to ultimately access the prize, these were very specific and addressed every aspect that was deem fundamental for commercially feasibly automobiles (see the table below).

Criteria for PIAXP models

| | |
|---|---|
| *Safety, emissions* | Vehicles must be designed so that a production vehicle would likely be able to meet U.S. safety standards and U.S. emissions standards. |
| *Manufacturability, cost* | Vehicles must be capable of being manufactured in quantities of 10,000 per year, with vehicle production costs within levels consistent with historical examples of comparable vehicles. |

828 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

829 Examples of candidates for this are: energy companies, environmentalist groups, and polluting companies aiming to change their public image.

830 Specifics of the panel and the profiles of those that compose it is made available by the X Prize Foundation through: http://auto.xprize.org/about/judges-advisors

831 Specifics of the panel and the profiles of those that compose it is made available by the X Prize Foundation through: http://auto.xprize.org/about/judges-advisors

832 As provided by the next news article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde

833 Fiona Murray et al.(2012). Grand Innovation Prizes: A Theoretical, Normative, and Empirical Evaluation. Available at: http://mitsloan.mit.edu/shared/ods/documents/Murray_2012_GrandInnovation.pdf&PubID=5446

| | |
|---|---|
| *Features* | Vehicles must be desirable, addressing the most important features and factors consumers consider when purchasing an automobile. |
| *Business Plan* | There must be a credible plan to manufacture, sell, and service 10,000 vehicles per year; The plan must show that the national fuel infrastructure will support the vehicles, especially if any non-standard fuels or fueling-methods are to be used |

In terms of PIAXP approach to qualification, it follows what the National Academies advanced regarding the rationale for prize programs: the primary reason for offering a prize is to attract different parties to contribute to a recognized societal or scientific objective, as such, it is strongly recommended that contests encourage participation from "a wide range of types of contestants, including those not ordinarily active in the research grant and contract world"[834]. Hence, a Mexican equivalent program should consider low barrier qualifications to promote participation by teams of diverse nature. In terms of the criteria for ultimately accessing the prize, the PIAXP example also provides a learning point that can advise a Mexican R&D prize implementation by showcasing the value of incorporating commercial feasibility considerations in order to increase the likelihood of this program actually resulting in breakthroughs towards viable market applications.

With regards to *Monitoring*, being a private program, the PIAXP had no added verification stage after its completion, or an organ in charge of surveillance throughout the development of the program. A Government run equivalent in Mexico could add this future through CONACYTs Internal Organ of Control, compelling this organ to publicly report its findings and activities when overseeing the application of this program.

Pertaining to *Strong Collaborative Approach*, the PIAXP was set in such a way that by having low entry barriers and a high-sum prize it incentivized participants from a broad array of affiliations: industry, non-profit, and the academia were represented in the different teams that were attracted by the particularities of the PIAXP design and therefore took part in it[835]. Apropos *International Collaboration*, 111 teams registered for the PAIXP, by 20 October 2009, the number of teams had decreased to 43, sponsoring 53 vehicles between them - these remaining teams represented 10 countries (some entries listed two countries of origin) with 28 coming from the USA and 7 from the state of California [836]– International involvement is also explained, beyond the factors of low barriers of entry and a high sum prize, by the fact that there were no impediments in place to preempt international participation. A Mexican equivalent program could follow the same rationale to promote collaborations, but perhaps exploring restricting international participation to teams that have a Mexican component can aid towards increasing the technical capacity of Mexican participants as well, by enabling access across expertise; and improved competitiveness by spreading the costs and risks between Mexican participants and those from other nations[837].

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[834] National Research Council, 2007. Innovation Inducement Prizes. Available at: http://www.nap.edu/catalog.php?record id=11816

[835] The list of the teams that participated and a description of its members is made available by the X Prize Foundation through: http://auto.xprize.org/teams

[836] The list of the teams that participated and a description of its members is made available by the X Prize Foundation through: http://auto.xprize.org/teams

[837] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

### 6.7. Research and Development Public Financing

As explained before, financial markets and financial institutions are traditionally reluctant to invest in R&D projects. This is due to the fact that there is a higher uncertainty/risk for R&D projects, compared to more traditional business projects. Hence, the European Community created the Risk-Sharing Finance Facility (RSFF) in order to promote the creation and sharing of knowledge by improving access to loans for R&D projects[838].

The RSFF consists in the financial collaboration between the European Commission and the European Investment Bank (EIB) with the goal of improving access to financial products by European higher risk Research, Technological Development, Demonstration and Innovation projects (RDI)[839]. Its success is evidenced by the fact that this program spurred a leverage of 5x the investment undertaken directly by the EIB, In other words, on average, the provisioning and capital allocation is 22 % of EIB lending for RSFF operation. Moreover, the RSFF program had a catalytic effect on other financiers of x3.39 of lending to riskier RDI projects, higher than expected, improving significantly access to financial support for "risky" research and development projects.

Mexico currently does not provide for a clean energy R&D focused shared-risk financing program. Hence, the first lesson to gather from the European example is the power that public financing can have when attempting to improve access to financing by R&D projects that tend to be deemed "too risky" by private lenders. A program as the RSFF with a clean energy focus can be implemented in Mexico, through a call for proposals from the CONACYT/SENER Sustainability Fund. The operation of the program through the EIB, would be similar in Mexico, as such a program would be developed by the Fund but undertaken by a Mexican development bank[840], BANOBRAS, which has already signed a contract with the Fund, through which this development bank is required to implement the financial products that the Fund develops[841].

In terms of *Strategy and Priority Setting*, when setting-up the RSFF, no clear and explicit intervention logic with set objectives, was defined[842]. Therefore, the internal coherence of objectives and targeted results by RSFF can be deemed partly unsatisfactory, as the too broad objectives included in the RSFF Cooperation Agreement allowed too much scope for interpretation and stifled the RSFF governance ability to identify performance indicators and milestones for the program. However, the flexibility character of the instrument and the ability of the RSFF steering committee to amend the Cooperation Agreement partly offset this key initial weakness in terms of design, allowing a further adaptation that derived in the establishment of specific objectives, which are showcased by the next diagram[843].

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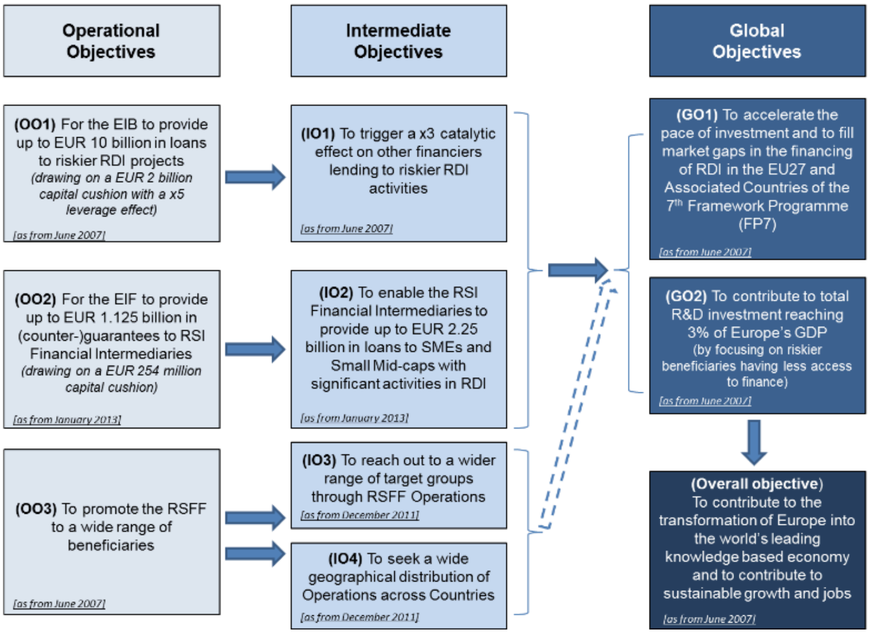
838 Information provided by the European Commission through: http://ec.europa.eu/invest-in-research/funding/funding02_en.htm
839 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf
840 Public entities in charge of implementing and managing financial products for the Federal Government.
841 Available at: http://sustentabilidad.energia.gob.mx/res/Contrato%20de%20Fideicomiso%202138.pdf
842 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf
843 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf




This is an instance in which a Mexican equivalent program can surpass the design characteristics of the policy example we are currently analyzing. As provided by the lessons derived from the evaluation committee of the EIB, when designing a public financing program it is important to establish a set of objectives that can serve both as desirable goals and also as evaluation guidelines to judge the progress of this program at different stages of its implementation[844]. The European RSFF program set objectives in terms of public funding amounts, leverage of private funding, widening beneficiaries to include high-risk projects, and increase of GDP percentage allocated to these type of projects, after it was amended[845]. Hence, the CONACYT/SENER Sustainability Fund should consider setting clear and quantifiable objectives since the inception of the program in light of the lessons provided by the RSFF example.

With regards to the issue of *Stable Government R&D Support,* the RSFF was allocated 10 billion Euros and was clearly set to operate from January 2007 until December 2013[846]. This practice resonates with the findings of the International Energy Agency in regards to the fact that stakeholders will be looking for concrete and long-term policy support that promotes the stated objectives of the particular program in order to react[847]. As such, Mexico should internalize the practice of setting a specific funding amount directed at a program with a clear lifetime in order to send the adequate signals to stakeholders in this regard.

Pertaining to *R&D Governance*, the RSFF was overseen and supervised by the RSFF Steering Committee (SC), which consisted of six European Commission General Directors[848], and six EIB representatives[849]. During RSFF SC meetings in, representatives

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[844] European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf
[845] European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf
[846] European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf
[847] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[848] Communications Networks, Content and Technology; Economic and Financial Affairs; Budget; Energy; Mobility and Transport; and Research & Innovation.
[849] Three from OPS A (the Operational Directorate General of the Bank for the European Union), two from the Secretariat General, and the Project Directorate General

of the European Investment Fund were also set to participate typically from the Strategic Development and EU Policies department, as well as its Guarantees, Securitization and Microfinance department.

Being managed by the Directorates of the relevant European Commissions and high-level officials of the European Investment Bank, the RSFF increased the likelihood of ensuring that the fundamental qualities for managing such financial program in terms of governance were met, given the characteristics of those that currently occupy those positions[850]. It is true that not because someone is appointed Directorate it is automatically conferred technical and administrative capacity, however, from the analysis of the profiles of current European Commission Directors, it is clear that they are individuals highly qualified in their field with proven administrative experience[851].

A Mexican equivalent program can follow the same approach as the RSFF, ensuring that high-level officials of the relevant Ministries and BANOBRAS are set to manage the governing body of this program. However, it is worth keeping in mind that, as advanced before, Mexico has been recently deemed the most corrupt Country of the OCED, and as such transparency and rule following in the selection process of the representatives of such a governing body should be deem fundamental. There are no indications in regards of how the selection of the representatives of the CONACYT/SENER Sustainability Fund is conducted nor who are the representatives operating its technical committee, hence, it is important to deviate from this practice within the Fund, but also when establishing the governing body of a public financing R&D program in order to preempt the possibility of corruption tampering with the purpose of the policy. The RSFF example sheds light on the possibility of directly appointing high-level officials of relevant agencies and the investment bank to promote adequate governance, by tying the responsibility of being part of the steering committee to a specific position, not by "pinpointing" them. Nevertheless it is worth noting that this is done in a transparent manner in a region where these high-level officials have proven qualifications.

In regards to *Effective Evaluation*, there were no formal requirements such as application forms or deadlines in order to apply for RSFF financing from the European Investment Bank other than presenting a coherent business plan confirming their capacity to repay for the financing[852]. The Investment Bank was in charge of making decisions regarding projects with a total project cost of EUR 15 million and above, for the financing of small and medium sized RDI projects (project cost of less than EUR 15 million) the application was managed by commercial banks[853].

The scope of eligible activities was wide, it extended from traditional asset investments to equipment and intangible investments such as R&D operating cost, salaries of researchers, management and support staff, utilities, consumables, etc. This up to a limit of EUR 300m per project: The share of EIB financing was limited to 50% of the total amount of eligible project cost, i.e. of the investments in RDI and/or research infrastructure[854].

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850 Managers should have proven technical and administrative capacities as provided by the International Energy Agency study.

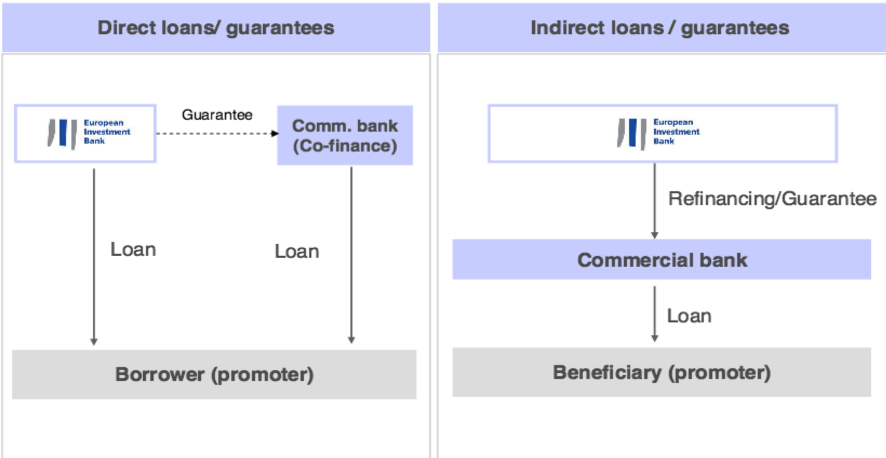
851 The profiles of all Commission Directors are made available by the European Commission and can be found at: http://ec.europa.eu/about/ds_en.htm

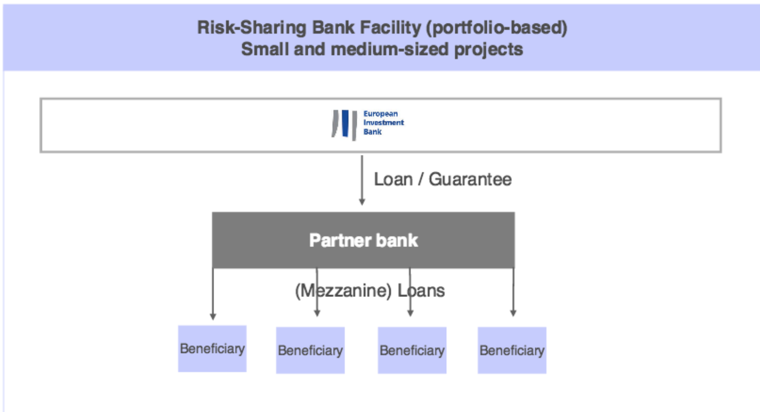
852 European Investment Bank (2010). Information Report: EIB New Products and Special Transactions Division Knowledge Economy / RD&I. Available at: http://www.eib.org/attachments/rsff_faq_31052007.pdf

853 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf

854 European Investment Bank (2010). Information Report: EIB New Products and Special Transactions Division Knowledge Economy / RD&I. Available at: http://www.eib.org/attachments/rsff_faq_31052007.pdf

The RSFF focused primarily on debt based financing via loans and guarantees[855]. RSFF financing could be made available directly to the project Promoter, where the EIB will in general provide (co) financing, jointly with commercial banks or other financing institutions. In addition, the EIB provided guarantees to commercial banks or other financial institutions financing "the Promoter". The next figures showcase the structure of the different financial products offered by the RSFF[856].




Under the RSFF, the EIB can accept exposure to higher credit risks than under its normal lending activities, either in the form of counterparts with a higher risk profile or through transaction structures involving higher financial risks for the EIB. RSFF finance can be provided to low or sub investment grade companies including the vast number of typically unlisted and unrated small or medium sized companies in Europe. Sub-investment grade financing refers to credit risks equivalent to "BB" or "B" on the rating scale of leading international rating agencies. RSFF transactions are by definition below investment grade as evidenced by the next figure[857].

855 European Investment Bank (2010). Information Report: EIB New Products and Special Transactions Division Knowledge Economy / RD&I. Available at: http://www.eib.org/attachments/rsff_faq_31052007.pdf
856 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf

857 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf

| Loan Grade | Description | RSFF Eligible |
|---|---|---|
| A° | Prime quality | **Loan Grading range allowed for standard EIB operations** (Research Infrastructures, including universities and public research organisations, exceptionally allowed for financing under RSFF even though above investment grade rating) |
| A+ | | |
| A- | | |
| B+ | High quality | |
| B- | | |
| C | Good quality | |
| D+ | Borderline quality | |
| D- | | **Loan Grading range for all RSFF operations** |
| E1+ | Loans that have experienced severe problems | |
| E2+ | | |
| E3+ | | |
| E1- | | |
| E2- | | |
| E3- | | |
| ETI/ETP | | |
| F | Loans representing unacceptable risk | |

Hence, a Mexican clean energy equivalent could explore establishing low barriers for qualification and easy access to the incentive, as the European RSFFF, with the purpose of improving access to financing products by clean energy R&D entrepreneurs, and increasing the comfort of commercial banks with this kind of projects[858]. However, in terms in the actual process followed to deem the capacity of repayment of the applicants and the value of the advanced project, it is important to establish clear and stringent rules, through the terms of reference of such a program, in order to deter corruption in these processes given Mexico's current struggle with this issue. Perhaps an adapted version of the "merit review system" (previously discussed in the Academic R&D Funding section) geared towards finance, can become a possible mechanism to ensure optimal allocation of this incentive in order to comply with the *Effective Evaluation* ingredient of successful clean energy R&D policy making in a transparent way

*In terms of Monitoring* the European Investment Bank, through its Directorate of Operations monitored RSFF operations as they took place in accordance with its own rules, policies and procedures[859]. Furthermore, complete assessments of the program and the attainment of its goals were to be conducted by an Independent Expert Group (which was formed by representatives from non-profits, the industry and the academia[860]), as provided by the original Cooperation agreement. The evaluation reports covered[861], inter alia, the following elements[862]:

- The extent to which the RSFF operated in accordance with the Cooperation Agreement;
- A review of the RSFF portfolio;
- An assessment of RSFFs performance;

858 Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation: An overview of mechanisms being used today to help scale up the climate mitigation markets, with a particular focus on the clean energy sector. United Nations Environment Programme (UNEP), Paris, France. Available at: www.unep.fr/energy/finance/documents/pdf/UNEP_PFM%20_Advance_Draft.pd.

859 These rules, policies and procedures are made available by the European Investment Bank and can be consulted at: http://www.eib.org/about/structure/control_and_evaluation/index.htm

860 Information about the participants of this committee is made available by the European Commission through: https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/rsff_expert_list.pdf#view=fit&pagemode=none

861 There were two full evaluation reports, one halfway through the program and the final one right before it ended.

862 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf

- Ways and means to optimize the design of the RSFF program

Just as CONACYT, BANOBRAS also has an Internal Organ of Control in charge of conducting monitoring activities, and detecting and preventing fraud, waste, and abuse within the BANOBRAS or by groups or individuals that receive funding[863], this Organ would be in charge of monitoring a Mexican clean energy equivalent program as it goes. Regarding complete evaluations as the ones conducted by the Independent Expert Group in the European example, this could be pursued by Mexico as well, by establishing the formation of such an evaluation team in the terms of reference of the program, and further devising the mechanism to elect its members.

In regards to *Strong Collaborative Approach*, the RSFF had no specific component to promote it. Eligibility was granted to private and public entities of all sizes and ownership, including Midcaps, Small and Medium-sized Enterprises, Special Purpose Companies, Joint Ventures, Public-Private Research Institutes, Universities, Science and Technology Parks, etc.… in other words, the financial opportunities were available to every participant that could potentially develop clean energy R&D, as long as they provided a coherent business plan confirming their capacity to repay the financing program[864], however there were no mechanisms in place to promote collaborations between non-profits-industry- and academia. This is an instance where a Mexican equivalent could surpass the example we are currently analyzing by establishing a collaborative mechanism, perhaps a modified "GOALI" type of categorization aimed at promoting participation by partnerships between industry, academic researchers and non-profit organizations, this, in order to accelerate technological development[865].

Given the nature of the European Community, the RSFF was accessible by participants of all member states[866] and associated Countries[867], however there were no mechanisms in place to promote *International Collaboration* in the form of partnerships within participants of the member states and/or associated Countries. Mexico can further improve the design characteristics of the program we are currently analyzing by promoting *International Collaboration* through bilateral agreements[868] aimed at fostering public financing for collaborative research projects, this, in order to enable access across expertise; and improve competitiveness by spreading the costs and risks of R&D financing between Mexico and other nations[869].

In terms of differences beyond those that have already been addressed trough the analysis of this study, between the European EIB and Mexico's CONACYT, although the EIB has significantly more resources[870], project costs between Mexico and Europe differ

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863 As provided by the Organizational Manual of Banobras. Available at: http://www.banobras.gob.mx/UnidadEnlace/Manual%20General%20de%20la%20Organizacin/300000%20%C3%93rgano%20Interno%20de%20Control.pdf

864 European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf

865 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

866 Member States: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland,
Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

867 For a comprehensive list of Associated Countries, please refer to: http://cordis.europa.eu/fp7/who_en.html#countries

868 As analyzed throughout this Chapter, this practice has been undertaken by Mexico before in regards to applied research and development, incentivizing international collaboration with the United Kingdom and the European Union.

869 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

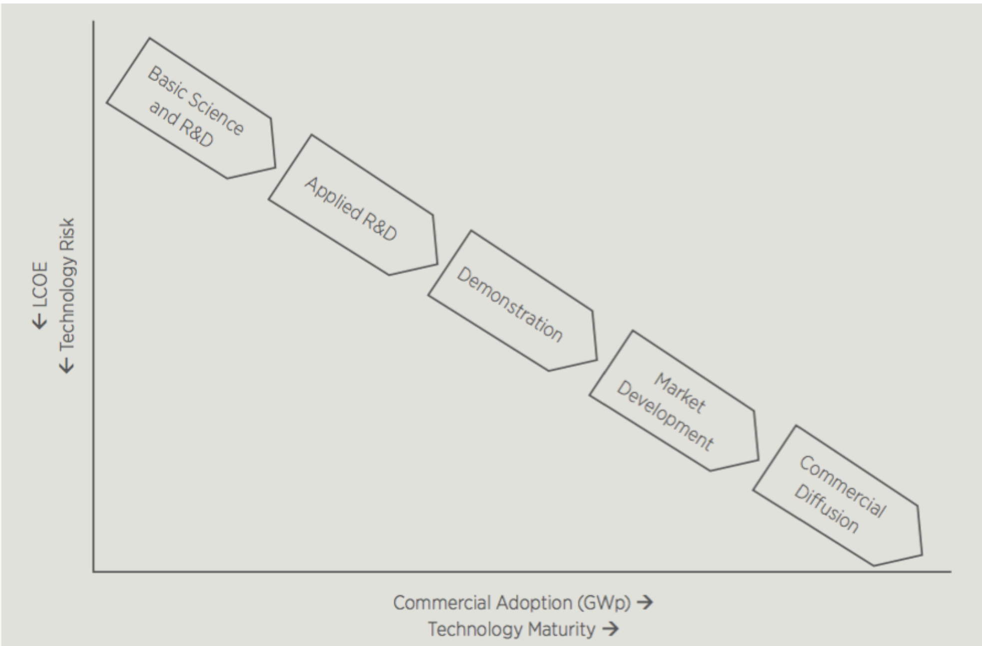
870 As explained before, the EIB was allocated 10 billion Euros for the RSFF program alone.

considerably[871]; the allocated funds for the CONACYT/SENER Sustainability Fund should be managed so this type of financial support can be provided in relation to its resource capacity, which will inevitably translate in a lesser amount of projects financed through this mechanism (the latter will also be exacerbated by the fact that the European mechanism comprises an effort in the whole European Union as opposed to a sole Country). As such the specific goals pertaining to the objectives of the program should be adjusted to reflect this, particularly, the specific amounts of the operational and intermediate objectives, and the considerations regarding territorial extent of application.

Moreover, technical capacity of the potential applicants can be signaled as a difference between Mexico and Europe as well. The rationale in discussing this is the same that was previously advanced regarding the U.S. and Mexico: a difference in the technical capacity between Mexico and Europe should not deter investment in R&D, as funding is crucial to develop technical capacity in the first place.

### 6.8. Choosing a "Supply-Push" Policy Portfolio for Mexico

As explained throughout this Chapter, Mexico has limited resources to undertake clean energy R&D policy[872]. The levels of available funding often determine government's ability to act, hence, in order to be efficient policy makers must allow for a coherent strategy when making policy choices, one that addresses every key stage of the innovation chain (see figure below)[873].




Each of the different research and development policies that have been deemed legally, politically and economically feasible for Mexico can be geared towards addressing one or more of the three key "supply-push" areas (Basic Science R&D, Applied R&D and

[871] Cost of living comparison can serve to shed light on the cost difference between Mexico and Europe. A comparison in this regard using Mexico City vs. Paris as a proxy is available at: https://www.expatistan.com/cost-of-living/comparison/paris/mexico-city
[872] The specific yearly amount of resources allocated to the CONACYT/SENER Sustainability Fund is determined by multiplying the petroleum dividend by .0065 and then multiplying that result by .20, which means that the funds for promoting renewable energy, and energy efficiency research and development activities in the Country amounts to .13% of the yearly petroleum dividend. To put things in perspective, in 2010, the sustainability fund received 713 million pesos from the "Petroleum Dividend" for renewable energy and energy efficiency research and development activities.
[873] International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

Demonstration) of this innovation chain. Nevertheless, as resources are limited, it is important to consider the advantages and disadvantages of each of these policies when constructing an innovation policy portfolio, in order to ensure its effectiveness in reaching the goals set forth. This section aims at aiding the policy-making process by highlighting the advantages and disadvantages as "Pros and Cons" for each policy option.

Academic R&D Funding

**Pros**

- *Avails upfront capital*: Perhaps the most obvious benefit of grants is that they provide much-needed funds necessary to underwrite renewable energy development programs[874].
- *Attracts external interest*: Receipt of grants could bring increased credibility to the research and development efforts. When private companies see energy research and development grants being developed, their interest in funding the cause piques[875].
- *Can provide and opportunity to offer technical support*: Grants from government can be offered with technical assistance. The donor body could offer seminars, workshops, or on-site consultation to the energy research outfit to help them in growing their organizational or programmatic capacity. The training could be beneficial to strengthening the research organization's service delivery ability; they track outcomes or monitor their own program participants' results and progress apart from increasing their technological capacity[876]. This could be done through the CEMIEs
- *Development of networks*: Research bodies/individuals receiving grants from the government have shown to engage in networking with broader resources and potential partners. Sometimes the donor may bring together all the participants receiving a particular grant; as the grantees' network of contacts broadens so too, do their awareness and exposure to resource sharing opportunities and potential additional funding[877].
- *Facilitates inclusion:* Research beneficiaries of government grants are exposed to the ability to have an influence on public policy; stakeholders within the government may view the research grantees as belonging to the table and may express more willingness to receive input from the energy research team[878].

**Cons**

- *No incentives for performance*: Since grants are not performance based, developers are not compelled to show incentive for design and development of efficient systems that would adequately perform over the long term[879].

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874 UNEP - Climate Change - Mitigation - Renewable Energy. Available at: http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx

875 Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071

876 UNEP - Climate Change - Mitigation - Renewable Energy. Available at: http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx

877 Mitchell, C., & Connor, P. (2004). Renewable energy policy in the UK 1990–2003. *Energy Policy*, *32*(17), 1935–1947. http://doi.org/10.1016/j.enpol.2004.03.016

878 Kitzing, L., Mitchell, C., & Morthorst, P. E. (2012). Renewable energy policies in Europe: Converging or diverging? *Energy Policy*, *51*, 192–201. http://doi.org/10.1016/j.enpol.2012.08.064

879Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

- *Transparency issues*: There is high probability of gaming to result by grantees, that is, a situation where developers or vendors inflate equipment prices artificially to maximize their incentive levels[880].
- *Administrative burden-* Participating in projects that have received donor money inevitability often involves a lot of paperwork, meticulous record keeping and cumbersome writing of reports. Research leaders ought to realize that the administrative needs will require a lot of energy and time from the team[881].
- *Recall of private funds*: Receipt of grants could lead to the withdrawal of funding from other quarters. Take a situation where the enemy R&D team receives a grant of $100,000 from a source such as government. It is possible that some donors would feel that their $100 donation per month no longer needed by the research and development cause and thus opt out[882].

R&D and Demonstration Grants

**Pros**

* These types of grants share the Pros of Academic R&D Funding described immediately before. Beyond these, R&D Demonstration Grants:

- *Could be designed to be more economically efficient*: Even though financial needs are usually satisfied upfront, such a program could be structured to tie disbursements with different demonstration stages, which could promote incentives for successful projects[883].

