MEXICO
Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

GEF Project Brief

Latin America and Caribbean Region
LCSFE

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Project ID: P077717	
Focal Area: G	

Project Financing Data

[ ] Loan [ ] Credit [X] Grant [ ] Guarantee [ ] Other:

For Loans/Credits/Others:
Total Project Cost (US$m): $272.50 **Cofinancing:** To be determined
Total Bank Financing (US$m):
Has there been a discussion of the IBRD financial product menu with the borrower? [ ] Yes [X] No

Financing Plan (US$m): Source	Local	Foreign	Total
BORROWER/RECIPIENT	7.50	0.00	7.50
GLOBAL ENVIRONMENT FACILITY	0.00	25.00	25.00
LOCAL SOURCES OF BORROWING COUNTRY	65.00	0.00	65.00
BILATERAL AGENCIES (UNIDENTIFIED)	0.00	25.00	25.00
FOREIGN PRIVATE COMMERCIAL SOURCES (UNIDENTIFIED)	0.00	150.00	150.00
Total:	72.50	200.00	272.50

Borrower/Recipient: UNITED MEXICAN STATES
Responsible agency: SENER (SECRETARÍA DE ENERGÍA)
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Project implementation period: 4/04 - 10/11

A. Project Development Objective

1. Project development objective: (see Annex 1)

The development objective of the proposed project is to assist Mexico in stimulating and accelerating the commercialization of renewable energy applications and markets, particularly at the grid-connected level, in order to reduce greenhouse gas (GHG) and other emissions while responding to increasing energy demand and energy diversification imperatives necessary for sustainable economic growth.

To reach this objective, the project proposes a two-phase approach to address key policy and tariff issues currently hindering renewable energy development, and facilitate initial investments with use of GEF support in a competitive Financial Mechanism to overcome initial investment barriers. Based on an adequate framework and market entry in the 3-year, $25 Million Phase I, the project would continue project replication and cost reduction in an anticipated $45 million Phase II.

2. Global Objective

The global objective, per GEF Operational Policy #6, is to address and reduce the barriers to development of grid-connected renewable energy technologies and markets in Mexico.

Mexico has a broad array of world-class renewable energy resources, but has developed very few of these resources due to the historic availability of domestic oil and gas and a Constitutionally-based mandate to acquire only least-cost electric power resources. For Mexico, the project will significantly contribute to their objective of diversifying the electricity sector (cost and supply) , while providing significant additional renewable energy (RE) capacity, organizational learning, and cost reductions in wind and other technologies.

While many of Mexico's emissions issues are related to the transport sector, and its growing fraction of natural gas in the power sector reduces overall emission intensity, there are significant local and global benefits associated with reducing GHG intensity in the power sector.

The project is also seen as a significant broadening of World Bank and GEF experience, particularly in stimulating grid-scale renewable energy technology. Previously, the World Bank has worked with GEF in developing and implementing the India Renewable Resources Development Project which helped introduce large scale wind energy to India. More recently, the World Bank has been working with China on the China Renewable Energy Scale-Up Program, which seeks to create a mandated market share and associated certificate trading mechanisms as an approach to enlarging markets. This project for Mexico will demonstrate important linkages between policy/pricing considerations and GEF incentive support delivered in a competitive, cost effective framework, enlarging the GEF toolkit for future projects.

Mexico is a regional industrial and technical leader with strong relations throughout Latin America, and is well positioned to extrapolate experiences in policy and technology. Further, while Mexico is a developing country, it is also an OECD country, a fact which has inhibited flows of soft donor financing that would have otherwise been attracted by the significant renewable energy resource in the country. OECD and NAFTA linkages position Mexico to be a global player in renewable energy policy and technology.

2. Key performance indicators: (see Annex 1)

The key performance indicators are as follows:

- Total electricity generated (GWh/yr) from renewable energy

- Total renewable energy generation capacity (MW)

- Emissions reduced (tons/year):
  - ✓ CO_2
  - ✓ NOx
  - ✓ SOx
  - ✓ Particulates

- Costs of renewable generated electricity ($/MWh) competitive in grid system

Additional indicators describing impacts and benefits will be developed during appraisal to evaluate other development contributions (industrial, local manufacture, employment, and other social benefits resulting from land leasing for wind farms, etc.). Their specific values will be further defined during project preparation.

GEF Phases and Trigger Conditions

GEF grant funds to promote renewable energy power generation will be provided in two phases. The first phase is expected to be 30-36 months, and the second phase will be approximately five years. The indicative timeline for Phase I, based on estimated effectiveness in approximately February 2004, is as follows:

Year 1
- Technical assistance for system modeling, policy development, and establishment of technical standards
- Development of CFE base tariff and legal and institutional arrangements for tender offer
- Operationalization of Financial Mechanism, business assistance services, and private sector outreach
- Issue call for pre-qualifications for renewable energy Independent Power Producers (IPPs)
- Coordination with UNDP activities

Year 2
- Initial tender offer, followed by bid review, selection of awardees, and issuance letters of intent
- Awardees finalize financing
- Initial commitments (contract closings) for GEF tariff support
- Initial project construction begins
- Mid-term/tripartite review meeting and report

Year 3
- Transition to Phase II initiated, based on successful first tender and financial closure on early projects

- Initial projects receive GEF tariff support (nominally for 5 years) based on renewable energy generation
- Second tender (if indicated, and pending availability of additional co-financing)
- Preparation and submission of revised project for Phase II

Based on this timeline, the primary use of GEF funds in Year 1 will be for technical and policy assistance, and to develop detailed operation of the Financial Mechanism. The initial tender offer expected in Year 2 will require commited availability of GEF tariff support to help stimulate the market and facilitate developer access to commercial financing, but no tariff support funds would flow until actual generation which would not be expected to occur before near the end of Year 2 or early in Year 3. Committed funds for winners of the initial and subsequent tenders would flow for five years from the start of actual renewable energy generation for the respective project.

Procedures and Triggers for Release Phase II of GEF Funds

One of the key lessons in international efforts to promote renewables has been the importance of maintaining continuity in support and avoiding ‘stop-start’ incentives. Thus, it will be important to ensure a smooth transition from Phase I to Phase II. Phase II is likely to be presented well before the conclusion of Phase I, but in any event would not be submitted prior to the completion of at least one successful program tender (a more precise definition of what constitutes a successful tender will be provided at the time of CEO endorsement of Phase I).

As the project will be prepared as a single, two-phase project, Phase II will be submitted to GEF as a revised project brief. This revised brief will include a monitoring and evaluation report to date for Phase I which will effectively serve as a World Bank appraisal for Phase II. The revised brief will be provided for Work Program inclusion as a regular project. In order to maintain continuity of funding flows and subsequent tender offers through the financial mechanisms, this revised brief is expected to be eligible for consideration at any Council meeting (including Intersessional). These triggers will be verifed at project appraisal on the basis of further analysis developed in the course of project preparation, and any proposed adjustments and accompanying rationale will be highlighted for GEF CEO review.

