FULL-SCALE PROJECT CONCEPT PAPER

Plan of Action for the Large-Scale and Sustainable Implementation of Renewable Energy in Mexico

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Project Objectives and Rationale

The purpose of this project is to create the proper environment for the large scale and sustainable implementation of renewable energy in Mexico. This will be done by introducing the proper legal, regulatory, institutional, financial and infrastructure elements to facilitate the creation of a competitive and sustainable market. Implementation of this project is expected to facilitate the operation of all stakeholders promoting the application of renewables in Mexico, and to help build consensus and synergy around common goals and objectives.

The development objective of this project is to avoid annual CO₂ emissions in Mexico by about 10 Mtons through the voluntary commercial installation and operation of renewable energy technologies, to deliver electricity and/or process heat. The operational objectives are to: remove identified barriers, reduce implementation costs, reduce long-term technology costs, raise consumer awareness, build capacities of public, private and social entities, strengthen/create technology intermediation centers, develop strategies and policy frameworks, help create new financing services and new institutions, in order to facilitate the installation and operation of the chosen renewable energy technologies.

The main motivations to launch this project are: Mexico is a country endowed with a large variety of natural resources. Renewable energy resources are plentiful, but with the exception of geothermal energy and large hydropower, they remain virtually untapped. Reasons for this include: other sources of energy, such as oil and associated fuels are also plentiful; per-capita energy consumption is still low for an OECD country; environmental concerns have not been traditionally high in the country’s agenda; the cost of renewables has been higher than that of conventional energy technologies; a set of direct and hidden subsidies are still in effect in the Mexican energy market. However, as the economy grows and the standard of living increases; and as local environmental awareness grows, turning Mexico into a major player in the international environmental scene, the need for more and cleaner energy will certainly grow.

In the medium and long term Mexico’s oil resources can be used to fuel the transition to a cleaner and more sustainable energy base, buying time to help local industry prepare for the new energy business, not only as users, but also as producers and exporters of the new energy technology. Revenues from oil exports can also help create the infrastructure (human, technical and institutional) needed to support this transition.

Mexico’s role in the UNFCCC process

Mexico ratified the UNFCCC in 1993, and the Kyoto Protocol in 2000. It has prepared national communications reports with updated national emission inventories. In response to the requirements of Article 3 of the Kyoto Protocol, in 1997 Mexico implemented a National Action Program for Climate Change (NAPCC) prepared by an inter-agency committee¹. The NAPCC includes the following energy terms: increased production and use of natural gas; increased fuel

¹ Integrated by the Environment, Energy, Foreign Relations, Commerce, Communications and Transport, and Agriculture ministries.
quality; use of economically viable renewable energy; and savings and efficient use of energy. Mexico’s population of almost 100 million inhabitants is responsible for nearly 1.48% of global CO$_2$ emissions (13th worldwide). In contrast, per capita emissions (3.46 tons of CO$_2$/inhabitant per annum) place the country in the 72nd position worldwide. The breakdown of CO$_2$ emissions by sector (1990) was as follows: land conversion and forestry (31%), transformation and energy industries (25%), transport (21%), other industry (15%), residential and commercial (5%), industrial processes (3%), other (1%). In context of the UNFCCC will take voluntary actions to limit GHG emissions without restricting its economic development.

**Vision of the future**

**What Renewables Can Offer to Mexico**

The large scale use of renewables will bring potential benefits, beyond kilowatts and kilowatt-hours, including an alternative path to development, more benign to the environment but with the same goals of economic well being, social stability and environmental security; energy security; new and competitive energy markets; new energy technologies; and restructured energy industries.

**Macroeconomic.** Cost advantages can be gained by producing both, useful forms of energy and new energy technologies. Renewables are the most cost-effective solution for remote power supply, and could become cost-competitive for grid-connected and industrial applications, if all costs and benefits are included in the economic analysis. Renewables offer good opportunities for participation in the already expanding markets for new power technology, which will allow the creation of new jobs, reactivation of stagnant industries, and creation of new forms of the energy business.

**Industrial Policy.** Technological requirements for the manufacture of renewable energy technologies are well within the already existing capabilities of the Mexican industry. The capital investment needed to build manufacturing plants for renewable energy technologies is within the reach of private Mexican investors, but foreign capital is also ready to enter the game as soon as the security of their investments is reasonably guaranteed.

**Rural and Local Development.** About 5% of the Mexican population (close to 5 million people) live in remote rural areas without access to commercial energy, and electricity-based services are not available to them. Local renewable energy resources can be used to improve the quality of life of these people and to foster their economic development through productive projects. Large-scale generation of electricity can benefit rural communities who could lease their land to developers of renewable energy projects.

**Public Health Considerations.** The use of renewables can be an important factor for improved health, by avoiding local emissions in substitution of conventional energy; and by improving the quality of services in rural health clinics and medical dispensaries where electricity is currently not available.

**Energy Diversification and Security.** Renewables can help the energy supply system move away from oil products and natural gas, to avoid future problems in the availability of these resources and that of the associated technology. Renewables can be a good instrument to help the energy sector expand its capacity to provide a reliable and secure supply, and hence to be in a better position to support any form of national or regional development. Renewables can also help increase the reliability of the power grid, avoiding economic problems derived from a poor quality power supply.

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Sustainable Development. Renewables offer good prospects for sustainable development. On the economic dimension, the benefit/cost balance can be favourable when hidden subsidies to conventional energy are removed and renewable energy technology is locally produced. On the environmental dimension, renewables are virtually non-polluting and they can help solve hard recurring local environmental problems3. On the social dimension, renewables are oftentimes the only reasonable possibility of providing electricity-based services to remote communities. Renewables can also constitute a “democratising force” to move away from centralized forms of energy supply, by providing opportunities for individuals to generate their own power and hence to financially contribute to the creation of energy infrastructure.

Clean Development. Renewables can help lower the carbon intensity index of the economy. This will put Mexico in a good position to honour any international obligations and to benefit from the economic mechanisms of the Kyoto Protocol and others4. This will in turn pay off in political benefits both at home and abroad.

Where the road is leading
Under the present circumstance, renewables will need a push to move forward in Mexico. New energy policies and a variety of technical and non-technical changes in the energy market must take place to this effect. Barriers that could inhibit progress need to be identified and strategies to remove them in the short to medium terms must be developed; new capabilities and infrastructure to identify and tap niches of opportunity where renewables are technically and economically viable must be created, so that enough experience is gained within the country in this new field of the energy business; finally, mechanisms to assure that the playing field is level enough for renewables to compete under equitable and transparent rules of game must be introduced.

Penetration of Renewables in 10 Years
No systematic study has been carried out to date to assess the impacts from the large-scale penetration of renewables in Mexico. Four scenarios have been suggested by different organizations. They are summarized in the following table. The business as usual scenario (low penetration) belongs to the latest prospective exercise for the power sector performed by SENER5 and basically represents CFE’s expansion plan for renewables. The moderate penetration scenario derives from the Energy Program 2001-20066 of the present administration, which states that the use of renewables in Mexico by the year 2006 should double that for the year 2000, in addition to the expansion program of CFE. This is a scenario committed by a government program and likely to happen without further push. The enhanced penetration scenario was derived by IIE and relies on a modest push to introduce changes in the regulatory framework (for wind), stiffer environmental regulations (for biomass), programmatic elements (for small hydro), and lower technology costs (for solar thermal and photovoltaics). The high penetration scenario was developed by a panel of experts of ANES7. It suggests that renewables could have a penetration in Mexico of between 5% and 10% of the total national energy consumption by the year 2010, considering the power, rural, urban and transport sectors. This scenario assumes a major push in favour of renewables.

Associated Costs

3 For example, the final disposal of urban solid waste or the reclamation of already deforested land for use in the production of energy crops.
4 The ability to trade carbon credits and to undertake joint emissions reduction projects, are two of the inherent benefits Mexico can derive from the Kyoto Protocol through the use of renewable energy
5 Prospectiva del Sector Eléctrico. SENER, Junio de 2001
The total required investment to reach the goals established in each scenario ranges from almost US$ 1,400 million in the low penetration case to almost US$8,400 million in the high penetration (see table). The average cost per kilowatt installed in each scenario will depend on the technology mix chosen.

<table>
<thead>
<tr>
<th>Scenario (Time Frame)</th>
<th>Technology</th>
<th>Capacity (MW)</th>
<th>Unit Cost (US$\text{kW})</th>
<th>Total Investment (MUS$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario 1: Low Penetration (business as usual)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prospective Power Sector (10 years)</td>
<td>Wind</td>
<td>177</td>
<td>900-1,440</td>
<td>207.09</td>
</tr>
<tr>
<td></td>
<td>Small hydro</td>
<td>229</td>
<td>800-6,000</td>
<td>778.60</td>
</tr>
<tr>
<td></td>
<td>Photovoltaics</td>
<td>23</td>
<td>4,000-10,000</td>
<td>161.00</td>
</tr>
<tr>
<td></td>
<td>Biogas from sanitary ladfills</td>
<td>16</td>
<td>600-1,170</td>
<td>14.16</td>
</tr>
<tr>
<td></td>
<td>Sugar cane bagasse/diesel</td>
<td>257</td>
<td>900</td>
<td>231.30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>686</td>
<td></td>
<td>1,392.15</td>
</tr>
</tbody>
</table>

| **Scenario 2: Moderate Penetration (committed by program)** | | | | |
| Energy Program 2001-2006 (6 years) | Solar | Not specified | Assuming average unit cost of US$ 2,029.37/kW | Will depend on technology mix |
| | Wind | | | |
| | Small hydro | | | |
| | Geothermal | | | |
| | Biomass | | | |
| **Total** | | 1,000 | | 2,029.37 |

| **Scenario 3: Enhanced Penetration (with modest push)** | | | | |
| Prospective IIE (10 years) | Wind | 2,000 | 900-1,440 | 2,340.00 |
| | Photovoltaics | 20 | 4,000-10,000 | 140.00 |
| | Solar thermal | 50 | 2,000-4,000 | 150.00 |
| | Biogas from sanitary ladfills | 150 | 600-1,170 | 132.75 |
| | Small hydro | 500 | 800-6,000 | 1,700.00 |
| **Total** | | 2,720 | | 4,462.75 |

| **Scenario 4: High Penetration (with strong push)** | | | | |
| Prospective ANES (10 years) | Wind | 4,000 | 900-1,440 | 4,680.00 |
| | Small hydro | 200 | 800-6,000 | 680.00 |
| | Biomass | 300 | 600-1,770 | 265.50 |
| | Solar thermal | 250 | 2,000-4,000 | 750.00 |
| | Photovoltaics | 250 | 4,000-10,000 | 1,750.00 |
| | Biogas plants (rural) | 50,000 | 1,500 | 75.00 |
| | Solar cookers | 100,000 | 800 | 80.00 |
| | Solar dryers | Not specified | | |
| | Solar water heaters | 200,000 m² | 2,000 | 100.00 |
| | Biofuels | Not specified | | |
| **Total** | | 5,000 | | 8,380.5 |

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*Source: Key Issues in Developing Renewables. International Energy Agency, 1997. Based on actual project costs, except where otherwise indicated. The mean values were considered to estimate total investment.