**Cons**

* Beyond those shared with Academic R&D Funding, if a "performance based" design is to be pursued:

- *It would provide no upfront support*: under this configuration they will be based on system performance and as such they won't help curb upfront cost barriers for clean energy systems[884].
- *Cumbersome system tracking*: In this configuration demonstration grants would require some type of metric to measure agreed milestones in regard to system performance. This may be cumbersome and lengthy[885].

Incubation Support

**Pros**

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[880] Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
[881] UNEP - Climate Change - Mitigation - Renewable Energy. Available at: http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx
[882] Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071
[883] Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf
[884] Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy*, *21*(1), 88–110. http://doi.org/10.1093/oxrep/gri005
[885] Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

- *Investment risk diversification-* The different energy research and development startups that could benefit from incubation support are a way for the grantor to diversify their investment risk by having the possibility of directing resources for a particular breakthrough to different startups[886].
- *Encourage wide participation*: Incubator programs are normally open to the general public and energy professional peers alike so long as the participants possess the potential to spur research and development of projects in the energy sector[887].
- *Technical support*: Incubation support is usually tied with technical assistance, typical incubator support systems have dedicated a team for the R&D incubates to gain wider understanding of the enterprise. Practitioner mentors contribute in sharing their experiences to surpass familiar barriers[888]. An alternative approach to provide this assistance could be envisioned through the CEMIEs
- *Development of networks*: seeking partnership and coordination networks of research and development incubators (like with the U.S. Sun Shot Incubator Program) could contribute significantly to ensure coordination of policy and transfer of knowledge among regions[889].

**Cons**

- *Rigidity*: Incubator programs are commonly cited as possessing rigidly institutionalized DNA, that is, having strict rules that do not allow for a more disruptive innovation approach[890].
- *Negotiation challenges*: Negotiating for ownership of equity can be complicated for all parties involved if this topic is not addressed in the design of the program. Grantors could soon realize that an inspiring clean energy research vision, which was all along a startup, could eventually be a hotly contested negotiation[891]. For the startups, they could soon find out that they have to give up more equity than they would have advocated for especially if the research and development efforts yield fruition. Sophisticated deal making could strain both sides' relationship and perception of the other[892].
- *Unidirectional research mindset*: Incubator programs are usually only interested in pursuing a specific clean energy trend and thus could prove to be not sustainable if breakthroughs in other technologies develop, which deem the latter more relevant; this could potentially derive in waste of research and development time and resources[893].

Establishment of Public Research Centers

886 Assmann, D. (2012). *Renewable Energy: A Global Review of Technologies, Policies, and Markets*. Routledge.

887 Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.

888 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

889 Johnstone, N., Haščič, I., & Popp, D. (2009). Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts. *Environmental and Resource Economics*, *45*(1), 133–155. http://doi.org/10.1007/s10640-009-9309-1

890 Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.

891 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

892 Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.

893 Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy*, *35*(3), 1844–1857. http://doi.org/10.1016/j.enpol.2006.06.005

**Pros**

- *Talent acquisition to propagate development*: Public research centers promote recruitment and retention. The centers accord new recruits a ready-made customized affinity group comprised of a community of researchers and professionals interested in the same agenda of clean energy, this environments offer job satisfaction and challenge for the professionals and increase their likelihood of retaining them in the public research centers[894].
- *Leverages collaboration*: The centers facilitate effective collaboration in energy research and the exchange of ideas in manners that differ from informal networking. The mechanisms allow researchers and industry professionals to meet, discuss similar interests and develop research and development ideas outside their conventional approaches and methodologies[895].
- *Wide participation*: Public research centers provide research members a ready group of colleagues from different affiliations with similar interests creating a sense of creativity and intellectual excitement, which encourages the development of new perspectives[896].
- *Effective and flexible*: They embrace organizational flexibility. In fast paced and competitive clean energy research environments, the research centers are nimble and react with good speed to new and fresh opportunities. They provide flexibility when responding to new prospects of clean energy proposals. Research centers are also flexible in their relative ease of creation without lengthy vetting processes with multiple review and approval levels[897].
- *Long-term continuity*: Institutions of this nature benefit from financial rewards that stem from patents and licenses that are a result of clean energy research commercialization[898]. This ensures resources are available for continuity of research efforts.

**Cons**

- *Administration difficulties*: Ownership disputes could arise between institutions that house public research centers and stakeholders that fund the research efforts. It could be a conflict of interest for the institutions, on one hand, their very mandate is to approach research without generally considering their initial commercial agenda, to share findings with scholarly peers for examination and validation, and to train a future generation of researchers, on the other hand, stakeholders that fund research often stipulate that the research centers cannot disclose data and research materials with academic peers nor can they be public as they could be proprietary information[899].
- *Rigidity*: Public research centers funded by external stakeholders could pose the opportunity for them to dictate specific topics and direction that the host

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[894] Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071
[895] Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
[896] Mitchell, C., & Connor, P. (2004). Renewable energy policy in the UK 1990–2003. *Energy Policy*, *32*(17), 1935–1947. http://doi.org/10.1016/j.enpol.2004.03.016
[897] Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071

[898] Assmann, D. (2012). *Renewable Energy: A Global Review of Technologies, Policies, and Markets*. Routledge.
[899] Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

institutions have to adhere strictly to[900]. This could present a problem, as researchers require the intellectual freedom to pursue various and different lines of inquiry. This could result in neglecting important issues (i.e. social impacts), if resources and funds are aimed only at specific activities to increase income through technology development[901].

Public-Private Research Partnerships

**Pros**

- *Reduced administration costs*: Private partnership with government entities avoids redundant costs of administration, which would occur if multiple entities run their own programs. Efficiencies achieved in functions such as data tracking systems maintenance and development; staff involved in administration and overhead; evaluation and monitoring of functions[902].
- *Leverages private capital*: Government involvement in renewable energy research and development alongside private financing has helped to assure long-term financing options[903].
- *Reduces investor risk*: Public-private research partnerships provide evaluation of collateral particularly on the government side of the partnership. Support for the project by the government lessens the risks and promotes renewable energy financial strength[904].
- *Government inclusion promotes social benefit research agenda*: Government administration functions in the partnership remove or reduce the potential for conflict of interest typical of energy program administration. The government's ultimate purpose (at least in theory) is the interest of the public as opposed to shareholder profit and thus, it can focus the research agenda on achieving societal benefits minus the influence of countervailing forces[905].

**Cons**

- *Project delays and lag times*: The government could get challenged in their ability to contract or hire rapidly as compared to entirely privately managed entities and as such, the partnerships could have a direct effect on the duration needed for project ramp-up, if this issue is not addressed[906].

[900] Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. *Renewable Energy*, *24*(1), 73–89. http://doi.org/10.1016/S0960-1481(00)00186-5
[901] Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. *Renewable Energy*, *24*(1), 73–89. http://doi.org/10.1016/S0960-1481(00)00186-5

[902] Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.
[903] Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy*, *35*(3), 1844–1857. http://doi.org/10.1016/j.enpol.2006.06.005
[904] Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.
[905] Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy*, *35*(3), 1844–1857. http://doi.org/10.1016/j.enpol.2006.06.005
[906] Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.

- *Talent acquisition challenges*: It may be harder to attract the most qualified talent to work for research in public-private partnerships, which normally remunerate less than entirely large private energy research firms[907].
- *Rigidity*: Government agencies usually lack the flexibility and speed to alter program strategy and goals with changing energy market climates, more so for market transformation programs. Typically, research and development efforts that involve the government are prone to higher bureaucracy levels and restrictions to operations than other models[908].

R&D Prizes

**Pros**

- *Foster innovations in renewable energy development*: Prizes encourage and foster innovation in pursuit of clean energy solutions. Sponsors present the particular challenges and terms to ensure success and contestants assume the risks and costs while finding solutions under relative freedom. Prize contests present an opportunity for anyone to succeed, catching a large pool of innovators[909].
- *Wide participation*: Prizes present opportunities for diverse entrants to participate. It is paramount particularly for tackling clean energy problems since it is not possible to predict fairly who will churn the best ideas or what combination of skills and knowledge will best find the appropriate solutions. Research has proven that sometimes the winners of challenges do not necessarily come from the field of expertise of the problem. It shows that there is an underscoring link between a wider range of outcomes and diverse participants[910].
- *Spur wide research approaches*: Conventional research and development teams are fashioned to meet predefined small goals of a research project and traditional methods of solving problems. Attempts to burst the organizational bubbles are often limiting and create design and governance problems. In contrast, competitions attract different types of groups pursuing an array of various goals with different approaches[911].

**Cons**

- *Lengthy and costly administrative processes*: Adjudication of prize contests can be a drawn out and costly process to determine which of the solutions is ideal from hundreds even thousands of entries. Evaluating innovative renewable energy processes is not only daunting but also challenging and more expensive[912].
- *Control challenges*: Prize competitions present control challenges. Any idea under crowdsourced or open source innovation cedes a significant amount of control to the competition entrants. The conventional precepts of project management that

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[907] Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. *Renewable Energy*, *24*(1), 73–89. http://doi.org/10.1016/S0960-1481(00)00186-5

[908] Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071

[909] Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy*, *35*(3), 1844–1857. http://doi.org/10.1016/j.enpol.2006.06.005

[910] Wiser, R., Bollinger, M., Barbose, G., Belyeu, K., Hand, M., Heimiller, D., …Subin, Z. (2008). Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2006. *Lawrence Berkeley National Laboratory*. Retrieved from http://escholarship.org/uc/item/8gw154pn

[911] Pahl, G. (2012). *Power from the People: How to Organize, Finance, and Launch Local Energy Projects*. Chelsea Green Publishing.

[912] Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy*, *35*(3), 1844–1857. http://doi.org/10.1016/j.enpol.2006.06.005

are centralized and review of milestones apply differently. It makes the risk factors out of the stakeholder's control[913].

Research and Development Public Financing

**Pros**

- *Provides upfront capital*: Public financing avails much needed funds to renewable energy research projects; they thus diminish requirements on financing from private parties that tend to be reluctant to support renewable energy research projects[914].
- *Equity of opportunity*: Public financing is independent of levels of income and other selection criteria applicable to other funding mechanisms by private parties[915].
- *Facilitates program evaluation*: Projects can be evaluated at the end of specified reporting period. The projects can give reports on how they have spent the funds, corresponding research results[916].
- *Adjustable*: Based on market conditions, public funding can be adjusted from a program cycle to the next. They can as well be customized to offer preferential and differential support to varied applications[917].
- *Leverages private capital*: Governments use limited public financing at their disposal to catalyze and leverage private capital. By doing it the state can raise their capability of lending and scope to fund clean energy research and development[918].

**Cons**

- *Could be economically inefficient:* It is difficult to set funding levels that are efficient economically to prevent under- and over subsidization, and to avail only the incentive level needed to make renewable energy research projects viable[919].
- *Unsuited for basic research support:* public financing is most suited to technologies that are soon to be market-ready and not for early stage or nonstandard innovations[920].

In order to maximize efficiency, strong links between a Country's energy R&D strategy, and other relevant policy areas (particularly demand-pull policy efforts) should be pursued[921]. A successful energy R&D policy must apply an interdisciplinary approach to bring together related policies, clarity of a coherent energy policy and articulation[922]. In an ideal scenario, a government coordinates an R&D strategy among its various agencies, and perhaps even in close consultation with the major stakeholders of both the public and the

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913 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

914 Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

915 Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071

916 Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.

917 Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

918 Pahl, G. (2012). *Power from the People: How to Organize, Finance, and Launch Local Energy Projects*. Chelsea Green Publishing.

919 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

920 Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1–10.

921 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

922 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

private sectors[923]. Which areas receive funding, how much, and through which policy measures is to be determined through analytically structured processes relying on available data, there is no "magic recipe" for clean energy innovation policy, the Federal Government must weight the pros and cons of the different policies, examine their resource availability, and analyze feasibility considerations, this, in order to develop an agenda focused at addressing "Basic Science R&D", "Applied R&D" and "Demonstration" advised by the best design practices previously identified.

Nevertheless, considering the information advanced throughout this exhaustive study, it is the view of this author that an efficient "supply-push" policy agenda aimed at spanning the innovation chain at the lowest cost, would be one that focuses at the implementation of the next policies.

*Establishment of Public Research Centers*

This policy has been chosen, as it has the potential to be designed to address the three main stages of the innovation chain that are to be covered by "supply-push" policy: "Basic Science R&D", "Applied R&D" and "Demonstration". This, providing that the three categories are covered through CONACYT's call for proposals, which should ensure that the selected proposals contain relevant research projects focused at these three different categories, by requiring this through its respective "terms of reference" as a condition for approval[924]. Moreover, Public Research Centers can support academic R&D efforts, provided that there are requisites in place to incorporate Universities in the governing body of these Research Centers, or to advance a detailed plan to engage the academia to participate in the different research projects undertaken by the Centers[925]. Furthermore, incorporating a private component to the terms of reference, by establishing that there are to be private parties within these Centers, which commercial activities are relevant to the clean energy field (broadly defined: technology, generation, installation, etc…) could provide an opportunity to reap the benefits of "public-private research partnerships" as well.

Nevertheless, it is important to note that the previously described "Cons" of this policy should be addressed to further improve the efficiency of this policy. Ownership disputes of intellectual property should be preempted by incorporating a mechanism of assignation of these rights through the contract that is to be signed between CONACYT and those consortiums that are to be selected as Public Research Centers. An option to do this would be providing that all the technological breakthroughs that are reached by efforts conducted under this policy should be shared in equal parts between each of the institutions that are housed in these Centers, and the individual or team that developed the breakthrough.

Pertaining to rigidity, providing for mechanisms to allow for the analysis and consent of research proposals that deviate from original approved plans by the evaluation committee of the CONACYT/SENER Sustainability Fund, should be explored to promote researcher's freedom of creation.

[923] International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[924] This would be judged through the "Merit Review System"
[925] These plans should be deemed viable before approval through the review system.

*R&D Prizes*

This policy has been chosen given that through it, a significant amount of participants from broad backgrounds come together with their own resources and planning to undertake applied R&D activities towards achieving demonstration of key technologies as determined by the contest design. This policy complements the Establishment of Research Centers policy, which tend to follow a stricter research agenda. This, as it promotes diverse research approaches focused at achieving a single breakthrough efficiently, given that the costs of the actual research are borne by contest participants. The costs for the CONACYT/SENER Sustainability Fund, will be limited to the administration of the program and setting the prize sum, which, as has been analyzed before, can come from sponsors that have a vested interested in the research, or those that want to be publicly associated with the cause.

Regarding the issue of the administrative burden of prize adjudication associated to this policy, providing for eliminatory rounds to condition advancement to further stages based on performance could be useful to reduce the pool of contestants that are to participate in the actual prize adjudication process. In terms of control challenges, developing specific criteria that is to be met by the technological products of participants, can promote control by constraining the end technology to meet certain desirable characteristics while still allowing flexibility on the teams' approach towards achieving them.

*Research and Development Public Finance*

This policy has been chosen as it addresses the issue of lack of confidence by commercial banks on clean energy research and development investments. Establishing a private avenue for this type of investments can help to ease the government's clean energy R&D support load once commercial banks get comfortable with them through the trial provided by this policy, and hence it helps to create a market that can operate even if government support expires in the future. Moreover, given that there is a possibility for repayment embedded in such a mechanism, it is a policy that may have the potential to generate returns, which can deem this policy, in the most positive of scenarios, an actual source of income for the Fund. Nevertheless, even in non-optimal scenarios, having some opportunity for repayment raises the possibility of spurring research at low costs, or at least lower costs than any kind of research grants, which pose no opportunity for repayment.

## 7. Policy Design Considerations in Light of Other Country Examples - "Demand-Pull"

As explained through Chapter 3, catalyzing technology deployment is fundamental in the path towards energy transition. This, in order to foster innovation and technical change by addressing market factors and facilitating learning-by-doing[926] which can ultimately result in price reduction and technological diffusion[927].

Governments have an important role in this regard: engaging the market through strategic deployment policies with the potential of removing the barriers that new energy technologies face, due to the way current markets have become structured to suit

926 The learning curve effect previously described based in the premise that prices decrease with every increase in technology deployment.
927 Dosi, G. (1988). Sources, Procedures, and Microeconomic Effects of Innovation. Journal of Economic Literature 26(3), 1120-1171.

incumbent technologies that do not bear their full external costs[928]. In order to be efficient in the approach taken towards this purpose, policy makers must allow for a coherent strategy when making choices, one that promotes creating markets, providing finance, developing infrastructure, and establishing a welcoming regulatory environment for clean energy technologies[929]. Each one of the "demand-pull" policies deemed feasible in Mexico through chapter 5, are indeed focused at attaining one or more of these four key goals, however, whether these policies are successful in achieving them or not, will depend on the specifics of their design.

Hence, this Chapter will focus on analyzing the implementation examples from other Countries that have undertaken similar "demand-pull" policy efforts to the ones chosen as feasible for Mexico, in a "successful"[930] manner. Drawing conclusions about proper policy design, while disclosing the differences and similarities that these Countries might have with Mexico in regards to factors that might affect the outcomes of policy implementation[931].

The approach towards selecting the design characteristics to be analyzed throughout this section differs from the one undertaken in the previous Chapter. This, given that as opposed to R&D policies which share a common framework[932], "demand-pull" policies vary greatly in their design characteristics depending on if they are quantity, price, quality, finance, or access driven policies[933]. As such, the aspects that will be highlighted as "key" for policy goal attainment during this study will be advanced within each policy discussion, in light of those characteristics that have found to be fundamental in their design by extensive research efforts from reputable institutions.

It is worth noting that as there is no such thing as "perfect policy-making", it is likely that there will be policy examples that do not address all of the advanced "good practices", but still achieve successful results. These situations shall be treated as opportunities to further include these practices in the Mexican versions of these policies, with the goal of furthering results even beyond those showcased through the different examples.

### 7.1. Accelerated Depreciation

Accelerated Depreciation is a financial incentive, and hence it is aimed at providing provide some form of monetary benefit to support deployment of clean energy technologies. It does this by quickening renewable energy fixed asset depreciation and thus,

928 Michael Grubb (2004). Technology Innovation and Climate Change Policy: an overview of issues and options. Keio Journal of Economics.

929 International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

930 Examples will be selected following successful implementation criteria, which will be showcased within the scope of each individual example with respect to the specific results that these policies have achieved.

931 Just as with the previous Chapter, the choice of examples that are analyzed through this section might seem biased based on the fact that they are selected out of efforts conducted by developed countries – Mainly the U.S. Nevertheless, it is worth noting that an important factor when selecting case studies undoubtedly was information availability, as the purpose of this analysis is to shed light on different approaches that can be used when developing successful "demand-pull" policy in light of the characteristics that have been deemed fundamental by extensive research efforts, which can only be done if information about those aspects is available (after a thorough research effort, this author has realized that it is rare to find developing Countries fully providing information regarding the specific details of their clean energy policies) . Moreover, it is important to keep in mind that the purpose of the study is not to frantically search for Countries that can be deemed very much similar to Mexico (which is always a relative categorization), undertaking those policies that have been chosen as feasible for this Country, but rather to find mature examples of strong policy making that has reaped successful results; this, in order to be able to provide policy design lessons for Mexico.

932 International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf

933 Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Available at: http://srren.ipcc-wg3.de/

through reducing taxable income, deferring tax liability in the early stages of renewable energy project development[934].

The National Renewable Energy Laboratory, has conducted a thorough study that provides a primer on key financial incentive design elements, by analyzing the lessons from different Country experiences, and curating support resources for more detailed and country-specific information on financial incentive design. The key financial incentive design elements applicable to accelerated depreciation mechanisms are[935]:

- Engagement of the private sector to add value to or address gaps and barriers associated with private investment
- Support market certainty by sending long-term policy signals.
- Expand outreach and easy access to the incentive.
- Monitor and evaluate benefits and costs to improve financial incentives over time.

The United States Tax Code's current depreciation system "MACRS" stands for Modified Accelerated Cost Recovery System and is considered essential in driving private investment to the sector of renewable energy technology[936]. This depreciation system provides an advantage, given that it reduces the present value of corporate income tax liabilities for renewable projects, "enabling developers to place more renewable projects in service, and for those projects to provide renewable energy at lower cost to consumers"[937].

Furthering these efforts, US Congress enacted legislation providing for "bonus depreciation," which in turn, enables business taxpayers to write-off the cost of acquiring certain assets more rapidly than MACRS would ordinarily permit. As an example, the bonus depreciation provision that President George W. Bush signed into law in 2002 has allowed taxpayers to immediately deduct 30% of the cost of new assets acquired during the provision's applicability; and the remaining 70% would be deducted under otherwise applicable MACRS rules[938]. Further, the Economic Stimulus Act of 2008[939], signed by President Bush, as well as the American Recovery and Reinvestment Act of 2009[940], signed by President Obama, have instituted a 50% bonus depreciation allowance. Later, the Tax Relief, Unemployment Compensation Reauthorization and Job Creation Act of 2010 had pushed for the allowance to reach 100% – such that the asset would be fully depreciated in the year of acquisition[941].

Since its inception in 1986, MACRS has assigned a five-year "useful life" attribute to most renewable energy property – including solar, wind, geothermal, combined heat and power (CHP), fuel cell and micro turbine property, as well as renewable energy generation property that is part of a "small electric power facility" and certain biomass property[942]. This property has been subject to the "200% declining balance" recovery method, which constitutes of a provision for the greatest depreciation allowance in the first full year of use,

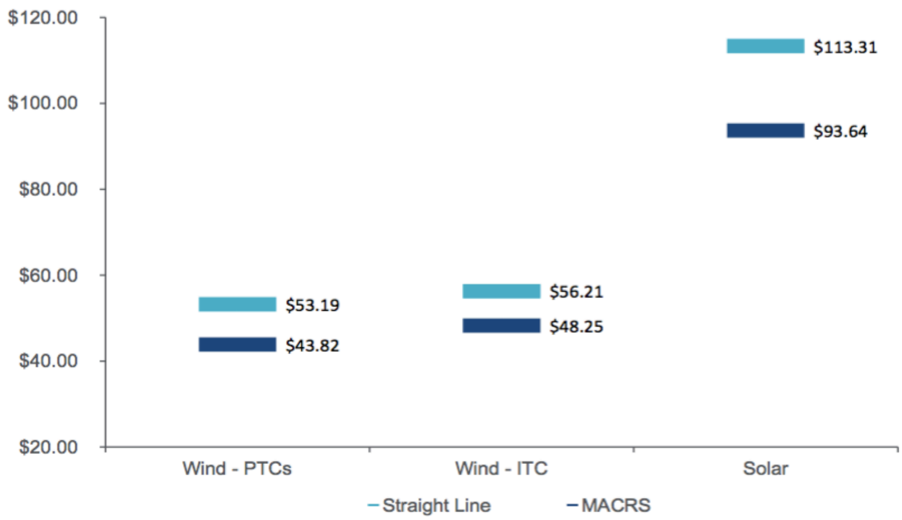
934 Sadie Cox (2016). Financial Incentives to Enable Clean Energy Deployment. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65541.pdf
935 Sadie Cox (2016). Financial Incentives to Enable Clean Energy Deployment. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65541.pdf
936 U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf
937 U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf
938 Job Creation and Worker Assistance Act of 2002, Pub. L. 107-147.
939 U.S. Congress: P.L. (Public Law) 110–185.
940 U.S. Congress: P.L. (Public Law) 111-5.
941 U.S. Congress: P.L. (Public Law) 111–312.
942 U.S. Congress: P.L. (Public Law) 99-514. The Emergency Economic Stabilization Act of 2008 shortened the deprecation recovery period for smart meter and smart electric grid systems to 10 years. P.L. 110-343.

declining over time[943]. The table below demonstrates the application of these rules, showing for both; without any bonus depreciation, and when there is 50% bonus depreciation (the amounts shown are the percentages allowed for depreciation of the asset per year by MACRS and MACRS + Bonus respectively).

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|---|---|---|---|---|---|
| MACRS | 20.00 | 32.00 | 19.20 | 11.52 | 11.52 | 5.76 |
| MACRS + 50% bonus depreciation | 60.00 | 16.00 | 9.60 | 5.76 | 5.76 | 2.88 |

[944]

There are diverse projections of how through its implementation, MACRS, has allowed return requirements for investment to be met in the U.S., which has further incentivized deployment of projects that would have otherwise been deemed uneconomic. The amount that a project undertaken today would need to increase its revenue in the future in order to satisfy return requirements, can be used for comparing the impact of MACRS with standard straight-line depreciation. Such a representation discloses how the reality of switching from MACRS to straight-line depreciation would affect projects, and require increased revenue by about a fifth (16.5-21.4%), in order to satisfy return requirements in the US. This revenue would likely mean that investments would not be made, or that the added revenue requirement would have to come from a corresponding increase in prices that would be charged directly to electricity consumers[945]. The pricing impact is illustrated by the figure below.

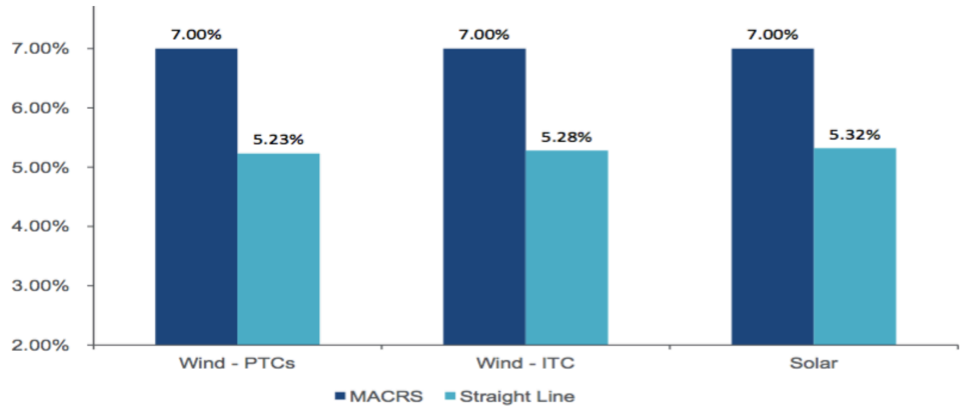



In terms of *Engaging the Private Sector* by removing barriers for investment, MACRS' acceleration of depreciation deductions allows for a shorter time period in which the capital expenses can be recovered[946]. In an investment climate cold with uncertainty, where market demand and the costs of production do change quickly, this faster return of capital has the reputation of lowered risk premium in the US, thus reducing the returns required to make a

943 I.R.C. § 168(e)(3)(B)(vi); see also Molly F. Sherlock, Energy Tax Policy: Historical Perspectives and Current Status of Energy Tax Expenditures, Congressional Research Service, May 7, 2010.
944 U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf
945 U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf
946 U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf

new investment infinitely attractive[947].

A model of typical renewable generation assets prepared by the U.S. Partnership for Renewable Energy Finance which analyzes typical renewable generation assets, found that replacing MACRS with the "standard" economic depreciation in the U.S.[948] would reduce the returns on new projects by around 25%[949]; provided the possibility of holding all other factors constant, replacing MACRS with straight-line[950] depreciation would drive down significantly - by about one-fourth, the returns on a project currently yielding 7%, to around 5.25%[951]. This impact is graphically illustrated in the figure below.




As we analyzed in chapter 5, the "Income Tax Law" in Mexico currently allows for the accelerated depreciation of renewable energy generation systems of up to a 100% of the purchase costs in the tax year that they are acquired[952], this, providing that these systems are set to operate for at least 5 years[953]. As such, this policy is even more ambitious that the one instrumented in the US towards renewables given that it allows the depreciation of 100% in the first year in which the assets where purchased, as opposed to the different percentages spread through the 5 year period, which the US MACRS + Bonus system provides. Following the rationale from the MACRS study, the Mexican accelerated depreciation system as it stands, can help remove barriers for investment by allowing for a shorter time period in which the capital expenses can be recovered; and, it can add value to private sector investments by increasing returns in new projects.

With regards to *Long-Term Policy Signals*, as explained before, since its inception in 1986, renewable energy property has been steadily subject to the "200% declining balance recovery method from MACRS, which constitutes of a provision for the greatest depreciation allowance in the first full year of use, declining over time[954]. Bonus

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947 U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf

948 The same as "straight-line" depreciation, which is explained below.

949 This model presumes that a 7% internal rate of return is required for an investor to provide capital for a project.

950 Under the "straight line" method of depreciation, each full accounting year will be allocated the same amount or percentage of an asset's cost. (The total amount of depreciation over the years of the asset's useful life will be the asset's cost minus any expected or assumed salvage value). Example: let's assume that a certain company purchases equipment at a cost of $430,000 and it is expected to be used in the business for 10 years. At the end of the 10 years, the company expects to receive a salvage value of $30,000. Under the straight line method each *full* accounting year will be allocated $40,000 of depreciation, which is one-tenth (1/10) or 10% of the $400,000 that needs to be depreciated over the useful life of the equipment. If the asset is purchased in the middle of the accounting year there will be $20,000 of depreciation in the first and the eleventh accounting year and $40,000 in each of the years 2 through 10.