Triggers

The performance indicators used to gauge the success of the first phase and trigger release of funds for the second phase are:

- Clear policy, contractual, and market framework for acquiring renewably-generated power by CFE, including introduction of a competitive tariff support function. Specifically, this will be demonstrated by (i) making operational a Financial Mechanism for tariff price support for renewable energy through competitive bidding, with the tariff support funds provided by GEF, (ii) committing $17 million of GEF funds to private sector investors, and (iii) committing to acquire at least 70 MW renewable energy generation capacity in Phase I. (While this is the expressed trigger, it is expected that the Financial Mechanism will support approximately 100 MW in Phase I, and that an additional 100 MW will be indirectly induced by the program through acceleration of activity under the auto-generation/self-supply provisions).

- Establishment of a pricing and procurement methodology for properly valuing renewable energy additions to the CFE system. Specifically, this will be demonstrated by shifting *from* a CFE power purchase tariff based on the system short-run marginal costs (SRMC) in Phase I *to* a Phase II tariff based on (i) SRMC, plus (ii) adjusted capacity value associated with the renewable energy power generation capacity, plus (iii) energy portfolio diversification value of the renewable power generation capacity. The calculation of the values for items (ii) and (iii) will be facilitated by GEF-cofinanced technical assistance undertaken during Phase I.

- Decline in the need for subsidies over time. Specifically, this would be demonstrated by a shift *from* a maximum GEF grant of US cents 1.5 per kWh of wind energy generation in Phase I *to* a reduced maximum GEF grant in Phase II. This figure will be re-estimated at time of updating the Project Brief but is expected to be approximately 0.8 US cents per kWh of wind energy generation in Phase II. The actual number of competitive tenders supported through the program will depend on several factors, including the results of the initial price discovery facilitated by the first tender.

A Monitoring and Evaluation program will be established for the project to detail anticipated outputs and outcomes, institutional responsibilities and reporting, and performance for phased release of GEF funds. This M&E plan, including budget, final organizational arrangements for implementation, and specifications of indicators, benchmarks, and means of measurement will be detailed in the Project Appraisal Document, and will provide for a program review at the end of the first program phase period.

B. Strategic Context

1. Sector-related Country Assistance Strategy (CAS) goal supported by the project: (see Annex 1)

Document number: 23849 - Mexico - Country Assistance Strategy - 2002/04/23 **Date of latest CAS discussion:**

The project is correlated with key CAS priorities on Balancing Growth and Poverty Reduction with Protecting the Environment. The World Bank will continue to play a catalytic role through further energy sector dialogue, addressing accelerated growth through enhanced competitiveness, ensuring the adequate provision of physical infrastructure while balancing other objectives required for ensuring sustainability.

The CAS reveals that environmental degradation - in which water, forests, biodiversity, and air quality are being depleted in order to foster growth - are shown under 'green' national accounting to be costing the country some 10 percent of GDP per year. Such degradation has now become a binding constraint to Mexico's external competitiveness, and to its ability to access new markets, attract foreign investments, and further develop its tourism industry. As a member of NAFTA, WTO, and the OECD, the country is compelled to enhance its environmental standards and compliance mechanisms. The GoM recognizes in the CAS that existing incentive structures, pricing policies and subsidies, can induce overuse, misallocation, and waste of environmental assets, and that unless implicit short-term tradeoffs between social protection and environmental protection are addressed, environmental quality will suffer.

At the same time, continued energy growth on a sustainable basis is a key objective for Mexico - without a stable, affordable source of electricity, Mexico's economic engine will stall. It is recognized that the infrastructure sector overall (petroleum, natural gas, and electricity) still requires structural reform to unbundle activities and establish a robust competition framework. While these efforts remain slow and politically difficult, the project will provide important information on real costs and current strategic choices in the electricity sector – this information will be key in balancing rapid energy growth while protecting environmental concerns. The GoM - and civil society - recognize the role that strengthening domestic market-oriented suppliers (including through linkages with NAFTA-driven ones) and the enhancement of their competitiveness can play in economic growth, job creation, and poverty reduction. The strong wind resource in Mexico, located in large part in *ejido* areas *(*largely indigenous communities) in Southwest Mexico, offers a significant potential to benefit national energy supply while providing local employment and revenue flows from wind farms and land leases.

1a. Global Operational strategy/Program objective addressed by the project:

The proposed program is fully consistent with GEF Operational Program #6 – *Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs*.

The global environmental objective of the project is to stimulate and accelerate the development of Mexico's significant renewable energy resources and reduce greenhouse gas emissions, while demonstrating the long-term value of these technologies in the Mexican energy context in terms of diversification, local and global environmental benefits, industrial development, and practical use of a wide range of available energy resources to augment and conserve Mexico's significant conventional energy resources. It is expected that the program will more than triple the installation rate of renewable capacity in the country, with direct and induced effects representing approximately 3,500 MW of additional capacity (or 3,062 MW above the base case), and representing a total carbon emission reduction potential of 58 million tons of CO_2 over the expected 20 year lifetime of the additional project capacity.

Despite the availability of a broad range of renewable energy resources, Mexico has traditionally been a significant oil producing and exporting country, and has not focused on RE resources because of high perceived costs, a strong focus on procuring least cost generation as defined by traditional methods, and a failure to internalize environmental costs. For example, Mexico has a world class wind resource of over 3,000 MW, but thus far only 2 MW has been developed.

A key challenge in the Mexican context is to facilitate the Comision Federal de Electricidad's (CFE) recognition through tariffs of the economic value - on a probabilistic basis - of the energy capacity value provided by renewable energy resources. Incorporation of this value will help make renewable energy projects more attractive and able to compete. Moreover, it will assist in re-evaluating the strategy of procuring power on a strict financial least-cost basis that is resulting in a heavy concentration in natural gas. The project approach of using concessional tariff support on a competitive and declining basis over the life of the program will be accompanied by policy and regulatory modifications that will highlight diversification, environmental and local and industrial development benefits while supporting organizational learning that will reduce system installed costs over time. As such, the project will provide a basis for Mexico - as well as other developing and industrializing countries - to mainstream these considerations in power sector policy and resource acquisition. In the Mexican context, the proposed program will transfer experience developed at the OECD level under the British Non-Fossil Fuel Obligation (NFFO) and a similar program now utilized in California. In addition, it will employ a domestically-financed partial risk guarantee for 'auto-generation' projects with industrials/municipals; use of these mechanisms will significantly broaden the GEF toolkit. In addition, there are strong prospects for cross-border energy flows and carbon trades with the Southwest United States that will provide valuable experience on renewable energy mechanisms that are now rapidly emerging.

2. Main sector issues and Government strategy:

Power Sector Background:

Electricity demand growth during the 2001-2010 period is expected to be strong and greater than the growth rate of GDP. The base case scenario using a GDP growth rate of 5.2% estimates that electricity consumption will grow at an annual rate of 6.3% and energy demand at an annual rate of 6%. Government estimates indicate that it will be necessary to increase capacity by 32,219 MW during the 2001-2010 period, of which 10,854 MW are already committed or under construction. Given the current regulatory framework, self-supply and cogeneration projects are estimated to account for only 4,862 MW of the total capacity addition requirements. The planning scenario also considers retiring 1,661 MW of capacity (mostly older oil-fired thermal) during this period, for a net addition of 30,558 MW, or an 83% increase.