1 Estimated by the author from projects in different countries.
2 Estimated by the author.
3 Estimated by the author, per unit of bio-digestor or solar cooker.
4 Estimated by the author, per each 4 m² solar collector installed, including storage tank.
5 Non-electrical technologies excluded.
Niches for the Application of Renewables in Mexico

Technically speaking, the power sector offers the largest possibilities for the application of renewables, but at the same time shows the lowest flexibility due to the limitations imposed by the current electricity law. Other sectors could use renewables for power generation without facing such limitations, or for other applications such as process heat.

The Power Sector

The Mexican power sector faces several issues, including the need for new capacity, increased system reliability, higher power quality, and modernisation of its technology base. Total installed capacity in 2000 was 39 GW, distributed as follows: thermoelectric 60.1%, hydropower 26.5%, coal 7.1%, nuclear 3.8% and geothermal 2.3% (plus a tiny portion of wind).

Growth scenarios. It is anticipated that electricity consumption will grow at an average rate of 6.3% in the period 2001-2010, according to the expected rate of economic growth. Consequently, the National Electrical System will require an additional 27,357 MW for the next ten years, out of which 10,854 MW are already committed or under construction, and 16,503 will be obtained from not yet committed projects for additional capacity. An additional 4,862 MW in projects for private generation are also anticipated, which represents an additional total installed capacity of 32,219 MW. The technology mix under consideration for this additional capacity relies heavily on the use of natural gas. Important geothermal and large-scale hydroelectric projects are also under consideration, but no other renewables are included. Heavy reliance on natural gas brings in questions about the security of future supply, price volatility and availability (and hence cost) of associate technologies such as gas turbines.

The business as usual scenario is mostly based on large central stations. Distributed generation is not under consideration. Since the Mexican power system is still under development, distributed generation could bring the following benefits: lower investments in transmission and distribution infrastructure, shorter lead investment times to build generating capacity, higher flexibility in the planning process, easier access to money markets, lower financial risks through a broader base of investors, lower technology costs through local manufacturing, and the use of local renewable energy resources. Renewables can attract new capital for investment and can help democratise the participation of private investments in the power sector through small, distributed self-generation projects.

Emissions. In the business-as-usual scenario natural gas represents 60% of all fossil fuels used for power generation by 2006. While new natural gas co-generation plants are efficient, their use to meet Mexico’s additional energy needs would likely result in a significant increase in total GHG emissions. Under this scenario, CO₂ emissions from the power sector would rise to 192 million tonnes by the year 2010, a 2.3 fold increase with respect to the 1996 level. Projections indicate that while overall SOx, HC and TSP emissions would tend to diminish (23% with respect to 1995), important increases in CO₂ (53%), CO (86.9%) and NOx (86.4%) would most likely be registered. The use of renewables could help relax this situation.

The Water Sector

From the availability, supply, and environmental points of view, water represents a potentially bigger problem than energy for Mexico in the medium to longer term. As the Mexican population and its economic activity grow, water demand also increases. A demand for electricity is

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necessarily linked to the supply and treatment of water. Since water is a critical commodity whose supply cannot be cut beyond short periods of time, the Water Sector in Mexico owns a large number of diesel gen-sets as back up power for water pumping stations. This redundant power supply requires large capital investments along with sizable budgets for operation and maintenance, and implies a no negligible amount of emissions to the atmosphere. The Water Sector could become a major user of renewables for the self supply of electricity. Biogas recovery from water treatment plants, and the use of mini-hydro turbines to tap the potential energy in the downhill sections of aqueducts, are only two of the most obvious possibilities.

The Municipal Sector
Municipalities in Mexico have to deal with a set of interconnected problems, which could be eased by the use of renewables. Large amounts of electricity are used for municipal services, which means a heavy financial burden for the administration since electricity tariffs for municipalities are among the highest in Mexico. On the other hand, solid waste disposal represents both a high cost for the municipality and a growing environmental problem. Programs are under way for the construction of sanitary landfills in medium size cities of Mexico. Additional investments could turn landfills into electricity generating facilities by using the biogas therein produced. Municipalities are entitled to generate their own power, by themselves or in association with private investors. Hence, solid waste, sludge from water treatment plants and other renewable energy resources available in the municipality’s territory, could be used for the self supply of electricity.

The Agriculture Sector
According to the National Energy Balance 2000\textsuperscript{18}, the agriculture sector had the lowest final energy consumption (only 3\%) of the whole Mexican economy and shows a declining tendency. Diesel fuel is the main energy carrier in this sector (68.8\%), followed by electricity (24.7\%) and LP gas (6.5\%). This sector is badly in need for economic reform, but any program to boost its economy will demand increased amounts of energy. Electricity can be locally generated from forest residues, cattle manure, bagasse and other organic materials, or from energy plantations which could be developed in already deforested regions. Local/regional production and use of biofuels and other renewables can bring a number of benefits to the agricultural sector, such as creating jobs, increasing the local turnover of money by avoiding regional imports of commercial fuels, and cutting harmful emissions to the environment.

The Rural Sector
This sector is closely linked to the agricultural sector. As such, it also shows limitations in the energy consumption patterns. Field studies carried out by IIE, SEMIP\textsuperscript{19} and others, show that the rural sector relies basically on firewood (69.15\%) for its energy supply. The use of commercial fuels is very limited. Gasoline represents 10.43\% of the total energy in this sector, followed by LP gas (9.98\%), diesel fuel (6.33\%), electricity (2.53\%), and kerosene (1.58\%)\textsuperscript{20}. When available, electricity is used in a very limited manner\textsuperscript{21}. Where electricity from the grid is not available, kerosene lamps, dry cells and candles are extensively used for illumination purposes. For this reason solar home systems became very handy to provide basic electricity services to the rural population. The wealthiest 10\% of the rural population use electricity to power refrigerators, colour television sets and other electrical appliances. The rest use electricity only to feed two or three light bulbs, to listen to some radio, and eventually to power small black-and-white television sets.

\textsuperscript{19} Secretaría de Energía, Minas e Industria Paraestatal, now the Ministry of Energy, SENER.
\textsuperscript{21} Only the wealthiest 10\% of the rural population use electricity to power refrigerators, colour television sets and other electrical appliances. The rest use electricity only to feed two or three light bulbs, to listen to some radio, and eventually to power small black-and-white television sets.
population in this country. The use of renewables for productive applications represents an important opportunity to improve the economic conditions of the rural population.

Renewables in Mexico: the Current Situation

Interest in the application of renewables has grown steadily in Mexico over the past 10 to 15 years. Several project initiatives have been instrumented and advanced beyond the planning stages. The number and importance of stakeholders promoting and supporting a diversity of renewable energy initiatives in Mexico, has increased. Firm steps to update and improve the institutional and regulatory frameworks to facilitate the use of renewables have been taken by the GOM. Important projects have been carried out by government agencies and private companies, from which important lessons have been learned. However, progress has been slower than desirable for a number of reasons.

Regulatory Framework

The legal framework for energy matters in Mexico, and electricity in particular, is quite comprehensive and fairly transparent. It stems from the Mexican Constitution, whose Article 27 establishes the exclusive right of the nation to generate, transport, transform, distribute and supply electrical energy with the purpose of providing a public service. Article 28 states that the functions performed exclusively by the State in the diverse strategic areas under its responsibilities, electricity among them, do not constitute a monopoly. This article also entitles the State to establish the required organisms and enterprises for the adequate handling of the cited strategic areas.

Current Electricity Law

The Law for the public electric energy service sets the operational rules for the electrical sector. It was reformed in 1992 to expand the possibilities for participation of private investors in electricity generation activities which do not qualify as public service. In December of 1993 new reforms were also introduced in order to give a more precise meaning to some of its articles. Article 3 of this Law now exempts from the definition of public service the following activities, where private entities are now allowed to invest:

- Generation of electricity: for self supply, by co-generation or small generation;
- Generation of electricity by independent producers for exclusive sell to CFE;
- Generation of electricity for export, either from co-generation, independent power production, or small generation;
- Imports of electricity by individuals or formally established entities, for the sole purpose of self supply;

23 Main stakeholders acting in Mexico: Non-government entities: the National Solar Energy Society (ANES, the Mexican chapter of the International Solar Energy Society ISES); the Mexican Foundation for Rural Development; the Mexican Hydrogen Society. Government agencies: the Commission for Energy Savings (CONAE); the Federal Commission of Electricity (CFE) through its Rural Electrification Unit and its Geothermal and Renewable Energy Unit; the Electrical Research Institute (IIE). Universities and research centres: the Centre for Energy Research (CIE-UNAM); the Engineering Institute (II-UNAM), both at the National Autonomous University (UNAM); the Energy Program of UNAM (PUE-UNAM); the Centre for Advanced Studies and Research of the National Polytechnic Institute (CINVESTAV-IPN); several schools of the Autonomous Metropolitan University (UAM).
International organizations: the United Nations Development Program (UNDP) and the World Bank (WB), both with GEF-related projects; the UN Food and Agriculture Organization (FAO). Bilateral aid agencies: the USAID, the German GTZ and the Japanese JICA. Other: National and international private investors, financing institutions, technology manufacturers and project developers, mainly in connection with photovoltaics, wind energy and small hydropower.