951 This financial model examined three scenarios: a wind project that elects the Section 45 production tax credit (PTC); a wind project that elects the Section 48 investment tax credit (ITC); and a solar project that qualifies for the ITC.

952 Article 34 of the Federal Income Tax Law, (Ley del Impuesto Sobre la Renta).

953 In case these systems operate for a shorter period of time, then the taxpayer would have to readjust and pay according to the normal depreciation schedule provided in the law.

954 I.R.C. § 168(e)(3)(B)(vi); see also Molly F. Sherlock, Energy Tax Policy: Historical Perspectives and Current Status of Energy Tax Expenditures, Congressional Research Service, May 7, 2010.

depreciation has provided an added long-term benefit for taxpayers every year since September 11, 2001 (with the exception of a three-year hiatus for the tax periods from 2005 through 2007), and is now set to be a benefit for taxpayers from 2015 through 2019, although there is a gradual phase-down programed in terms of the bonus[955]:

- As of January 1, 2015 through December 31, 2017: 50%
- As of January 1, 2018 through December 31, 2018: 40%
- As of January 1, 2019 through December 31, 2019: 30%

Its Mexican equivalent, although more aggressive (100% the first year), it is programed to be available only until the end of 2017[956], through the advancement of the "Economic Packet" of 2016[957], which can potentially negate the benefits derived from it. This goes against what has been described as the *Long-Term Policy Signal* component of financial policy "good practice", hence considering extending its application should be explored. Nevertheless, it is worth noting that if the latter is to be pursued, it will require undertaking a legislative process.

Pertaining to *Expanding Outreach and Easy Access*. In many cases, there is a need to educate and build market awareness of the benefits of renewable energy and energy efficiency technologies and on the specific financial incentive offered. Ensuring that public guidance and procedures to participate in the program are available and easy to understand, can improve participation levels, which are fundamental to attain policy goals[958]. In terms of the latter, the Internal Revenue Service of the U.S. makes a comprehensive guide with all the details of the "MACRS" incentive and how to access it easily available, a simple "Google" search using the word "MACRS", has as the first result this in-depth IRS guide[959]. In Mexico, accessing this incentive seems complicated, there is no easily accessible guide provided to understand its extent or the methods of its application; being able to do so requires certain legal or accounting knowledge to be able to derive these processes from the laws and regulations. As such, the U.S. IRS example can shed light on the possibility of addressing the issue of outreach and access through the development of an easily accessible comprehensive guide. Furthermore, well-designed outreach programs and educational events targeted at the investment community can also prove to be helpful in this regard[960].

Withal, financial incentive programs should have a robust plan in place to *Monitor* energy production, costs, market uptake, and other impacts; this information can be evaluated and used to inform potential changes to the level of incentive and improvements to the incentive program overall[961]. "MACRS" has no specific method embedded in its design, the Research, Analysis and Statistics Division of the IRS is in charge of analyzing the impacts of all IRS policy[962], however their analysis are presumed to be conducted as part of their operations and they are not made public. Consultable efforts in this regard have come mostly from the academia and other research institutes that have informed

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[955] As provided by the next news article: http://www.prnewswire.com/news-releases/president-signs-new-tax-act-with-depreciation-changes-300195934.html

[956] As evidenced by the next news article: http://www.cnnexpansion.com/economia/2015/09/08/6-cambios-fiscales-que-propone-hacienda-para-2016

[957] Available at: http://www.shcp.gob.mx/ApartadosHaciendaParaTodos/ppef2016/index.html

[958] Sadie Cox (2016). Financial Incentives to Enable Clean Energy Deployment. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65541.pdf

[959] The guide can be consulted at: https://www.irs.gov/publications/p946/ch04.html

[960] Sadie Cox (2016). Financial Incentives to Enable Clean Energy Deployment. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65541.pdf

[961] Sadie Cox (2016). Financial Incentives to Enable Clean Energy Deployment. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65541.pdf

[962] Par 1, Chapter 1, Section 18 of the Organization Manuel of the Internal Revenue Service, available at: https://www.irs.gov/irm/part1/irm_01-001-018.html#d0e53

policy-making indirectly through their endeavors[963]. This is an instance in which the Mexican equivalent program could improve the design characteristics of the example we are currently analyzing, providing that a clear mechanism is put in place to *Monitor* the impacts of this depreciation policy and making them available to the public, without relying on efforts of the academia or research institutes that might or might not develop. This responsibility would most likely fall within the structure of the Ministry of Finance and Public Credit, which oversees the policies implemented by the Mexican Tax Administration Service (Servicio de Administracion Tributaria)[964].

It is worth mentioning that in Mexico, the "Servicio de Administracion Tributaria", equivalent to the IRS, is in charge of the application of the accelerated depreciation policy. These two agencies are very similar in their structure and operations[965], both are the entities in charge of Federal tax collection in their respective Countries, and they are structurally part of their respective Departments of Treasury[966]. Hence, the implementation of accelerated depreciation in both Countries can be considered homologous. Nevertheless, a key difference between Mexico and the U.S. arises in regards to the issue of corruption, which has the potential to impact the outcomes of the implementation of this policy. Bearing in mind that Mexico has been recently deemed the most corrupt Country of the OCED[967], special attention should be given towards applying depreciation rules in a transparent and equitable manner across those entitled to the incentive[968].

### 7.2. Direct Investments

Clean energy infrastructure investments often take place in a situation of imperfect competition where a state-owned enterprise (as the Federal Electricity Commission) is the incumbent. Policy-makers aiming to increase investment in clean energy infrastructure will therefore have to consider ways of creating a level playing field between independent power producers and stated-owned ones, in order to prevent crowding out private investment, while using "Direct Investments" to increase clean energy deployment[969]. Hence, when undertaking this policy, the next key elements should be considered[970][971].

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963 An example of this is the analysis conducted by the U.S. Partnership for Renewable Energy Finance, regarding MACRS. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf

964 Article 31 of the Organic Law of the Federal Public Administration (Ley Orgánica de la Administración Pública Federal).

965 For more information in this regard, see http://www.sat.gob.mx/que_sat/Paginas/default.aspx and https://www.irs.gov/uac/The-Agency,-its-Mission-and-Statutory-Authority

966 In Mexico the Ministry of Finance and Public Credit (Secretaria de Hacienda y Credito Publico)

967 As provided by the next news article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde

968 This could be promoted by incorporating a mandate to make information regarding the application of the incentive publicly available through a website. This information could include but not be limited to: which companies access it, reasons for rejection in case they take place, and specifics of the depreciated assets and their lifetime.

969 OECD (2013). Policy Guidance for Investment in Clean Energy Infraestructure. Available at: http://www.oecd.org/g20/topics/energy-environment-green-growth/CleanEnergyInfrastructure.pdf

970 Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

971 Given that this Chapter of the dissertation is focused at increasing the likelihood of success of clean energy deployment policies feasible in Mexico, this section is focused on analyzing the provisions that have been found to be key, and within the scope of Government and Congress powers, towards promoting clean energy deployment while state-owned companies are undertaking "Direct Investments" in clean energy projects, in order to prevent crowding-out private investment and maximize clean energy deployment. As explained through Chapter 2, by virtue of law, the government can not advice the company as to how to conduct its dealings, in fact, this is even discouraged by well-established research efforts that have analyzed situations in which state-owned companies interact with the private sector in the field of clean energy, as we will see through the discussion of this section. As such, the analysis contained here is not focused at how the state-owned company should undertake its investments, but at how to establish the adequate environment through law and policy for clean energy investments to thrive, in the current configuration of the Mexican electricity sector in which a state-owned electricity company is investing directly in clean energy projects. This given that the law has provided complete freedom to CFE's administration committee to conduct its dealings (constrained to private law provisions), and assigned as its main goal maximizing profits, making it likely then, that its dealing will follow those investment precepts of successful private companies (topic that is neither within the expertise of this author, nor within the scope of this work).

- Applying private sector company law to only permit the influence of the government as a shareholder.
- Legislating and contracting for new public sector governance to address the specifics of the relationship between the public sector and state-owned enterprises.
- Requiring additional public reporting of performance and policies.
- Instilling a commercial culture.
- Subjecting the utility to new pressures from lenders.
- Listing a minority of shares.
- Alleviating the government's conflict of interest as owner and policy-maker.

New Zealand is similar to Mexico in regards to the fact that both have state-owned enterprises that are to compete with private companies for the provision of the services that follow electricity generation and consumption[972]. New Zealand's case study is interesting because it represents an ambitious attempt to make state-owned electricity firms operate like privately owned firms, just as we have seen through Chapter 2, Mexico is attempting to do so with the categorization of the Federal Electricity Commission as a "National Productive Enterprise"[973]. New Zealand's major reforms in this regard date back to 1986, so enough time has passed to form an impression of their effects and whether the ambitions have been achieved, overall, it has been found that the reforms ushered in by the State-Owned Enterprises Act 1986 of the governance of generator–retailers and other state-owned businesses appear to have successfully depoliticized the management of the business[974].

Subjecting state-owned utilities only to standard *Private-Sector Company Law,* is a way of raising the cost of political interference by separating the utility from the government and only permitting its influence as a shareholder[975]. Applying private company law is useful towards insulating utilities from political interference, as it helps to ensure the utility has a legal identity separate from the government's, implying that, from a legal perspective, choices of the government are not automatically choices of the utility; gives the directors of the utility certain legal rights and duties that make political interference more difficult (for example, it may establish that directors, not shareholders, are legally responsible for managing the company); and it subject politicians and officials to new legal disciplines—for example, ministers in New Zealand are warned that company law may deem them directors and thus subject them to potential personal legal liability if they direct state-owned enterprises[976].

In New Zealand the generator–retailers are all limited-liability companies, having legal identities separate from the government's. Laws that apply to privately owned companies apply also to the state-owned generator–retailers and other state-owned enterprises, including those relating to taxation, employment conditions, the organization and operation of companies (the Companies Act 1993), and financial reporting (Financial Reporting Act 1993). Mexico complies with this key element as well, the secondary laws that followed the enactment of the reform of December 2013 transformed the Federal

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972 As has been analyzed in Chapter 2.

973 Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

974 Spicer, Barry, Robert Bowman, David Emanuel, and Alister Hunt (2001). The power to manage: restructuring the New Zealand Electricity Department as a State-Owned Enterprise—the Electricorp experience. Auckland: Oxford University Press.

975 Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

976 Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

Electricity Commission in what is referred to as a "National Productive Enterprise", this entity was granted a special regime drafted with the goal of reducing the Ministry's intervention in the Federal Electricity Commission dealings allowing it to conduct its operations focusing on maximizing its income[977]. The Federal Electricity Commission is therefore, no longer submitted to the "legality principle"[978] in which its activities as a public agency could only follow specifically what the Law of the Public Service of Electric Energy provided. Nowadays this enterprise is set to conduct its dealings following the decisions of its administration committee and private law stipulations[979].

Because general company law is not designed to deal with the special problems affecting the relationship between government and government-owned utilities, *Legislating and Contracting for New Public-Sector Governance* should be pursued, to establish additional or different rules to govern that relationship[980]. New Zealand's State-Owned Enterprise Act in 1986 was established with this purpose, it is set to regulate, among other things, the specifics of the relationship between government-owned enterprises and the government[981]. Mexico has a similar law that dates back to 1986 as well, the "Federal Law for State-Owned Enterprises" (Ley Federal de Entidades Paraestatales), this law was reformed in 2014 to incorporate the Federal Electricity Commission as a "National Productive Enterprise" to the scope of this law[982][983].

Rules requiring *Public Reporting of Information* help interested outsiders (journalists, think tanks, academics, and interested customers, taxpayers, and other citizens) to understand utility's performance and hence promote transparency, which can in turn deter corruption[984]. In New Zealand, the companies are required to prepare financial statements that comply with the Financial Reporting Act 1993, in addition, the government's audit body, the Auditor-General, has responsibility for auditing the government-owned generator–retailers' accounts, but can delegate the audit task to private audit firms[985]. The Federal Electricity Commission in Mexico is also required to prepare financial statements, which are to be made public by virtue of law[986], moreover, beyond financial statements, there is a provision in law that encourages the publication of the general operations of the Commission in a public website, however this is subject to the authorization of the General Director[987]. The Federation's Superior Audit Organ (Auditoria Superior de la Federacion) is in charge of auditing the Commission's operations[988].

There may be benefits not only in changing the formal rules applying to the utility and its relationship with the government, but in taking other steps to *Instill a Commercial*

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977 Title 1, article 4 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

978 This principle limits the operations of public agencies, which cannot do anything that is not explicitly mandated to them by virtue of law.

979 Before, this agency was obligated to follow what was specifically mandated in the law regardless of any economic or technical considerations. Nowadays this agency will only be subjected to private law stipulations, as such, it is no longer submitted to the "legality principle" meaning that now this agency can operate freely following only what its administration committee decides, as a private company, with the goal of maximizing profit. Title 1, article 3 of the Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

980 Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

981 Part 1 of New Zealand's State-Owned Enterprises Act of 1986.

982 This law was reformed in 2014 for this purpose. Reforms can be consulted within the text of the law.

983 This section speaks to the importance of actually having a legal framework for new public-sector governance. Details about the relationship between government and state-owned utilities covered through these legal provisions are addressed through the sections below, specifically, *Instilling a Commercial Culture in the utility, Public Reporting of Information, and Alleviating the Government's Conflict of Interest.*

984 Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

985 The accounts of the state-owned utilities: Genesis and Meridian for 2002 were audited by Deloitte Touche, while Mighty River Power's were audited by Ernst& Young—in each case on behalf of the Auditor-General.

986 Title 2, Article 45 Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

987 Title 4, Article 113 Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

988 Title 3, Article 56 Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

*Culture in the utility*. Appointing business people as directors help, by increasing the probability that directors will resist political interference and ensuring the top management of the company has commercial rather than political habits[989]. Consistent with this precept, Executive Directors of the three different state-owned electric companies in New Zealand have strictly a business profile, which they have developed through a long history of managerial positions in the private sector[990]. This can be a learning point for Mexico which has as the first Director of the Federal Electricity Commission as a "National Productive Enterprise", an individual that, although has strong academic and public service credentials, its background is predominantly governmental[991].

Lenders are a common source of commercial pressure on privately owned firms, and the government may be able to make use of that pressure by requiring a state- owned utility to borrow from lenders other than the government[992]. For this approach to work, of course, the lenders cannot believe that the government guarantees the utility's debt; otherwise, they will care only about the government's creditworthiness, not the utilities[993]. Thus the government cannot provide an open-ended guarantee of the utility's debt and may have to require the utility to state when borrowing that it benefits from no government guarantee that is the approach taken by New Zealand. Mexico addresses this as well through law by allowing the Commission to seek credit for the conduction of its activities, and further advancing that there will be no guarantees provided to credit holders by the Mexican State[994][995].

Minority shareholders offer another potential source of pressure. Because shareholders have a residual rather than a prior claim on the firm's assets, the value of minority shareholders' investments in the utility depends more strongly on the performance of the utility than does lenders, which in turn promotes accountability[996]. The government can retain control of the firm (and thus achieve goals of full public ownership) while selling a minority of shares[997]. It can also sell hybrid securities that are not ordinary shares, but have some of the characteristics of equity[998]. For example, if it doesn't want to give up any voting control at all, it can sell securities that give their holders the same rights to cash flows as its own ordinary shares, but to which no voting rights attach, New Zealand does this by allowing state-owned utilities to issue "equity bonds" with such characteristics[999]. Mexico also takes this approach by allowing the Commission to issue

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[989] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

[990] The profiles of the Executive Directors of these Enterprises are made available by them through their websites: http://www.mightyriver.co.nz/About-Us/Executive-Management-Team.aspx https://www.meridianenergy.co.nz/about-us/about-meridian/our-people

[991] The profile of the Director is made available by the Commission through: http://www.cfe.gob.mx/ConoceCFE/1_AcercadeCFE/Paginas/Semblanza-del-Director-General.aspx

[992] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

[993] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

[994] Title 4, Article 109 Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).

[995] In regards to how credible the legal promise that the Mexican government won't bail out the electricity company is, it is true that in the US, despite such promises, the government has bailed out major home finance companies that were quasi-public entities in the past. Nevertheless, in Mexico, given that this mandate is contained in law, if the government wants to bail out the electricity company it would have to undertake a legislative process to modify this law. In case there are advances towards bailing out the company without modifying the law, those government officials that participate in the bail-out can be subject to a "political trial" from Congress for disregarding Federal Law according to Article 110 of the Mexican Constitution, and Article 7 of the Federal Law for the Responsibility of Public Servants (Ley Federal de Responsabilidad de los Servidores Publicos).

[996] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

[997] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

[998] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf

[999] Part 2, Article 12 of New Zealand's State-Owned Enterprises Act of 1986.

bonds that provide no control rights over the operations of the Commission to their holders[1000][1001].

*Alleviating the Government's Conflict of Interest* as owner and policy-maker should be pursued[1002]. This can be done by changing which minister or ministers in the government are, legally, the shareholders and making them different from the minister or ministers with responsibility for other aspects of electricity policy; or creating and using independent utility-regulatory and competition-policy agencies to make and enforce rules biased in favor of competition[1003]. New Zealand takes the first approach towards this; in this Country the central government owns all the shares of the generator–retailers, when the major reform of policy toward state-owned enterprises was ushered in by the State-Owned Enterprises Act 1986, companies were legally required to have at least two shareholders and, accordingly, two ministers (the Minister for State-Owned Enterprises and the Minister of Finance) each hold half the government's shares in the generator–retailers state-owned electricity enterprises[1004]. Mexico on the other hand, takes the latter approach towards this goal, legally, the Federal Government is the shareholder of the Commission, however there is no allocation towards a specific Ministry or agency, nevertheless, there are two independent agencies in place (the Energy Regulatory Commission and the Federal Competition Commission) which are responsible of ensuring that potential conflicts of interest in this regard are abated[1005].

After this analysis, it is clear that Mexico's approach towards "Direct Investment" is, for the most part, in line with all the key provisions discussed in this section, other than the one that calls for non-government profile Directors. However, whether these provisions adequately transcend to practice is yet to be seen as the new framework has just started to operate.

### 7.3. Shared-Risk Financing

It has been explained, that due to the limited experience, the early stage development of the relevant markets, and the risk-aversion of the players in developing countries, mechanisms that reduce risks of private investors should be developed. This is a task for the public sector, which by sharing credit risk can mobilize domestic lending. Providing for shared loans and guarantees[1006] help banks to gain experience with the management of portfolios of renewable energy loans putting them in a better position to evaluate true project risks, addressing with this the perceptions of elevated risk associated with renewable energy projects, and facilitating commercial investment flow to the

[1000] Title 4, Article 109 Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
[1001] These types of shares beg the question: What shareholders will buy stocks without voting rights? However, companies that give no control rights over operations are more common than one would think. The New York Stock Exchange goes so far as to define such companies in filings using the term "controlled company". Nevertheless, given that holding shares in these companies could be very lucrative (in some cases), having no control over operations might not be a deterrent for its purchase. Some notable examples of "controlled companies" in the U.S. are: Google, Hershey, New York Times, the Blackstone Group, and American International Group. John C. OGG (2012). Companies Where Shareholders Have no Power- At All. Available at: http://247wallst.com/investing/2012/06/04/companies-where-shareholders-have-no-power-at-all/
[1002] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf
[1003] Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf
[1004] Brumby, Jim, Michael Hyndman, and Stuart Shepherd (1998). "State Owned Enterprise Governance: Focus on Economic Efficiency" in Corporate Governance, State-Owned Enterprises and Privatization. OECD Proceedings.
[1005] As provided by Title 1, Article 12 of the Federal Law for Economic Competition (Ley Federal de Competencia Economica); and, Chapter 1 Article 2 of the Law of the Energy Regulatory Commission (Ley de la Comision Reguladora de Energia)
[1006] Guarantees to a private lender that if the company defaults on a loan related to the project, the government will step in to repay the outstanding balance.

renewable energy sector[1007]. The next elements are deemed fundamental when developing a shared-risk financing scheme[1008]:

- Providing for program flexibility.
- Establishing low interest rates.
- Devising a simplified, high quality application process.
- Setting monitoring and evaluation mechanisms.
- Engaging in program marketing.

In Germany, the current activities of its development bank, KfW, are tied with the political priorities of its two shareholders: the German Federal Government and the German States (Länders)[1009]. Set out by the Law on Kreditanstalt für Wiederaufbau (KfW-Law, Gesetz über die Kreditanstalt für Wiederaufbau), KfW holds the mandate of promoting and financing measures in the areas of: small as well as medium sized companies (SMEs), start-ups, risk capital, housing, infrastructure, social measures and education, environmental protection, innovation, financing of municipalities and development co-operation in specific areas of Project and Export Finance[1010].

KfW is especially active in a number of areas related to climate change, through economic facilitation. KfW provides intermediated lending for energy efficiency and renewable energy programs; the numerous KfW's investment activities in low-carbon projects occur principally through facilitating access to capital offering subsidized concessional loans by "on-lending"[1011] through local finance institutions[1012].

KfW has been promoting renewable energy and energy efficiency through renewable energy programs for more than 20 years[1013]. Throughout this time, this bank has demonstrated a proven ability to leverage private financing through the programs it has developed. As an example, through lending for energy efficiency projects in the German Housing Sector in 2011, KfW made EUR 6.5 billion in commitments, while leading close to EUR 18.4 billion of total investments across 282 thousand housing units; this was done at a cost to the Federal Budget of EUR 934 million –representing a leverage effect of almost twenty-fold (20 private euros spent for 1 euro of public funds)[1014].

The German KfW example sheds light on the value of using a national development bank to promote clean energies through loans in collaboration with local financial institutions[1015]. Such a program can be replicated in Mexico through KfW's homologous entity: BANOBRAS. This Mexican development bank has been collaborating

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1007 KfW Entwicklungsbank (KfW Development Bank) 2005. Financing Renewable Energy: Instruments, Strategies, Practice Approaches. Available at: https://www.kfw-entwicklungsbank.de/Download-Center/PDF-Dokumente-Diskussionsbeitr%C3%A4ge/38_AMD_E.pdf

1008 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1009 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1010 Art. 2. Paragraph 1. KfW-Law – "Promotional Business"

1011 KfW in Germany does not lend directly to enterprises or individuals, but rather lends through local commercial banks (the "on-lending banks"), which share the liability. Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1012 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1013 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1014 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1015 As provided by the European Union Renewable Energy Database and Support through: http://www.res-legal.eu/search-by-country/germany/tools-list/c/germany/s/res-e/t/promotion/sum/136/lpid/135/

with the CONACYT/SENER Sustainability Fund to provide financial R&D products focused at clean energy development, and given the objectives that it has been assigned through law, this bank is also authorized to undertake any kind of financial programs in regards to public services as electricity provision[1016]. Through the decision of its Directive Council, this institution can develop a clean energy loan program, which will require the approval of the Ministry of Finance and Public Credit to start operating[1017].

This program could also be implemented in Mexico through the "Shared Risk Trust Fund" (Fideicomiso de Riesgo Compartido), which was established by presidential decree in 1981 with the goal of promoting land productivity and technology diffusion[1018]. This trust fund currently has as one of its goals: the promotion of renewable energy through the implementation of shared-risk mechanisms, as the "on-lending" scheme[1019]. However, given that this trust fund is under the Ministry of Agriculture, Livestock, Rural Developments, Fisheries and Food (SAGARPA), most of its programs are currently focused on agriculture and rural development[1020], not in renewable energy deployment per se. The trust Fund has a signed contract with "Rural Financier" (Financiera Rural)[1021], to implement and administer the financial products that the Fund develops.

In terms of *Program Flexibility*, it has been found that shared-risk programs need to be designed and adjusted to meet market objectives as they go, and hence establishing provisions that allow for program changes should be undertaken[1022][1023]. According to the laws that govern KfW, this bank can perform its tasks freely as long as they are pursuant to a state mandate[1024] KfW undertakes its renewable energy program in support of the German Federal Government's 2010 "Energy Turnaround Action Plan" (or "Energiewende" in German), this program is also in line with the Federal strategy in terms of sustainability[1025]. By 2020, Germany aims to reduce greenhouse gas emissions by 40% compared with 1990 as well as reduce primary energy consumption by 20% (compared with 2008). By 2050, Germany aims to reduce greenhouse gas emissions by at least 80% as well as reduce primary energy consumption by 50% by improving energy efficiency and encouraging the use of renewable energies[1026]. This implies that KfW is allowed to develop and adapt any programs that it has established pursuant to these goals.

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1016 Article 6 of the National Works and Public Services Bank Law (Ley del Banco Nacional de Obras y Servicios Publicos).
1017 Article 21 of the National Works and Public Services Bank Law (Ley del Banco Nacional de Obras y Servicios Publicos).
1018 Information provided by the Ministry of Agriculture, Livestock, Rural Developments, Fisheries and Food (SAGARPA) through: http://www.sagarpa.gob.mx/quienesomos/datosabiertos/firco/Paginas/default.aspx
1019 As provided by information made available by the Trust Fund through: http://www.firco.gob.mx/firco/Paginas/Quienes-Somos.aspx based on article 2 of the Presidential Decree that regulates this trust fund (2004), available at: http://www.firco.gob.mx/POTTtransparencia/Documents/Lineamientos/DecretoFirco2004.pdf
1020 Out of the four programs that are available as of November of 2015, only one covers renewable energy systems and only for its use in agriculture, livestock or fishing activities. See: http://www.firco.gob.mx/componentes_2015/Paginas/Componente_de_Bioenergia_y_Sustentabilidad_2015.aspx
1021 A Mexican Development Bank that has the same attributions as BANOBRAS but with a particular focus in rural development.
1022 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.
1023 At first, this key element might seem to go against the *Strategy and Priority Setting* component discussed throughout the policies advanced in Chapter 6, however, the reader must not forget that the elements advanced in Chapter 6 where particular to "supply-push" policy. As explained through the introduction of this Chapter, "demand-pull" policies vary greatly in their design characteristics depending on if they are quantity, price, quality, finance, or access driven policies, reason for which the components analyzed in each of the policies advanced through this Chapter vary, and are to be interpreted to be only applicable to the specific policy that is being analyzed at each particular section. Financial markets are very dynamic, and hence allowing for flexibility to adapt to rapid changes in the market is desired when implementing a shared-risk financing policy. Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf
1024 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf
1025 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf
1026 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

In regards to a Mexican equivalent, if it is to be developed through BANOBRAS, the laws establish that the Ministry of Finance and Public Credit should approve the programs undertaken by this development bank[1027]. As such, if this program will be pursued through this avenue, it is important to embed in the particular program a provision that allows flexibility to BANOBRAS to react to market conditions and change the specifics of the program accordingly. If however, the program is to be undertaken by the "Shared Risk Trust Fund" (Fideicomiso de Riesgo Compartido), this entity has flexibility in managing its programs by virtue of law[1028], and hence, it has the ability to implement any changes per se, without having to rely on formal agreements with other entities to do so.

With respect to *Low Interest Rates*, good practice indicates that in shared-risk financing program, interest rates should be below those of commercial lenders with a long repayment term (at least 10 years) and minimal fees[1029]. KfW's Renewable Energy Program consists of three subprograms that provide long-term, below-market interest loans, for a broad range of investors, from private individuals to small as well as medium sized companies (SMEs) and municipalities[1030].

- The Standard program focuses on the production of electricity and (to a small extent) heat from renewable energies (solar PV, biomass, onshore wind farm construction or modernization, CHP power stations, low-voltage and medium-voltage power grids). The high-volume, below-market rate loans cover Up to 100% of the investment costs eligible for financing, however, not more than EUR 25 million per plant/project. It is a long-term and low-interest loan with a fixed interest period of 5 or 10 years including a repayment-free start-up period. A fixed interest period of up to 20 years is granted if technical and economic duration of co-financed investment is longer than 10 years. Moreover, a commitment fee of 0.25% per month is charged[1031].

- The Storage program provides financing for new installations of stationary battery storages systems combined with photovoltaic systems. The loans provided through the on-lending system cover up to 100% of investment costs[1032].

- The Premium program promotes large plants in which heat is generated from renewable energies. The concessional loans cover up to 100% of the financeable costs of investment, up to EUR 10 million. In the framework of the KfW Programme Renewable Energy – Premium, only geothermal energy is eligible for electricity production. The installations need to be erected in Germany and have to be operating for at least 7 years[1033]. A combination with the "KfW Geothermal Exploration Risk Programme", the "KfW Renewable Energy Programme – Standard" and other non-KfW subsidies is possible as long as the overall subsidies do not exceed 80% of the investment costs[1034]. Loans for deep geothermal

[1027] Article 29 of the National Works and Public Services Bank Law (Ley del Banco Nacional de Obras y Servicios Publicos).
[1028] Per presidential decree, article 58 of the "Federal Law for State-Owned Enterprises" (Ley Federal de Entidades Paraestatales), applies to this Fund.
[1029] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.
[1030] Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf
[1031] As provided by the European Union Renewable Energy Database and Support through: http://www.res-legal.eu/search-by-country/germany/tools-list/c/germany/s/res-e/t/promotion/sum/136/lpid/135/
[1032] As provided by the European Union Renewable Energy Database and Support through: http://www.res-legal.eu/search-by-country/germany/tools-list/c/germany/s/res-e/t/promotion/sum/136/lpid/135/
[1033] Guidelines for the support of RES-H Art. 6.4.
[1034] KfW Renewable Energy Programme – Premium p. 5.

installations are granted up to 80% of the eligible investment costs. The loan has an interest period of 5, 10 or 20 years including a repayment-free start-up period of maximum 1, 2 or 3 years respectively[1035]. Interest rates depend on the developments at the capital market, but are, however, fixed over 10 years. For loans exceeding 10 years, the interest rate will be redefined after 10 years[1036].