Given their relative efficiency and fuel price projections, the majority of capacity built or contracted by the public sector during the 2001-2010 period will be met with combined cycle gas turbines. **This trend will result in gas-based generation accounting for 52.1% of total generation by 2010, up from 9.2% in 2001,** while conventional thermal generation (fuel oil based) will reduce its contribution from 46.6% to 13.8%. Renewable energy sources (including large hydro) represent around 12% of energy additions. A low rate of capacity retirement resulting from government budgetary and financing restrictions is expected to persist (in the past decade only 816 MW of capacity was retired) and will leave numerous inefficient oil thermal and open-combustion gas units in operation.

Capacity Additions (MW)
2001-2010

	Committed	Not committed	Total	% share
Combined cycle	9,344	8,025	17,369	63.5
Repowering	272		272	1.0
Hydro	936	2,255	3,191	11.7
Coal		2,100	2,100	7.7
Combustion Turbine	134	83	217	0.8
Internal Combustion	51	161	212	0.8
Geothermal	118	5	123	0.4
Undefined		3,874	3,874	14.2
Total	**10,854**	**16,503**	**27,357**	**100.0**

Source: Prospectiva del Sector Eléctrico 2001-2010, Secretaría de Energía.

Electricity sector reform initiatives currently underway are not expected to proceed in their originally proposed form; specifically, partial unbundling and the creation of a wholesale electricity market are not expected to occur in the near future. More likely, a measure will be passed to codify or solidify private sector participation in generation so as to address ambiguities in the 1992 legislative reforms. There are also opportunities for reforms that will expand opportunities for renewable energy development, as these appear to enjoy support across a range of political interests.

Current situation of renewable energy in the Mexican power sector:

Currently, only a small portion of Mexico's total energy needs are met by renewable energy sources. In 2000, hydrocarbon based generation accounted for 60.7% of total installed capacity. The country's dependence on hydrocarbon based generation is even greater, however, when taking into account that while hydroelectric power accounted for 26.2% of total installed capacity, it only accounted around 14% of actual generation as insufficient water supplies exist for year-round production. Geothermal power is the second most important renewable source of energy in Mexico today, with a total capacity of 855 MW. It is followed by wind, with approximately 2 MW from 'La Ventosa' and 'Guerrero Negro'. Solar PV installed capacity, which is not connected to the grid, accounts for 14 MW.

Baseline Projections - Current projections considering available resources and the existing legal and institutional framework estimate that renewable energy capacity will grow by 3,752 MW over the 2001-2010 period (from 10,735 MW to 14,487 MW). Excluding large hydro and geothermal projects, the scenario of renewable growth capacity between 2001 and 2010, is reduced dramatically to only 438 MW, a small number when compared to the additional 27,357 MW in total generation capacity which must be built during this period to meet demand.

Baseline Renewable Energy Capacity Additions 2001-2010 (MW)

	Bagasse	Mini-Hydro	Wind	Solar	Biogas	Geothermal	Hydro	Total
2001	210	20.3	2.0	14	11	855	9,619	10,735
2010	246	225.0	187.0	24	17	978	12,810	14,487
Installed 2001-2010	36	204.7	181.3	10	6	123	3,191	3752
Investment Cost (USD/kW installed)	-	800-6000	1000	3500-7000	630-1170	1,340	740	
Total Investment Cost (millions USD)	-	163.7-1,228.2	181.3	35-70	3.78-7.02	164.8	2,361.3	2,910-4,013

Source: Prospectiva del Sector Eléctrico 2001-2010, Secretaría de Energía; CRE

In addition to this projection, the policy objectives laid out in the *Programa Sectorial* seek to augment these target and promote an additional 1,000 MW of renewable capacity, but recognizes that a significant policy push and supporting instruments will be required. The national electricity research institute (IIE) has performed analysis that has suggested that an even more aggressive growth scenario could be possible given the appropriate policies and regulations over the 2001-2010 period (below) .

Renewable Energy: Aggressive Expansion Scenario 2001-2010 (MW)

Wind	2,000
Small scale hydro	300 – 500
Biomass	150
Photovoltaic (solar)	10 – 20

Source: IIE

Policy Context

Mexican constitutional and legal framework establishes that the State has the exclusive power to generate, conduct, transform, distribute and supply electricity related to the provision of electricity for "public service" (Article 27). The Constitution limits private sector participation to IPP projects where all electricity generated is sold to CFE. For cogeneration, CFE is required to purchase surplus energy up to 20 MW. For self-supply projects, CFE is obligated to purchase surplus energy, but at rates equivalent to 85% of the short-run marginal costs of the most efficient units on the system. Currently there is no decentralization process in the electricity sector, nor is such a process likely under the current legal framework and political context. Article 3 of the Law for Public Electric Energy Service exempts the following activities from the definition of public service, thus establishing the scope for private sector participation in the electricity business:

- Self supply, through co-generation, or small generation (under 20 MW for sale to CFE or under 1 MW for supply of remote communities);
- Generation of electricity by independent producers for exclusive sale to CFE;
- Generation for export sales to neighboring countries (from co-generation, independent production, or small generation);
- Electrical energy import by individuals or formally established entities for self supply only;
- Generation for emergencies caused by interruption of public service.

End users typically pay electricity tariffs that are determined using the average cost of providing service, except for residential and agricultural irrigation tariffs, which are heavily subsidized. Municipal and industrial customers pay higher tariffs to cover the costs of this subsidization. The low rate of capacity retirement for older systems has created a significant difference between system average and marginal costs. Thus, tariffs paid by industry, commercial establishments, and municipalities are well above the marginal cost of combined cycle gas turbines, and clear economic opportunities exist where the willingness to pay of these consumers exceeds the costs of renewable energy supply. (Some municipalities, for example, pay up to $0.19 per kWh).

Recent regulatory modifications permit indirect contracts between renewable energy private producers and consumers and allow for new generation/sales relationships to be developed. In September of 2001, the energy regulator (CRE) published special rules for interconnection contracts between CFE and suppliers of renewable energy which benefit self-suppliers whose consumption points are not adjacent to the production site, summarized as follows:

- Priority dispatch requiring that CFE must provide dispatch for RE providers whenever they generate power (recognizing that RE providers have limited control over when they can generate);
- Discounts on the transmission tariff levied by CFE (which can currently reach 50%);
- Energy Storage, obliging CFE to return unused energy to self-suppliers when required.

Key Barriers to Development of Renewable Energy in Mexico:

A key challenge to cultivating private development and investment in large-scale energy resources is CFE's existing Constitutional mandate of CFE to acquire energy at 'least cost' and its current interpretation in CFE procurement. Under the Electricity Law, SENER has the legal mandate to define methodologies for calculating costs based on long-run marginal costing principles, but has heretofore not utilized this approach, and the method for calculating least cost was in practice developed and applied by CFE. Addressing this definition is a key strategic objective of the program.