24 Under 30MW for sell to CFE or under 1MW for the supply of remote rural communities.
• Generation of electricity in case of emergency caused by the interruption of the public electrical service.

**Electric Tariffs Structure**
Subsidies are applied taking into consideration the direct correlation between family income and the use of electricity. The use of subsidies has created a backlog in the price/cost of electricity in Mexico. At the end of 2000, the value of this backlog was 70% for CFE and 51% for LFC; this means a deficit of 30% and 49%, respectively, with respect to the real cost of supply, which represented a total of 56,800 million pesos\(^{25}\) of total subsidy in the year 2000. The largest share is taken by the agricultural and residential sectors\(^{26}\).

**Grid Interconnection Issues**
Up until late 2001, one of the main stumbling blocks for grid-connected renewable energy projects was the need for a regular interconnection contract with CFE, under which renewables could not compete. To overcome this barrier the Regulatory Energy Commission (CRE) has issued new contract forms for the interconnection with CFE's electrical grid of intermittent sources of power, such as wind and small hydro and the wheeling of electricity from these sources. After the implementation of these contract forms, a number of wind farm projects are now moving forward. Although these contract forms represent a step forward in the right direction, they are mainly applicable to self-generation type projects.

**Technical Normative Framework**
Availability of technical norms applicable to renewables is very limited in Mexico. A technical norm for solar water heaters is under development but some work still remains to be done. Technical specifications and guidelines for off-grid PV projects were developed by IIE and have been applied for the past 12 years in rural electrification projects financed with federal funds and are regularly updated\(^{27}\). Infrastructure for quality assurance of small PV systems was developed for the same purpose, but needs to be updated. Technical standards applicable to the GEF/WB-supported PV and wind water pumping projects(see below) are also under development, but much remains to be done. Much remains to be done in terms of developing, adopting and adapting technical standards, guidelines, norms and specifications, to guide the correct implementation of renewable energy projects. Guidelines for project development, follow up and monitoring, as well as best practices manuals for project replication, are also necessary in preparation for market deployment.

**Renewable Energy Policy**
Energy, as an economic activity in Mexico, accounts for 3% of the GDP and 8% of all exports. Taxes on hydrocarbons amount to 37% of the Government's tax collection, and almost 60% of public investment is used for energy projects. According to the National Development Plan for the period 2001-2006, one of the main goals of the energy sector is to increase its contribution to the country's economic and social development. This will have to be accomplished with full respect to the environment, by strongly encouraging the efficient use of energy, widely promoting energy diversification and the use of alternative and renewable energy sources, and firmly supporting research and technological development. The Energy Sector Program 2001-2006\(^{28}\) acknowledges the possibility of an increased development of the nation's renewable energy.

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\(^{25}\) US$ 6,140.5 million at the current rate of exchange (March 2002)
\(^{27}\) Working in close cooperation with international organizations such as the International Electrotechnical Commission, the Expert Group of the Photovoltaic Power Systems Agreement of the International Energy Agency, and other laboratories abroad
resources, and sets as one of its main objectives "To increase the use of renewable energy sources and to promote the efficient use of energy and energy savings". The strategy to achieve this objective is to develop programs, projects and plans of action for the use of renewables. Some of the specific actions are described in the Policy section of the Instruments chapter of this project proposal.

Institutional framework
Renewables are still far from becoming a major energy source in Mexico, but a favourable institutional framework is emerging, both in the public and private sectors.

The Energy Sector
Secretaría de Energía, SENER, is the sector head. It was recently restructured and a new under-secretariat for Energy Policy and Technology Development was created. This new under-secretariat has strongly emphasized the development of renewable energy, and is building the necessary policy and planning instruments to facilitate the large scale introduction of renewables in Mexico, which are partially reflected in the present project proposal. Comisión Nacional para el Ahorro de Energía, CONAE, acts as a technical consulting body for the federal administration in matters of efficient use of energy, energy savings, and the use of renewable energy. In a joint initiative, CONAE and ANES, created in 1996 a consulting body named COFER29, to foster the use of renewables. Comisión Reguladora de Energía (CRE) regulates the activities of both public and private energy operators. CRE has recently been paying attention to the renewable energy aspects of its duties, with the results previously mentioned. Comisión Federal de Electricidad (CFE). The Unit of Geothermal and Renewable Energy is doing work to assess the potential of wind energy, and has built over 2 MW of grid-connected wind generators. It has also built some off-grid PV-wind hybrid projects in remote communities. The Unit of Rural Electrification has been implementing basic PV rural electrification projects and has acted as technical normative agency for other projects financed by the federal government. Instituto de Investigaciones Eléctricas (IIE). Renewable energy activity is concentrated in the Unit of Non-conventional Energy which for over 25 years has been actively working on the development and application of renewable energy technology, in support of CFE and other government and non-government entities.

The Environment Sector
SENER and the Ministry for the Environment and Natural Resources (SEMARNAT) are coordinating their energy and environmental policies, so that a long-term sustainable energy policy can be established. SEMARNAT has created an advisory body named COMIA to address critical environmental problems involved in the supply of municipal services, including energy30.

The Academic Sector

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29 COFER: Consejo Consultivo para el Fomento de las Energías Renovables. Its mission is to promote and strengthen the use of renewable energy in Mexico, under the premise of free market competition, and within the framework of the Law for Electrical Service. COFER is integrated by Mexican representatives from industry, academia, government and financing institutions and acts as a consulting body for project identification, as well as for the design and development of programs and policies related to the use of renewable energy. COFER also analyses the potentialities and barriers existing for the implementation of renewable energy projects, and carries out national and international events to promote the use of renewable energy as part of the energy mix in Mexico.

30 COMIA: Comisión Mexicana de Infraestructura Ambiental, is an initiative jointly created by the public sector represented by SEMARNAT and the private industrial sector represented by the Coordinating Council for Private Enterprise (Consejo Coordinador Empresarial, CCE). The official members of COMIA include other government bodies, public research institutions, national financing organizations, industrial chambers representatives and private companies. COMIA is currently in the process of defining its program of work for the next 5 years, which will focus on water supply, solid and liquid urban waste disposal, and disposal of industrial and medical hazardous and infectious materials. The use of renewable energy whenever possible has been established as a goal by the Commission.
A critical mass of academic and R&D institutions in the field of renewable energy has been created in Mexico over the past 25 years, some of which are well known internationally for their scientific and technological achievements. Other local universities and research centres around the country are slowly undertaking renewables as a new field of activity. However, the number of specialized human resources in this field, is still short and is considered one of the most critical bottle necks for the large-scale and sustainable implementation of renewables in Mexico.

**The Non-Government Sector**

The Asociación Nacional de Energía Solar (ANES) is the Mexican chapter of the International Solar Energy Society (ISES), and has been actively promoting the use of renewable energy for the past 25 years. Several other non-government organizations are also promoting the use of renewables in Mexico.

**International Cooperation**

The GOM formally interact with key international players in the field of renewables. In the framework of the International Energy Agency, Mexican institutions participate in five Implementing Agreements on renewable energy, and collaborate with the Renewable Energy Working Party. Mexico also participates in the renewable energy working groups of the Asia Pacific Economic Cooperation forum (APEC) and of the Iberoamerican Program of Science and Technology for Development (CYTED). Bilateral cooperation agreements on renewables have also been signed with several nations. This international activity has been a good instrument for information exchange, knowledge and technology transfer, and joint implementation work.

**Resources and Applications**

**Energy Resources**

Renewable energy resources are abundant in Mexico. However, site-specific, detailed information is very limited and usually not good enough to support large-scale commercial projects. With the exception of high temperature geothermal energy, evaluation of renewable energy resources has been done mostly for academic and research purposes. Synoptic solar radiation and wind maps are available, but low temperature geothermal, small hydro and biomass are practically unexplored. From the available information the following can be concluded: Solar energy, excellent availability, with average density around 5 kWh/m2-day. Wind, several regions with good potential, indicative measurements show around 5,000 MW that could be now economically viable. Further exploration could add up to 15,000 MW in new inventories. Small hydro, full potential unknown; some estimates indicate that at least 3,550 MW could be harnessed. Biomass, potential not fully assessed. Information on cattle waste, forest and agriculture residues, is not available in aggregate and useful form. Sugar cane bagasse is already fueling 210 MW and could support 36 MW more in

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31 ANES organizes yearly technical conferences, topical workshops and short training courses, along with the publication of the only magazine specialized in renewable energy in Mexico (La Revista Solar). ANES also carries out work of its own or commissioned by other entities, to analyse critical issues around the implementation of renewable energy in Mexico. In September of 2000, ANES released the results of a prospective study carried out by a panel of national experts and the corresponding strategies proposed for the development of renewable energy in Mexico. Some sections of the present project proposal draw from the consensus reached by the ANES panel of experts, as indicated in the references.

32 The Mexican Foundation for Rural Development, a nation-wide organization with the mission to promote economic activities in rural areas; the Mexican Electric Energy Association (AMEE), an association of independent power producers, with a chapter on renewable energy; the Mexican Chamber of Electric Equipment Manufacturers (CANAME) which has expressed interest in manufacturing wind generator components and other renewable energy technologies.