The KfW example sheds light on a viable approach to promote good practice considerations in regards to *Low Interest Rates*; hence, if such a program is to be developed in this Mexico, it is important to establish interest rates that are below those of commercial lenders, with a long repayment term, and minimal fees.

Pertaining to *Simplified, High Quality Application Process*, programs should have an easy, concise application process, with quick loan approval; and the staff in charge of approving it should be knowledgeable about renewable energy in order to properly evaluate and underwrite loan requests[1037].

Savings banks, cooperative banks and commercial banks are KfW's main distribution partners for KfW's renewable energy lending activity, local banks conduct the appraisal of the borrower, evaluate their plans and make the decision on whether to finance the project and to apply for a loan from KfW using their own processes[1038]. KfW provides the commercial bank with a low interest rate compared to market terms; and the commercial bank charges its own remuneration by including a margin for credit risk and handling into the interest rate applied to the final beneficiary - KfW determines the maximum amount of this margin, in order to secure the transmission of the promotional advantage to the beneficiary[1039]. KfW believes that this is a useful method, as acting through local banks allows for a relationship to develop between the bank and the customer, thus making it easier for the local institution to accurately judge plans; moreover, this method enhances the local commercial banks' capacity and readiness to provide loans for energy efficiency and renewable energies by experience with such customers[1040].

A Mexican equivalent program could go beyond the design characteristics of the example we are currently analyzing in terms of ensuring a *Simplified, High Quality Application Process*. This, by establishing certain parameters that are to be followed by commercial banks in order to be able to participate in the program and access the profit margin. These parameters can be set in terms of application speed and the completion of a training program for their loan professionals, in order to ensure they are qualified to deal with clean energy requests.

In terms of *Monitoring and Evaluation*, loan programs should include a mechanism for tracking the details of program use, costs, and energy production for program evaluation and improvement[1041]. KfW addresses this by regularly commissioning

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1035 KfW Renewable Energy Programme – Premium p. 6.

1036 As provided by the European Union Renewable Energy Database and Support through: http://www.res-legal.eu/search-by-country/germany/tools-list/c/germany/s/res-e/t/promotion/sum/136/lpid/135/

1037 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1038 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1039 Virginie Marchal, and Geraldine Ang. (2012). "Climate and Energy Policy in Germany: Mechanisms to Encourage
Private Sector Investment/participation in Low-carbon Development: A Case Study of Germany's Building Sector Prepared by the German Federal Environment Agency and KfW". OECD

1040 Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

1041 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

evaluations of the impact of its key promotional programs for Germany[1042]. These are usually macroeconomic assessments, comprising a calculation of avoided GHG emissions, an example of this is the recent evaluation performed by the Centre for Solar Energy and Hydrogen Research in Stuttgart, which found that the German renewable energy promotion programs managed by the KfW bank support 44% of the newly installed electrical power generated by renewable energy sources, and thereby contributes to the annual decrease of 9.5 tons of greenhouse gas emissions and reduction of 520 million Euros for energy imports[1043]. Most of the co-financed investments (a total of EUR 14.4 billion), in electricity generation facilities, accounted for around 70% onshore wind energy 15% photovoltaic (15%)[1044].

Following this example, establishing a mandate in regards to implementing evaluations by external research institutes when designing the program, should be pursued by an equivalent policy in Mexico, in order to comply with this key element of shared-risk financing policies.

Regarding *Program Marketing*, the government should build program awareness among both potential borrowers and private lending partners[1045]. This is currently implemented by KfW with a special focus on possible borrowers, as there is a risk that commercial banks could not propose KfW promotional schemes to their client, since they may potentially offer services that are more profitable to them[1046]. Therefore KfW has launched several information campaigns of its own (via a call centre, flyers, etc.)[1047]. Hence, the need to embark in outreach strategies and informational campaigns should be kept in mind when implementing an equivalent shared-risk financing program in Mexico.

Apart from the differences that stem from resource availability between Mexico and Germany for undertaking such a program, which can be countered through the leverage of international resources available for development through lending programs offered by the "World Bank" or the "Inter-American Bank"[1048]. Crucial differences arise in terms of the possibility of corruption and lack of technical capacity, which can end up impacting the instrumentation of this program[1049]. Given these issues, considering a cost-sharing approach in the design of the Mexican program instead of offering the 100% of the required capital (as KfW does), should be explored as a possibility to determine the potential productivity of the recipients of funding and the value of their proposals[1050]. In addition, requiring the submission of a coherent business plan confirming their capacity to repay the financing can also increase the likelihood of repayment.

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[1042] After analyzing the English version of the laws that govern KfW made available by the bank through: https://www.kfw.de/Download-Center/KfW-Gesetz-und-Satzung-sowie-Gesch%C3%A4ftsordnungen/Law-concerning-KfW-and-KfW-By-laws/KfW_Gesetz_E.pdf it is not clear if there is an actual mandate to undertake this external evaluations, however in practice these evaluations are constantly taking place. Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

[1043] As provided from the summary of the Centre for Solar Energy and Hydrogen Research evaluation, which can be consulted at: http://www.buildup.eu/en/news/kfw-bank-publishes-evaluation-report-renewable-energy-promotion-programmes-20132014

[1044] As provided from the summary of the Centre for Solar Energy and Hydrogen Research evaluation, which can be consulted at: http://www.buildup.eu/en/news/kfw-bank-publishes-evaluation-report-renewable-energy-promotion-programmes-20132014

[1045] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

[1046] Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

[1047] Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf

[1048] As an example see the Inter-American Development Bank Climate Financing Program. Information available at: http://www.iadb.org/en/topics/climate-change/climate-change-and-sustainability,19086.html

[1049] This given Mexico's high corruption levels as evidenced by the next article: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde

[1050] Robert Poulton (2008). The Role of Cost-Sharing as a Signal of Quality in the Federal Funding of Academic Research: an Application to the National Science Foundation.

In terms of corruption abatement, setting strict evaluation parameters for the analysis of the disbursements, and providing for transparency mechanisms in the assignation processes will be of utmost importance to guarantee that resources assigned to this program are being properly spent. Access to information on the actions and performance of government expenditures will be critical to achieving accountability, unless the public knows what financial services are provided, how well they are provided, who the beneficiaries are, and how much they cost, it cannot demand (nor expect) effectiveness[1051]. To promote government accountability, government budgets for the particular program, and fund assignations need to be disclosed to the public[1052] - an option to do this would be to build a public website where this information is showcased. Another mechanism that promotes transparency and accountability with respect to public finance is establishing periodic and exhaustive audits by independent organizations aimed at analyzing the specifics of funds allocation[1053].

### 7.4. Public Procurement

Effective public procurement policy requires a change in the standard practices of governmental organizations, which tend to focus at purchasing lower cost products first[1054]. A successful program in this regard establishes clean energy products as the routine procurement choice for the government, not just a viable alternative; under successful programs the selection of these products becomes standard operating procedure[1055]. The next are key features that should be addressed when implementing a clean power "Public Procurement" program[1056]:

- Establishing Intent.
- Setting Clear Goals.
- Assigning responsibility and Establishing Monitoring Requirements.

Many state and local governments in the United States have committed to buying green power to account for a certain percentage of their electricity consumption; they are finding that green power purchasing is an effective part of a strategic energy management plan, one that considers options such as energy efficiency, load management, power purchases, on-site generation, and non-electric energy needs to achieve environmental, financial, and other goals[1057].

Located in Northwest Washington State, Bellingham, is one of the most successful green power communities in the United States, reason for which it was chosen in 2007 and 2008 as the EPA's green Power Partner of the year, the most prestigious of the green power purchaser awards[1058].

As a community (city government, businesses, state agency offices, the local

[1051] Michael Schaeffer (2002). Corruption and Public Finance. USAID. Available at: http://pdf.usaid.gov/pdf_docs/Pnact881.pdf
[1052] Michael Schaeffer (2002). Corruption and Public Finance. USAID. Available at: http://pdf.usaid.gov/pdf_docs/Pnact881.pdf
[1053] Michael Schaeffer (2002). Corruption and Public Finance. USAID. Available at: http://pdf.usaid.gov/pdf_docs/Pnact881.pdf
[1054] Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.
[1055] Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.
[1056] Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.
[1057] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.
[1058] As provided by EPA through: http://www3.epa.gov/greenpower/documents/2008awards.pdf

University, and residential customers), Bellingham purchases over 91 million-kilowatt hours (kwh) of green power annually to cover 13.3% of its electricity demand; as a result, it has occupied high rankings nationwide on the EPA's list of green Power communities[1059].

Pertaining to *Establishing Intent*, effective policy establishes sustainable procurement as an organizational priority, and communicates a commitment to action from the highest levels, without this signal of intent, there is little to no impetus for individual entities to change business-as-usual practices[1060]. From September 2006 through earth day 2007, the City of Bellingham partnered with a utility and a non-profit organization to start the "Bellingham Green Power Community Challenge", the challenge's goal was to increase green power purchasing among the City's citizens and businesses, to this point, the Bellingham City Council established *Intent* by passing a 2007 resolution committing to reducing GHG emissions from Government operations by 64% below 2000 levels by 2012 and 70% by 2020 and obligating the Mayor to procure green power for municipal facilities for this purpose[1061]. In Mexico, *Intent* for this policy has been established through a reform to the "Law for the Use of Renewable Energies and the Financing of the Energy Transition" in 2013, which established as a requirement, renewable energy procurement for the facilities of the Federal Public Administration, according to their capabilities[1062].

With respect to *Setting Goals*, it has been found that intent must be accompanied by clear goals that support the commitment to changing purchasing practices, effective policies set goals that are actionable and achievable with current resources[1063]. The goal of the "Bellingham Green Power Community Challenge" was to increase community green power purchasing to at least 2% of the City-wide electric load, for this purpose it set as a plan purchasing renewable energy credits (RECS) for 100% of the electricity used by the City's Government; the City achieves an approximate 60% overall reduction in GHG emissions for municipal operations[1064].

From a municipal perspective, green power purchase costs come from the same funds that pay for electricity generated from traditional sources[1065]. The City's participation in the utility green power program (by purchasing third-party certified RECS) adds an additional fee to the City's electricity bill[1066]. The Washington Utilities and Transportation Commission (WUTC) regulates the rates the utilities charges its in-state customers; the utility then has to obtain WUTC approval for in-state customer rates and must offer the same rates to all qualifying customers[1067]. This in contrast to private renewable energy generating companies or third-party brokers, who can sell RECS as a commodity directly to

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1059 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1060 Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.

1061 Bellingham's City Council Resolution #2006-28 , available at: http://mrsc.org/getmedia/61F82CA1-9372-417E-BD3A-F560A4E4AF60/B45r06-28.aspx

1062 Article 24 of the "Law for the Use of Renewable Energies and the Financing of the Energy Transition" (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).

1063 Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.

1064 In may 2007, the City adopted a greenhouse gas inventory and climate Protection action Plan based on a GHG emissions inventory conducted from august 2005 to august 2006. The inventory noted that government operations account for just over 2% of the community's total GHG emissions, with electricity use being the largest share (60%) of the city government's contributions. Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1065 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1066 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1067 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

a consumer at a competitive, market-based price[1068]. The City in 2009 opted to seek a better price from the national retail REC market for the purchase of some of its third party certified RECS, while still maintaining its relationship with the utility green power program[1069]. Costs to the City for its 100% green power purchase (24 million kwh) averaged approximately $131,000 annually from 2007 to 2009 but with new contracts through 2011, the City's cost for green power dropped to less than $55,000 annually (24 million kwh)[1070]. As explained in Chapter 5, The Mexican Ministry of Energy is currently developing a program named "Clean Energy in the Federal Public Administration". This has as a claimed goal: promoting the installation of renewable energy generation equipment in buildings and facilities from the Federal Public Administration[1071]. A lesson that can be derived from the Bellingham's example, following the good practice considerations in this regard, is the importance of setting a goal for clean energy participation in the overall procurement requirements of the Federal Government and addressing the funding sources for its development. To this point, the Ministry has already set a goal but it has done it in terms of deployment of distributed generation systems, this deployment goal is set at 2.4 MW of installed renewable based capacity to provide clean and independent electricity supply to buildings and facilities from the Federal Government[1072], but has not advanced any considerations in regards to funding.

In terms of *Assigning Responsibility and Establishing Monitoring Requirements*, effective policy also assigns ownership of program targets to organizations or individuals within the purchasing process and establishes monitoring provisions[1073]. In Bellingham, a City Council Resolution assigns the responsibility of undertaking the program to the Mayor.[1074] In regards to *Monitoring*, the fact that this City complied with its procurement goals through REC purchasing, allowed a way to prove compliance by holding RECs which lower administration and verification costs associated with more complex methods when this program is undertaken through a different approach[1075]. Currently there are no indications of what Mexican agency or individual within the Federal Public Administration is vested with the responsibility of the implementation of the program, furthermore, no considerations about *Monitoring* have been advanced. Hence, addressing this key element of public procurement policy should pursued; if the change towards procurement for renewable energy input instead of deployment of distributed systems is undertaken, Bellingham's REC monitoring system could be replicated with ease, this given that as it has been explained before, a REC system is already set to operate in Mexico. *Assigning Responsibility and Establishing Monitoring Requirements* has special relevance in Mexico as compared to Bellingham, given its differences pertaining to administrative and territorial extent of application.

[1068] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.
[1069] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.
[1070] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.
[1071] As disclosed by the Ministry of Energy through: http://www.energia.gob.mx/portal/Default.aspx?id=2936
[1072] As disclosed by the Ministry of Energy through: http://www.energia.gob.mx/portal/Default.aspx?id=2936
[1073] Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.
[1074] Bellingham's City Council Resolution #2006-28 , available at: http://mrsc.org/getmedia/61F82CA1-9372-417E-BD3A-F560A4E4AF60/B45r06-28.aspx
[1075] Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

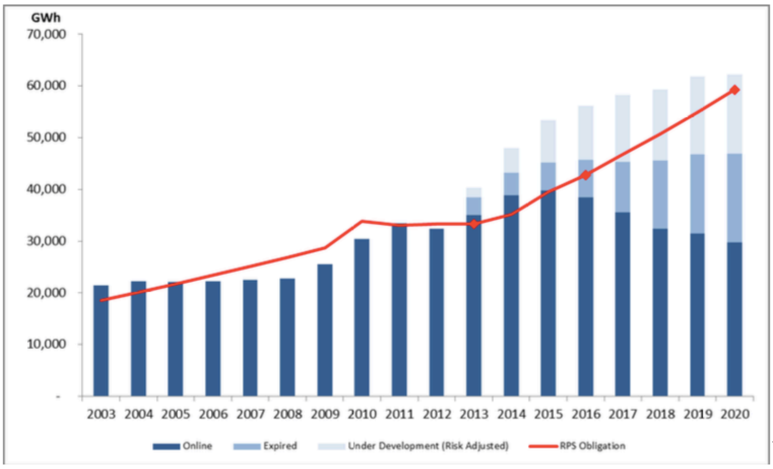
### 7.5. Renewable Portfolio Standards

The main policy drivers behind an RPS include environmental enhancement, economic development, and greater energy security (by way of reduced reliance on price-volatile electric-generation fuels such as natural gas)[1076]. Program design can affect the relative importance of some of these drivers; hence, it is important to undertake the next good practices when implementing an RPS policy[1077]:

- Conducting Technical and Economic Analysis to Inform Policy Design
- Identifying Eligible Resources and Technologies
- Setting RPS Requirements
- Clearly Defining the Standard
- Establishing a Compliance Mechanism

In 2002, the California Legislature established California's first Renewable Portfolio Standard (RPS), requiring the state to meet 20% of its electricity demand from eligible renewable energy resources by 2010 (eligible resources included wind, solar Photovoltaics, solar thermal, tidal wave, small hydroelectric, geothermal, biodiesel, biomass, and biogas)[1078]. Governor Schwarzenegger, by executive order in 2008, increased the renewable goal to 33% by 2020, which was then codified by the California Legislature through SB 2 (1x) in 2011[1079]. Further, on October 2015, California's Governor Edmund G. "Jerry" Brown Jr. signed S.B. 350, the "Clean Energy and Pollution Reduction Act of 2015" into law, which, among other things, raised California's renewable portfolio standard to 50% by 2030[1080]. As showcased by the next figure, this policy has been proceeding according to schedule in this State.

Progress towards 33% renewables (actual and forecasted by year)



[1081]

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[1076] David Hurbult (2008). State Clean Energy Practices: Renewable Portfolio Standards. NREL. Available at: http://www.nrel.gov/tech_deployment/state_local_governments/pdfs/43512.pdf

[1077] Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

[1078] California Senate Bill 1078

[1079] Jeremy Carl et al. (2013). Renewable and Distributed Power in California: Symplifying the Regulatory Maze – Making the Path for the Future. Hoover Institution, Stanford University. Available at: http://www.hoover.org/sites/default/files/uploads/inline/docs/energy-policy-tf-grueneich-study.pdf

[1080] Milbank (2015). Project Finance Group Client Alert: California Confronts Climate Change by Boosting Renewable Portfolio Standard to 50%. Available at: https://www.milbank.com/images/content/2/1/21864/Project-Finance-Client-Alert-California-RPS-Raised.pdf

[1081] California Public Utilities Commission (2015). Renewable Portfolio Standard, Second Quarterly Report.

There are three main benefits derived from the implementation of an RPS policy: Emissions reductions, economic development impacts and compliance costs[1082]. In California, these three rubrics have shown positive results of the implementation of its RPS, suggesting that this policy has been successfully undertaken in the state.

In terms of "Emissions Reductions" California's RPS is the electricity focused demand-pull policy that has proven to reduce more greenhouse gas emissions independently. Recent studies have found that California's RPS is responsible for an average reduction of 16.6 $MtCO_2e$ (Metric Tons of $CO_2$ Equivalent[1083]) per year, which is set to increase exponentially as the goals keep strengthening[1084]. Regarding economic development, California's RPS has spurred investment in utility-scale renewable energy generation which has topped $20 billion in California, and as the RPS policy drives more renewable energy onto the grid, it is creating demand for a skilled green workforce reducing unemployment; since 2010, California's unemployment rate has been cut in half while the amount of renewable energy produced has nearly doubled[1085]. With respect to compliance cost impacts, the California Public Utilities Commission has used an avoided cost method[1086] to calculate this, and including the all-in cost of a combined cycle gas generator their analysis has yielded RPS compliance costs equal to -$24/MWh in 2011 and -$4/MWh in 2012 (i.e., a net cost savings in both years)[1087].

California's RPS program, evidences the role that quantity based instruments can play in promoting clean energy deployment, lowering emissions, and increasing economic development, while keeping compliance costs low. As analyzed though Chapters 1, 2 and 5, Mexico has taken a step towards reaping these benefits by setting a maximum percentage for fossil fuel electricity generation (65% by 2024, 60% by 2035, 50% by 2050)[1088], and further establishing the "clean energy certificate system". Nevertheless, analyzing California's policy example can shed light on policy design lessons that might be worth exploring in order to strengthen the Mexican implementation of the RPS policy.

Regarding *Conducting Technical and Economic Analysis to Inform Policy Design*, setting specific RPS requirements involves complex consideration of resource availability and technology market conditions within the context of broader economic, social, and environmental development goals; To set an appropriate RPS and ensure achievability, it is important to assess[1089]:

- Availability of supply using geospatial and resource assessments
- Cost estimates

1082 Galen Barbose et al (2015). Costs and Benefits of the Renewable Portfolio Standards in the United States. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032115008229

1083 "Carbon dioxide equivalent" or "$CO_2e$" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, $CO_2e$ signifies the amount of $CO_2$, which would have the equivalent global warming impact. IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

1084 Jefferey Greenblatt (2013). Modeling California Policy Impacts onf Green House Gas Emissions. Energy Policy. Available at: http://www.sciencedirect.com/science/article/pii/S0301421514006892

1085 Natural Resources Defense Council (2015). California's Renewable Portfolio Standard: Slashing Pollution, Creating Jobs. Available at: http://www.nrdc.org/globalwarming/files/ca-renewables-portfolio-standard-FS.pdf

1086 This method accounts for resources that would have been used and/or built in the absence of the energy and capacity procured as a result of the RPS program.

1087 California Public Utilities Comission (2013). Report to the Legislature in Compliance with Public Utilities Code Section 910.

1088 This through the transitory provisions of: the Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).

1089 Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

- Siting considerations
- Transmission and distribution requirements and renewable energy access provisions
- Other policies at the national and subnational level.

There is no detailed information available regarding the completion of these assessments in California when setting the initial RPS target in 2002[1090]. Nevertheless, since the establishment of Assembly Bill 32, the California Air Resources Board was instituted and assigned as one of its main responsibilities developing a "scoping plan", which outlines the state's strategies to meet green house gas emission limit's goals[1091]. This plan contained comprehensive discussions regarding availability of renewable energy supply, cost estimates for RPS and other climate policy, renewable energy siting considerations, transmission and distribution requirements and renewable energy access provisions. The plan preceded 2008's ramp up in the RPS program, which implies that it provided the technical analysis required to inform this policy adaptation.

In Mexico, through a mandate established by the "Law for the Use of Renewable Energies and the Financing of the Energy Transition", the Ministry of Energy prepares and publicizes a National Energy Strategy, and a Special Program for the Development of Renewable Energy, which tend to provide detailed analysis in these regards[1092]. However, as the Law that set the Renewable Portfolio Standard percentages, is the same Law that established the mandate to the Ministry to develop the Strategy and the Special Program, these began to be publicized only after the RPS percentages where set, again this does not necessarily mean that these analysis were not undertaken when designing the RPS policy and setting the percentages, it is possible that they in fact were conducted but not made available to the public.

An opportunity to incorporate these assessments towards setting renewable generation penetration goals beyond the general RPS goals established in the "Law for the Use of Renewable Energies and the Financing of the Energy Transition", is given by the Electric Industry Law that, through the establishment of the "clean energy certificate system", provides that the quantity of certificates that an electricity purchaser[1093] holds must be enough to guarantee that a certain percentage, established yearly[1094] by the Ministry of energy, has been met[1095]. Hence, incorporating this type of analysis to determine the yearly goal to be set by the Ministry should be pursued.

With respect to *Identifying Eligible Resources and Technologies*, in the absence of specific technology provisions, RPSs will typically support the development of renewable energy technologies with the lowest project development costs[1096]. Setting "carve-outs" for different technologies can help to address the classic critique to quota schemes that advances that these mechanisms only allow lowest-cost renewable energy options achieve

1090 This does not necessarily mean that these assessments where not conducted, perhaps they were, but they were not made available to the public.
1091 SB-32 California Global Warming Solutions Act of 2006
1092 Article 6 Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).
1093 Purchasers of electricity in the wholesale electricity market, mainly, the Federal Electricity Commission and qualified users.
1094 As a transitory measure provided in the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition", the required percentage of acquisition of clean energy for 2016 and 2017 will be zero.
1095 Only the last proprietor of the certificates can account them towards the percentage requirement.
1096 Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

notable levels of deployment[1097]. Carve-outs tackle this issue by enabling less mature renewable energy technologies to thrive given that only particular types of renewable energy technologies can meet a prescribed part of the overall target[1098]. California RPS currently has no carve-outs in place; hence, this poses an opportunity for Mexico to improve the example we are currently analyzing by incorporating carve-out provisions in its RPS program. An example of a U.S. State that does this is Illinois, which RPS requires large investor-owned electric utilities and alternative retail electric suppliers to source 25% of eligible retail electricity sales from renewable energy by 2025, but further establishes specific technology carve outs: a minimum of 60% of the renewable energy requirement must come from wind power, 6% from solar power, and the remaining amount (34%) can come from any eligible renewable energy technology[1099][1100]. In Mexico, there are currently no "carve-outs" set to operate to aid the RPS policy, as such the Illinois example sheds light on a possible approach that can be taken in Mexico to address *Identifying Eligible Resources and Technologies*; it is worth mentioning however than the specific carve-outs percentages should also be set after conducting viability assessments in light of the considerations advanced in the *Conducting Technical and Economic Analysis to Inform Policy Design* discussion.

In terms of *Setting RPS Requirements*, RPSs are normally defined as a percentage of generation, a specified installed capacity or a combination of each, and they can be ramped up over time to allow the market to expand gradually yet ensure entities are meeting interim steps towards compliance. Effective RPS targets send a stable policy signal, avoiding unpredictable shifts, and support long-term finance through contractual agreements rather than relying solely on shorter-term REC markets described below[1101]. This was addressed in California since the establishment of the policy in 2002; utilities were required to source 20% of retail electricity sales from renewable energy by 2010 and 25% by 2016 and each year thereafter with escalations every three or four years through 2030 (there is a specific schedule that advances the required percentage for compliance per year up until 2030) [1102]. In Mexico, this is addressed differently; the "Law for the Use of Renewable Energies and the Financing of the Energy Transition" incorporates the Renewable Portfolio Standard in terms of a maximum percentage for fossil fuel electricity generation for the years to come (65% by 2024, 60% by 2035, and 50% by 2050)[1103].

*Clearly Defining the Standard*, relates to *Setting RPS Requirements*; it advances that Renewable portfolio standards vary in definition, often linked to either installed power plant capacity or total electricity generated (or sold); and that as such, these definitions

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1097 Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Available at: http://srren.ipcc-wg3.de/

1098 Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Available at: http://srren.ipcc-wg3.de/

1099 Eligible renewable energy technologies include wind, solar thermal, solar photovoltaic (PV), dedicated crops grown for energy production, untreated and unadulterated organic waste biomass, trees and tree waste, in-state landfill gas, biodiesel, hydropower that does not involve the construction of new dams or significant expansion of existing dams, other such alternative sources of environmentally preferable energy," which may include (among other resources) waste heat from industrial processes and anaerobic digestion. Several means of energy production are specifically excluded from standard eligibility: the incineration of tires; garbage; general household, institutional and commercial waste; industrial or office waste; railroad ties; utility poles; landscape waste other than trees and tree waste; and construction or demolition debris other than untreated and unadulterated waste wood.

1100 Table provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/584

1101 Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

1102 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/840

1103 This through the transitory provisions of: the Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).

should be clear to deter confusion that can potentially impact policy outcomes[1104]. Both California and Mexico, comply with this by advancing clear definitions for their RPSs policies, the former in terms of retail electricity sales, and the latter in terms of a maximum percentage for fossil fuel electricity generation.

In the topic of *Establishing a Compliance Mechanism*, effectively designed RPS include compliance mechanisms, entities can comply with the RES by purchasing electricity generation through long-term contracts, buying renewable energy certificates, or paying a fine called an alternative compliance payment (ACP)[1105]. An ACP also serves as a cost control mechanism as entities can choose not to meet the RES if the cost of doing so is higher than the cost of the ACP; proper design can minimize costs and ratepayer impacts if the availability of affordable renewable energy becomes restricted[1106].

In California there are no ACPs in place, under existing law, the California Public Utilities Commission (CPUC) has been authorized to impose penalties on utilities that fail to meet their procurement requirements under the RPS, nevertheless, those potential penalties have never been clearly quantified as in some other states that have an Alternative Compliance Payment[1107]. Senate Bill 350, however, tasks the CPUC with adopting a schedule of penalties for noncompliance; the legislation further states that the cost of any penalties paid by a utility will not be collected in the rates it charges its customers[1108]. Existing law establishes a series of conditions by which the CPUC may waive enforcement of the procurement requirements for an investor-owned utility, including inadequate transmission capacity, delays from permitting and interconnection, and insufficient supply of eligible renewable energy projects[1109].