While combined cycle gas turbines have emerged as the prototypical least cost power source, gas price fluctuations (which have been significant in Mexico over the last several years) can upset this metric. As CFE carries the entire gas price risk for IPP's, the acquisition of least cost generation sources does not necessarily equate over time with least cost generation. The volatility of such price impacts can be further magnified by the high level of concentration in CCGT's which is emerging in Mexico and is expected to increase significantly over the next decade.

Widespread adoption of renewables would not displace major quantities of natural gas, but would complement gas while diminishing risks. In addition, accessing and maximizing the value of potential carbon credits would facilitate local and industrial development. While there is currently a broad opportunity to open the renewable energy market, this opportunity is time-limited: Mexico's efforts to expand the rate of gas-fired power installations, and the resulting increase in gas demand, are being met with an aggressive program to develop LNG ports and distribution system. Once this LNG infrastructure is in place, it will become politically more difficult to promote renewables.

The lack of a full enabling legal and policy framework for renewable energy has resulted in a low level of entrepreneurial and financial experience for RE projects. Partly as a result of the low level of RE activity, there has also been a lack of detailed resource assessments for some RE technologies and/or failure to integrate such information that is available.

Indicative Deal Flow of Grid-connected Renewable Energy Projects

Mexico has great potential for wind energy, small hydro plants, biomass and small geothermal plants. On wind energy, the potential is due to the exceptional wind resources available in the southern regions of the country. Most of the wind power plants are likely to be developed in the region of Oaxaca where the geography of the area[1] provides a world class wind resource estimated to have a potential for more than 3,000 MW of installed capacity. On small hydro, a large number of competitive projects can be developed due to the existence of numerous abandoned small projects that can be refurbished and thus present small capital cost investment needs. The biomass potential is related with the availability of sugar industry plants that are currently looking into developing biomass power plants.

Actual renewable energy investments related to the GEF project will only become final after the conclusion of auctions under the financing mechanism. However, under the auspices of the September 2001 legal framework (that enables private sector renewable energy power plants to sell electricity for "auto-consumption") there have been clear indications that a strong pipeline of prospective renewable energy projects is developing. Information about the development of renewable projects (particularly wind and small hydro) have been made available to the World Bank by interested parties inquiring about financing from the Prototype Carbon Fund. The main barrier for these projects is the uncertainty of financial cash-flows --related with the credit risk of power consumers, that need to be partners in the projects in order to buy electricity using the auto-consumption law. Under the proposed financing mechanism of this GEF project, this risk will be minimized since payments with the competitively allocated tariff support will be arranged directly with the national electricity provider, CFE.

Identified Projects Currently Under Development:

Fuerza Eolica is currently developing a wind project in Oaxaca in two phases for a total of 150 MW. The first phase aims to build 51 MW and sell part of the electricity produced to the cement company Cruz Azul. The project has all administrative permits and approvals and has obtained initial equity financing from the Deutsche Bank Scudder Latin American Power Fund, while it is currently negotiating debt financing with a number of different institutions (including BANOBRAS), and export credit agencies. Fuerza Eolica is also developing a 30 MW wind facility in Cozumel, which is expected to be developed within the next two years.

CISA is developing a number of renewable energy projects in different parts of Mexico, and has a partnership with Gamesa, the Spanish turbine maker, to develop a number of wind farms in Oaxaca with the first to be a 20 MW facility, the Binestipa Project, planned by 2004. They are also partnered with Guascor, another Spanish company, to develop wind projects and mini-hydros in Baja California and other areas of the country. The company has obtained land rights for wind power installations and is working to obtain operating permits.

Eneolica is a project developer focusing on wind farms and other opportunities in Oaxaca, and is partnered with Grupo Foster of Spain to help assess projects and share development costs. They are studying a 40 MW wind project that is in an early state of development, however the company is already entering into contractual agreements with land owners for the rights to install wind turbines.

Guascor is a Spanish company focused in engine manufacture and energy development and is affiliated with Gamesa, a turbine manufacturer. Guascor is developing a wide array of renewable projects such as biomass, oil recycling, and animal waste energy generation, as well as more traditional renewable projects such as mini-hydro and wind farms as well. They are targeting a total potential of 400 MW of wind farms in Oaxaca, for which they are entering into agreements with land owners, and their most advanced project is a 3 MW mini-hydro facility in Puebla.

Deproe is currently developing a 67 MW facility in Oaxaca to sell electricity to four different municipalities in the Mexico Valley. Specific details were provided about investment costs, production costs, financing, difficulties experienced, and leasing arrangements with the *ejidos* and land owners. The project developers are SIIF Energie and Deproe as equity partners, and Credit Agricole Indosuez and BANOBRAS as debt providers. The company has an overall target to build more than 200MW of wind power plants in Oaxaca with the backing of SIIF. Moreover, Deproe has years of experience in developing small hydroelectric projects and is currently developing a 17 MW hydroelectric plant.

Endesa currently owns a number of small gas-fired cogeneration facilities totaling 25 MW in Mexico, and plans to expand to others as well as develop renewable projects. Endesa has reserved land to develop two or three 25 to 30 MW wind farms in Oaxaca, expected to be operative in two years.

Comexhidro/INELEC is a mini-hydro developer already making fast progress with the World Bank's PCF regarding a number of projects totaling about 60 MW. The company has a strong pipeline of an additional 50-100 MW that can be economically developed with some tariff support.

CFE (the national electricity company of Mexico) is preparing the development of a 50 MW wind power plant also for the region of Oaxaca. The company is considering submission of the project for approval in the national budget of 2004 while it has indicated that it can access favorable financing terms with the German development bank KfW (Kreditanstalt fuer Wiederbau). Moreover, CFE has prepared a list of small hydro plants that can become competitive with some concessional tariff support.

The degree to which any of these above projects may receive GEF support will hinge on their financial analysis and their participation in the competitive tenders.

3. Sector issues to be addressed by the project and strategic choices:

The key sector issue to be directly addressed by the program is to broaden diversification of the power sector by stimulating renewable energy development, thus continuing to meet critical energy demand growth while addressing economic and environmental sustainability.

The promotion of renewable energy forms an important part of Mexico's energy policy for the future for a range of reasons including:

- Diversification (long term). Currently the Mexican power sector is heavily dependent on oil, natural gas, and coal. Fossil fuel based generation accounts for 68% of installed capacity and an even larger share of production. Under the current growth and regulatory scenario, the share of conventional thermal generation will fall from 47% to 13% of total generation over the 2000-2010 period, while the share of natural gas will increase from 9% to 52%. During this same period, hydroelectric generation is forecast to fall from 17 to 11% (due to slow growth relative to CC gas, limited availability of new sites and low water availability). Purely on a percentage basis, Mexico's dependency on natural gas will increase significantly, increasing exposure risks of supply disruptions and stranded investments.