33 Geothermal, solar thermal, solar photovoltaics, wind, and solar heating and cooling.

34 CONAE: Recursos de Energía Renovable en México. Reunión-Diálogo para Incentivar la Inversión en Energías Renovables en México. Febrero 2002. Studies by IIE indicate that around 10% if this figure can be found in irrigation channels.
the next 10 years; 150 MW could be supported by the 90,000 tons of urban solid waste produced daily in all medium size cities in this country. The potential for energy crops in Mexico is not known.

A geographical information system (SIGER) is being developed by IIE as part of an agreement with SENER, which has the purpose of providing good and timely information to facilitate the development of commercial renewable energy projects.

The use of Renewables

Renewables represent 4.2% of the overall energy supply in Mexico, and 28.4% in the electric power sector alone. Most of this contribution comes from traditional sources (biomass, 3.5% of the overall supply) or established technologies (big hydroelectricity and high temperature geothermal, with 26% and 2.35% of the power supply, respectively). Solar water heaters, off-grid photovoltaics, and grid-connected wind generators have only a modest penetration in the Mexican energy market.

Grid-Connected Applications

A Pilot Plan for the Development of Renewable Energy, launched in 1999, is currently operated by IIE. Criteria established by SENER to guide this Pilot Plan include close interaction with industry, international cooperation, shared financial risk and operational links with academia to foster the development of specialized human resources. The following projects are included:

Photovoltaics. Pilot grid-connected PV systems (in the range of 1.5-2 kW each) are in operation in northwest Mexico, to test the viability of roof tops to shave peak power loads caused by air conditioners in cities with high summer ambient temperatures. A project proposal has been submitted to the GEF-UNDP to expand these activities, as a preparatory stage for the massive deployment of this type of systems.

Solar Concentrators. Work on parabolic troughs for process heat and dish-Stirling technology for remote power generation is under way. A cooperation agreement has been signed between IIE and CIEMAT, for joint work in this field. A call for bids was recently issued to build a solar-assisted combined-cycle gas-fired power plant in north Mexico, financially supported by the WB-GEF.

Wind Farms. Just a little over 3 MW of grid-connected wind generators have been installed, of which 2.28 MW belong to CFE and the rest to private companies. Operational experience has been mixed, but valuable to show the potential for further applications. Several larger wind farm projects, in the range of 20-50 MW each, are at different stages of development, but up to now none of them has been built. The main barriers to the large scale implementation of wind energy in Mexico are being identified as part of the Pilot Plan and strategies to remove them are being developed. Development of technical support infrastructure, facilitation of project development and local industry participation, are among the specific objectives of this project. Some state governments have taken the lead in facilitating institutional and local policy changes to foster the use of wind power in their territories.

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35 SENER: Prospectiva del Sector Eléctrico 2001-2010. Actual figures will depend on the development of the sugar cane industry.
36 Arvizu, José Luis: Energía a partir de la basura. Boletín IIE, Vol. 21, Num. 6, Nov-Dic 97.
37 Because of its tropical climate, regions in central and southern Mexico could be good candidates for energy plantations. Besides the energy potentially produced, energy plantations would offer the additional environmental benefit of recovering already deforested lands.
38 A variety of technologies (water desalinating units, solar coolers and ice makers, grain dryers, solar concentrators for different purposes, biodigestors) have been researched on and off for almost 25 years in various Mexican academic and technology research centres, but have not advanced beyond the prototype or pilot stages in the best cases.
39 CIEMAT, the Spanish research Research Centre for Energy, the Environment and Technology
40 This cincludes a 550 kW generator installed in 1997 by the cement company Apasco, in north-central Mexico, and a 250 kW machine installed more than 10 years ago by the company Exportadora de Sal, in Baja California.
41 Participating states include: Oaxaca, Baja California, Baja California Sur, Nuevo Leon, Tamaulipas, Hidalgo, Veracruz and Quintana Roo
numbers of investors and financing enterprises, wind project developers and engineering companies, both from Mexico and abroad, are actively seeking to implement the first large-scale wind energy projects in this country.

**Biogas from Sanitary Landfills.** A portfolio of projects is under development, where municipalities, private investors and technologists team up to form joint ventures for the self supply of electricity to the municipality. Preliminary studies have been carried out for two of the most promising sites, while a number of foreign and local investors and technologists have expressed their interest to participate in the projects. A similar project is in progress in the city of Monterrey, supported by the WB-GEF.

**Geothermal Energy.** Mexico is currently the third largest user of geothermal power in the world, with an installed generating capacity of 855 MW, based on high temperature reservoirs. Geothermal energy has been commercially exploited by CFE for over 25 years. Private investors are now participating in the heat supply side of the cycle. Plans to install 120 MW more by the year 2005 already exist. Low temperature geothermal, estimated to have a large potential, are only used for recreational purposes. A project to assess and map the full potential of low enthalpy geothermal reservoirs is included in the Pilot Plan.

**Off-Grid PV**
A market a little greater than one MW per year of PV applications is already well established in Mexico, and growing basically for remote power supply. All PV modules currently being installed are imported. Balance of system components for solar home systems (SHS) are now manufactured in Mexico. A small local manufacturing industry is growing under the umbrella of the official programs for PV rural electrification; some of these companies are now exporting their products to other Latin American countries.

**Rural Electrification.** A program to alleviate poverty in rural areas which allows the use of renewables to provide basic electrical services for remote communities has been in effect since 1989. SHS are the preferred technology, but a couple dozen mini-grids powered by small hydro and PV-wind hybrids have also been built. Over 13,000 PV-powered rural telephones have been installed, and over 2,500 rural communities are now electrified with renewables. Preparations are under way to establish a new program to deliver electricity and electricity-based services to all native Indian communities above 400 people currently without access to the electrical grid.

**Water Pumping.** Tens of PV water pumps are being installed in a program partially financed by the GEF, FIRCO and the user. An undetermined amount of small wind generators have also been installed for water pumping and other productive applications.

**Professional Applications.** Electricity supply in off-shore oil rigs, cathodic protection, signalling and telecommunications, are currently the main applications of PV in Mexico aside from rural electrification. Other applications (eco-hotels, natural preserves and forest surveillance posts, electric fences, emergency telephones, etc.), are becoming common practice.

**Non-electrical Uses**

**Water Heating.** Solar water heaters (SWH) are produced in Mexico for more than 50 years, but with little market penetration. Some 50 companies are known to manufacture and/or retail SWHs.

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42 SENER: Prospectiva del Sector Eléctrico 2001-2010.
43 The technology for manufacturing PV solar cells and modules was indigenously developed in Mexico since the early 1980's. A pilot manufacturing plant was built, but commercial production never took place.
44 Charge regulators, batteries, small inverters, compact fluorescent lights and other small appliances.
45 Over 60,000 SHS have been installed, and hundreds of rural schools, medical dispensaries, and communal buildings are being supplied with PV electricity. Additionally, over 30,000 SHS and a large number of systems for professional applications have been privately sold by commercial companies established in Mexico.
46 Fideicomiso de Riesgo Compartido, a trust fund of the Mexican Secretariat for Agriculture, created to support the development of infrastructure to support agricultural productivity.
the total amount of solar collectors installed is a little over 373,000 m$^2$, mostly for heating swimming pools. The energy supplied is comparatively very small, only 1.8 Petajoules$^{48}$ (PJ). Industrial process heat and other higher temperature applications of solar energy are not common in Mexico. Studies are under way to assess the environmental, energy and economic impacts from the potential massive installation of SWH in the metropolitan Mexico City area$^{49}$. Another study by IIE showed the large market prospects and economic advantages of implementing solar water heaters as part of new housing projects$^{50}$.

**Traditional Uses.** Renewables, solar energy in particular, have been traditionally used in Mexico for a variety of low tech applications, such as drying of agricultural products, but the total amount of conventional energy saved by this practice (and emissions avoided thereof) has not been estimated. Firewood is used in a yearly amount equivalent to 2.6% of the total energy supply. Serious environmental concerns, such as deforestation and the corresponding impact on biodiversity, call for improved technical and resource management schemes for future use of firewood. Co-generation from sugarcane bagasse contributes an estimated 88 PJ to the national energy balance$^{51}$. Some 7 million tons of common salt are produced annually from evaporation of sea water at the salt works in Baja California, where solar and wind energy do the basic job. It is estimated that the amount of renewable energy used in the process is equivalent to around 1% of the total commercial energy supply in Mexico.

**Renewables and the Power Sector**

According to the National Energy Balance$^{52}$, the total final energy consumption in Mexico in the year 2000 reached 4,029 PJ, 89% of which is supplied by fossil fuels. The rest is electricity of non-fossil origin (hydropower, nuclear power, geothermal and wind energy) which amounts to 5.1%, biomass 3.5%, and coal 2.4%. In the electric power sector alone, slightly over 67% of the total generation comes from fossil fuels. The rest is hydroelectric (26%), nuclear (3.75%), geothermal (2.35%), and a tiny portion of wind power (only around 2MW). Under these terms, in 1999 Mexico contributed with around 360 million tons of CO$_2$ emissions to the global greenhouse problem$^{53}$. CFE generates, transmits distributes and sells electric power in Mexico to 19 million customers, equivalent to around 76 million people. By October 2001, CFE had a total of 154 power plants, 35,078 kilometres of transmission lines and an installed generating capacity slightly over 37,000 MW. An additional 7,118 MW of new capacity are at different stages of project development. Luz y Fuerza del Centro is the second state-owned electric company that generates and distributes electric power in Central Mexico. It has 3,431 kilometres of transmission lines, 53,000 kilometres of distribution lines and a generating capacity of 827 MW. These two companies form the National Electric System, which currently provides electricity to 95 million people, equivalent to around 95% of the Mexican population$^{54}$. The remaining 5% is rural population living in remote and hardly accessible places. Over 80,000 small and disperse rural communities, under 100 people each, have no access to the grid. CFE has been instrumental in applying renewables for rural electrification as mentioned before. CFE installed the only wind farm in Mexico as of this writing$^{55}$, and the single largest wind

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$^{49}$Estudio PUE.