An example of a State that does have an Alternative Compliance Payment, is Illinois, where the renewable obligation for alternative retail electric suppliers (ARES) is measured as a percentage of the actual amount of metered electricity (megawatt-hours) supplied by the ARES in the compliance year, as reported for that year to the Illinois Commerce Commission (ICC), ARES must meet at least 50% of their renewable energy obligation through alternative compliance payments (ACPs) [1110]. The price of ACPs is calculated by averaging the REC prices in the most recent Illinois Power Agency[1111] REC procurement; each ARES's ACP is different, based on the utility service territory in which it operates[1112]. The remaining 50% of an ARES's obligation may be met with ACP payments or by procuring renewable energy or renewable energy credits (RECs). The ACPs submitted by ARES is remitted directly to the ICC, which forwards that money to the

1104 Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

1105 Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf

1106 Brown, Adam, and Simon Muller. (2011). Deploying Renewables 2011: Best and Future Policy Best Practice. International Energy Agency. Available at: http://www.iea.org/publications/freepublications/publication/deploying-renewables-2011.html

1107 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/840

1108 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/840

1109 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/840

1110 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/584

1111 Illinois the Illinois Power Agency, was established to develop electricity procurement plans for large investor-owned electric utilities and broker all contracts between utilities and suppliers to ensure "adequate, reliable, affordable, efficient, and environmentally sustainable electric service at the lowest total cost" and hence, The IPA procures renewable energy to satisfy the requirements of EUs.

1112 Adapted from the information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/584

Illinois Power Agency's Renewable Energy Resources Fund (RERF) to be used for the purchase of RECs[1113].

In contrast with California, Mexico's RPS program does in fact establish ACPs, and hence, it has the opportunity to reap the previously described benefits associated with this mechanism. As explained before, in Mexico, the laws establish a requirement to acquire tradable "Certificates" to whoever purchases energy in the wholesale electricity market[1114], which have to be enough to guarantee that a certain percentage, set yearly[1115] by the Ministry of energy, has been met[1116], and the guidelines for the implementation of the program establish a provision that states that if the credits are not enough to guarantee the required percentage, those purchaser will have to pay a fine as well (equivalent to the ACP)[1117]. However, it is worth noting that the fine is set at a range of between 6 to 50 times the minimum daily salary in Mexico per MWH, which is 73 Mexican pesos (around 4 dlls), this means that the fine can range from 438 pesos to 3,650 (from around 24 dollars to 205) per MWH[1118]. Setting the fine payment as a range provides an opportunity for corruption, moreover, even in the case that a non-compliant participant had to pay the highest fine per MWH, the amount set seems low, which can negate the transitional benefits of this REC policy as participants can find economically cheaper to pay fines that to comply with the REC requirement.

Key differences between Mexico and the State of California, beyond those described through this analysis, might arise in terms of the structure of the electricity system, administrative and territorial extent of application, and the previously explained corruption factor. As we analyzed through Chapter 2, in Mexico the participants of the wholesale electricity market are not only retailers but also "qualified users" which are consumers with high input requirements[1119], this means that as opposed to only addressing retailers like in California, the Mexican program will include these users as well. These users will inevitably have to absorb the costs of the implementation of this program directly, which might develop in competitiveness issues[1120], as they are mainly industrial consumers.

With regards to the administrative and territorial extent of application, the Energy Regulatory Commission is in charge of implementing this program, as it has been given the responsibility of distributing the renewable generation certificates and verifying compliance by the obligated parties[1121]. As such, it is important to equip the Commission with the required monetary and human resources to be able to undertake the task. In terms of corruption, abating it will fall in the hands of the Commission as well, given its responsibilities. Therefore, it is of utmost importance that this Commission establishes stringent rules for the distribution of the certificates and the verification of compliance.

1113 See the ICC website, available at: https://www.icc.illinois.gov/electricity/RenewablePortfolioStandards.aspx

1114 Title 4, Chapter 3, Article 122 of the Electric Industry Law (Ley de la Industria Eléctrica).

1115 As a transitory measure provided in the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition", the required percentage of acquisition of clean energy for 2016 and 2017 will be zero.

1116 Only the last proprietor of the certificates can account them towards the percentage requirement.

1117 Title 5, Chapter 2, Article 165 of the Electric Industry Law (Ley de la Industria Eléctrica).

1118 The latest amount of the minimum salary is made available by the Ministry of Finance and Public Credit through: http://www.sat.gob.mx/informacion_fiscal/tablas_indicadores/Paginas/salarios_minimos.aspx

1119 Users with at least a 3 MW input demand requirement. This is programed to be ratchet down throughout a 2-year period until it falls to 1 MW as provided by the transitory dispositions of the Law of the Electric Industry.

1120 These industrial consumers will have higher costs derived from complying with the RPS policy that will have to be absorbed directly when procuring electricity. If this higher costs are transferred through the price of their goods they risk becoming less competitive when venturing in foreign markets or in national markets, against goods produced in other Countries that do not have policies that increase industry costs to the extent that this policy could increase the costs for Mexican industry.

1121 Title 1, Chapter 2, Article 12 of the Electric Industry Law (Ley de la Industria Eléctrica).

Lack of accountability by national and international politicians and civil servants has been deemed as one of the most important reasons why sustainable development has been sluggish in several of the world's developing countries[1122]. As advanced before, access to information on the policies and performance of government actions will be critical to achieving accountability. Unless the public knows what policies are being implemented and their design characteristics, it cannot demand effectiveness[1123]. To promote government accountability, compliance information with the particular program needs to be disclosed to the public[1124] - an option to do this would be to build a public website where this information is showcased. Another mechanism that promotes transparency and accountability, is establishing periodic and exhaustive audits by independent organizations aimed at analyzing the specifics of the program in question[1125].

### 7.6. Net Metering

As analyzed before, net metering encourages the installation of grid-connected PV generators owned by the consumers of electricity by providing credit to customers with solar PV systems for the full retail value of the electricity their system generates and injects into the grid[1126]. The Interstate Renewable Energy Council (IREC)[1127] has identified "best practice" net metering rules that have been highly influential in some of the most successful programs of the U.S. these rules are concerned with[1128]:

- Net metering system size.
- Application of Standards.
- Eligibility.
- No extra charges.
- Allowing carry-overs.
- Ownership of environmental benefits.

Oregon has used best practices from other states to implement net metering standards that are among the highest quality in the United States, reason for which, the program has earned recognition as one of the best in the Country by "Freeing the Grid", a policy guide that grades states on their current net metering and interconnection practices[1129].

Unlike many other programs, Oregon's net metering program is inclusive, allowing customers with more than one electric meter on their property to use net metering credits

1122 Petter Langseth (1999). Prevention: An Effective Tool to Reduce Corruption. United Nations Office for Drug Control and Crime Prevention. Available at: https://www.unodc.org/pdf/crime/gpacpublications/cicp2.pdf

1123 Michael Schaeffer (2002). Corruption and Public Finance. USAID. Available at: http://pdf.usaid.gov/pdf_docs/Pnact881.pdf

1124 Michael Schaeffer (2002). Corruption and Public Finance. USAID. Available at: http://pdf.usaid.gov/pdf_docs/Pnact881.pdf

1125 Michael Schaeffer (2002). Corruption and Public Finance. USAID. Available at: http://pdf.usaid.gov/pdf_docs/Pnact881.pdf

1126 Rodolfo Dufo-Lopez et al (2015). A Comparative Assesment of Net Metering and Net Billing Policies, Study Cases for Spain. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S0360544215003254

1127 Established in 1982, IREC is a non-profit organization, and an accredited American National Standards Developer that focuses on advising regulation for clean energy deployment, through the generation of information and objective analysis grounded in best practices and standards to achieve sustainability and economic development through clean energy development. This "Council" is pro renewable energy, hence, its work concerns advising implementation of policies to promote renewable energy, and studying cases of policy success in terms of clean energy deployment throughout the U.S. States, and their key characteristics. As we have seen through Chapter 3, there are several reasons to promote clean energy deployment (mainly: abating climate change, promoting economic development, and advancing electrification to increase quality of life), therefore, this author has chosen to construct this section in light of the findings of IREC, precisely because they are focused at establishing the best policy environment for renewable energy technology to thrive.

1128 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1129 The details of the policy guide and State grades can be consulted at: http://freeingthegrid.org/#state-grades/

at multiple sites[1130]. Oregon's interconnection standards benefit owners of both large and small systems, by setting high limits and reducing unnecessary and redundant safety requirements for smaller systems[1131].

As explained before, in Mexico, residential and low-consuming commercial customers are to be serviced by the Federal Electricity Commission[1132], which has been granted independence in their operations. Therefore, the decision of paying for the electricity sent to the grid by distributed systems would lie on the Federal Electricity Commission itself, as there is currently no mandate in the laws that obligate the Commission to do so.

Currently the commission does not provide for a payment in return for the electricity injected by distributed systems into the grid, instead, they implement what is known as "Net metering with rolling credit"[1133]. Through this application, the banking period extends over a billing period (typically one year), and if during a billing period there is excess energy (IE [imported energy] e EE [exported energy] < 0), this value (EE e IE) is used as a credit to reduce the bill in future billing periods.

In terms of *Net Metering System Size*, upper limits should be at least 2 mw to accommodate large commercial and industrial customers' loads[1134]. The Oregon Public Utilities Commission (PUC) adopted new rules for net metering for the customers of its utilities in July 2007, raising the individual system limit from 25 kilowatts (KW) to two megawatts (MW) for non-residential applications, complying with this good practice element. Mexico's limit is set considerably low for both residential and commercial/industrial customers, for residential customers is set at a maximum of 10KW (The residential limit in Oregon is 25KW), while the commercial/industrial limit is set as low as 30KW[1135], almost 67 times less than the suggested limit advanced by IREC. Hence, the Federal Electricity Commission should explore increasing the limit accordingly.

With respect to *Application of Standards*, they should be applied to all utilities in the state, including investor-owned utilities, municipal utilities, and electric cooperatives[1136]. Oregon's complies with this by mandating that all municipal utilities, electric cooperatives and people's utility districts must offer customers net metering pursuant to Oregon Revised Statutes 757.300. As we analyzed through Chapter 2, in Mexico, customers with input requirements of up to 3MW are to be serviced by the Federal Electricity Commission, so theoretically they all have access to the net-metering program of the Commission under the terms currently set for it. Nevertheless, it is worth noting that there is no legal mandate to guarantee that this program will have to be in operation for a set period or time or indefinitely; being free in its operations, the Federal Electricity Commission, could cancel this program at anytime, this may cause uncertainty in future returns and as such it could

[1130] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

[1131] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

[1132] Customers with input requirements of less than 3 MW of electricity in the first stage of implementation. This 3 MW input demand requirement is programed to be ratchet down throughout a 2-year period until it falls to 1 MW.

[1133] As provided by CFE's interconnection contract available at: http://www.cfe.gob.mx/ConoceCFE/Desarrollo_Sustentable/Lists/Energia%20renovable/Attachments/3/CONTRATODEINTERCONEXIONPEQUE%C3%91AESCALA.pdf

[1134] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

[1135] As provided by CFE's interconnection contract available at: http://www.cfe.gob.mx/ConoceCFE/Desarrollo_Sustentable/Lists/Energia%20renovable/Attachments/3/CONTRATODEINTERCONEXIONPEQUE%C3%91AESCALA.pdf

[1136] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

deter participation.

Regarding *Eligibility*, all renewable technologies and customer classes should be eligible for net metering[1137]. In Oregon, systems that generate electricity using solar power, wind power, hydropower, fuel cells, landfill or digester gas, biomass resources, geothermal energy, or marine energy can access this benefit[1138]. While in Mexico eligible technologies for this program are set to be those specified as such by the "Law for the Use of Renewable Energies and the Financing of the Energy Transition", which in its article 3 advances that wind, solar, hydro, biomass, geothermal, and ocean energy are to be considered renewable. In terms of customer classes, both in Oregon and in Mexico, all customer classes are allowed to access the benefit providing that they comply with the maximum limits described before.

Pertaining to *No-Extra Charges*, utilities should not be allowed to charge extra fees or impose unneeded rules and procedures, such as application fees[1139]. In this regard, in Oregon, utilities may not charge a customer-generator a fee or charge that would increase the customer-generators minimum monthly charge to an amount greater than that of other customers in the same rate class as the customer-generator, however, the Public Utility Commission, may authorize an electric utility to assess a greater fee or charge, of any type, if the electric utility's direct costs of interconnection and administration of the net metering outweigh the distribution system, environmental and public policy benefits of allocating such costs among the electric utility's entire customer base[1140].

The latter obeys to the fact that in recent years, many electric utilities have experienced reduced customer usage driven in part by increased deployment of distributed energy resources[1141]. The rise of these resources has prompted concern by some utilities that flat or declining sales will generate insufficient revenue to cover the fixed costs of maintaining the grid; in response, some utilities have proposed imposing higher fixed charges on their customers[1142]. Fixed charges, also known as customer charges or access fees, are fees customers pay for electric service that do not vary with usage, because they are fixed, the charges cannot be avoided through measures such as energy efficiency or customer-sited renewable resources[1143]. When utilities impose high fixed charges, they increase the proportion of their revenue requirements recovered through such charges, and decrease the proportion recovered through a volumetric, per-kWh energy rate[1144]. Thus, high fixed charges inherently penalize low-use customers, who are often low-income customers, apartment residents, or small businesses, resulting in proportionally higher electric bills for those customers[1145].

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1137 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1138 Oregon Revised Statutes 757.300

1139 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1140 Oregon Revised Statutes 757.300

1141 American Public Power Association (2013). Distributed Generation: An Overview of Recent Policy and Market Developments. Available at: https://www.publicpower.org/files/PDFs/Distributed%20Generation-Nov2013.pdf

1142 American Public Power Association (2013). Distributed Generation: An Overview of Recent Policy and Market Developments. Available at: https://www.publicpower.org/files/PDFs/Distributed%20Generation-Nov2013.pdf

1143 Synapse Energy Economics (2015). Fixed Charges and Utility Consumers. Available at: http://www.synapse-energy.com/sites/default/files/Fixed_Charges_Factsheet.pdf

1144 Synapse Energy Economics (2015). Fixed Charges and Utility Consumers. Available at: http://www.synapse-energy.com/sites/default/files/Fixed_Charges_Factsheet.pdf

1145 Synapse Energy Economics (2015). Fixed Charges and Utility Consumers. Available at: http://www.synapse-energy.com/sites/default/files/Fixed_Charges_Factsheet.pdf

An increasingly popular alternative to fixed charges is the adoption of a minimum bill[1146]. A well-designed minimum bill guarantees the utility a minimum annual revenue level from each customer, even if his or her usage is zero, but does not significantly alter the volumetric, per-kWh rate[1147]. Unlike a fixed charge, a minimum bill does not come into effect unless the customer uses less than a certain amount of power each month, essentially ensuring utilities that even if no power is consumed, the connection is paid for and that every customer contributes at least a minimum amount toward the maintenance of the grid[1148]. The structure of a minimum bill is crucial to its effectiveness, because a poorly structured minimum bill can result in similar negative effects as a high fixed charge[1149]. The key to minimum bills is to set the minimum at a level that ensures the utility a consistent level of appropriate revenue, while not penalizing the vast majority of customers, or inhibiting efficiency[1150]. Minimum bills are determined by calculating the marginal cost to deliver the average daily minimum metered charges per customer. If structured correctly, a minimum bill preserves the incentive to conserve energy by not drastically decreasing the per-kWh energy charge or by shifting the bulk of a bill to a fixed charge, while still providing adequate revenue for the utility[1151].

The caveat embedded in Oregon's provision may give way to interpretations that may in fact present a fixed-cost for program participants, and hence, this is an instance in which the Mexican equivalent program can surpass the design characteristics of Oregon's net metering program. Currently the interconnection agreement in Mexico does not advance any extra costs beyond those required for equipment installation; but again, given that the Commission is free in its operations, exploring the establishment of a mandate that guarantees that no extra costs will be put in place should be pursed. In case issues of reduced customer usage begin posing grid maintenance concerns, then the Ministry of Finance and Public Credit should explore "a minimum-bill" approach towards coping with this issue instead of allowing high-fixed charges[1152].

If the credit from the renewable energy system is not used in the month in which it is generated, excess electricity should be allowed to *Carry-Over* at the utility's full retail rate until the customer leaves the utility[1153]. In Oregon, net excess generation (NEG) is carried over to the customer's next bill as a kilowatt-hour credit for a 12-month period, unless a utility and a customer otherwise agree, the annual billing cycle will conclude at the end of the March billing cycle of each year. Any NEG remaining at the end of a 12-month period will be credited at the utility's avoided-cost rate to customers enrolled in Oregon's low-income assistance programs[1154]. Mexico's net-metering program allows *Carry-Overs* for up to

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1146 Caroline Golin et al. (2015). A Troubling Trend in Rate Design: Proposed Rate Design Alternatives to Harmful Fixed Charges. Southern Environmental Law Center. Available at: https://www.southernenvironment.org/uploads/news-feed/A_Troubling_Trend_in_Rate_Design.pdf

1147 Peter Bronski et al. (2014). The Economics of Grid Defection. Rocky Mountain Institute. Available at: http://homerenergy.com/pdf/RMI_Grid_Defection_Report.pdf

1148 Caroline Golin et al. (2015). A Troubling Trend in Rate Design: Proposed Rate Design Alternatives to Harmful Fixed Charges. Southern Environmental Law Center. Available at: https://www.southernenvironment.org/uploads/news-feed/A_Troubling_Trend_in_Rate_Design.pdf

1149 Caroline Golin et al. (2015). A Troubling Trend in Rate Design: Proposed Rate Design Alternatives to Harmful Fixed Charges. Southern Environmental Law Center. Available at: https://www.southernenvironment.org/uploads/news-feed/A_Troubling_Trend_in_Rate_Design.pdf

1150 Caroline Golin et al. (2015). A Troubling Trend in Rate Design: Proposed Rate Design Alternatives to Harmful Fixed Charges. Southern Environmental Law Center. Available at: https://www.southernenvironment.org/uploads/news-feed/A_Troubling_Trend_in_Rate_Design.pdf

1151 Jim Lazar (2013). Rate Design Where Advanced Metering Infrastructure Has Not Been Fully Developed. Regulatory Assitance Project.

1152 The Ministry of Finance and Public Credit is in charge of setting Tariffs for low input consumers (under 3MW) according to Title 3, Chapter 6, Article 139 of the Electric Industry Law (Ley de la Industria Eléctrica), and article 33 of the Organic Law of the Federal Public Administration (Ley Orgánica de la Administración Pública Federal).

1153 Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

1154 Oregon Revised Statutes 757.300

12 months, however if there is any NEG remaining after, this NEG is to be cancelled[1155], perhaps exploring allowing indefinite *Carry-Overs* throughout the lifetime of the system, or crediting the remaining NEG at the utility's avoided-cost rate to customers[1156], can be explored to enhance the Mexican implementation of this program. Nevertheless, it is worth noting that any of the latter adaptations will inevitably translate in added costs to the program, which could be borne by the Commission itself, or through a special fund allocated for this by the Federal Government.

Moreover, customers should retain *Ownership of the Environmental Benefits* their renewable energy system produces[1157]. This practice is currently undertaken both in Oregon[1158] and in Mexico[1159] where customers retain ownership of all renewable-energy credits (RECs) associated with the generation of electricity.

### 7.7. Carbon Taxes[1160]

Carbon taxes place a value on CO2 and other GHG emissions, thus internalizing some portion of the costs associated with their environmental impact. Carbon taxes serve primarily to reduce GHG emissions by placing a cost on emissions, but can also raise revenues to provide funding for carbon mitigation programs or create market signals for consumers[1161]. Policy design considerations that should be kept in mind when developing such a policy are[1162]:

- The tax base should be plainly advanced.
- Tax Rates should be clearly presented.
- Carbon tax policies should address revenue distribution.
- Potential impact on consumers should be addressed.
- Mechanisms to ensure emission reductions are to be set.

The BC carbon tax was implemented on July 1, 2008. It was borne of a unique confluence of social, political, and economic forces. Public concern over climate change risks surged in Canada and elsewhere during the first decade of the 21st century as a result of mounting scientific evidence of human influence on the climate system increased attention in the press and in popular culture to climate change with a call for political action, and emerging expectations that all major emitting Countries were poised to take

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[1155] As provided by CFE's interconnection contract available at: http://www.cfe.gob.mx/ConoceCFE/Desarrollo_Sustentable/Lists/Energia%20renovable/Attachments/3/CONTRATODEINTERCONEXIONPEQUE%C3%91AESCALA.pdf

[1156] At least to low-income customers as its done in Oregon, given the previously described nexus between electricity access and development.

[1157] Renewable Energy and Energy Efficiency Partnership et al. (2010). Compendium of Best Practices: Sharing Local and State Successes in Energy Efficiency and Renewable Energy in the United States.

[1158] Information provided by the Database of State Incentives for Renewables & Efficiency. Available at: http://programs.dsireusa.org/system/program/detail/39

[1159] As provided by Section 2 of the "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition" (Lineamientos para el Otorgamiento de Certificados de Energías Limpias y los Requisitos para su Adquisición).

[1160] Although their main goal is not directed at spurring deployment of clean energy technologies per se, it has been recognized that their implementation can potentially result in clean energy technology development. This, given that a significant carbon price established by a *tax*, can grant economic sense to clean energy investments that can substitute carbon-intensive hydrocarbon generation which are made expensive by virtue of the *tax,* reason for which we are undertaking this discussion at the "demand-pull" policy section. Lawrence Goulder and Andrew Schein (2013).Carbon Taxes VS. Cap and Trade: A Critical Review.

[1161] Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

[1162] Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf serious action to reduce GHG emissions under the United Nations Framework Convention on Climate Change[1163].

Although there is no available data regarding the encouragement of renewable energy generation deployment caused by the implementation of this tax in British Columbia. Its success can be analyzed in terms of its reduction in emissions of green house gases. Based on official data from British Columbia's provincial government, greenhouse gas emissions from "stationary combustion" (electricity generation, heating, industry, etc.) and transport combined appear to have fallen around 5 percent in the tax's initial four years (2008 to 2012). That equates to a per capita drop of 9 percent, considering the province's 4.5 percent population growth over that span. During the same period, emissions from the rest of Canada reportedly increased slightly[1164].

As explained through Chapter 5, in April 2012, Mexico's Congress passed the General Climate Change Law, which was signed into law in June 2012, this law set the target for a 30% reduction in emissions, below business as usual, by 2020 and a 50% reduction below 2000 levels by 2050[1165]. The current administration has the task of implementing the mandates of the General Climate Change Law of 2012 and hence, with these goals in mind, in October 2013, Enrique Peña Nieto put forward plans for a *Carbon Tax* on fossil fuel production as part of the fiscal reform package of that year, which was further approved by Congress and its now contained in the "Special Production and Services Tax Law". Although this represents a first step in the "right direction" for Mexico, the example of British Columbia's Carbon Tax, can shed light on key provisions that should be explored by this Country if the full benefits of the implementation of this policy are to be reaped.

In terms of the *Tax Base*, it has been found that when implementing carbon taxes, governments must decide which fuels or sources to place the tax; most commonly carbon taxes are placed on gasoline, coal, and natural gas[1166]. Some governments, however, exempt certain industries from carbon taxes or allow those industries to pay lower tax rates, which can potentially negate the emission reduction benefits of the tax[1167].

In British Columbia, the tax covers GHG emissions resulting from the combustion of all fossil fuels used within the province, with some minor exceptions, the taxed fuels include liquid transportation fuels such as gasoline and diesel as well as natural gas or coal used to power electric plants, along with other types of fuels[1168]. It covers 70 – 75% of the province's GHG emissions; the uncovered remaining emissions include non-combustion CO2 in industrial processes (e.g., lime production in cement manufacture), methane (CH4) emissions from natural gas extraction and transmission, methane and nitrous oxide (N2O) emissions from agriculture and CO2 emissions from forestry[1169].

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1163 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1164 Information provided by the "Carbon Tax Center" through: http://www.carbontax.org/where-carbon-is-taxed/british-columbia/

1165 Article 2 of the transitory provisions of the "Climate Change General Law" (Ley General de Cambio Climatico)

1166 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

1167 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

1168 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1169 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

In Mexico the "Special Production and Services Tax Law" provides for a *Carbon Tax* that covers fossil fuel sales and imports by manufacturers, producers, and importers, is not a tax on the full carbon content of fuels, but rather on the additional amount of emissions that would be generated if the particular fossil fuel were used instead of natural gas (natural gas therefore is not subject to the carbon tax)[1170]. Needless to say covering only the extra content of CO2 as compared to natural gas and excluding the latter completely can considerably limit the impact on emission reductions and further negate the potential of this policy to spur renewable technology deployment, and hence including the full carbon content of the fuels and adding natural gas should be explored.

Regarding *Tax Rates*, they should be clearly presented keeping in mind that higher carbon tax rates provide stronger signals to consumers to change behavior, while lower rates may not do much to change behavior but could provide some funds for carbon mitigation programs[1171]. In British Columbia, the tax started at C$10 (Canadian dollar) per ton of carbon dioxide equivalent when introduced in 2008, and it then raised C $5 per ton each year until in 2012 it reached C$30 per ton, at which it remains today[1172]. In Mexico, currently the "Special Production and Services Tax Law" provides for a *Carbon Tax* set at MXN$39.80 (US$3.50) per tCO2-e of fossil fuels[1173] with a cap set at 3% of the sales price of the fuel.[1174]The low tax rate in Mexico could prove to be insufficient to ensure reductions of green house gases to the levels required to reach the goals of the General Climate Change Law and to spur renewable energy deployment, even more considering the lenient tax base previously described, therefore, exploring increasing the rate should be pursued as well, which can be done by the Ministry of Finance and Public Credit by virtue of law[1175].

Moreover, carbon tax policies should address *Revenue Distribution*. Revenues from carbon taxes are directed in different ways: they can be directed specifically to carbon mitigation programs, directed to individuals through measures, such as reductions in income taxes, or used to supplement government budgets[1176].

In British Columbia, one key aspect of the carbon tax is its revenue neutrality. Rather than raise taxes and increase government expenditure, it operates as a tax shift; wherein carbon tax revenues are countered by cuts in other taxes or direct transfers to households[1177]. Every dollar generated by the revenue-neutral carbon tax is returned to British Columbians through tax reductions as a result, B.C. now has the lowest income tax rates in Canada for individuals earning up to $122,000[1178]. The general corporate income tax rate in B.C. is among the lowest in North America and the G7 nations, and since 2001,

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1170 World Bank (2014). Putting a Price on Carbon With a Tax. Available at: http://www.worldbank.org/content/dam/Worldbank/document/SDN/background-note_carbon-tax.pdf

1171 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

1172 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1173 The Law provide for the possibility of modifying the amount of the tax on a yearly basis. The Ministry of Finance and Public Credit is in charge of publishing the potential changes in the Official Federal Gazette.

1174 Article 2 of the "Special Production and Services Tax Law" (Ley del Impuesto Especial Sobre Produccion y Servicios).

1175 Article 2 of the "Special Production and Services Tax Law" (Ley del Impuesto Especial Sobre Produccion y Servicios).

1176 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

1177 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1178 Information provided by the Ministry of Finance of British Columbia through: http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm

B.C.'s small business income tax rate has been reduced by 44 percent[1179]. Revenue neutrality has two main advantages: economists often favor revenue-neutral carbon taxation because it has the potential to enhance economic growth by lowering distortions from the current tax system[1180]; and, it reduces private opposition as it gives businesses "some peace of mind" about their overall tax obligation[1181].

In Mexico the carbon tax is not revenue-neutral, the "Law of Fiscal Coordination" establishes that the revenue streams that derive from the taxes contained in the "Special Production and Services Tax Law" are to be ultimately granted to state governments[1182]. Hence if expanding the tax base and increasing the tax rate will be considered, revenue neutrality can prove to be a powerful tool to build consensus towards a stronger carbon tax policy.

Pertaining to *Potential Impact on Consumers*, when designing a carbon tax, the impact on low-income households is also a consideration; a common criticism of carbon taxes is that they disproportionately burden low-income households[1183]. Policies, including income tax reductions and credits to low-income households, can be used to mitigate this concern[1184]. In British Columbia this issue is also addressed through revenue neutrality, revenue that is collected by the tax is allocated to low-income households with the goal of alleviating concerns related to its distributional incidence[1185]. The revenue recycling mechanisms include the Low Income Climate Action Tax Credit, which (in 2011) provided returns as much as $115.50 per adult and $34.50 per child to households with incomes of less than $31,700 (for singles) or $37,000 (for couples)[1186]. In addition, reductions in the personal income tax rate were implemented on the first two income tax brackets (a 5% reduction in the tax rate for households with income up to about $75,000), resulting in a larger reduction in the average tax rate for low-income individuals compared with high-income individuals[1187]. In Mexico, there are currently no policies in place aimed specifically at counteracting the carbon's tax burden in low income population, hence, evaluating the use of revenue neutrality strategies could be useful as well in this regard. Implementing a specific subsidy could also be explored if revenue neutrality is not considered viable, especially if expanding the base and increasing the rate is to be pursued.