- Diversification (short term). Past evidence shows that natural gas is the most volatile energy commodity in terms of price. Promotion of renewable energy sources would allow Mexico to take advantage of the stable and low (or non-existent) fuel prices of renewables and reduce its exposure to volatility in fossil fuel markets.

- Self-Sufficiency. Current projections estimate that Mexico will need to import about 20-25% of its required gas supply from the U.S. and Caribbean. A significant portion of this requirement could be met over the long term from indigenous sources if gas sector reform proceeds, but this is not viewed as a strong prospect at present.

- Environmental. While many of Mexico's emissions issues are related to the transport sector, and its relatively high quotient of natural gas in the power sector reduces overall emissions intensity, there are significant local benefits in the form of reduced SOx, NOx, and particulate emissions, coincident with the capture of global benefits associated with reducing GHG intensity in the power sector.

Additional policy structures benefiting renewable energy could assist important niches within Mexico:

- Private sector participation and financing flows can be significantly augmented and reduce public sector commitments for new capacity construction. Promotion of renewable energy projects in Mexico will also stimulate the development of domestic suppliers, contributing indirectly to the diversification of the sector (currently gas turbines are imported). As CFE continues to move toward IPP procurement, there will be additional opportunities to build private sector experience across a wider range of renewable energy technologies.

- Agricultural and Rural Development. This sector urgently requires economic reform, but programs to boost its economy will demand more energy. Local generation from forest residues, manure, bagasse and other organic materials, or energy plantations can be developed and relieve deforestation pressures, create jobs, and reduce emissions. Other energy source options like mini-hydro and photovoltaics may be implemented in non-grid connected locations.

- Water Sector. Water is a critical human and agricultural commodity requiring consistent supply. The water sector in Mexico maintains a large number of diesel gensets as back up power for pumping, requiring large capital investments along with sizable budgets for operation and maintenance, as well as generating significant emissions. Renewables can provide cost effective generation sources through biogas recovery from waste water treatment plants and through mini-hydro turbines in aqueducts.

- Municipal Sector. Large amounts of electricity are used for municipal services, coupled with the particularly high tariffs in the sector, create heavy financial burdens. Renewables can provide additional, low cost generation through landfill methane recovery and sludge from water treatment processes while reducing solid waste disposal costs.

Government Strategy and Renewable Energy Imperatives

Regulatory changes form part of imperatives described in the Programa Sectorial de Energía 2001-2006, in which the government recognizes the lag in the development of renewable energy and lays out a comprehensive strategy aimed at correcting this situation. Some of the key objectives include:

- 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 RE 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.

Strategic Choices:

Based on this commitment to diversification, Mexico has acted an a range of strategic choices to broaden development of Mexico's broad RE resources:

The first strategic choice has been to not focus RE development efforts exclusively on self-generation projects not integrated with the CFE grid. The new enabling environment created under the Law for Public Electrical Energy Service (Article 3, described earlier) has created a nascent 'self-generators' market. Under such arrangements, municipals and industrials can purchase a share in an RE project and qualify as 'self-generators', thereby avoiding the high above-average cost tariffs of 10-18 cent per kWh tariffs they pay. Currently, the indicative deal flow includes some 150-200 MW in wind projects being planned by three or four private sponsors. One of these municipal projects has arranged a partial payment guarantee through Mexican development bank BANOBRAS, which is positioned to enforce payment if needed through withholding funds it otherwise would channel to municipalities from Federal and State sources. This modality will be further developed in the GEF program.

While providing an initial opening, the transaction and structuring costs of such projects are high and uncertainties remain in the regulatory and wheeling arrangements, limiting their value as a critical mass for a sustainable market. Internal risks remain high, as cross-shareholdings between partners make legal recourse difficult if one party fails to perform. There is also risk that the self-generation market could be closed if a critical mass of such customers (whose high tariffs of 12 to 18 cents per kWh provide a cross-subsidy to other customers in the system) left the CFE system. An April 2002 Supreme Court action challenged several of the self-generation provisions in the Public Energy Service Law, but did not include the renewable self-generation option within its mandate.

While this type of self-generation is a real market in Mexico under current law, it is not mainstreamed and there is a risk that it may not be permanent. As such, it will continue to be developed as one modality under the GEF program but is not viewed as an substitute for private IPP projects contracted to CFE and integrated with the grid. As a result, Mexico has determined to also develop the direct contract and tariff linkages required to establish a sustainable RE IPP market with CFE (described below).

The second strategic choice has been on determining the program and financial approach to be used to most pragmatically address Mexico's goal of sector diversification through renewables with available resources available from GEF and other sources (described in more detail in Annex on Cost Reduction and Sustainability in Wind Energy). Internationally, two main strategic approaches have been developed to stimulate renewable energy:

- Financial and other incentives to stimulate renewables investment, such as capital cost subsidies, tariff-based incentives, tax incentives, subsidized interest rates, and cost-shared demonstration programs.

- Mandated market policies to create a market demand for renewable electricity, typically implemented as 'feed laws' that specify an attractive **price** for renewables, or approaches that define a **quantity** target of renewable capacity, either through a Renewable Portfolio Standard specifying a percentage of the portfolio to be renewables, or a System Benefit Charge, which typically seeks increments of renewables in competitive bids.

Increasingly, incentive mechanisms and elements of mandated markets are being used as mutually reinforcing tools, and tailored to suit specific country circumstances and objectives. Further, as the Kyoto Protocol has emerged as an international framework to limit CO_2 emissions, new green pricing, Clean Development Mechanism, and/or tradable certificate mechanisms have emerged in response and can provide an important additional source of funds for clean energy development. Mexico has weighed the emergence of these carbon avoidance markets with other lessons learned in financing and implementing renewable energy support programs.

Financial Incentives: Global experience has demonstrated that direct subsidies on a capital cost basis tend to be expensive and often distort incentives to the project developer, resulting in installed capacity but not necessarily the desired outcomes of energy production, sustainable project operation, and continued technology price reduction. As such, this approach is considered more appropriate for developed countries and generally only in the very early stages of technology development, and is not considered appropriate given the high level of technology experience that Mexico can now access. Similarly, accelerated depreciation was considered, but on balance: Too high a level effectively acts as a direct cost subsidy, but at lower levels it can be an effective signal to the market and attract investment. Tariff-based and other support mechanisms based on electricity production (vs. merely construction) were also considered, but hampered in the Mexican context by the Constitutionally-mandated practice of CFE acquiring only least-cost energy resources.

Mandated markets : In employing such approaches, policy can specify either the price that must be paid for renewable electricity on a unit basis or the quantity of renewable electricity that must be bought*;* <u>it cannot do both</u>. Stimulus approaches that dictate levels of clean capacity and specify buyback rates for renewable power typically support costs through a surcharge across ratepayers. Renewable energy portfolio standards, on the other hand, drive utilities to either build RE capacity or buy credits from another entity that builds and operates it, and recover the additional costs through ratepayers. In terms of costs to the government or consumers, both feed laws (with a prescribed price but an indeterminate subscription level) and RPS approaches (with set targets but indeterminate costs) can encounter higher than expected total program costs that can threaten their long-term political sustainability.