$^{50}$Medrano VC, Huacuz JM: Calentadores Solares de Agua para el Ahorro de Gas LP en el Sector Doméstico. IIE/01/14/10407/I001/F Febrero 1996.


$^{52}$Ibid.

$^{53}$CO$_2$ emissions from fuel combustion 1971-1999. IEA-OECD.

$^{54}$SENER: Mexico’s Energy Sector. Brochure.

$^{55}$Seven wind generators, 225 kW each, operating since 1997 in the La Ventosa region in south Mexico.
.generator (700 kW), both for pilot purposes. CFE is the executing agency of a World Bank-GEF project that integrates a solar concentrating field into a gas-fired combined cycle power plant.

Renewables and the International Agencies in Mexico

The World Bank
The following three WB-GEF projects are under implementation: a) Construction of a gas-fired combined cycle power plant with capacity between 198 and 242 MW, with a GEF grant of almost 50 million US$ to incorporate no less than 25 MWe from solar heat produced by parabolic trough concentrators. As of this writing, CFE has issued a call for bids; b) Electricity production using biogas from sanitary landfills in the city of Monterrey, in northern Mexico. This project titled “Methane Gas Capture and Landfill Demonstration” is being executed by the municipal government of Monterrey. Contracts for construction have been awarded to a consortium of private companies; c) Water pumping for small agro-industrial operations and cattle raising are the objectives of the project “Renewable Energy for Agriculture” or FIRCO project as is commonly known, which has three sources of financing, including a GEF grant of 8.9 million US$. The FIRCO project is in its early stages of field implementation with several PV pumps already installed. Small wind powered pumps are also contemplated for future projects.

The UN Development Program
The following projects are being promoted by the UNDP within the Climate Change Initiative of the GEF: a) "Plan of action for removing barriers to the full-scale commercial implementation of wind power in Mexico" is a multi-year project with a programmatic approach to remove barriers to the large scale implementation of wind energy. The project is due for final approval by the GEF Council; b) "Small grid-connected photovoltaic systems" is already in the GEF pipeline. Its objective is to advance in the identification and solution of the main technical and non-technical issues currently affecting the application of photovoltaic technology for electric peak shaving during the Summer months in north and northwest Mexico. As of this writing, the project brief is being prepared; c) A third project aims at the use of agricultural residues in rural areas for the on-site generation of electricity, with the additional purpose of avoiding negative environmental impacts caused by such residues. This project is still in the early stages of concept development.

Other Agencies
The UN Food and Agriculture Organization (FAO). For a number of years the FAO has been supporting activities in Mexico to foster the efficient use of firewood. Possible cooperation within the GEF programs, concerning the application of renewable energies for productive projects in rural areas, is under discussion.

The North American Commission for Environmental Cooperation (CEC). CEC is exploring the feasibility of applying renewable energy in specific niche markets. With financing from CEC, IIE carried out a pre-feasibility study for a 150 MW wind farm in La Ventosa, Oaxaca. The CEC also financed CONAE to study the willingness to pay for green energy among the 100 largest users of electricity in Mexico.

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56 Licitaciones Obra Pública. Central Mexicali II. www.compranet.gob.mx
57 Projects. www.worldbank.org
58 Besides the GEF grant for capacity building and partial system subsidy, the FIRCO project operates with funds from the "Programa para el Campo" (Procampo) program of the Mexican Federal Government, plus contributions from the project beneficiaries.
59 Proposed by IIE with support from SENER, the local UNDP office, and the GEF-SEMARNAT liaison office in Mexico City
60 Same as above
61 This body was created within the framework of the North America Free Trade Agreement (NAFTA)
Bilateral Cooperation. Bilateral development agencies, including the USAID, the German GTZ, and the Japanese JICA, are actively promoting and financially supporting activities to foster the implementation of renewables in Mexico. Other agencies, such as the German bank KfW, the Canadian Office for the Clean Development Mechanism, the Shell Foundation, the Spanish Araucaria Program for the preservation of the biosphere, the Centre for Clean Air Policy and the Texaco-Ovonic joint venture for renewable energy, to name a few, are also involved in the promotion of renewables in Mexico.

Renewables in Other Sectors

Government Entities

Oaxaca. The state Government (OSG) has taken the lead in the development of its vast wind energy resource. International wind technology companies and investors in association with Mexican counterparts are taking action to develop this resource. The OSG is facilitating these initiatives by ironing out critical issues such as land ownership and the local legal framework. Interested companies are being requested not only to establish electricity generating facilities, but also wind technology manufacturing operations. IIE is technically supporting this effort by assessing the wind resource and advancing new initiatives such as the creation of a regional wind energy technology centre. The OSG is also leading the application of photovoltaics and other renewables in rural areas.

Baja California Sur. The state Government developed the programmatic elements for the application of renewables to promote sustainable development of the fishing communities within the preserve of the biosphere called "El Vizcaíno." These communities have no access to electricity and other services. Renewable energy projects are being developed with technical support from CFE and IIE.

Capacities Installed

Mexico is a fairly well developed economy and, as such, a variety of capabilities that could support the deployment of renewable energy are already in place. However, most of these capabilities have to be expanded and updated in the context of renewables.

In the public sector, human resources and institutions are already available in the traditional fields of energy planning, policy making, regulation and research. New topics such as the Clean Development Mechanism and the carbon economy need to be incorporated.

In the private sector, large numbers of energy consulting and engineering companies are also available, but with very limited knowledge about renewable energy technologies and the opportunities in the renewable energy business. Local capabilities for commercial project identification, development and implementation need to be developed. Analyses show that most renewable energy technologies could be locally manufactured by Mexican companies, using the

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62 Other states where important renewable energy activities, mainly wind, are taking place include: Hidalgo, Tamaulipas, Nuevo León, Baja California, Aguascalientes, Chihuahua and Quintana Roo.

63 It is estimated that more than 2,000 MW could be generated by wind in only one portion of the Tehuantepec Isthmus, where strong and sustained winds are available during most part of the year.

64 These activities are part of the UNDP-GEF project proposal mentioned earlier.

65 This is a vast desert region in the Peninsula of Baja California with no access to the conventional supply of fuels and electricity. The region is endowed with abundant natural fishing resources and breathtaking beauty that could be sustainably developed by means of renewable energy.
already available industrial infrastructure. Over 200 Mexican companies have been identified, who could manufacture and supply parts and components for wind generators. The banking system has mature and experienced institutions, but with little or no mechanisms to financing renewable energy investments. First floor financing mechanisms need to be developed to support the massive introduction of these technologies. BANOBRA is developing criteria to finance municipal renewable energy projects. Academic and research institutions are either well established or freshly entering in the field of renewable energy. Work being done in most of these institutions is first class, but mostly with an academic orientation. There is need to complement these capabilities by developing institutions and R&D groups closely linked to industry and with a strong vocation for applied research and product development.

**Barriers to the Implementation of Renewables in Mexico**

Barriers of different kind have to be removed to facilitate the large-scale introduction of renewable energy in Mexico.

Legal, Institutional and Policy Issues.
The current legal framework in Mexico does not favour the commercial expansion of renewable energy for power production (hydropower and geothermal notwithstanding). Specific articles in the Electricity Law mandate CFE to buy the cheapest electricity available in the market, and to give preference to firm instead of intermittent capacity for new power installations (to ensure reliability and stability of the electric system, since the precise effects of intermittent sources on the grid have not been adequately explored). The latter limitation has been relaxed with the new contract forms for interconnection and transmission of intermittent sources of energy. Renewables lend themselves for the introduction of new concepts such as distributed power generation. Introduction of such new concepts within a centrally structured electric utility may face crucial barriers, including the perceived notion of losing political control of the electricity business and the fear of third parties affecting the integrity, safety and quality of the grid. Mental barriers, such as opposing the change for the change itself, could also be met. The availability of fossil fuels and large scale renewables such as hydropower and geothermal, puts additional question marks on the wisdom of locally developing new renewable energy sources. Facilitation of project identification, permitting, evaluation, certification and technical support, requires effective institutions, not currently available in sufficient quantities and with enough knowledge on the subject in Mexico.

Financial Limitations
Due to budgetary constraints it is unlikely that the GOM will finance capital-intensive renewable energy projects. Thus, in order for commercial projects of this type to grow successfully, diverse funding and project supervision capacities -both national and international- must be brought to bear confidence on the renewable power market. Experience in commercial renewable power projects are

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66 Mejía Neri F. et al.: Base de datos de Empresas e Instituciones que podrían integrar la Plataforma de una Industria Eoloeléctrica Mexicana. IIE/01/14/10819/0003/A4/F/V2. Diciembre 1999. One Mexican company is already manufacturing and exporting large state of the art electrical generators for wind machines assembled abroad.

67 Commercial financing is readily available in this country for a number of durable goods (housing, cars, domestic appliances, and so forth), but no lines of credit can be easily found, for instance, for solar water heaters, photovoltaics and other renewable energy technologies at the consumer level or for project developers.

68 The national bank to finance municipal infrastructure.

development does not exist in Mexico, and hence, the potential financial network needs to be identified and strengthened. The incumbent business opportunities and risks associated with renewable power development must also be identified to know the size and risk of this new energy technology market. Regulatory barriers as outlined above, turn into financial constraints by perpetuating perceived high investment risks associated with elevated project preparation costs, without any guarantee that the project can be implemented within a reasonable time frame. There is a critical need to cultivate a confident and stable business environment that provides appropriate guarantees and certainty to international and national financial institutions on renewable energy project viability and profitability. International experience shows that success is contingent upon private sector involvement. Experience also shows that while vital to overall success of renewable energy deployment, government participation in the early stages of market development should concentrate on providing adequate institutional support and setting long-term goals. Removal of subsidies now applied to conventional energy is also critical to increase the economic viability of renewable energy projects.