With respect to *Ensuring Emission Reductions,* one of the key arguments against carbon taxes is that taxes do not necessarily guarantee emissions reductions; therefore, a tax policy should be structured so that rates automatically increase if emissions reduction goals are not met[1188]. Neither British Columbia nor Mexico implement this "good practice"

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1179 Information provided by the Ministry of Finance of British Columbia through: http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm

1180 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1181 Clean Energy Canada (2015). How to Adopt a Winning Carbon Price. Available at: http://cleanenergycanada.org/wp-content/uploads/2015/02/Clean-Energy-Canada-How-to-Adopt-a-Winning-Carbon-Price-2015.pdf

1182 Article 4o-A of the Law of Fiscal Coordination (Ley de Coordinacion Fiscal)

1183 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

1184 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

1185 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1186 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1187 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1188 Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf provision, in British Columbia the tax was set to start at C$10 (Canadian dollar) per ton of carbon dioxide equivalent when introduced in 2008, providing for raises of C $5 per ton each year until in 2012 it reached C$30 per ton, at which it remains today[1189]; In Mexico, there was not even a ramp-up schedule incorporated in the Laws, instead the Laws provide for the "possibility" of modifying the amount of the tax on a yearly basis (the Ministry of Finance and Public Credit is in charge of publishing the potential changes in the Official Federal Gazette)[1190]. As such, this is an instance in which the Mexican equivalent program could surpass the policy design characteristics of the example we are currently analyzing, this if the incorporation of a mechanism to increase the rate to ensure emission reductions is pursued. Implementing the latter would require undertaking a legislative process to incorporate a provision in the "Special Production and Services Tax Law" that triggers automatic tax rate increases if the goals set out in the "General Climate Change Law" are not met[1191].

Key differences between Mexico and British Columbia, beyond the ones discussed throughout this analysis, might arise in terms of administrative complexity, "leakage", and corruption. British Columbia's carbon tax has been administratively simple, the tax was designed to "piggyback" on an existing tax levied on British Columbia's fuel wholesalers, a relatively small number of companies — so only a small percentage of businesses (and no citizens) had any new paperwork to complete[1192]. Such an option might not be readily available in Mexico, which means that the process had to start with the administrative obstacles that suppose structuring a new tax. Moreover if a decision to broaden the tax is taken, additional administrative hurdles will arise.

In terms of "leakage", recent analysis indicates that at times, up to a quarter of BC's electricity may be generated by fossil fuel sources outside the province, whose carbon emissions are not covered by the tax. Indeed, this instance of leakage points to the need for adjacent jurisdictions, perhaps especially those linked through the power grid, to enact their own carbon taxes[1193]. Having a National coverage, the Carbon Tax implementation in Mexico is not likely to be impacted by substantial leakage issues, which poses an advantage for Mexico in terms of carbon abatement, however, this can also have economic impacts beyond those shown in British Columbia. The empirical evidence tracked by researchers at the University of Ottawa's Sustainable Prosperity think tank, has shown that British Columbia's economy has slightly out-performed the rest of Canada's since the carbon tax came into effect in 2008[1194]. Nevertheless, this might not tell the full story, the fact that due to "leakage" electricity consumed in British Columbia is generated outside its borders, means that electricity prices have been kept low, as effectively electricity generation is not being taxed – at least not entirely; this in turn, can have helped contain the impacts to the economy associated with high electricity prices, thus negating the full effect of carbon abatement and deployment of clean energy technologies.

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1189 Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf

1190 Article 2 of the "Special Production and Services Tax Law" (Ley del Impuesto Especial Sobre Produccion y Servicios).

1191 Specific amounts of these increases should be determined through analytical processes that evaluate market conditions within the context of broader economic, social, and environmental development goals.

1192 Clean Energy Canada (2015). How to Adopt a Winning Carbon Price. Available at: http://cleanenergycanada.org/wp-content/uploads/2015/02/Clean-Energy-Canada-How-to-Adopt-a-Winning-Carbon-Price-2015.pdf

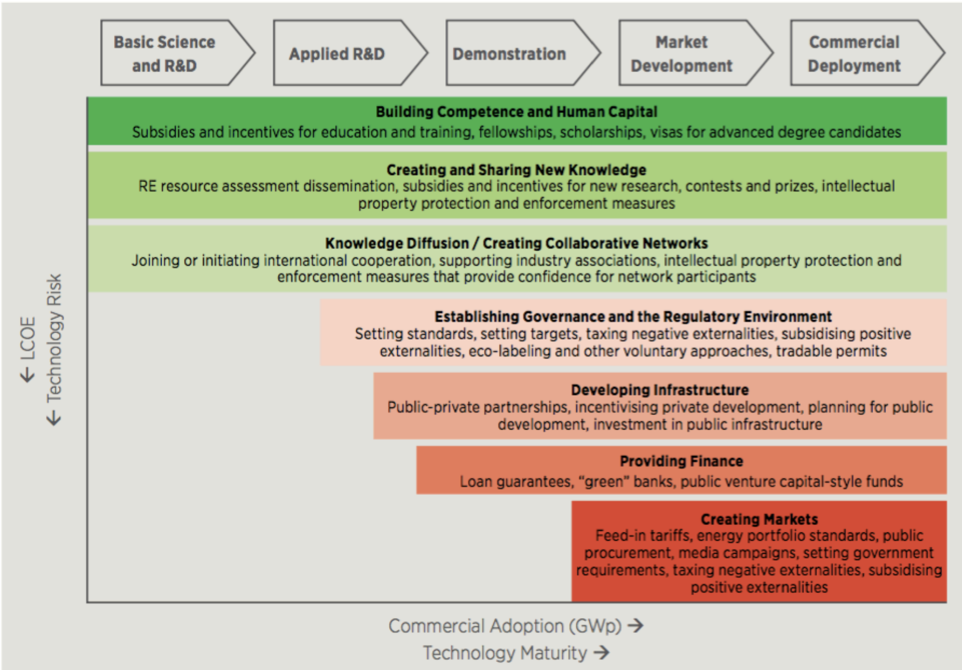
1193 Information provided by the "Carbon Tax Center" through: http://www.carbontax.org/where-carbon-is-taxed/british-columbia/

1194 Clean Energy Canada (2015). How to Adopt a Winning Carbon Price. Available at: http://cleanenergycanada.org/wp-content/uploads/2015/02/Clean-Energy-Canada-How-to-Adopt-a-Winning-Carbon-Price-2015.pdf

As for corruption, given that Mexico has been deemed the most corrupt Country of the OECD[1195], setting strict evaluation parameters of the tax program, and providing for transparency mechanisms in the processes associated with the application of the tax will be of utmost importance to guarantee that the tax is being applied without concessions, and that the resources acquired through it are in fact serving the net-neutrality principle.

### 7.8. Choosing a "Demand-Pull" Policy Portfolio for Mexico

As explained before, "technology-push" instruments facilitate knowledge transfer, and provide direct funding for technological R&D (research and development), improving the perceived cost-benefit ratio of R&D for firms, which in turn alter their routines in favor of explorative activities increasing innovative output[1196]. While "demand-pull" instruments, foster innovation and technical change by addressing market factors and facilitating learning-by-doing[1197][1198]. A policy portfolio that addresses the latter (in addition to "supply-push" policies) will hence be of utmost importance to close the loop of the innovation chain.




[1199]

When developing such a portfolio, it is fundamental to incorporate policies aimed at creating markets, providing finance, developing infrastructure, and establishing a welcoming regulatory environment for clean energy technologies[1200]. Each of the different "demand-pull" policies that have been deemed legally, politically and economically feasible for Mexico can be geared towards addressing key "demand-pull" areas of this innovation chain. Nevertheless, as resources and administrative capacity might be limited, it is important to consider the advantages and disadvantages of each of these policies when constructing a demand-pull policy portfolio, in order to ensure its effectiveness in reaching

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1195 As evidenced by the next news article: http://internacional.elpais.com/internacional/2016/01/28/mexico/1453942417_968156.html
1196 Bessen, J., (2008). The Value of Us Patents by Owner and Patent Characteristics. Research Policy 37(5), 932-945.
1197 The learning curve effect previously described based in the premise that prices decrease with every increase in technology deployment.
1198 Dosi, G., 1988. Sources, Procedures, and Microeconomic Effects of Innovation. Journal of Economic Literature 26(3), 1120-1171.
1199 International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.
1200 International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

the goals set forth. This section aims at aiding the policy-making process by highlighting the advantages and disadvantages as "Pros and Cons" for each policy option.

Accelerated Depreciation

**Pros**

- *Positive investor signals*: The policy allows investors in renewable energy to obtain depreciation benefits earlier than with standard depreciation rules[1201].
- *Short recovery periods spur deployment*- In India, for example, the government permitted a 100% depreciation in year one helping push, amongst developing countries, the largest wind power industry[1202].

**Cons**

- *Excess capital investment without performance considerations*: Large investment due to accelerated depreciation policy without appropriate regard to the long-term performance of operations and maintenance has resulted in lower capacity factors for renewable energy[1203].
- *Not a robust enough incentive*: Accelerated depreciation alone is not a sufficient enough incentive to support clean energy purchase[1204].

Direct Investments

- *Administrative ease*: The money from direct investment goes straight into financing the renewable energy projects. It does not involve lengthy bureaucracy like establishing a kitty and hiring fund managers who pool a big amount of investment and allocate the pool across different sectors and companies[1205].
- *Longevity*: Direct investments are long-term, because renewable energy projects that could last for up to 25 years. It gives a form of predictability and guarantee on the longevity of the investment[1206].

**Cons**

- *Need for long-term funding*: Early adopters of the route of investment have already shown that revenue streams from the investment are post-construction, they usually require constant capital inject to finance stages leading up to construction[1207].

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1201 Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy*, *21*(1), 88–110. http://doi.org/10.1093/oxrep/gri005
1202 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
1203 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
1204 Komor, P. (2004). *Renewable Energy Policy*. iUniverse.
1205 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
1206 Komor, P. (2004). *Renewable Energy Policy*. iUniverse.
1207 Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy*, *21*(1), 88–110. http://doi.org/10.1093/oxrep/gri005

- *Equity gap*: Clean energy projects could still need additional equity contributions upfront given high costs. Direct investment may not cover 100% of funds required to finance the project[1208].
- *High administrative costs*: The investing team must possess the capability to do an evaluation on both credit risk and project risk. There also needs to be long-term evaluation of the project and monitoring[1209].

Shared-Risk Financing

**Pros**

- *Reduced risk*: Through underwriting part or all of a project's debt, lenders are exposed to significantly lesser risk should there be underperformance of the project or default in repayment, which incentivizes lending to clean energy projects[1210].
- *Adaptable:* Loan programs supported by the government can offer below-market interest rates and longer repayment terms to match the actual energy production and cash flow of the project over time[1211].
- *Sustainable:* A shared-risk loan program allows the state to deploy capital and potentially recover it with a return, to be used or loaned again (assuming no defaults)[1212].

**Cons**

- *Default risks*: If a renewable energy project fails to cover its debt and eventually goes bankrupt the shared risk for stakeholders in the venture not getting satisfied momentarily becomes high[1213].
- *High Capital Requirements*: The capital required to establish a public loan fund may exceed that required for rebates or grants since project loans may need to cover a larger share of the project cost[1214].
- *High administrative Costs*: The lending team must have (or sub-contract for) the capability to evaluate both project risk and credit risk. Loan funds also require ongoing loan servicing and monitoring[1215].

Public Procurement

**Pros**

- *Environmental benefit from government's operations*: Green energy public procurement policy helps reduce environmental impacts of government operations.

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1208 Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, *25*(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003

1209 Komor, P. (2004). *Renewable Energy Policy*. iUniverse.

1210 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

1211 Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

1212 Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

1213 Mitchell, C., & Connor, P. (2004). Renewable energy policy in the UK 1990–2003. *Energy Policy*, *32*(17), 1935–1947. http://doi.org/10.1016/j.enpol.2004.03.016

1214 Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

1215 Clean Energy States Alliance (2009). Distributed Renewable Energy Finance and Policy Toolkit. Available at: http://www.cesa.org/assets/Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf

Governments have committed efforts to purchasing green energy as a strategic tool for meeting greenhouse gas emissions reduction[1216].

- *Economic support*: Green public procurement supports the growth of the economy through market development and job creation. Buying clean energy can result in increased employment in a region. When green energy generation facilities situated near the end user, they locally set up jobs and operate them. The majority of local governments are utilizing their power of purchasing to boost regional sectors in manufacturing in the U.S.[1217]
- *Fosters government's leadership role*: Advantages of clean energy are widely known to the public, investing in renewable power supply is a proven way for local governments to show leadership in the community and encourage private investment. A good number of local governments lead communities by encouraging efforts to purchase renewable power[1218].

**Cons**

- *Negative public perception regarding cost*: There is general belief that clean energy products are more expensive on the initial cost, which could cause negative perception in regard to expenses. However, the overall costs often depict a downward trajectory caused by lower maintenance, operating and disposal costs[1219].
- *Lack of sufficient support information*: There is a shortage of information and practical tools concerning green energy products. It is somewhat unrealistic to require procurement officials to adopt green public procurement without easy to comprehend and use tools and structures[1220].
- *Requires public education:* Related to the previous issue, procurement officials need to educate, adequately,on technical and legal processes associated with green public procurement. End users need training on the sustainable use of green energy products[1221].

Renewable Portfolio Standards

**Pros**

- *Assured production results*: Renewable generation assured at a required amount. As a bare minimum, a successful RPS will result in the production of a specified amount of renewable generation. It is unlike other deployment policies that have unpredictable deployment impacts[1222].
- *Maintenance of price pressure*: Renewable energy generators are compelled to reduce prices as there is no set guaranteed price[1223].

[1216] Georgakellos, D. A. (2012). Climate changeexternal cost appraisal of electricity generation systems from a life cycle perspective: the case of Greece. *Journal of Cleaner Production*, *32*, 124–140. http://doi.org/10.1016/j.jclepro.2012.03.030
[1217] Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
[1218] Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, *25*(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003
[1219] Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, *25*(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003
[1220] Georgakellos, D. A. (2012). Climate changeexternal cost appraisal of electricity generation systems from a life cycle perspective: the case of Greece. *Journal of Cleaner Production*, *32*, 124–140. http://doi.org/10.1016/j.jclepro.2012.03.030
[1221] UNEP - Climate Change - Mitigation - Renewable Energy. Available at: http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx
[1222] Mitchell, C., & Connor, P. (2004). Renewable energy policy in the UK 1990–2003. *Energy Policy*, *32*(17), 1935–1947. http://doi.org/10.1016/j.enpol.2004.03.016
[1223] Komor, P. (2004). *Renewable Energy Policy*. iUniverse.

- *Low administrative costs*: Costs incurred are only for government enforcement and monitoring after set goals and agreed upon[1224].
- *Simple and transparent*: Albeit presence of some challenges the policy is simpler and more transparent than many others. Politically, an RPS is attractive for that reason[1225].
- *Avails technology-focused support*: This takes advantage of the combination of regulatory requirements of RPSs with market dynamics, forces to fulfill both RPS carve-out, and avail technology focused support structures[1226].

**Cons**

- *Lack of upfront support*: RPS approach lacks the capability to offer upfront lump sum capital for generation that might be crucial for deployment[1227].
- *Without carve-outs it just favors the cheapest technologies*: Challenges exist with variable costs across different technologies. Expensive technologies will not be able to compete favorably financially and thus will not benefit from renewable portfolio standards if no carve-outs are set[1228].
- *Increased investor risk*- Due to their dependence on RECs, RPS are affected by the same limitations of the former. REC prices variability results in significant risks to investors. When evaluating an investment, the majority of lenders discount the projected value of RECs, which are tradable[1229].
- *Negotiation risks*: Energy generators are exposed to extra risk associated with negotiating contractual agreements for both electricity and renewable energy certificates, which are sold separately[1230].
- *Less economic efficient at reducing carbon emissions than market-based policies*: formal economic analysis advance that an RPS is not an economic efficient alternative to reduce greenhouse gases. This, given that its costs have shown to be higher than those of flexible market-based policies which allow approaches other than renewable energy deployment to achieve carbon emission reductions[1231].

Net Metering

**Pros**

- *Low consumer prices*: With net metering customers are entitled to retail prices for the additional electricity they produce, hence it incentivizes deployment of distributed systems as if this policy was not available, this customers would have to sell their excess electricity generated at lower wholesale prices[1232].

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1224 Komor, P. (2004). *Renewable Energy Policy*. iUniverse.
1225 Komor, P. (2004). *Renewable Energy Policy*. iUniverse.
1226 Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy*, *21*(1), 88–110. http://doi.org/10.1093/oxrep/gri005
1227 Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071
1228 Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy*, *21*(1), 88–110. http://doi.org/10.1093/oxrep/gri005
1229 Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy*, *21*(1), 88–110. http://doi.org/10.1093/oxrep/gri005
1230 Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, *25*(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003
1231 Fischer C, Newell R (2008). Environmental and Technology Policies for Climate Mitigation. Journal of Environmental Economics and Management, 55: 142-162.
1232 Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, *25*(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003

- *Ease of access*: Net metering projects are relatively easier to get permits for and build, they do not encounter many regulatory hurdles or organized lobby opposition usually associated with renewable energy projects of industrial scale[1233].
- *Environmental benefits*: The installation of net metering distributed generation systems linked directly to the grid helps to lessen the demand for power generated by fossil fuels promoting less green house gas emissions[1234].
- *Cheaper alternative*: From the perspective of marginal costs, net metering could provide cheaper power to the local grid than peak electricity[1235].

**Cons**

- *Requires long-term implementation:* Lack of long-term contracts for net metering makes it harder to finance[1236].
- *Dependence on other incentive policies*: Net metering has been historically unable to drive market growth on its own unless combined with other incentives[1237].
- *Competition with main utility providers*: There is a high likelihood of net metering starting to look like a competitor that sells electricity that is higher priced than could be obtained elsewhere[1238].
- *Utility fixed-costs concerns*: Should net metering be taken up by a significant number of customers in the projected future, there could be concerns as to how utilities would continue to cover fixed costs while revenues drop[1239].
- *Regressive cost-impacts:* The option to utilize distributed systems is principally available for those people who own their own homes, rental properties or businesses. This means that most distributed energy installations and all of the government benefits flow to individuals of some means. The unintended outcome of the wealthier utility customers enjoying the benefits of net metering subsidies at the expense of their lower-income neighbors has been labeled the "reverse Robin Hood effect"[1240].

Carbon Taxes

**Pros**

- *Alternative revenue channel*: They provide countries with an alternative source of revenue thus lowering pressure to generate much-needed funds through hikes in income tax and cuts in social programs[1241].
- *Environmental support*: Carbon tax adoption cited as a sure means of stemming global buildup of carbon dioxide and other greenhousegas. Improving countries' ability to

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1233 Pahl, G. (2012). *Power from the People: How to Organize, Finance, and Launch Local Energy Projects*. Chelsea Green Publishing.
1234 Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, *25*(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003
1235 Utilities and Net Metering. Available at: http://www.renewableenergyworld.com/articles/2008/06/utilities-and-net-metering-52703.html
1236 UNEP - Climate Change - Mitigation - Renewable Energy. Available at: http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx
1237 UNEP - Climate Change - Mitigation - Renewable Energy. Available at: http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx
1238 Utilities and Net Metering. Available at: http://www.renewableenergyworld.com/articles/2008/06/utilities-and-net-metering-52703.html
1239 Utilities and Net Metering. Available at: http://www.renewableenergyworld.com/articles/2008/06/utilities-and-net-metering-52703.html
1240 Institute for Energy Research (2013). Net Metering False Free Market Claims and a Regressive Green Tax. Available at: http://instituteforenergyresearch.org/analysis/net-metering-false-free-market-claims-and-a-regressive-green-tax/#_ftn5
1241 Hsu, S.-L. (2012). *The Case for a Carbon Tax: Getting Past Our Hang-ups to Effective Climate Policy*. Island Press.

foster wider initiatives to stabilize greenhousegas levels and avoid or mitigate catastrophic disruption of the climate[1242].

- *Implementation simplicity*: Implementation of Carbon tax is ideal because of its market-based simplicity. Economists agree that prices perhaps are the most efficient way of directing decisions by producers and consumers [1243].
- *Facilitate market transformation:* Greenhouse emissions have a high societal cost regarding their detrimental effects on climate. If set at a high enough level these taxes send a powerful price signal through the costs thus discouraging carbon and greenhouse emissions and promoting clean energy deployment[1244].
- *Efficiency*: Compared to subsidies for alternative fuels, carbon taxes form a more efficient and cheaper means of reducing carbon emissions. For example, big subsidies for bio-fuels have cost a significant amount of money. By lowering gasoline prices, they actually might have perversely raised rather than reduced carbon emissions[1245].

**Cons**

- *No guarantee*: There exists no tangible guarantee that carbon emissions will decrease or than clean energy deployment will increase if consumption of fossil fuels and other sources of emissions do not respond to price increments[1246].
- *Hard to design*: The degree to which carbon taxes would result in the best outcomes are most of the times not accurately predicted in advance, they tend to require several cycles of change and modifications to attain the desired effects[1247].
- *Unpopular*: Being a tax in their very essence, carbon taxes are not popular politically[1248].
- *Political vulnerability*: Carbon taxes exhibit political vulnerability, as it is very likely that a significant price set for a carbon tax to the point required to spur change, might not be politically sustainable[1249].
- *Distributional Impacts*: Studies have found that Carbon Taxes tend to pose a heavier economic burden on low-income consumers than on high-income ones[1250]. This as lower income households spend a larger fraction of their income and, because energy-intensive goods are necessities, they make up a larger share of lower income households' expenditure[1251].

Experience shows that the level of support alone does not necessarily determine success in terms of renewables production. A well-designed support scheme needs to be embedded in a coherent policy framework. Support schemes work best when they are part

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1242 The Many Benefits of a Carbon Tax, The Hamilton Project. Available at: http://www.hamiltonproject.org/papers/the_many_benefits_of_a_carbon_tax/

1243 Report: Carbon tax could halve deficit, The Hill. Available at: http://thehill.com/policy/energy-environment/258773-report-carbon-tax-could-halve-the-deficit-

1244 Hsu, S.-L. (2012). *The Case for a Carbon Tax: Getting Past Our Hang-ups to Effective Climate Policy*. Island Press.

1245 Hsu, S.-L. (2012). *The Case for a Carbon Tax: Getting Past Our Hang-ups to Effective Climate Policy*. Island Press.

1246 A Carbon Tax Will Save the Economy. (2012). http://www.triplepundit.com/2012/10/studies-highlight-economic-benefits-carbon-taxes/

1247 Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.*Energy Policy*, *40*, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062

1248 A Carbon Tax Will Save the Economy. (2012). http://www.triplepundit.com/2012/10/studies-highlight-economic-benefits-carbon-taxes/

1249 A Carbon Tax Will Save the Economy. (2012). http://www.triplepundit.com/2012/10/studies-highlight-economic-benefits-carbon-taxes/

1250 Aparana Mathur and Adele Morris (2012). Distributional Effects of a Carbon Tax in Broader U.S. Fiscal Reform. The Climate and Energy Economic Project. Available: http://www.brookings.edu/~/media/research/files/papers/2012/12/14-carbon-tax-fiscal-reform-morris/14-carbon-tax-fiscal-reform-morris.pdf

1251 Terry Dinan (2012). Offseting a Carbon Tax Costs on Low Income Households. Congressional Budget Office. Available at: https://www.cbo.gov/sites/default/files/cbofiles/attachments/11-13LowIncomeOptions.pdf of a long-term predictable and stable strategic framework with clear objectives[1252]. As we have analyzed, support for deployment of renewables can be implemented in a variety of ways with differing impacts on how the functioning of the market. The means of providing the support can be more or less distorting (less or more corrective), depending on the instrument applied. Just as with "supply-push" policy, which technologies receive "demand-pull" incentives, how much, and through which policy measures is to be determined through analytically structured processes relying on available data; there is no "magic recipe" for clean energy deployment policy, the Federal Government must weight the pros and cons of the different policies, examine their resource availability, and analyze feasibility considerations, this, in order to develop an agenda focused at creating markets, providing finance, developing infrastructure, and establishing a welcoming regulatory environment for clean energy technologies[1253] advised by the best design practices previously identified.

Nevertheless, considering the information advanced throughout this exhaustive study, it is the view of this author that an efficient "demand-pull" policy agenda aimed at promoting deployment of renewable energy at the lowest possible cost for the government, would be one that focuses at the implementation of the next policies.

*Carbon Taxes*

This policy has been chosen given its market-based simplicity. Economists since Adam Smith have insisted that prices are by far the most efficient way to guide the decisions of producers and consumers, which can adjust their behavior in response to this signal in ways that are most efficient for them. As we have analyzed before, this policy is easier to administer than "command and control" regulation, and has also the potential to provide much-needed revenue for the government. Moreover, the transformation of the market through it, is gradual but inevitable (again, providing that the adequate base and rate is set) and hence it has the potential to deliver positive outcomes, while allowing market participants to adjust its activities throughout its implementation, without requiring abrupt "on-the-spot" investments from them.

In terms of abating the "Cons" of this policy in order to increase its chances of success. Its popularity could be increased through "revenue-neutrality" as analyzed through the British Columbia example. Furthermore, "Revenue-neutrality" could also help ameliorate distributional impacts given that the poorest could be compensated for their additional expenditure through tax-neutrality. Pertaining to the lack of guarantees that carbon emissions will decrease, the previously explained automatic rate increase mechanism could provide a way to cope with this issue. Finally the fact that optimal tax rates can be hard to predict, can be overcome - at least to some extent - by undertaking technical analysis of market conditions within the context of broader economic, social, and environmental development goals; in addition the automatic rate increase mechanism could help correct inaccurate rate setting, in practice.

*Accelerated Depreciation*

This policy has been chosen given that it promotes capital investments without requiring any expense from the government. As explained before, most long-lived assets are depreciated in one way or another for tax purposes, hence, depreciation itself does not

[1252] European Commission (2013). European Commission Guidance for the Design of Renewables Support Schemes.
[1253] International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.

pose any costs, as it only incorporates a different schedule for these deductions to take place.

Regarding the "Cons" of this policy, incorporating provisions that mandate certain reasonable performance levels for projects deployed through this policy in terms of meeting a required capacity factor should be explored. Moreover, the fact that it has been found that this policy is not a sufficient enough incentive to support clean energy deployment by itself, calls for a complimentary deployment policy, which can be embodied in a Renewable Portfolio Standard.

*Renewable Portfolio Standards*

They embody a focused policy aimed towards renewable deployment that may provide Mexico with the opportunity to access the economic, developmental, and technological benefits that renewable energy technology provides almost immediately by mandating its deployment. This counteracts the traditional issue faced by Carbon Taxes in terms of the challenge of reaching a rate that sends stringent enough price signals to spur renewable energy technology deployment in practice; while helping to complement *Accelerated Depreciation* as a policy that directly addresses deployment. In addition, the current envisioned RPS policy could be modified to increase its likelihood of success in response to the findings of this study without requiring burdensome afresh policy-making efforts, as it will only entail a few adaptations.

With regard to the "Cons" associated to this policy, capital support for deployment can be provided through the benefits that *Accelerated Depreciation* brings; incorporating carve-outs can help expand its benefit to other technologies beyond those that are currently deemed the cheapest; investor risks derived from variability in REC prices will be inevitable as these prices will depend on the market, however, *Accelerated Depreciation* allows for an extra capital benefit associated with deployment, which can help ameliorate the return risks posed by REC prices variability.

*Shared-Risk Financing*

Just as with R&D Public Finance, this policy has been chosen as it addresses the issue of lack of confidence by commercial banks on clean energy investments. Establishing a private avenue for this type of investments helps to create a market that can operate even if other mechanisms of government support expire in the future. Moreover, given that there is a possibility for repayment embedded in such a mechanism, it is a policy that may have the potential to generate returns, which can deem it, in the most positive of scenarios, an actual source of income for the government. Nevertheless, even in non-optimal scenarios, having some opportunity for repayment raises the possibility of spurring deployment at low costs, or at least lower costs than any kind of grants, which pose no opportunity for repayment.

Regarding the concern of high capital requirements that implementing this policy might pose, establishing the previously described cost-sharing mechanism can ameliorate the government's load. Moreover, in terms of lender's technical capacity, as explained before, establishing a required training program for commercial banks in order to be able to participate in the program and hence access the profit margin, can be explored to cope with the issue.

Pertaining to those policies that have not been chosen as priorities by this author even though they have been deemed feasible in the current Mexican setting. Whilst *Net-Metering* and *Direct Investments* are solid policies, the government is preempted by law of interfering with the Federal Electricity Commission's management decisions, hence it will be up to the Commission's administrative board if they are to consider undertaking them, and in which way. In that sense they have not been deemed as optimal policies to be implemented by the Federal Government, as they are out the scope of its authority.

*Public Procurement* is a policy that requires upfront direct investments from the Federal Government, administration, and oversight, which makes it costly. Furthermore, its capacity for deployment is limited to government-owned buildings, which could have a marginal effect in the system as a whole, and hence it has not been considered as a priority by this author.

*Conclusion*

As Warren Buffet said: "The investor of today does not profit from yesterday's growth." Current oil prices have changed the panorama of the energy sector not only in Mexico, but all across the world. Mexico has to then overcome the "hangover" left by the abrupt change in circumstances derived from the drop in oil prices and understand that investing today for the world of tomorrow can be the key for economic prosperity.