In Mexico, several strategic choices readily emerged. First, significant direct government funds are not available, and it was not viewed as politically practical to generate a financial pool for renewables from a ratepayer surcharge, no matter how small. This limited stimulus funds initially to what could be generated from GEF and other bi-lateral sources, and indirect revenues. Further, development of a mandated market policy based on a renewable energy portfolio standard (pursued in the WB-GEF CRESP program for China) proves impractical for Mexico as the existence of only a single utility entity (CFE) leaves no basis for effective trading among different utilities to seek least cost resources. Mexico also recognized the global lessons that, in order to stimulate and maintain a stable RE industry, financial incentives need to be provided in a stable manner, or the industry may collapse or the stop-start impacts may prevent learning and price reductions. Perhaps most importantly, financial incentives need to be accompanied by a clear set of policies, available tariffs, and capacity development to facilitate sustainable mainstreaming of renewable technologies into the countries' portfolio. Further background information on incentive approaches for renewable energy can be found in the Appendix 7.

As a result, Mexico has elected to undertake a hybrid approach:

- based on a version of the competitive auction system for limited tariff support, operated in California (which is itself analogous to the Non-Fossil Fuel Obligation program operated in the U.K.);
- including agreement by CFE to calculate the value of renewable generated electricity based on their system-based marginal costs reflecting the value of renewables in the system, and offering this as a base price in competitive IPP tenders;
- augmented by a moderate level of accelerated depreciation. The scope currently being discussed (5 years / 20% on equipment, linked to generation from assets placed in service, and verification through CRE and CFE) is considered to be appropriately scaled and indicates significant GoM co-financing.

The third Strategic Choice is the continued involvement by the GoM with the assistance of the World Bank in a Programmatic Environment Structural Adjustment Loan (EnvSAL II). One of the triggers for the second phase of this loan is to fully develop by December 2003, the structure and functioning of a National Fund for the promotion of renewable energies. This National Fund is being created as the Financial Mechanism under this GEF project. This GoM commitment demonstrates the linkages they perceive between environmental issues and sustainable economic growth, as well as their commitment to continued development of clean energy sources.

[1] This zone, aptly named by the locals "La Ventosa" (windy), consists of a flat valley which lies between the Atlantic and Pacific ocean. Temperature gradients between the two seas, combined with a mountain range in the north of the valley create a 'venturi' effect that results in steady strong winds almost all year round.

C. Project Description Summary

1. **Project components** (see Annex 1):

Component	Indicative Costs (US$M)	% of Total	Bank financing (US$M)	% of Bank financing	GEF financing (US$M)	% of GEF financing
Technical Assistance:	0.00	0.0	0.00	0.0	0.00	0.0
Least Cost Analysis	2.50	0.9	0.00	0.0	2.00	8.0
System Operations	3.00	1.1	0.00	0.0	2.50	10.0
Business Development	3.00	1.1	0.00	0.0	2.50	10.0
Market Development	1.00	0.4	0.00	0.0	1.00	4.0
	0.00	0.0	0.00	0.0	0.00	0.0
Financial Mechanism	263.00	96.5	0.00	0.0	17.00	68.0
GEF (17 M)	0.00	0.0	0.00	0.0	0.00	0.0
GoM (6 M)	0.00	0.0	0.00	0.0	0.00	0.0
Local Commercial Finance (65 M)	0.00	0.0	0.00	0.0	0.00	0.0
International Commercial Finance (150 M)	0.00	0.0	0.00	0.0	0.00	0.0
Bilateral co-financing (25 M)	0.00	0.0	0.0	0.0	0.00	0.0
Total Project Costs	272.50	100.0	0.00	0.0	25.00	100.0

Total Financing Required	272.50	100.0	0.00	0.0	25.00	100.0

The project's objectives address three primary tracks for developing and sustaining large-scale renewable energy development, including:

1. To open avenues for direct sale to CFE at prices that increasingly recognize over time the full value of renewable resources - including intermittent resources - to the integrated grid system.
2. To remove risk and transactions costs barriers currently limiting private projects serving municipals and industrials under provisions of the September, 2001 renewable energy self-supply regulations enacted by CRE.
3. To define and open up development of the renewable energy export market with U.S. border states that have enacted Renewable Energy Portfolio Standards (RPS) incentive mechanisms, and facilitate this opening with elements of emissions reduction certification and trading.

In addressing these tracks, there are **two main components** under the program:

- A collection of Technical Assistance activities at the analytical, policy, institutional, and business development assistance levels to stimulate and facilitate project investments, and
- A Financial Mechanism to provide targeted tariff-based incentive support in response to competitive tenders for CFE renewables capacity.

Component #1: Technical Assistance

Within the Technical Assistance component are four main categories:

System-based Least Cost Determination: These tasks will include development and implementation of methodologies that establish system marginal costs incorporating diversification and environmental value of renewables. Comisión Federal Electricidad (CFE) and the Secretaría de Energía (SENER) have already agreed in-principle on performing such and analysis and offering a base tariff for renewable generators (described in more detail under the following section on the Financial Mechanism). Specific tasks include:

- Development of methodologies and operational guidelines to interpret least cost power acquisition mandate. (SENER)
- Assessment of the value of energy diversification, including the application of the Capital Asset Pricing Model, options analysis, probabilistic simulation and other approaches. (IIE)
- Development of methodologies and operational guidelines for the valuation of local/regional environmental externalities in power system resource valuation, planning, and dispatch. (SENER)
- Software procurement and training in appropriate software models and tools (e.g., enhanced WASP-based system expansion planning models under ENPEP framework) capable of analyzing the system impacts, cost/value and emissions impacts of intermittent renewable energy sources. (CFE/CENACE)
- Analysis on a regular basis (at least at subsidy auction frequency) of impacts on system expansion of renewable sources and regular estimation of system marginal costs for translation into benchmark or reference prices for acquisition of renewable energy. (CFE/CENACE)

Integration of Renewables in System Operations: These tasks include analysis, modeling, and informed investment decisions on effectively integrating the unique operational characteristics of renewables into the CFE system:

- Expansion of the coordinated hydro-wind dispatch study currently underway for Oaxaca to national scale assessment. (IIE)
- Detailed load flow analysis and system stability studies. (CFE/CENACE)
- Development of a transmission expansion and substation reinforcement plan for windy areas, and development of appropriate policies to amortize and spread the interconnection costs equitably across the expected range of wind farm developments over the planning horizon. (CFE w/CENACE)

Renewable Energy Project and Business Development to facilitate projects attracted and incentivized by the Financial Mechanism**:**

- Development of standardized protocols and contract forms for CFE purchase of renewably generated power. (CFE/CENACE)
- Refinement/expansion of mechanisms to mitigate political and payments risks associated with renewable energy auto-generation schemes and replication strategy for this approach. (BANOBRAS)
- Strengthening of one-stop shop business development services addressing marketing, financing, permitting and planning issues. (SENER's Investment Promotion Unit)
- Expansion of renewable energy industry outreach and development of interconnection and business protocols for power export into U.S. border states, managed by SENER's International Affairs Division. (SENER)

Additional business support tasks and activities are to mitigate political and payments risks associated with renewable energy auto-generation schemes now permitted under the September 2001 renewable energy self-supply regulations enacted by CRE. Facilitation of this 'auto-generation' market will include technical assistance to address:

(a) high search and transactions costs in concluding power sales agreements with multiple parties and balancing supply with load,
(b) payment risks associated with selling to municipalities with varying credit histories,
(c) potential recourse limitations between parties who by regulation must be legally affiliated as opposed to the normal arms-length contract for sale-purchase of electricity, and
(d) Replication of 'self-guarantee' arrangements already demonstrated by BANOBRAS (described earlier).