Regulatory Issues
A lot still remains to be done in Mexico to tackle regulatory issues negatively affecting the introduction of renewables. Examples include needed mandatory measures to use solar water heaters in substitution/back-up of gas-fired water heaters, rules for awarding capacity credits to intermittent power sources, schemes for the internalisation of environmental, social and other costs associated with the conventional generation of electricity, tougher environmental measures, etc.

Incremental Costs
One of the main barriers to the widespread use of renewables is their perceived higher costs. The higher capital costs involved usually overshadow their life-cycle costs, which are often lower than for other alternatives, but difficult to perceive. The lack of accounting for both the environmental and social costs associated with the combustion of fossil fuels works against renewables when comparing alternatives. Finally, the substantial and continuing hidden subsidies to fossil fuel technologies, which are estimated at over US$250-300 billion a year world wide make any comparison inequitable. The average price for electricity during 2000 in Mexico was estimated at 6.0 US¢/kWh. This is close to the pay-back price required for some renewable projects, such as wind and biogas from sanitary landfills, to reach economic feasibility. However, most renewables do not compete with conventional power on the basis of conventional investment and/or generation costs alone. This is further complicated by the fact that usually pay-back prices depend on location, generation voltage, time of day, and other factors difficult to obtain by the financial analyst under common circumstances. Furthermore, availability of good renewable energy resources does not often coincide in location or time of day with the most favourable conditions to get a cost-effective buy-back price for electricity. No credits for capacity are currently granted for intermittent power production facilities in Mexico, and CFE is under no obligation to purchase any renewable energy production within its energy mix. The regulatory framework is such that power regulations are issued by the Regulatory Energy Commission, while pay-back prices for electricity are based on consumer rates determined by the Secretariat of Economy (formerly SECOFI). Hence, in the commercial environment, CFE cannot unilaterally grant exceptions or provide incentives for renewable energy, unless the legal framework is modified or alternative attractive market based solutions are identified.

Political

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The current high political support for renewables on behalf of the federal administration and some state governments is unprecedented in Mexico. This is best exemplified by the Energy Program 2001-2006. However, regulatory and institutional changes to level the playing field cannot go beyond the limits set by the current Law. Further legal and regulatory changes will require approval of Congress, where some political barriers may need to be removed. Land ownership issues, for instance for the implementation of wind farms or energy plantations, may represent important political barriers to be dealt with.

Market Structure and Human Resources.

Much needs to be done to ensure a healthy domestic industry that can supply renewable energy technologies on a competitive commercial basis. Broader exchange and closer practical cooperation must be fostered between the Mexican manufacturing industry on one side, and the Mexican R&D and academic institutions involved in the assimilation and development of renewable energy technology on the other, in order to consolidate national capacities.

There is a significant lack of personnel trained in the development and implementation of renewable energy projects. The same is true with respect to personnel with experience in the operation and maintenance of large renewable energy systems. Training programs and activities to solve this problem are under way, but they are still very limited. The considerable theoretical and empirical knowledge that exists in Mexico’s academic and research institutions need be transformed into practical applications and national training programs. Important but limited efforts have been made in this respect. Such efforts need to be expanded and replicated in other parts of the country. This is fully consistent with STAP recommendations on capacity building in the alternative energy market, and has been documented as a best practice by the Centre for Global Change.

Technical and Information Barriers.

Activities are under way to compile, screen and organize available data into the geographical information system SIGER. Availability of good quality information is very limited, and further actions need to be carried to upgrade the data bases, to improve prediction models and to expand the geographical coverage of monitoring stations.

On the technical side, international standards, technical specifications, and recommended engineering practices need to be assimilated by local organizations to strengthen the local technical capacity for further development. Lessons from international demonstration projects need to be incorporated and adjusted to local needs, while local pilot and demonstration projects are needed in several areas to build local capacity. There is a generalized lack of knowledge about the potential market for renewable energy in Mexico and the economic benefits that could derive thereof. Beyond CONAE’s efforts at the national level in this regard, outreach initiatives are still limited, basically by the lack of funding necessary to launch promotional campaigns and awareness building activities. Adequate mechanisms and comprehensive programs are required to collect and distribute objective and updated information about the national and international experience on renewable energy, including the key factors for success or failure of renewable energy projects.

Interagency Coordination

71 As of this writing, the Green Ecologist Party of Mexico submitted an initiative in the Senate to modify the Law to favour the use of non-polluting energy sources.

72 Worth mentioning are the topical refresher courses offered regularly by ANES; the Master's Degree program on solar energy of CIE-UNAM; the Engineering Diploma Degree on wind power, recently instrumented by IIE with a consortium of engineering colleges in south Mexico, supported by the Oaxaca State Government. Foreign aid agencies have also made a significant effort to back the development of human resources in Mexico, either by financing the work of Mexican students abroad, or by offering training courses in Mexico, on their own or in association with the programs of the Mexican institutions.
To fully realise the benefits from the large-scale implementation of renewables an effective coordination among different agencies in the three levels of governments, and among other stakeholders, is necessary. Lack of interagency coordination represents an important barrier towards a more dynamic renewable energy activity in Mexico.

**Strategies to Move Forward**

The large-scale implementation of renewables in Mexico could be achieved with the following strategies:

- An enabling policy and regulatory framework to level the playing field, so that mature renewable energy technologies can compete on equal grounds with other alternatives;
- Adequate and effective institutional and technical settings to support the deployment process;
- *ad-hoc* financing mechanisms to help advance pre-commercial renewable energy technologies into the market;
- Concerted action plans to coordinate energy issues with other government sectors, so that renewables have equal opportunities for participation in infrastructure projects as conventional technologies do;
- Appropriate mechanisms to facilitate a growing participation of the private and social sectors in the development of energy projects;
- An effective coordination among all national and international stakeholders interested in the promotion of renewable energy in Mexico.

Operational mechanisms and considerations for each of these elements are discussed below.

**Strategy 1: Enabling Policy**

An important policy baseline has already been established in objective 4 of the Energy Program 2001-2006, which calls for the increased use of renewable energy. The following elements and actions are considered therein as necessary to meet this objective:

- Energy tariffs and prices that reflect the costs associated with environmental impacts, on top of those from generation, transmission, storage and distribution;
- Medium and long-term programs (national and regional) for energy conservation and the use of renewable energy, according to the structural changes of the energy sector;
- A set of norms and mechanisms for the promotion of co-generation and renewable energy;
- A national system for the evaluation, registration and diffusion of renewable energy resources;
- Financial support mechanisms for energy conservation and renewable energy projects;
- Financial resources for research activities on energy conservation and renewable energy;
- An active and permanent bilateral and multilateral link of Mexican institutions with similar international organisms in other countries.

Other elements, such as an adequate legal structure for the protection of consumers against faulty and low quality renewable energy goods and services, and a clear definition of targets for the introduction of zero emissions regulations applicable to motor vehicles might be necessary.

**Strategy 2: Institutional Setting**

Already existing infrastructure will be complemented with new one (human, technical and physical), to assure high operational standards of the renewable energy programs to be established. The institutional framework will focus on the development and implementation of operational rules, technical and non-technical, to create a healthy renewable energy markets. The following actions are contemplated:

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Centre for Energy Information and Policy.
SENER has identified a need to improve the national capacity for long term planning and the research capacity to carry out prospective studies on energy and the environment. There is also a permanent need to create and operate large databases, and to support its use by third parties. To build these capacities, the creation within SENER of the Centre for Energy Information and Policy (CEIP) is being proposed. CEIP will focus on the following areas: a) Long-term modelling of the interrelated issues on energy, the environment and the economy; b) Research on the effects of the energy sector on climate change and acid rain; c) Development of the most viable scenarios for the penetration of renewables and to assess its impacts on the economy. CEIP will establish and operate as the hub for thematic networks among the research centres of the energy sector and the universities, to increase their strength and create synergy. A national energy information system is currently being set up by SENER with the support of the companies, commissions, and institutes of the sector, as a first step in this direction.

Operational Framework for CDM
The GOM has decided to play an active role in the world-wide implementation of the Clean Development Mechanism (CDM), as defined in the Bonn and Marrakech Agreements. The institutional setting and the operational framework for project approval, monitoring, verification, validation and eventual certification, will be developed. The National Authority for project approval is in the process of being defined. Guidelines for project development and methodologies for the establishment of the Base Line, and for project approval, monitoring and verification will be developed.

Technical Support Infrastructure
A cadre of world-class scientists and engineers, with an average experience of over 15 years in the development and implementation of renewables, is already available at IIE. From the quantitative point of view, this capacity will not be enough to support the full process of sustainable market deployment. Therefore, these capabilities will have to be cloned and multiplied as necessary. Plans to upgrade the Non-Conventional Energy Unit at IIE to become a Centre of Excellence for renewables are underway. Several new technology-specific regional centres (RTCs) will be created, with support from the National Council for Science and Technology (CONACYT). These RTCs will operate in close networks with local universities and engineering schools, and will basically serve the needs of industry. They will have a strong focus on capacity building, including technology development and technology transfer. Among other tasks, the RTCs will train project developers and implementing agents. Permanent programs for training and certification of human resources on the subject of renewables will be implemented. Other important tasks of the RTCs include: Development of guidelines and best practices for project development and implementation; adopting and/or adapting technical norms, standards and specifications; development of engineering tools, such as spreadsheets, data bases and handbooks; technology testing and characterization; measurement and characterization of renewable energy resources; and support to develop pre-commercial technologies of interest to local industry. Once in full operation, the RTCs will have to become at least partially self-financed from the fees paid by industry for the goods and services received. The network of RTCs will be coordinated by IIE’s Centre of Excellence, who

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74 Some of these activities are already underway at research institutes of the energy sector and at several universities, but with limited coordination. SENER itself is doing part of this work, but with some shortcomings, including the limited expertise and time availability of its personnel.