The constitutional energy reform of December 2013 and the secondary laws that followed it, provide Mexico with an unprecedented opportunity to promote economic growth while contributing to the world's climate change abatement efforts through the development of clean technology.

As awareness of climate change advances and the economic benefits of renewable development become more apparent, clean energy is gaining relevance all over the world. Biophysical constraints make a future in which the world satisfies its energy hunger through clean sources, inevitable, and as such, those Countries that invest in developing the technology to cope with that demand will be the ones that thrive in this next "energy race".

Consequently, Mexico should pave the way towards this goal by establishing a welcoming regulatory environment, one in which clean energy technology may thrive. Both, the theoretical and the case study literature agree that successful technological change in renewable energies requires a mix of "supply-push" and "demand-pull" policies to induce innovation and diffusion of renewable energy technologies, and as such Mexico should explore the application of a strong policy agenda aimed at achieving its energy transitional goals in order to access the benefits thereof.

Which policies to undertake, shall not be decided "blindly" but rather guided by the legal, political and economic feasibility considerations that showcase the current viability in the Country of the different policies available to span the innovation chain. Currently most "supply-push" policies are feasible in the Country given the structure of the CONACYT/SENER Sustainability Fund – a big caveat being resource availability, which will inevitably constrain the amount of efforts that can be undertaken in this regard. Pertaining to "demand-pull", there are some policies already in place, some in queue to start operating, and others that aren't currently scheduled, but that are feasible under the current Mexican scenario, which provides this Country with a solid base that can be furthered to close the gap between deployment objectives and results.

Nevertheless, the study of the pre-reform framework evidenced how in the past, policies aimed at spurring renewable energy have been programed to operate, and how they have fallen to serve only as "catalogues of good intentions". Therefore, policy design efforts should be advised through "best practices" derived from mature implementation examples of Countries that have undertaken those "supply-push" and "demand-pull" policies deemed as feasible under the current Mexican scenario, in order to increase their likelihood of success.

Which technologies receive incentives, how much, and through which policy measures is to be determined through analytically structured processes relying on available data. There is no "magic recipe" for clean energy policy, the Federal Government must weight the pros and cons of the different policies, examine their resource availability, and analyze their viability, this, in order to develop an agenda focused at promoting the creation and sharing of knowledge; improving knowledge diffusion by establishing collaborative networks; creating markets; providing finance; and developing infrastructure, ultimately establishing a welcoming regulatory environment for clean energy technologies to prosper.

Hence, this dissertation has aimed to objectively expose the context of the Mexican electricity system, present the benefits that the diversification of energy sources could bring to Mexico, showcase the importance of a cohesive "supply-push" and "demand-pull" policy agenda to span the clean energy innovation chain, reveal the current feasibility levels of the available "supply-push" and "demand-pull" policy in Mexico, and advance "best practices" for policy design in light of mature implementation examples; this, with the purpose of advising the required policy making efforts to close the gap between objectives and results in the Mexican electricity sector.

**References**

**Laws, Statutes, Regulations and Resolutions:**


- Mexico's Constitution.
- Mexico's Law of the Public Service of Electric Energy (Ley del Servicio Público de Energía Eléctrica).
- Mexico's Law of the Energy Regulatory Commission (Ley de la Comisión Reguladora de Energía).
- Mexico's Law for the Use of Renewable Energies and the Financing of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética).
- Mexico's Law of the Federal Electricity Commission (Ley de la Comisión Federal de Electricidad).
- Mexico's Electric Industry Law (Ley de la Industria Eléctrica).
- Mexico's Law of Geothermal Energy (Ley de Energía Geotérmica).
- Mexico's Organic Law of the Federal Public Administration (Ley Orgánica de la Administración Pública Federal).
- Mexican Petroleums Law (Ley de Petroleos Mexicanos).
- Mexico's Federal Law of Budget and Treasury (Ley Federal de Presupuesto y Responsabilidad Hacendaria)
- Mexico's Law of Science and Technology (Ley de Ciencia y Tecnologia)
- Mexico's Law of Credit Institutions (Ley de Instituciones de Credito).
- Mexico's Federal Income Tax Law, (Ley del Impuesto Sobre la Renta)
- Mexico's "Federal Law for State-Owned Enterprises" (Ley Federal de Entidades Paraestatales), applies to this Fund.
- Mexico's National Works and Public Services Bank Law (Ley del Banco Nacional de Obras y Servicios Publicos).
- Mexico's Law of Fiscal Coordination (Ley de Coordinacion Fiscal)
- Mexico's Regulation of the Law of the Energy Regulatory Commission (Reglamento de la Ley de la Comisión Reguladora de Energía).
- Mexico's Federal Law for Economic Competition (Ley Federal de Competencia Economica)
- Mexico's Regulation of the Law of the Public Service of Electric Energy (Reglamento de la Ley del Servicio Público de Energía Eléctrica), Chapter 6, article 47.
- Mexico's "Guidelines for Granting Clean Energy Certificates and the Requisites for their Acquisition" (Lineamientos para el Otorgamiento de Certificados de Energías Limpias y los Requisitos para su Adquisición).
- Mexico's Rules of the Electricity Market.
- Mexico's "Special Production and Services Tax Law" (Ley del Impuesto Especial Sobre Produccion y Servicios).
- Mexico's "Climate Change General Law" (Ley General de Cambio Climatico)
- Mexico's Federal Expense Budget 2015
- Mexico's Federal Expense Budget 2016

- Formal resolution by the Energy Regulatory Commission #RES/207/2011 (RESOLUCION Núm. RES/207/2011 Commission Reguladora de Energía).
- "Electric Industry Law" decree project.
- Filing 22/2001 of the Mexican Supreme Court of Justice.
- Fiscal Code of Mexico City (Codigo Fiscal del Distrito Federal).
- U.S. Internal Revenue Code.
- 26 USC § 168(e)(3)(B)(vi))
- 26 USC § 48(a)(3)(A)
- US. Inspector General Act of 1978
- Job Creation and Worker Assistance Act of 2002, Pub. L. 107-147.
- U.S. Congress: P.L. (Public Law) 110–185.
- U.S. Congress: P.L. (Public Law) 111-5.
- U.S. Congress: P.L. (Public Law) 111–312.
- U.S. Congress: P.L. (Public Law) 99-514.
- I.R.C. § 168(e)(3)(B)(vi)
- New Zealand's State-Owned Enterprises Act of 1986.
- German KfW-Law
- Oregon Revised Statutes 757.300
- Bellingham's City Council Resolution #2006-28


**Agencies, Organizations and Governments Programs and Reports:**


- Mexico's Energy Regulatory Commission (2012). Reserve Capacity Open Season Program Details. Available at: http://www.cre.gob.mx/documento/2317.pdf
- Mexico's Ministry of Energy (2012). Renewable Energy Prospective 2012-2016. Available at: http://sener.gob.mx/res/PE_y_DT/pub/2012/PSE_2012_2026.pdf
- Energy Information Administration (2004). Changes in U.S. Natural Gas Transportation Infrastructure. Office of Oil and Gas. Available at: http://www.eia.gov/pub/oil_gas/natural_gas/feature_articles/2005/ngtrans/ngtrans.pdf
- U.S. Energy Information Administration. Natural Gas Exports to Mexico. Available at: http://www.eia.gov/dnav/ng/hist/n9132mx2m.html
- Mexico's Ministry of Energy (2009). Special Program for the Use of Renewable Energies. Available at: http://dof.gob.mx/nota_detalle.php?codigo=5101826&fecha=06/08/2009
- Mexico's Federal Government (2014). Expanded Explanation of the Energy Reform of 2013. Available at: http://reformas.gob.mx/wp-content/uploads/2014/04/Explicacion_ampliada_de_la_Reforma_Energetica1.pdf
- Mexico's Federal Electricity Commission (2012). Infrastructure and Investment Electricity Sector Program 2012-2026. Available at: http://sener.gob.mx/res/index/Proyectos%20y%20Obras%20Transmisi%C3%B3n.pdf
- Mexico's Ministry of Energy (2013). Electric Sector Prospective 2013-2027. Available at:

http://sener.gob.mx/res/PE_y_DT/pub/2013/Prospectiva_del_Sector_Electrico_2013-2027.pdf

- Mexico's CONACYT/SENER Sustainability Fund (2013) Mexican Centers of Energy Innovation Report. Available at: http://sustentabilidad.energia.gob.mx/res/CEMIE_General.pdf
- Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (2007). Climate Change: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC.
- World Health Organization (2003). Climate Change and Human Health Risks and Responses. Available at: http://www.who.int/globalchange/publications/climchange.pdf
- IPCC (2007). Fourth Assessment Report: Climate Change 2007. Available at: http://www.ipcc.ch/publications_and_data/ar4/syr/en/mains5-4.html
- Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Available at: http://srren.ipcc-wg3.de/
- University of Massachusetts (2009). The Economic Benefits of Investing in Clean Energy, This report can be found at: http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF
- Union of Concerned Scientists (2013). Renewables: Energy You Can Count. Available at: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/Renewable-Electricity-Standards-Deliver-Economic-Benefits.pdf
- United States Agency for International Development (2011). Hybrid Mini-Grids for Rural Electrification: Lessons Learned. Available at: http://www.ruralelec.org/fileadmin/DATA/Documents/06_Publications/Position_papers/ARE_Mini-grids_-_Full_version.pdf
- Energy Access Practitioner Network (2013). Towards Achieving Universal Access by 2030. United Nations, Sustainable Energy For All. Available at: http://www.se4all.org/wp-content/uploads/2013/09/FINAL-ESG-ALL.pdf
- World Energy Council (1993). Energy for Tomorrow's World, Kogan Page Ltd. (London, UK).
- Goldemberg, J, Energy for a Sustainable World Population, in Polunin, and Nazim, M (1994). Population and Global Security, United Nations Population Fund (UNFPA), Geneva, Switzerland.
- World Energy Outlook (2012). Executive Summary. Available at: http://www.iea.org/publications/freepublications/publication/english.pdf
- IPCC (2013). Fifth Assessment Report (AR5). Available at: http://www.ipcc.ch/.ur
- German Federal Network Agency, Photovoltaic systems : data messages as well as feed-in tariff rates, found at: http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/Photovoltaik/DatenMeldgn_EEG-VergSaetze/DatenMeldgn_EEG-VergSaetze_node.html

- International Energy Agency (2013). PVPS Annual Report 2013. Available at: www.iea-pvps.org/index.php?id=6&eID=dam_frontend_push&docID=2040
- Mexico's Ministry of Energy (2013). Renewable Energy Prospective 2013-2027. Available at: http://www.sener.gob.mx/res/PE_y_DT/pub/2013/Prospectiva_Energias_Renovables_2013-2027.pdf
- Sustainable Energy For All Initiative, The Secretary-General's High-level Group on Sustainable Energy for All found at: http://www.un.org/wcm/content/site/sustainableenergyforall/home/Initiative
- Overview Study of Mexico prepared by the Department of Energy of The United States found at: http://www.geni.org/globalenergy/library/national_energy_grid/mexico/LatinAmericanPowerGuide.shtml
- U.S. Embassy in Mexico report regarding renewable energy, found at: http://photos.state.gov/libraries/mexico/310329/july2014/2014_07_Renewable%20Energy.pdf
- Rebecca Williams (2015). Paris 2015: Getting a Global Agreement on Climate Change. Available at: http://www.greenalliance.org.uk/resources/Paris%202015-getting%20a%20global%20agreement%20on%20climate%20change.pdf
- Commonwealth of Massachusetts, Biomass Sustainability and Carbon Policy Study found at: http://www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-chapter6.pdf
- World Business Council for Sustainable Development. Recommendations on Biomass Carbon Neutrality – Report. Available at: http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=15347&NoSearchContextKey=true
- Hydroelectricity Review by the Environmental Protection Agency of the United States, found at: http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html
- Renewable Portfolio Standard Eligibility Guidebook, prepared by the California Energy Commission, found at: http://www.energy.ca.gov/2013publications/CEC-300-2013-005/CEC-300-2013-005-ED7-CMF-REV.pdf
- Ocean Energy Review, California Energy Commission, found at: http://www.energy.ca.gov/oceanenergy/
- National Science Foundation (2004) Science and Engineering Indicators Report. Available at: http://www.nsf.gov/statistics/seind04/c5/c5s1.htm
- Life Cycle Emissions Analysis Report, prepared by the Nuclear Energy Institute, found at: http://www.nei.org/Issues-Policy/Protecting-the-Environment/Life-Cycle-Emissions-Analyses
- UNEP (2005). Public Finance Mechanisms to Catalyse Sustainable Energy Sector Growth. United Nations Environment Programme (UNEP), Paris, France. Available at: www.uneptie.org/energy/activities/sefi/pdf/SEFI_PublicFinanceReport.pdf.
- Infodev (2010). Global Good Practice in Incubation Policy Development and Implementation. Available at: http://www.infodev.org/infodev-files/resource/InfodevDocuments_834.pdf

- OECD (2004). Public-Private Partnership for Research and Innovation: An Evaluation of the Dutch Experience Available at: http://www.oecd.org/netherlands/25717044.pdf
- Laura Tyson and Greg Linden (2012). "The Corporate R&D Tax Credit and U.S. Innovation and Competitiveness," Center for American Progress. http://www.americanprogress.org/issues/tax-reform/report/2012/01/06/10975/the-corporate-rd-tax-credit-and-u-s-innovation-and-competitiveness/.
- Shally Venugopal and Aman Srivastava (2012). Glossary of Financial Instruments. World Resources Institute. Available at: http://www.wri.org/sites/default/files/pdf/glossary_of_financing_instruments.pdf
- United Nations Environmental Program (2012). Financing Renewable Energy in Developing Countries. Available at: http://www.unepfi.org/fileadmin/documents/Financing_Renewable_Energy_in_subSaharan_Africa.pdf
- Jenna Goodward and Mariana Gonzales (2010). The Bottom Line on Renewable Tax Credits. World Resources Institute. Available at: http://www.wri.org/sites/default/files/pdf/bottom_line_renewable_energy_tax_credits_10-2010.pdf
- Dsire Solar (2012). Dsire Solar Policy Guide. Available at: http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2015/09/Solar-Policy-Guide.pdf
- Intergovernmental Panel on Climate Change (2011). Special Report on Renewable Energy Sources and Climate Change Mitigation. Chapter 11. Available at: http://srren.ipcc-wg3.de/
- KfW Entwicklungsbank (KfW Development Bank) 2005. Financing Renewable Energy: Instruments, Strategies, Practice Approaches. Available at: https://www.kfw-entwicklungsbank.de/Download-Center/PDF-Dokumente-Diskussionsbeitr%C3%A4ge/38_AMD_E.pdf
- European Commision DG Environemnt (2011). Green Public Procurement, Technical Background Report. Available at: http://ec.europa.eu/environment/gpp/pdf/tbr/electricity_tbr.pdf
- The U.S. President's Climate Action Plan, 2013, available at: https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf
- National Renewable Energy Laboratory (2014). Renewable Portfolio Standards, Resources and Technical Assistance. Available at: http://www.nrel.gov/docs/gen/fy14/62350.pdf
- Gabriela Elizondo et al (2011). Design and Performance of Policy Instruments to Promote the Development of Renewable Energy: Emerging Experience in Selected Developing Countries. The World Bank. Available at: http://siteresources.worldbank.org/EXTENERGY2/Resources/DiscPaper22.pdf
- European Wind Energy Association. Position on Priority Dispatch of Wind Power. Available at: http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA_position_on_priority_dispatch.pdf

- Energy Information Administration (2013). Further Sensitivity Analysis of Hypothetical Policies to Limit Energy-Related Carbon Dioxide Emissions. Available at: https://www.eia.gov/forecasts/aeo/supplement/co2/
- Mexico's National Development Plan (Plan Nacional de Desarrollo), available at: http://pnd.gob.mx/
- Mexico's Ministry of Energy (2013). "National Energy Strategy". Available at: http://www.energia.gob.mx/res/PE_y_DT/pub/2013/ENE_2013-2027.pdf
- Mexico's Ministry of Energy (2014). Special Program for the Use of Renewable Energies 2014-2018. Available at: http://vmwl1.iie.org.mx/sitioIIE/sitio/control/11/6PEAER2014-2018.pdf
- Mexico's Ministry of Energy (2014). Transition Strategy for the Use of Cleaner Technologies and Fuels 2014-2018. Available at: www.dof.gob.mx/nota_to_doc.php?codnota=5376675
- NREL (2010). A policy Makers Guide to Feed-In-Tariff Policy Design. Available at: http://www.nrel.gov/docs/fy10osti/44849.pdf
- Energy Information Administration (2013). Further Sensitivity Analysis of Hypothetical Policies to Limit Energy-Related Carbon Dioxide Emissions. Available at: https://www.eia.gov/forecasts/aeo/supplement/co2/
- International Energy Agency (2011). Good Practice Policy Framework for Energy Technology Research, Development and Demonstration. Available at: https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
- International Renewable Energy Agency (2013). Renewable Energy Innovation Policy: Success Criteria and Strategies.
- NSFs Office of the Inspector General (2015). Semiannual Report to Congress Available at: http://www.nsf.gov/pubs/2015/oig15002/oig15002.pdf
- NRCan, Office of Energy (2014). Clean Energy Fund Summary Report. Available at: http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/files/pdf/CLEAN-ENERGY-FUND-ENG-FINAL-may-29.pdf
- Departmental Evaluation Committee, NRCan (2014). Clean Energy Fund Evaluation Report. Available at: http://www.nrcan.gc.ca/evaluation/reports/2014/16534#a2-0
- NREL (2002). National Renewable Energy Laboratory, 25 years of excellence report. Available at: http://www.nrel.gov/docs/gen/fy02/30845.pdf
- OECD (2004). Public-Private Partnerships for Research and Innovation: An Ealuation of the Dutch Experience. Available at: http://www.oecd.org/netherlands/25717044.pdf
- U.S. Department of Energy , Office of the Inspector General (1999). Audit conducted to NREL. Available at: http://energy.gov/ig/downloads/audit-report-wr-b-99-05
- National Research Council (2001). Review of the Research Program of the Partnership for a New Generation of Vehicles. Available at: http://www.nap.edu/read/10180/chapter/1
- U.S. Council for Automotive Research (1996). PNGV Technical Accomplishments.
- U.S. General Accounting Office (2000). Results of U.S.-Industry Partnership to Develop a New Generation of Vehicles, Report to Congress, available at:

https://books.google.com/books?id=fAJspw3l3aMC&pg=PA8&lpg=PA8&dq=operational+steering+group+PNGV&source=bl&ots=UcaW-HGMqV&sig=H1laVJucu1foHEt-1fzwYflZLGw&hl=en&sa=X&ved=0ahUKEwiW4JfI0JPLAhUEKGMKHc2LCgoQ6AEIJjAE#v=onepage&q=operational%20steering%20group%20PNGV&f=false

- U.S. Partnership for Renewable Energy Finance (2013). MACRS Depreciation and Renewable Energy Finance. Available at: http://www.ourenergypolicy.org/wp-content/uploads/2014/01/MACRSwhitepaper.pdf
- National Research Council (2007). Innovation Inducement Prizes. Available at: http://www.nap.edu/catalog.php?record id=11816
- European Investment Bank (2013). Second Evaluation of the Risk Sharing Finance Facility. Available at: http://www.eib.org/attachments/ev/ev_second_evaluation_of_rsff_en.pdf
- OECD (2013). Policy Guidance for Investment in Clean Energy Infraestructure. Available at: http://www.oecd.org/g20/topics/energy-environment-green-growth/CleanEnergyInfrastructure.pdf
- European Investment Bank (2010). Information Report: EIB New Products and Special Transactions Division Knowledge Economy / RD&I. Available at: http://www.eib.org/attachments/rsff_faq_31052007.pdf
- Clean Energy Canada (2015). How to Adopt a Winning Carbon Price. Available at: http://cleanenergycanada.org/wp-content/uploads/2015/02/Clean-Energy-Canada-How-to-Adopt-a-Winning-Carbon-Price-2015.pdf
- World Bank (2014). Putting a Price on Carbon With a Tax. Available at: http://www.worldbank.org/content/dam/Worldbank/document/SDN/background-note_carbon-tax.pdf
- Illinois Power Agency IPA (2013). Annual report: the costs and benefits of renewable resource procurement in Illinois under the Illinois power agency and Illinois public utilities acts. Available at: https://www.illinois.gov/ipa/Documents/201304-IPA-Renewables-Report.pdf
- Bureau of Economic Analysis (2013). RIIMS II: An Essential Tool for Regional Developers and Planners. Available at: https://bea.gov/regional/pdf/rims/RIMSII_User_Guide.pdf
- KfW Entwicklungsbank (KfW Development Bank) 2005. Financing Renewable Energy: Instruments, Strategies, Practice Approaches. Available at: https://www.kfw-entwicklungsbank.de/Download-Center/PDF-Dokumente-Diskussionsbeitr%C3%A4ge/38_AMD_E.pdf

**Academic Publications:**

- Herzog (1973). Historia de la Expropiación de las Empresas Petroleras. Instituto Mexicano de Investigaciónes Económicas.
- Tip. Garrido (1939). La expropiación petrolera en México y sus consecuencias económicas: recopilación de artículos de la prensa Mexicana.
- Paul L. Joskow (2008). Lessons Learned from Electricity Market Liberalization. Page 11. The Energy Journal. Available at: http://economics.mit.edu/files/2093

- The Stern Review on the Economics of Climate Change, 2006. found at: http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf
- Dosi, G., 1988. Sources, Procedures, and Microeconomic Effects of Innovation. Journal of Economic Literature 26(3), 1120-1171.
- Grubler and Wilson (2011). Lessons from the history of technology and global change for the emerging clean technology cluster. World Economic and Social Survey 2011.
- Huenteler J. The Impact of Technology Policy on Technical Change: Assessing Alternative Pathways to Competitiveness of Renewable Energy Technologies. RWTH Aachen. 2011.
- Michael Grubb 2004. Technology Innovation and Climate Change Policy: an overview of issues and options. Keio Journal of Economics.
- Aleman-Nava et al (2014). Renewable Energy Research Progress in Mexico: A Review. Elsevier doi:10.1016/j.rser.2014.01.004
- Douthwaite, B. (2002). Enabling Innovation: A Practical Guide to Understanding and Fostering Technological Change. Zed Books, London, England
- Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.
- Lichtenberg, F.R., 1986. Energy prices and induced innovation. Research Policy 15 (2), 67–75.
- Newell, R.G., Jaffe, A.B., Stavins, R.N., 1999. The induced innovation hypothesis and energy-saving technological change. Quarterly Journal of Economics 114,
- Nemet, G., 2009. Demand-pull, Technology-push, and government-led incentives for non-incremental technical change. Research Policy 38 (5), 700–709
- Bessen, J., (2008). The Value of Us Patents by Owner and Patent Characteristics. Research Policy 37(5), 932-945.
- Kemp, R., 1997. Environmental Policy and Technical Change. A Comparison of the Technological Impact of Policy Instruments. Edward Elgar, Cheltenham.
- Rennings, K., 2000. Redefining innovation – eco-innovation research and the contribution from ecological economics. Ecological Economics 32, 319–332.
- Grossman, G., Helpman, E., 1991. Innovation and Growth in the Global Economy. MIT Press, Cambridge, MA.
- Ricardo J. Caballero & Adam B. Jaffe, 1993. "How High are the Giants' Shoulders: An Empirical Assessment of Knowledge Spillovers and Creative Destruction in a Model of Economic Growth," NBER Working Papers 4370, National Bureau of Economic Research, Inc.
- Joelle Noailli, Victoria Shestalova. Knowledge Spillovers from Renewable Energy Technologies. Netherlands Bureau for Economic Analysis.
- Dechezleprêtre, A. R. Martin, M. Mohnen, 2013, Knowledge spillovers from clean and dirty technologies: A patent citation analysis, downloadable at http://personal.lse.ac.uk/dechezle/DMM_sept2013.pdf
- Peters, M., Schneider, M., Griesshaber, T., Hoffmann, V.H., 2012. The impact of technology-push and demand-pull policies on technical change—does the locus of policies matter? Research Policy, Forthcoming.

- P.A. Geroski (2000). Models of Technology Diffusion. Elsevier Science B.V.
- "Innovation Inducement Prizes at the National Science Foundation" (The National Academies Press, Washington, D.C.).
- Carbon Capture and Storage Development Trends from a Techno-Paradigm Perspective. Bobo Zheng and Jiuping Xu. Energies Journal. 2014, 7, 5221-5250; doi:10.3390/en7085221
- Jaffe, Newell, Stavins (2002). Environmental Policy and Technological Change. Environmental and Resource Economics 41-69 (2002)
- Peters, M., Schneider, M., Griesshaber, T., Hoffmann, V.H., 2012. The impact of
- Thomas Helbling (2012). Externalities: Prices do no Capture All Costs. International Monetary Fund. Op Ed
- Peters, M., Schneider, M., Griesshaber, T., Hoffmann, V.H., 2012. The impact of technology-push and demand-pull policies on technical change—does the locus of policies matter? Research Policy, Forthcoming.
- Bush, V., 1945. Science the endless frontier: a report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development Report - United States Government Printing Office
- Johnstone, N., Hasˇcˇicˇ, I., Popp, D., 2009. Renewable energy policies and technological innovation: evidence based on patent counts. Environmental and Resource Economics 45, 133–155.
- Industrial dynamism and the creation of a "virtuous cycle" between R&D, market growth and price reduction: The case of photovoltaic power generation (PV) development in Japan. Chichiro Watanabe, Kouji Wakabayashi, Toshinori Miyazawa (2000). Elsevier. doi:10.1016/S0166-4972(99)00146-7
- Kline, S., Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy. Academy of Engineering Press, Washington.
- Carbon Capture and Storage Development Trends from a Techno-Paradigm Perspective. Bobo Zheng and Jiuping Xu. Energies Journal. 2014, 7, 5221-5250; doi:10.3390/en7085221
- Vennevar Bush (1945). Science the Endless Frontier.
- Roll-Hansen, Nils ( 2009). Why the distinction between basic (theoretical) and applied (practical) research is important in the politics of science. The London School of Economics and Political Science.
- Witters et al. (2012). The Role of Public-Private Partnerships in Driving Innovation. The Global Innovation Index. Available at: http://www.wipo.int/export/sites/www/econ_stat/en/economics/gii/pdf/chapter2.pdf
- David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf
- Qiang Fu et al (2011). Incentivizing R&D: Prize or Subsidies? Elsevier 2011.
- Michael Hendrix (2014). The Power of Prizes. U.S. Chamber of Commerce Foundation. Available at:

http://www.uschamberfoundation.org/sites/default/files/article/foundation/Power%20of%20Prizes_0.pdf

- Jonathan Adler (2011). Eyes on the Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization. Available at: http://paloaltoprize.com/wp-content/uploads/2014/09/Prizes_EYES_ON_A_CLIMATE_PRIZE_CaseWestern_3_2011.pdf
- Mary Moore (2013). Incentivizing U.S. Innovation: Enhancing the R&D Credit. Grant Thornton. Available at: http://www.grantthornton.com/staticfiles/GTCom/Public%20companies%20and%20capital%20markets/RD-Credits-Perspective-May2013-FINAL.pdf
- Bronwyn Hall and John Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," Research Policy29, no. 4–5 (April 2000): 449–69, doi:10.1016/S0048-7333(99)00085-2.
- Bessen, J., (2008). The Value of Us Patents by Owner and Patent Characteristics. Research Policy 37(5), 932-945.
- Mark Bolinger (2014). An Analysis of the Costs, Benefits, and Implications of Different Approaches to Capture the Value of Renewable Energy Tax Incenctives. Lawrence Berkeley National Laboratory. Available at: http://eetd.lbl.gov/sites/all/files/lbnl-6610e_0.pdf
- Wiser, R., and S. Pickle (2000). Renewable Energy Policy Options for China: Feed In Laws and Renewable Portfolio Standards Compared. Center for Resource Solutions, San Francisco, CA, USA.
- Connor, P., V. Bürger, L. Beurskens, K. Ericsson, and C. Egger (2009). Overview of RES-H/RES-C Support Options. D4 of WP2 from the RES-H Policy project. University of Exeter, Exeter, UK. Available at: www.res-h-policy.eu/downloads/RES-H_Policy-Options_(D4)_fi nal.pdf.
- Galen Barbose et al (2015). Costs and Benefits of the Renewable Portfolio Standards in the United States. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032115008229
- Pablo del Rio et al (2014). Back to the future? Rethinking Auctions for Renewable Energy Support. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114002007
- Angeliki Kylili et al (2014). Competitive auction mechanisms for the promotion renewable energy technologies: The case of the 50 MW photovoltaics projects in Cyprus. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114008399
- Angeliki Kylili et al (2014). Competitive auction mechanisms for the promotion renewable energy technologies: The case of the 50 MW photovoltaics projects in Cyprus. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114008399
- Fan Zhang (2013). How Fit are Feed in Tariffs, Evidence from the European Wind Market. World Bank Policy Research Working Paper. WPS 6376.
- Rodolfo Dufo-Lopez et al (2015). A Comparative Assessment of Net Metering and Net Billing Policies, Study Cases for Spain. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S0360544215003254
- Dr. Dörte Fouque et al. Rules on grid access and priority dispatch for renewable

energy in Europe. Bekker Buttner Held. Available at: http://www.keepontrack.eu/contents/virtualhelpdeskdocuments/grid-access_7691.pdf