Green Power/Export Market Development to enhance the ability of renewable projects to attract external financial inflows based on their global environmental benefits and to define and open up development of the renewable energy export market with U.S. border states that have enacted Renewable Energy Portfolio Standards (RPS). The project will:

- Develop of green power/renewable energy tradeable permit systems. (CONAE)
- Develop of Monitoring and Verification Protocols (MVP) initially applicable for energy efficiency ESCO projects. (CONAE)
- Develop and broaden business advisory and financing facilitation services to renewable energy project developers addressing information barriers, wheeling arrangements, and transaction

support, including both pre-bid (on a contingent finance/reimbursable basis) and post-bid project development assistance. (BANOBRAS in coordination with SENER's Investment Promotion Unit)

Component #2 - Financial Mechanism:

Incorporating lessons from British, Irish and California experiences promoting renewables, tariff price support for renewable projects will be delivered from a Financial Mechanism on a per kWh production basis through competitive bidding for increments of capacity for a specific time period (nominally 5 years). Bidding would be periodic and expected to target an expanding level of capacity increments over time. Capital for projects would be provided primarily by the private sector through commercial markets, with the tariff support and contract bid for providing a key ingredient in obtaining project financing. At least one competitive tender will be completed in Phase I and its successful result will serve as a trigger for proceeding to Phase II. Tariff support will be offered as a commitment within winning IPP contracts, augmenting the CFE base tariff, and is expected to be paid for the first five years of the project to facilicate financial closure with commercial sources. Payment of GEF support will be contingent on certified renewable energy generation linked with CFE payments for energy, and no tariff support would flow until construction and actual generation.

Over the life of the wind projects supported under Phase I, the expected level of tariff support is expected to result in a leveraging ratio of GEF funds of apporoximately 7:1. For the entire project (Phase I and Phase II), the leveraging ratio is expected to be approximately 10:1 as the supporting policy framework will be in place and cost reductions for installed capacity are attained. To the degree that additional co-fianncing can be attracted to the project, the effective leveraging ratio could be higher.

Operational Principles for this financial mechanism or “Green Fund” will be further developed based on the following indicative approaches:

- Competitive bidding to minimize cost requirements.
- Payment to support electricity production only (no capital cost support).
- Clear linkage with long-term power purchase contracts to facilitate deal closure.
- Only new projects considered, with large hydro and large geothermal excluded.
- Support to be limited in duration with phase-out an integral part of project economics.
- Project size to be limited to avoid depleting the Mechanism with only a few large projects.
- Time limitation for completion, after which projects lose their right to incentive support.
- A cap on available support to protect the program from uncompetitive bids or gaming.

CFE has already agreed in principle to undertake the system-based marginal cost analysis (described above) and to define a price point (re-assessed on a periodic basis for each tender) at which they would acquire renewably generated power under conditions of competitive procurement. In order to protect the competitive integrity of their IPP bid system, CFE would not reveal this price but would blend it with available GEF funds as an additional increment, providing a composite price representing the maximum tariff available. This composite price would then be made available in a series of competitive tenders for renewable energy capacity.

Current information indicates that the CFE system short-run marginal cost is 3.5-4.0 cents per kWh on a time-weighted average basis. Based on communications with developers, profitable wind projects can now be undertaken at or near 4.6 cents; approximately 1.5 cents per kWh would be provided by GEF as an upper limit for initial auctions. Competitive response to the tender would result in both minimization of the required GEF incentive and convergence toward a narrow range, revealing both important information about the market and a legitimate proxy for the incremental cost as perceived by project developers.

CFE has indicated that, given the strong resource base in Mexico, wind power can contribute to system capacity and could be recognized within the price structure. Recognition of capacity value would be introduced in Phase II once the required system impacts and coordinated dispatch technical assistance is substantially complete. CFE has also expressed their willingness to increasingly integrate other renewable energy values (i.e., diversification, local environmental, and the capture of global environmental values). Such additional consideration would effectively augment the CFE offer price and reduce GEF requirements.

Development of the Financial Mechanism: This task will require development of the detailed Operational Manual governing the operation of the financial mechanism, including legal framework, structure of program tenders and bidding documents, bid awards, contracts, flow of funds, settlement, and disbursement, development of criteria for frequency of calls and allocation of fund resources, technology banding, maximum per project and unit subsidy limits. Framework development of this manual and associated policy guidance will be financed out of PDF-B resources up to project appraisal; final detailed development of the manual and procedures will be developed under the GEF project during the initial stage of project implementation. Among the key points addressed in development of the Financial Mechanism will be:

- Accounting for proposed Accelerated Depreciation in the context of the program; depending on the final level expressed in an upcoming policy ruling, this provision could reduce the need for GEF support (or result in leverage of a larger number of projects).

- Sequencing – Under the California Energy Commission program, funds for the tender program flowed from a legislatively created system benefit charge. For Mexico, the logistical challenge in using GEF funds will be in smoothly moving beyond the first tender. Preliminary results will be needed in terms of projects supported and in policy changes achieved in order to justify a subsequent GEF phase, and this will have to be achieved and documented in real time in order to avoid interruptions in the program.

Co-Financing By Government of Mexico

TA Component Support: $1.5 million
Mexico is prepared to commit approximately 20% of project costs, toward the cost of and delivery of technical assistance services. This includes salaries, overhead, and coordination support by SENER, CFE, CENACE, CONAE, IIE, and other Mexican entites in preparation and implementation of the project, and coverage of domestic taxes for local consultant services (consistent with the World Bank's standard disbursement percentages).

Accelerated Depreciation: $6 million
This figure is calculated on the basis of proposed SENER guidelines on accelerated 5-year deprecation for clean energy investments in service and generating, and applied to the estimated 200 MW of wind projects estimated to be served by the Financial Mechanism in Phase I, plus expected auto-generation and self-supply projects also qualifying for the accelerated depreciation. This incentive is equivalent to about 3% of total project costs. Moreover, and perhaps even more importantly, lower tax payments in the early

project years allow for better financing terms and loan service requirements for project developers. It should be noted that the provision for accelerated depreciation would be available to all qualifying renewable energy installations generating electricity, regardless of whether they receive GEF support from the Financial Mechanism (direct project investments by CFE would not be eligible for such accelerated depreciation allowance).