75 Project proposal: Center for Energy Information an Policy. Internal document, SENER.

76 Some work is already in progress with support from the World Bank and the International Atomic Energy Agency.

77 This work is intended to devise market mechanisms to reduce the emissions of environmentally damaging emissions, in the context of the clean development mechanism of the UNFCCC and other international instruments.
will assure high quality standards and compliance with international best practices. Plans for the implementation of the Regional Centre for Wind Technology in the windy state of Oaxaca are already included in the UNDP-GEF project proposal mentioned earlier.

**Strategy 3: Financing Mechanisms**

The current Law in Mexico rules out the possibility of directly adopting many of the financing mechanisms that have proven suitable to support the penetration of renewables in other countries. Hence, a relatively short-life instrument with the following elements to transform the market is being proposed:

- A Green Fund, as the main vehicle to remove financial barriers for electricity projects;
- Long-term power purchase contracts, to give financial security to the investments;
- Fiscal, contractual and economic incentives to foster market entrance of pre-commercial projects.

**The Green Fund.**

**Objective.** To provide supplemental financing for the purchase of electricity from renewable energy.

**Concept.** Conceptually, the Fund will operate as follows: Independent power producers of electricity from renewables will sign long-term (to be determined) power purchase contracts with CFE, subject to the economic terms and conditions established in the current Law. CFE will sell that electricity (green electricity) to consumers at the established tariff for the dispatching period. Consumer of green electricity will pay a premium fee (to be determined) over the established tariff. This premium fee will go to the Green Fund. The Green Fund, in turn, will sign medium-term (to be determined) contracts with the producers of green electricity, awarding them an incentive to help cover incremental costs and leave margin for profit.

**Operational Rules.** Operational rules for the Green Fund will be developed as part of the project proposed here. A few indicative ideas follow: Clear policy objectives and flexible operational criteria; only new projects to be considered; large scale hydro (size to be determined) and high temperature geothermal, to be excluded; established shares for other renewables Incentives to be awarded: in terms of the maturity of the participating industry; not applicable as capital for plant construction; to be based on plant performance; to be limited in time after plant coming on line; to be gradually phased out in accordance to the economics of the project. Plant size to be limited to avoid depleting the Fund with only a few large projects. Competitive forces to be used to make subsidies decline over time. Projects to be chosen by competitive bidding based on the lowest requirements for incentives. A period of time to established for projects to be built, after which defaulting projects will lose any right to the incentive. Defaulting low bidders to be severely penalized. Long-term power purchase contracts awarded to wining projects. Close cooperation between bidders and CFE required. The Green Fund will look for sustainable results.

**Size of the Green Fund.** A minimum revolving fund of US$ 120 million will be required to facilitate projects with a total capacity of 1,000 MW in a period of 5 years. If sustained, the Fund could support implementation of additional 4,000 MW in the next 5-7 years.

**Fund Replenishment.** Several mechanisms to replenish the Green Fund are under consideration. They include the proposed premium fee for green electricity, carbon and green certificates, voluntary contributions, bilateral and multilateral financial assistance, and other international financing instruments, such as the GEF, the Prototype Carbon Fund, and those to derive from the Clean Development Mechanism. Willingness to pay for green electricity in Mexico has been explored, with 94% of the 100 largest industrial electricity consumers expressing their willingness to buy green electricity, for which 54% would pay a surcharge of up to 11% of the regular tariff.

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79 CONAE. Aspectos relevantes de la encuesta realizada por Gallup sobre la demanda de energía verde en México.
Further studies will be carried out as part of this project to define in more clear terms the necessary mix of funds and strategies to support the operation of the Green Fund. NAFIN and BANOBRAS could establish special funds, earmarked for environmental and renewable energy projects\(^{80}\) to complement the Green Fund.

**Duration and Exit Strategy.** It is estimated that the creation of a market for renewables energy in Mexico could take over two decades. The anticipated duration of the Green Fund would be 20 years. Renewable energy technologies reaching economic competitiveness would be gradually excluded from the benefits of the Fund. Green prices for the electricity from such technologies would also gradually diminish. At the end of the Green Fund life time, carbon credits and other financial incentives deriving from the Clean Development Mechanism and other bilateral and multilateral instruments, would be treated according to the internationally agreed rules and time tables for such mechanisms.

**Potential Show Stoppers.** The strategy to implement the Green Fund could fail for one or several of the following reasons: a drastic change in policy towards renewable energy; lack of sufficient funds to constitute the Fund; lack of interest from industry to participate in the process; mismanagement of the Fund.

A number of issues will have to be resolved before the Green Fund is fully operational. International experience with similar mechanisms\(^{81}\) will have to be reviewed. The Fund will have to be tailored to the particular conditions of the different market sectors were renewables will be applied, and it will have to be tested in a number of pilot projects.

Initiatives will be promoted to create awareness among commercial banks and financing entities, so that lines of credit are open to finance small industries and the general public towards the purchase of renewable energy goods and services. Credits of this sort could play an important role in opening the retail market for renewable energy technology.

**Strategy 4: Concerted Plans of Action**

The power sector offers the best opportunities for the massive application of renewable energy, but is not the only ripe field for the application of renewables in Mexico. Other sectors also offer good opportunities, and a concerted Plan of Action will be negotiated, so that renewable energy matters are collectively addressed among the main stakeholders from the different sectors. This will allow the creation of synergies and will create equal opportunities for the participation of renewables in the projects of the different sectors.

**Renewable Energy and the Rural Sector**

It is expected that during the first years of the project proposed here a strong rural electrification activity will take place. It is also anticipated that, complementary to the program for native communities mentioned earlier, the FIRCO project will step up its level of activity and will increase its geographical coverage. Both programs may eventually merge into each other to constitute the backbone for the application of renewables in rural areas. Private activities in rural areas are expected to grow in a business as usual mode, motivated by the higher costs of other conventional alternatives and the economic benefits that could derive from the new supporting instruments. Environmental reasons point to the need for a sustained program to improve the use of firewood in rural communities, by introducing advanced technology such as biomass gasifiers, solar cookers and efficient stoves. Programs for the use of forest residues from the timber industry and energy plantations for the local production of electricity in substitution of diesel fuel will be promoted.

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\(^{80}\) Projects such as municipal self-generation of electricity by using biogas from sanitary landfills, and others, could soon find sources of soft money within Mexico.

Renewable Energy and the Municipal Sector
A program to foster the use of renewable energy for self generation of electricity by municipalities will be implemented in coordination with state governments and BANOBRAS. This program will also be coordinated with COMIA, and will include the following activities: a) assessment of the impacts from electric tariffs on the economics of municipalities; b) identification and characterization of renewable energy resources available to municipalities; c) formulation of a portfolio of financially viable renewable energy projects for self generation of electricity at the municipal level; d) promotion of this project portfolio among potential investors; e) implementation of strategies for the removal of institutional barriers impeding the implementation of these projects; f) leverage of shared financing for the implementation of a few pilot/demonstrations projects (at least one of each, solar, wind, biomass and micro-hydro) with innovative components in the non-technical aspects of project implementation; g) evaluation of the pilot/demonstration projects and development and diffusion of lessons learned and best practices.

Renewable Energy and the Water Sector
A program under the title "Clean Water with Clean Energy" will be implemented in close coordination with SEMARNAT's National Water Commission. The main objective of this program will be to foster the use of renewables in the operations of the Water Sector. Here, the overall potential for the self supply of electricity will be assessed, and a number of pilot/demonstration projects will be identified and developed. Barriers specific to the participation of private capital for the supply of electricity in this sector will be identified, and policy schemes compatible with the overall policy for the promotion of renewables will be developed and implemented.

Renewable Energy and the Environment
SENER and SEMARNAT are working on the development of policy instruments and operational mechanisms for the implementation of a carbon market in Mexico. This activity will be expanded and supported by the present project.

Strategy 5: Participation of the Private and Social Sectors
Extensive consultations will be carried out on program design with key organizations of the private and social sectors. Participation of private investors and the manufacturing industry will be intensively promoted. For this purpose, a portfolio of technically and economically viable renewable energy projects of different sorts will be prepared and publicized. A concerted effort will be carried out to expand and improve the quality of the data base on renewable energy resources for Mexico. This will include: a) Fine-tuning the prediction methods for solar energy and wind power; b) expanding the geographical coverage of reference measuring stations for these two resources; c) Assessing the small hydroelectric potential using analytical methods and integrating a portfolio of potential sites for development of commercial projects; d) Compiling, organizing and analysing available information on the various biomass sources, in order to assess the overall potential and identify promising projects by source; e) developing quality standards and methodological procedures to be applied in future and ongoing activities for resource assessment; f) laying the methodological foundation to assess the potential for ocean energy -in particular small tidal power. Work will be done to reach a consensus among organizations interested in the assessment of renewable energy resources in Mexico, so that individual activities adhere to standard protocols and international practice. The geographical information system SIGER will be used as the national clearing house for information on renewable energy resources, technology markets and project opportunities. For this purpose, standard practices for resource assessment and reporting will be established, and SIGER will be made available on the Internet for easy access by all interested parties. Information on policy and regulations will be also made available on a Web site. A well
structured program for the development of local industries to produce renewable energy goods and services will be created. A practical scheme will be implemented to introduce energy crops as substitutes for traditional firewood for both, domestic and agro-industrial uses, thus preventing further deforestation and helping to reclaim already deforested land. An appropriate legal and regulatory framework will be sought to foster the creation and successful development of rural energy services companies within the framework of the current Law. A mechanism will be created to foster the use by industry of environmentally friendly technology.