- Lawrence Goulder and Andrew Schein (2013).Carbon Taxes VS. Cap and Trade: A Critical Review. Available at: http://web.stanford.edu/~goulder/Papers/Published%20Papers/Goulder%20and%20Schein%20-%20Carbon%20Taxes%20vs%20Cap%20and%20Trade%20-%20Cl%20Ch%20Economics.pdf
- G. Wagner (2015). Carbon Cap and Trade. Available at: http://www.sciencedirect.com/science/article/pii/B9780123750679000711
- Erik Delaure and Kenneth Van Den Bergh (2016). Carbon Mitigation in the Electric Power Sector Under Cap-and-Trade and Renewable Policies. Available at: http://www.sciencedirect.com/science/article/pii/S0301421516300295
- Study prepared by Leonardo Beltran, current Underminister of Energy Transition, this study is available at: http://energiaadebate.com/el-fondo-de-sustentabilidad-energetica-impulso-al-desarrollo-tecnologico/
- Tom Giovanneti (2015). How Tax Uncertainty Harms Economic Growth: Agricultural Investment and Section 179. Institute for Policy Innovation. Available at: http://www.ipi.org/ipi_issues/detail/how-tax-uncertainty-harms-economic-growth-agricultural-investment-and-section-179
- Galen Barbose (2015). The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States, Summary Report. Available at: https://emp.lbl.gov/sites/all/files/lbnl-188238_presentation.pdf
- Jessie Jenkins and Sara Mansur (2011). Bridging the Clean Energy Valleys of Death. Available at: http://thebreakthrough.org/blog/Valleys_of_Death.pdf
- Robert Poulton (2008). The Role of Cost-Sharing as a Signal of Quality in the Federal Funding of Academic Research: an Application to the National Science Foundation.
- Daniel Sperling (2001). Public-private Technology R&D Partnerships: Lessons From U.S. Partnership For a New Generation of Vehicles. Available at: http://www.uctc.net/research/papers/585.pdf
- David Trinkle (2010). A Vehicle For Change: PNGV, an Experiment in Government-Industry Cooperation. Available at: http://www.rand.org/content/dam/rand/pubs/rgs_dissertations/2010/RAND_RGSD253.pdf
- Robert M. Chapman (1998). The Machine That Could: PNGV, A Government-Industry Partnership. Available at: https://www.rand.org/content/dam/rand/pubs/monograph_reports/1998/MR1011.pdf
- Alan Maccormack et al. (2013). Spurring Innovation Through Competition. MIT Management Review, available at: http://sloanreview.mit.edu/article/spurring-innovation-through-competitions/
- Jonathan Bays et al (2009). Using Prizes to Spur Innovation. McKinsey 7 Company, available at: http://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/using-prizes-to-spur-innovation
- Fiona Murray et al.(2012). Grand Innovation Prizes: A Theoretical, Normative, and

Empirical Evaluation. Available at: http://mitsloan.mit.edu/shared/ods/documents/Murray_2012_GrandInnovation.pdf&PubID=5446

- Anadon, L.D., et al. (2009). "Tackling U.S. Energy Challenges and Opportunities: Preliminary Policy Recommendations for Enhancing Energy Innovation in the United States", Belfer Center Newsletter, Belfer Center for Science and International Affairs, Harvard Kennedy School, Cambridge, MA.
- Dosi, G. (1988). Sources, Procedures, and Microeconomic Effects of Innovation. Journal of Economic Literature 26(3), 1120-1171.
- Molly F. Sherlock (2010). Energy Tax Policy: Historical Perspectives and Current Status of Energy Tax Expenditures, Congressional Research Service.
- Sadie Cox (2016). Financial Incentives to Enable Clean Energy Deployment. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65541.pdf
- Timothy Irwin and Chiaki Yamamoto (2004). Some Options for Improving the Governance of State-Owned Electric Utilities. The World Bank. Available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/Irwin_Some_Options_for.pdf
- Spicer, Barry, Robert Bowman, David Emanuel, and Alister Hunt (2001). The power to manage: restructuring the New Zealand Electricity Department as a State-Owned Enterprise—the Electricorp experience. Auckland: Oxford University Press.
- Brumby, Jim, Michael Hyndman, and Stuart Shepherd (1998). "State Owned Enterprise Governance: Focus on Economic Efficiency" in Corporate Governance, State-Owned Enterprises and Privatization. OECD Proceedings.
- Romain Hubert, et al. (2013). Public Finance Institutions and the Low-Carbon Transition Case Study: KfW Bankengruppe. Available at: http://www.cdcclimat.com/IMG/pdf/14-09_kfw_case_study.pdf
- Virginie Marchal, and Geraldine Ang. (2012). "Climate and Energy Policy in Germany: Mechanisms to Encourage Private Sector Investment/participation in Low-carbon Development: A Case Study of Germany's Building Sector Prepared by the German Federal Environment Agency and KfW". OECD
- Christopher Payne et al. (2013). Energy-efficient Public Procurement: Best Practice in Program Delivery. Lawrence Berkeley National Laboratory.
- Sandie Cox and Sean Esterly (2016). Renewable Electricity Standards: Good Practices and Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy16osti/65507.pdf
- David Hurbult (2008). State Clean Energy Practices: Renewable Portfolio Standards. NREL. Available at: http://www.nrel.gov/tech_deployment/state_local_governments/pdfs/43512.pdf
- Brown, Adam, and Simon Muller. (2011). Deploying Renewables 2011: Best and Future Policy Best Practice. International Energy Agency. Available at: http://www.iea.org/publications/freepublications/publication/deploying-renewables-2011.html
- Rodolfo Dufo-Lopez et al (2015). A Comparative Assesment of Net Metering and Net Billing Policies, Study Cases for Spain. Elsevier. Available at: http://www.sciencedirect.com/science/article/pii/S0360544215003254
- Jenny Summer et al. (2009). Carbon Taxes: A Review of Experience and Policy

Design Considerations. NREL. Available at: http://www.nrel.gov/docs/fy10osti/47312.pdf

- Brian Murray and Nicholas Rivers (2015). British Columbia's Revenue-Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf
- N. Nakicenovic, K. Riahi (2002): An Assessment of Technological Change Across Selected Energy Scenarios RR-02-005, International Institute for Applied Systems Analysis, Laxenburg, Austria. Reprinted from a publication by the World Energy Council (WEC) on behalf of the Study Group on Energy Technologies.
- Georgakellos, D. A. (2012). Climate changeexternal cost appraisal of electricity generation systems from a life cycle perspective: the case of Greece. Journal of Cleaner Production, 32, 124–140. http://doi.org/10.1016/j.jclepro.2012.03.030
- Hsu, S.-L. (2012). The Case for a Carbon Tax: Getting Past Our Hang-ups to Effective Climate Policy. Island Press.
- Komor, P. (2004). Renewable Energy Policy. iUniverse.
- Mallon, K. (2012). Renewable Energy Policy and Politics: A Handbook for decision-making. Routledge.
- Kitzing, L., Mitchell, C., & Morthorst, P. E. (2012). Renewable energy policies in Europe: Converging or diverging? Energy Policy, 51, 192–201. http://doi.org/10.1016/j.enpol.2012.08.064
- Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. Energy Policy, 35(3), 1844–1857. http://doi.org/10.1016/j.enpol.2006.06.005
- Masini, A., & Menichetti, E. (2012). The impact of behavioral factors in the renewable energy investment decision-making process: Conceptual framework and empirical findings.Energy Policy, 40, 28–38. http://doi.org/10.1016/j.enpol.2010.06.062
- Assmann, D. (2012). Renewable Energy: A Global Review of Technologies, Policies, and Markets. Routledge.
- Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. Energy Policy, 37(12), 4997–5006. http://doi.org/10.1016/j.enpol.2009.06.071
- Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. Oxford Review of Economic Policy, 21(1), 88–110. http://doi.org/10.1093/oxrep/gri005
- Pahl, G. (2012). Power from the People: How to Organize, Finance, and Launch Local Energy Projects. Chelsea Green Publishing.
- Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. Renewable Energy, 24(1), 73–89. http://doi.org/10.1016/S0960-1481(00)00186-5

- Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. Technovation, 25(7), 753–761. http://doi.org/10.1016/j.technovation.2003.12.003
- Wiser, R., Bollinger, M., Barbose, G., Belyeu, K., Hand, M., Heimiller, D., …Subin, Z. (2008). Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2006. Lawrence Berkeley National Laboratory. Retrieved from http://escholarship.org/uc/item/8gw154pn


**News Articles, Blogs, and Press Releases:**


- Carlos Rodriguez (2012). U.S. Shale Glut Means Gas Shortage for Mexican Industry: Energy. Bloomberg, available at: http://www.bloomberg.com/news/2012-09-03/u-s-shale-glut-means-gas-shortage-for-mexican-industry-energy.html
- Victor Ballinas (2014). The Secondary Reforms of Peña Nieto Weaken Pemex and CFE: PRD. La Jornada: http://www.jornada.unam.mx/2014/05/07/politica/008n1pol
- Alma Munoz (2014). The Federal Government Wants to Hand Mexican Resources to Foreign Interests: Cardenas. La Jornada: http://www.jornada.unam.mx/ultimas/2014/07/16/reforma-energetica-acelera-la-desaparicion-de-pemex-y-cfe-cardenas-6162.html
- Matilde Perez (2013). There will be More Violence With the Energy Reform of the PAN and PRI: AMLO. La Jornada: http://www.jornada.unam.mx/2013/07/23/politica/005n1pol
- PROCESO (2014). The Energy Reform Only Benefits Foreign Oil Companies: AMLO. Available at: http://www.proceso.com.mx/?p=377597
- Santiago Carvajal (2008). 10 Reasons to Reject the Energy Reform. Available at: http://tecamachalco.net/10-razones-por-las-cuales-rechazamos-la-reforma-energetica.html#.VhgA0rcyEvs
- Sinembargo (2014). In Ten Years, Three Presidents Filed at Energy Reform Attempts, Congress stopped them. Available at: http://www.sinembargo.mx/20-06-2013/660436
- CNN Expansion (2012). PAN: Two Presidential Periods Ignoring Oil Dollars. Available at: http://www.cnnexpansion.com/economia/2012/07/03/la-reforma-energetica
- Alex Forbes (2014). New Energy Era For Mexico As Reforms Become Law. Gas Tech News. Available at: http://www.gastechnews.com/lng/new-energy-era-for-mexico-as-reforms-become-law/
- Nicholas Casey (2013). Mexico Proposes Opening Electric Sector to Competition. Wall Street Journal. Available at: http://www.wsj.com/articles/SB10001424127887324085304579010993985696728
- Imelda Garcia (2013). Congress Approves the Energy Reform. CNN Expansion. Available at: http://www.cnnexpansion.com/economia/2013/12/12/diputados-aprueban-reforma-energetica

- Elizabeth Ruiz (2014). Renewable Energies, the Way for Mexico. El Economista. Available at: http://eleconomista.com.mx/entretenimiento/2014/03/12/energias-renovables-rumbo-mexico
- Robert Fares (2015). Methane Leakage from Natural Gas Production Could Be Higher Than Previously Estimated. Scientific American Blog. Available at: http://blogs.scientificamerican.com/plugged-in/methane-leakage-from-natural-gas-supply-chain-could-be-higher-than-previously-estimated/
- Jude Webber (2014). Oil Price Plunges Raises Energy Reform Concerns. Financial Times. Available at: http://www.ft.com/cms/s/0/5715257e-7cd3-11e4-b944-00144feabdc0.html#axzz3oT77pZdc
- Ana Lydia Valdez (2010). The New "Laguna Verde". CNN Expansion. Available at: http://www.cnnexpansion.com/obras/2010/01/11/la-nueva-laguna-verde
- Gus Schaefer. The Value of Public-Private Partnerships in Driving Innovation."the Congress Blog". Available at: http://thehill.com/blogs/congress-blog/economy-a-budget/318805-the-value-of-public-private-partnerships-in-driving-innovation
- CONACYT (2015). Enrique Peña Nieto Presides the General Council of Research and Technological Development. Press Release. Available at: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/458-preside-enrique-pena-nieto-el-consejo-general-de-investigacion-cientifica-y-desarrollo-tecnologico-e-innovacion
- Mauricio Rubi (2015). Mexico and the European Union Agree on Research and Development Collaboration. El Economista. Available at: http://eleconomista.com.mx/entretenimiento/2015/06/14/mexico-ue-mas-colaboracion-investigacion-desarrollo
- CONACYT (2014). Formalization of Disbursement Agreements to Form Three Mexican Centers of Innovation in Renewable Energy. Press Release. Available at: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/312-formalizacion-de-los-convenios-de-asignacion-de-recursos-para-tres-centros-mexicanos-de-innovacion-en-energias-renovables-cemie-s
- CONACYT (2014). Public and Private Sectors Agree on Forming an Alliance in Favor of Innovation. Press Release. Available at: http://www.conacyt.mx/index.php/comunicacion/comunicados-prensa/371-a-propuesta-del-conacyt-los-sectores-publico-y-privado-acuerdan-una-alianza-en-favor-de-la-innovacion
- Carolina Reyes, Karla Ponce y Felipe Gazcon (2016). Less Privileges to Allow More Revenue. Excelsior. Available at: http://www.excelsior.com.mx/nacional/2013/09/09/917770
- CNN Mexico (2013). The New Taxes That Will Have to be Paid in 2014. Available at: http://mexico.cnn.com/nacional/2013/10/31/cuales-son-los-nuevos-impuestos-que-pagaras-en-2014
- Yussel Gonzalez (2015). Fiscal Reform: The Savior of the Budget for 2016. CNN Expansion. Available at: http://www.cnnexpansion.com/economia/2015/09/09/los-impuestos-salvaran-las-finanzas-publicas-en-2016

- Notimex (2015). Public Finance Dependence on Oil Fell: SHCP. La Jornada. Available at: http://www.jornada.unam.mx/ultimas/2015/06/09/cayo-dependencia-del-petroleo-en-finanzas-publicas-shcp-7391.html
- Redaccion Huellas (2015). OCDE Reduces Growth Expectations for Mexico. Prensa Latina. Available at: http://huellas.mx/nacional/2015/11/09/ocde-recorta-expectativas-de-crecimiento-economico-en-mexico/
- Patricia Tapia and Leonor Flores (2014). Federal Government Presents Energy Funds. Milenio. Available at: http://www.milenio.com/negocios/Presenta-gobierno-fondos-energia-economia-financiera-Banobras-Nafin_0_382761755.html
- Notimex (2016). CFE Will Invest 4800 Million Dollars in Renewable Energies. El Economista. Available at: http://eleconomista.com.mx/industrias/2015/03/05/cfe-invertira-4800-mdd-energias-renovables
- ER (2015). Acciona and CFE Sign Agreement To Spur Renewable Energies. Energias Renovables Available at: http://www.energias-renovables.com/articulo/acciona-y-la-cfe-firman-acuerdo-para-20151019
- Forbes Staff (2015). Salinas Group Obtains a Concession for a Geothermal Project. Forbes Mexico. Available at: http://www.forbes.com.mx/grupo-salinas-obtiene-concesion-para-proyecto-de-energia-geotermica/
- Notimex (2015). Mexico has a Firm Commitment With Green Development: Peña. Radio Formula. Available at: http://www.radioformula.com.mx/notas.asp?Idn=548750&idFC=2015
- Notimex (2015). Renewable Energies are a Synonym of Equity and Strength: Joaquin. Radio Formula. Available at: http://www.radioformula.com.mx/notas.asp?Idn=505320&idFC=2015
- Elias Medina (2015). CFE Will Sell Solar Panel to Their Clients: Ochoa Reza. El Sol de Mexico. Available at: http://www.oem.com.mx/elsoldemexico/notas/n3759248.htm
- Elias Medina (2015). CFE Will Invest 2 Thousand Million Pesos in Baja California Sur: Ochoa Reza. El Sol de Mexico. Available at: http://www.oem.com.mx/elsoldepuebla/notas/n3736793.htm
- Notimex (2015). Mexico and Quebec Agree on Collaboration Against Climate Change. Zocalo Saltillo. Available at: http://www.zocalo.com.mx/seccion/articulo/acuerdan-mexico-y-quebec-fortalecer-cooperacion-en-cambio-climatico-1444693
- Leonora Chapman (2015). Mexico Interested in Quebec's Carbon Market. Radio Canada. Available at: http://www.rcinet.ca/es/2015/10/13/mexico-interesado-en-el-mercado-de-carbono-de-quebec/
- Ricardo Homs (2016). Mexico is the Most Corrupt Country of the OCED. El Universal. Available at: http://www.eluniversal.com.mx/blogs/ricardo-homs/2016/01/28/mexico-el-pais-mas-corrupto-de-la-ocde
- NREL (2012). Alliance to Continue Management of National Renewable Energy Laboratory. Press Release. Available at: http://www.nrel.gov/news/press/2012/2002
- PIAXP (2009). 5.5 Million in Funding From U.S. DOE to Further Competition Goals. Press Release. Available at: http://auto.xprize.org/news-events/press-release/55-million-in-funding-from-us-doe-to-further-goals-of-competition

- Peter Diamandis (2011). Congratulations to the PIAXP Winners. Huffington Post. Available at: http://www.huffingtonpost.com/peter-diamandis/congratulations-to-the-wi_b_718840.html
- Ryan (2015). President Signs New Tax Act With Depreciation Changes. PRNews Wire. Available at: http://www.prnewswire.com/news-releases/president-signs-new-tax-act-with-depreciation-changes-300195934.html
- Yussel Gonzalez (2015). 7 Fiscal Changes Proposed by the Ministry of Finance and Public Credit for 2016. CNN Expansion. Available at: http://www.cnnexpansion.com/economia/2015/09/08/6-cambios-fiscales-que-propone-hacienda-para-2016

**Websites**

- Mexican Center of Geothermal Energy Innovation site: http://www.cemiegeo.org/index.php/ProjInvest?id=2
- Emission Data Base for Global Atmospheric Research, European Commission, which can be found at: http://edgar.jrc.ec.europa.eu/part_CO2.php
- Washington State University. Natural Gas Methane Study. Overview. https://methane.wsu.edu/program-overview/
- Nasa. Global Methane Inventory. http://icp.giss.nasa.gov/education/methane/intro/cycle.html
- Geographic Information System for Renewable Energies in Mexico (SIGER): http://sag01.iie.org.mx/evaluarer/CNRegistroSIGER.asptp://www.helioscsp 47
- North American Center for Transborder Studies. U.S.-Mexico Renewable Energy Development and Exchange. http://gis.clas.asu.edu/EnergySources/?index.html
- Atomic insight. Energy Density Comparison. http://atomicinsights.com/energy-density-comparison/
- "The Innovation Policy Platform" OECD. https://www.innovationpolicyplatform.org/content/universities-and-public-research-institutes
- Live Science. How is Uranium Enriched? http://www.livescience.com/6463-uranium-enriched.html
- Policonomics. The Learning Curve. http://www.policonomics.com/learning-curve/
- Lawrence Berkeley National Laboratory Site. http://www.lbl.gov/about/
- Database of State Incentives for Renewables & Efficiency. Available at: http://www.dsireusa.org/
- Solar Energy Industry Associations. Solar investment Tax Credit. http://www.seia.org/policy/finance-tax/solar-investment-tax-credit
- "The American Wind Energy Association". Federal Production Tax Credit. http://awea.files.cms-plus.com/2015%20PTC%20Handout.pdf
- Arizona Solar Center. State Tax Credits. http://www.azsolarcenter.org/economics/incentives/state-tax-credits.html

- Clean Energy Authority. Solar Rebates and Incentives Colorado. http://www.cleanenergyauthority.com/solar-rebates-and-incentives/colorado/sales-tax-exemption-for-renewables/
- United States Internal Revenue Service. Depreciation Overview. https://www.irs.gov/Businesses/Small-Businesses-&-Self-Employed/A-Brief-Overview-of-Depreciation
- U.S. Department of Energy. Loan Program Office Site. http://www.energy.gov/lpo/about-us-home
- The U.S. Energy Information Administration through: http://www.eia.gov/todayinenergy/detail.cfm?id=11471
- Clean Energy Solutions Center. Priority Dispatch Resources. https://cleanenergysolutions.org/cegin/resources/priority-dispatch
- The "Carbon Tax Center". What is a Carbon Tax. http://www.carbontax.org/whats-a-carbon-tax/
- CONACYT. Open Call For Proposals of the CONACYT/SENER Sustainability Fund. http://www.conacyt.mx/index.php/el-conacyt/convocatorias-y-resultados-conacyt/convocatorias-fondos-sectoriales-constituidos/convocatoria-sener-conacyt-sustentabilidad-energetica/convocatorias-abiertas-sener-conacyt-sustentabilidad-energetica
- Ministry of Finance and Public Credit. Economic Packet 2016. http://www.shcp.gob.mx/ApartadosHaciendaParaTodos/ppef2016/index.html
- OilPrice.Net. Real Time Oil Price. http://www.oil-price.net/
- Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food. Shared-Risk Fund. http://www.sagarpa.gob.mx/quienesomos/datosabiertos/firco/Paginas/default.aspx
- New York State. Renewable Portfolio Standard Frequently Asked Questions. http://www.nyserda.ny.gov/All-Programs/Programs/Main-Tier/FAQs#funded
- California Carbon Dashboard. Carbon Price. http://calcarbondash.org/
- Federal Business Opportunities. Call For Proposals. https://www.fbo.gov/index?s=opportunity&mode=form&id=ad1f92ce9c8df1dc297005aac290f7e2&tab=core&_cview=0.
- National Science Foundation. "Energy for Sustainability" program. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026
- National Science Foundation. Awards Granted Under the "Energy for Sustainability" Call for Proposals. http://www.nsf.gov/awardsearch/advancedSearchResult?WT.si_n=ClickedAbstractsRecentAwards&WT.si_x=1&WT.si_cs=1&WT.z_pims_id=501026&ProgEleCode=7644&BooleanElement=Any&BooleanRef=Any&ActiveAwards=true&#results
- National Science Foundation. Organizational Structure. http://www.nsf.gov/about/index.jsp
- CONACYT. Explanation of How R&D Incentive Programs are Developed. http://www.conacyt.mx/index.php/fondos-y-apoyos
- National Science Foundation. Director of the division of Astronomical Sciences profile. https://www.nsf.gov/news/news_summ.jsp?cntn_id=116331

- National Science Foundation. Specifics of the Merit Review System”. http://www.nsf.gov/about/how.jsp
- U.S. Energy Information Administration. Analysis of Mexico. http://www.eia.gov/countries/cab.cfm?fips=mx
- CONACYT. National Researcher System Details. http://www.conacyt.gob.mx/index.php/el-conacyt/sistema-nacional-de-investigadores
- Numbeo. Cost of Living Comparisons. http://www.numbeo.com/cost-of-living/compare_countries_result.jsp?country1=Mexico&country2=United+States
- CONACYTs. Annual Reports. http://www.conacyt.gob.mx/siicyt/index.php/indicadores-cientificos-y-tecnologicos
- Natural Resources Canada. Clean Energy Fund Overview.http://www.nrcan.gc.ca/energy/funding/current-funding-programs/17905
- Natural Resources Canada. Profile of the Assistant Deputy Minister of the Environment. https://www.ec.gc.ca/default.asp?lang=En&n=BC5E38F9-1
- U.S. Department of Energy. Technology to Market Program. http://energy.gov/eere/sunshot/technology-market
- U.S. Department of Energy. Sun Shot Program: http://energy.gov/eere/sunshot/sunshot-incubator-program
- U.S. Department of Energy. Organizational Structure: http://energy.gov/leadership/organization-chart
- U.S. Department of Energy. Profile of the Director of the Office of Solar Energy Technologies. http://energy.gov/eere/sunshot/leadership
- U.S. Department of Energy. Data Base of Semiannual Reports to Congress by the Office of the Inspector General. http://energy.gov/ig/listings/semiannual-reports-congress
- R&D Magazine. R&D 100 awards. http://www.rd100awards.com/
- National Renewable Energy Laboratory. Patent List. http://techportal.eere.energy.gov/search.xhtml?action=presetSearch&labID=10
- National Renewable Energy Laboratory. Leadership. http://www.allianceforsustainableenergy.org/leadership.html
- National Renewable Energy Laboratory. Publications Database. http://www.nrel.gov/research/publications.html
- National Renewable Energy Laboratory. Programs by Focus Area: http://www.nrel.gov/research/
- National Renewable Energy Laboratory. Yearly Budgets. http://www.nrel.gov/about/funding-history.html
- X-PRIZE Foundation. PIAXP Overview. http://auto.xprize.org/about/overview
- X-PRIZE Foundation. PIAXP Guidelines. http://auto.xprize.org/about/guidelines
- X Prize Foundation. PIAXP Judges. http://auto.xprize.org/about/judges-advisors
- X Prize Foundation. List of PIAXP Teams. http://auto.xprize.org/teams
- European Commission. Research Funding Program. http://ec.europa.eu/invest-in-research/funding/funding02_en.htm

- Profiles of all European Commission Directors: http://ec.europa.eu/about/ds_en.htm
- European Investment Bank. Rules, Policies and Procedures. http://www.eib.org/about/structure/control_and_evaluation/index.htm
- Mexico's Servicio de Administracion Tributaria Site. http://www.sat.gob.mx/que_sat/Paginas/default.aspx
- U.S. Internal Revenue Service Site. https://www.irs.gov/uac/The-Agency,-its-Mission-and-Statutory-Authority
- Federal Electricity Commission. Director's Profile. http://www.cfe.gob.mx/ConoceCFE/1_AcercadeCFE/Paginas/Semblanza-del-Director-General.aspx
- European Union Renewable Energy Database and Support. Renewable Energy Support in Germany. http://www.res-legal.eu/search-by-country/germany/tools-list/c/germany/s/res-e/t/promotion/sum/136/lpid/135
- Centre for Solar Energy and Hydrogen Research Evaluation. KFW evaluation. http://www.buildup.eu/en/news/kfw-bank-publishes-evaluation-report-renewable-energy-promotion-programmes-20132014
- Inter-American Development Bank. Climate Financing Program. http://www.iadb.org/en/topics/climate-change/climate-change-and-sustainability,19086.html
- Mexican Ministry of Energy. Public Procurement Program. http://www.energia.gob.mx/portal/Default.aspx?id=2936
- Database of State Incentives for Renewables & Efficiency: http://www.dsireusa.org/
- Illinois Chamber of Commerce. Renewable Portfolio Standards. https://www.icc.illinois.gov/electricity/RenewablePortfolioStandards.aspx
- Mexico's Ministry of Finance and Public Credit. Minimum Salary Information. http://www.sat.gob.mx/informacion_fiscal/tablas_indicadores/Paginas/salarios_minimos.aspx
- Freeing the Grid. Policy Guide. http://freeingthegrid.org/#state-grades/
- Carbon Tax Center. British Columbia Carbon Tax. http://www.carbontax.org/where-carbon-is-taxed/british-columbia/
- Ministry of Finance of British Columbia. Tax Cuts Funded by the Carbon Tax. http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm
- Triple Pundit. The Economic Benefits of Carbon Taxes. http://www.triplepundit.com/2012/10/studies-highlight-economic-benefits-carbon-taxes/
- UNEP. Climate Change Mitigation, Renewable Energy. http://www.unep.org/climatechange/mitigation/RenewableEnergy/tabid/29346/Default.aspx
- Renewable Energy World. Utilities and Net Metering. http://www.renewableenergyworld.com/articles/2008/06/utilities-and-net-metering-52703.html

**Miscellaneous**

- CFE's interconnection contract available at: http://www.cfe.gob.mx/ConoceCFE/Desarrollo_Sustentable/Lists/Energia%20renovable/Attachments/3/CONTRATODEINTERCONEXIONPEQUE%C3%91AESCALA.pdf
- Organizational Manual of the National Council of Science and Technology (CONACYT).
- Operation Rules of the CONACYT/SENER Sustainability Fund
- National Science Foundation, Program Solicitation #12-513: http://www.nsf.gov/pubs/2012/nsf12513/nsf12513.htm
- U.S. Department of Energy, Opportunity Announcement Number DE-FOA-0000651
- U.S. Congressional Budget Requests, 2016
- The Organization Manual of the U.S. Internal Revenue Service