**Strategy 6: Coordination Among Stakeholders**

Government and non-government organizations, international and bilateral agencies, financing institutions and industrial agents promoting renewable energy activities in Mexico, will be invited to join forces within the framework of the present project, to achieve the national goal of a mature market for renewable energy and the corresponding decrease in GHG emissions. It is expected that energy-related GEF-supported projects in Mexico, both in progress and new approvals, will lead this effort of coordination. Coordination is essential to avoid duplicating efforts and repeating mistakes. It is also essential to create synergy among the different projects and to share lessons learned. Coordination will also facilitate the implementation of a comprehensive national program for the promotion of renewable energy among the general public and the creation of awareness on energy related environmental issues.

**Expected outcomes: The First Three Years**

The following results are expected in the first three years of project implementation:

**Under Strategy 1, Enabling Policy**
- Adequate public policies to remove the existing barriers in the energy market, to foster the large-scale implementation of renewable energy;
- Well supported proposals for the modification of the existing regulatory framework of the power sector to facilitate the use of renewables.
- Advanced proposals to establish specific regulations in other sectors, such as mandatory use of solar water heaters in new housing and the use of PV in public buildings.

**Under Strategy 2, Institutional Setting**
- The Centre for Energy Information and Policy will be created
- The operational framework for the Clean Development Mechanism will be established
- The Non-Conventional Energy Unit of IIE will be upgraded to become a centre of excellence for renewable energy technology
- The first three Regional Centres for Renewable Energy Technology (wind, solar and small hydro) will be created
- A yearly program to foster the generation of electricity by means of renewable energy will be developed
- A national program for renewable energy technology research and development will be jointly established with the National Council for Science and Technology (CONACYT).
- Current activities to develop human resources specialised in the use of renewable energy will be reinforced. Implementation of diploma courses, workshops, seminars and graduate programs in the field of renewable energy will be fostered

**Under Strategy 3, Financing Mechanisms**
• The proposed Green Fund will be designed and implemented. The Fund’s objectives will be defined, policies and rules for operation will be established, eligibility criteria to benefit from the Fund will be developed, a host institution for the Fund will be identified and properly staffed, and the operation of the Fund will be launched.
• Several commercial projects will be piloted as part of the operational tests of the Fund
• The availability of low cost financial resources to be applicable to programs, projects and activities on de subject will be increased
• A national fund for the promotion of renewable energy will be created
• Funds specifically to support R&D programs for the development of renewable energy technologies will be allocated

Under Strategy 4, Concerted Plan of Action
National and regional programs to apply renewable energies in different sectors of the economy will be implemented and operated, including the following:
• Renewable energy in the Power Sector
• Energy services for rural communities
• Municipal uses of renewable energy
• Clean Water with Clean Energy
• Industrial applications of renewable energy

Under Strategy 5, Participation of Private and Social Sectors
• Permanent programs for the promotion of renewable energy will be launched
• A portfolio of potentially commercial projects will be created and continuously updated
• Development of capacities among energy users will be fostered and supported, so that they are able to design and instrument renewable energy programs
• A national program to register, integrate and process information on the potential for application of renewable energy will be implemented. Results will be made available on the Internet
• A program on biofuels and rural energy will be launched
• Teaching of renewable energy topics in a larger number of institutions will be fostered.

Under Strategy 6, Coordination Among Stakeholders
• Regular meetings will be held with other entities working in the field of renewable energy in Mexico, to promote the exchange of ideas and experience.
• Mexico's links in the international context, will be expanded and strengthened in order to take advantage of available low cost financing, exchange of experiences and technical resources on the subject.
• The transfer of experience and technology from other countries, will be strengthened in order to instrument technology research and development programs in the field

Project Monitoring, Evaluation and Impact Assessment
A permanent activity to follow up the progress of this projects will be implemented. At the end of the first three years the whole project will be reviewed. Progress will be measured according to pre-established performance indicators. Indicative triggers for subsequent phases will include:
• The Green Fund already set up and operational
• Several (to be defined) pilot projects implemented within the Green Fund and lessons documented
• A mechanism for carbon trading well defined and operational
• The creation of a facilitating regulatory framework in progress
• A reasonable level (to be defined) of social and private sectors participation
• An improved data base on Mexico’s renewable energy resources available on the Web
• A portfolio of possible renewable energy projects accessible on the Web
• Improved technical/institutional infrastructure

**Implementing Costs (Thousand US$)**

**Total Cost and Financing**

<table>
<thead>
<tr>
<th></th>
<th>Amount (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GEF</strong></td>
<td></td>
</tr>
<tr>
<td>Barrier removal and capacity building grants</td>
<td>45,000</td>
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<tr>
<td>Financial mechanisms (Green Fund)</td>
<td>90,000</td>
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<tr>
<td>PDF</td>
<td>1,500</td>
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<td><strong>Sub-total</strong></td>
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<td><strong>Government of Mexico</strong></td>
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<td></td>
<td>332,500</td>
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<tr>
<td><strong>Sub-total</strong></td>
<td><strong>332,500</strong></td>
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<tr>
<td><strong>Private Companies</strong></td>
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<tr>
<td>Equity for 5,000 MWe plus non-electric projects</td>
<td>2’514,150</td>
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<tr>
<td>Studies</td>
<td>5,000</td>
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<tr>
<td>Industrial infrastructure development</td>
<td>200,000</td>
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<td><strong>Sub-total</strong></td>
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<td><strong>International Financing</strong></td>
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<tr>
<td>Commercial loans for up-front investment</td>
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<tr>
<td>Complementary financial mechanisms (Green Fund)</td>
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<td><strong>Sub-total</strong></td>
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<tr>
<td><strong>TOTAL PROJECT (with PDF)</strong></td>
<td><strong>9’084,500</strong></td>
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**Summarized Breakdown Cost and Financing**

**Phase 1 (first three years)**

<table>
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<th>Amount (US$)</th>
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<tbody>
<tr>
<td><strong>GEF</strong></td>
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<tr>
<td>Institutional strengthening</td>
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<tr>
<td>IIE’s Centre of Excellence (infrastructure upgrading)</td>
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<tr>
<td>Regional Renewable Technology Centres (creation)</td>
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<tr>
<td>International consulting</td>
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<td>Green Fund</td>
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<td><strong>Government of Mexico</strong></td>
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<tr>
<td>Estimated incurred costs**</td>
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<tr>
<td>Regional Renewable Technology Centres (operation)</td>
<td>6,000</td>
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<tr>
<td>Rural energy projects</td>
<td>180,000</td>
</tr>
<tr>
<td><strong>Private Companies</strong></td>
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</table>

82 Cost estimates made for the high penetration scenario.
83 Yearly estimates are as follows: SENER (100), CONAE (100), IIE (1,000), CRE (50)
### Strategic Partnership. Final Concept Paper. Versión 2.2, marzo 2002

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Total Phase 1</th>
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<tr>
<td>Equity for 600 MW plus non-electric projects</td>
<td>292,500</td>
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<tr>
<td>Studies</td>
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<td>Industrial infrastructure</td>
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<tr>
<td><strong>International Financing</strong></td>
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<tr>
<td>Commercial loans</td>
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<td><strong>Total Phase 1</strong></td>
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### Phase 2

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<td>Institutional strengthening</td>
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<tr>
<td>Regional Renewable Technology Centres (creation)</td>
<td>6,000</td>
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<tr>
<td>International consulting</td>
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<tr>
<td>Green Fund</td>
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<tr>
<td><strong>Government of Mexico</strong></td>
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<tr>
<td>Estimated incurred costs</td>
<td>8,750</td>
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<tr>
<td>Regional Renewable Technology Centres (operation)</td>
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<tr>
<td>Rural energy projects</td>
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<td><strong>Private Companies</strong></td>
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<tr>
<td>Equity for 4,400 MW plus non-electric projects</td>
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<tr>
<td>Studies</td>
<td>4,400</td>
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<tr>
<td>Industrial infrastructure</td>
<td>130,000</td>
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<tr>
<td><strong>International Financing</strong></td>
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<tr>
<td>Commercial loans</td>
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<tr>
<td>Green Fund</td>
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<tr>
<td><strong>Total Phase 2</strong></td>
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<tr>
<td><strong>TOTAL PROJECT</strong></td>
<td><strong>9’083,000</strong></td>
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</tbody>
</table>

### Implementing Structure

This project will be executed by SENER, through CRE, CONAE and IIE. Implementation of the project will be guided by a Steering Committee chaired by SENER and integrated by the following government bodies and private organizations: the Ministry for the Environment and Natural Resources, SEMARNAT; the Ministry for the Economy, SE; the Ministry for Finance and the Budget, HACIENDA; the National Council for Science and Technology, CONACYT; the National Chamber of Electrical Equipment Manufacturers, CANAME; the Federal Commission of Electricity, CFE; the National Energy Savings Commission, CONAE; the Electrical Research Institute, IIE; the National Solar Energy Society, ANES. The Steering Committee will be supported by technical committees as necessary, with representatives from the Steering Committee member institutions and other organizations, who will deal with the technical and operational aspects of the project.

### Regional Impact

It is anticipated that this project will have an important regional impact in Latin America for several reasons. Mexico plays a leading role in the concert of these nations. In particular, the so-called “Plan Puebla Panamá” launched by Mexico is a political instrument already available, which will facilitate sharing experience and supporting similar activities in the Central American
countries. Once developed, Mexican renewable energy industries will seek to expand their operations to other Latin American countries. For idiosyncratic and language reasons, Mexico is a place many professionals from further south choose for advanced training and education in energy matters, electricity in particular.

**Strategic Partnership**

The GOM has decided to submit this project proposal to the WB-GEF Strategic Partnership Program (WBGEF SPP) in order to benefit from the extensive experience these institutions have gained by facilitating the implementation of renewable energy programs and projects in many countries over the past 10 years. In particular, the GOM seeks technical and financial support from the WBGEFSPP in the areas of capacity building, creation of new institutions and financing services, development of market transformation initiatives, and development of strategies for the participation of the private sector. Support is also sought to improve the renewable energy resource data base and to jointly coordinate and oversee development of the whole project.

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84 This is already happening with balance of system components for solar home systems.