In addition to this nominal total of $7.5 million, discussions are underway with German, Italian and Spanish authorities on potential additional co-financing applied to the project. Additional co-financing would most likely be directed to augment the Financial Mechanism to extend its lifetime, support a larger number of installations, and achieve broader diversity across technologies served.

Fund Replenishment: Additional mechanisms to replenish the Financial Mechanism will continue to be explored and developed, including bi-lateral contributions, assignment of potential carbon credit revenues assigned back to the Mechanism by the GoM, and/or premium fees for green electricity, carbon and green certificates, and voluntary contributions. Willingness to pay for green electricity in Mexico has been investigated, 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. Conditions will be fostered for green certificate holders to eventually convert them CO_2 emission reduction certificates in international markets.

Phase I of the program would target renewable energy technologies on a least-cost basis in terms of minimizing the level of GEF tariff support required, both initially and over time. Initially these projects are expected to be primarily wind, and potentially small hydro. Based on availability of funding, and making most cost effective use of GEF resources in addressing OP 6 imperatives, wind was selected as the primary target for Phase I as it offers the greatest short- and mid-term prospects for organizational learning and domestic market cost reduction. In addition, focus on one leading technology is considered the most cost effective way to achieve a consistent set of policy linkages and CFE engagement that could later benefit other technologies. If additional cost prospects for other technologies are identified, and/or additional co-financing is identified, other renewable energy technologies may be supported in Phase I.

Phase II is expected to continue tenders under the Financial Mechanism to amplify and replicate renewable energy installations under the program. Incentive support will be ‘banded’ to expand support to other technologies (including small geothermal, biomass and small hydro) and differentiate support to levels required to stimulate these applications.

As described in the Technical Assistance components above, a range of TA activities in Phase I on Green Power/Export Market Development is expected to enhance the ability of renewable projects to attract additional internal and external financial inflows based on consumer willingness to pay for clean energy sources and the global environmental benefits associated with renewable energy power generation. Facilitated by the Phase I introduction of clear policies regarding renewable energy, IPP contractual arrangements, and expression in tariffs of the various values associated with development of these resources, these TA components will prepare the environment in Phase II for further defining and developing the renewable energy export market with U.S. border states.

All the U.S. States bordering Mexico, plus Nevada, have enacted Renewable Energy Portfolio Standards (RPS) incentive mechanisms requiring varying but significant amounts of their future capacity additions to be met with renewable energy. It is expected that these programs will accept cross-border renewable energy flows as legitimate contributions to these targets, and that there are significant opportunities for construction of facilities in Mexico that will be cost-competitive. The project will facilitate opening of these markets with elements of emissions reduction certification and trading and related monitoring and verfication protocols to support these markets.

Currently legislated targets in these states are:

California	20% by 2017
Arizona	1.1% by 2007 (60% of which should be solar)
New Mexico	10% by 2011
Texas	3% by 2009
Nevada	15% by 2013

The RPS program in Texas has been a particular boon to wind energy development in the state, with over 900 MW of new wind power slated for construction this year. Due to a significant wind resources potential, additional customer-driven markets for green power, and favorable transmission rules, this market is expected to continue to grow. California's RPS legislation was only recently passed (September 2002), but this significant requirement provides an important linkage with the California Energy Commission competitive tariff incentive program that the Mexico program is modeled after.

2. Key policy and institutional reforms to be sought:

The primary policy objective of the project is to address the interpretation of Mexico's Constitutionally-based mandate to procure least-cost power. Under the Electricity Law, SENER has the legal mandate to define a methodology for calculating least cost in the long term, but has heretofore not exercised this mandate as the method for calculating least cost has in practice been developed and applied by CFE. As described previously, this traditional interpretation of 'least cost' has failed to adequately represent values in the system for diversification of generation resources and environmental impacts; if continued, this practice would likely exacerbate the lack of diversification in the system. In combination with a failure to acknowledge the capacity value of renewable energy technologies, the current interpretation of least cost has essentially closed renewable energy from the grid-scale market.

A broader definition of least cost has been discussed with CFE and SENER management that would include:

- recognition of true system Short-Run Marginal Costs (based on system costs, not just the short-run costs of Combined Cycle Gas Turbine units as the most efficient units in service);
- recognition of partial capacity value of seasonal or intermittent renewable resources;
- recognition of the energy portfolio diversification value of renewables;
- internalization of local/regional environmental values; and
- capture of global environmental value.

Discussions with CFE top management have resulted in an agreement in principle for CFE to acquire renewably generated power under conditions of competitive procurement, so long as the acceptable offers do not exceed an agreed reference price that would be regularly determined on the basis of agreed system marginal cost-based methodologies. The function of the tariff incentive financed by the Financial Mechanism would be to ensure that all bids would result in a net price to CFE at, or less than, the reference price, up to the limits of the Financial Mechanism resources available for a given bidding round and a per unit tariff support ceiling to be established as part of the fund operational criteria.

CFE also recognizes that renewables do offer partial capacity value in their system. Determining the value of partial capacity credits will be further developed through the project as a function of avoided or postponed conventional investment and/or contribution to system Loss of Load Probability. Based on further analysis, these values will be introduced as part of the tariff offered through the Financial Mechanism and will be modified over time to reflect experience gained on capacity contributions from renewables, conjunctive operation with hydro and other resources to derive energy firming benefits, and other impacts on the system.

CFE management has also expressed their willingness to increasingly integrate other renewable energy values (i.e., diversification, local environmental, and the capture of global environmental values) in the course of project development, technical assistance and Financial Mechanism implementation.

A condition for appraisal will be CFE and SENER's commitment to: (i) define a methodology for calculating least-cost that takes account of the factors described above, (ii) acquire renewable energy generated power under conditions of competitive procurement, so long as the acceptable (net) offers do not exceed an agreed reference price, and (iii) establish a financial mechanism or "Green Fund" to provide competitively bid subsidies for the renewable energy power acquired under (ii).

3. Benefits and target population:

Global and local benefits are in terms of reduced emissions of GHG's and other pollutants such as SOx, NOx, and particulates. For wind installations directly addressed under Phase I, these are estimated to total approximately 8 million tons of CO_2. Induced effects would be expected to be on an order of 2 to 3 times higher. Even greater cost effectiveness in terms of CO_2 would be expected with the larger level of funding expected for the financial mechanism, lower technology prices resulting in greater leverage of GEF funds, and broader induced effects.

There are broad country benefits from the project in terms of electricity source diversification, as described above, in terms of:

- direct diversification resulting from the introduction of additional renewable resources
- increasing country capabilities in managing a wide array of generating sources with different characteristics
- additional diversification by stimulating a broader interpretation of least cost power acquisition.

Mexico already has companies manufacturing some wind turbine components. In terms of technical and business development capabilities the country is well positioned to develop a significant indigenous industry for expanded in-country applications and for export. Expanded renewable energy development offers a potentially significant new line of business for investors and financial intermediaries.

Key beneficiaries from the wind development targeted in Phase I are the e*jido* communities in Southwest Mexico where much of the country's wind resource is concentrated. For these communities, there will be significant local benefits in terms of increased income, income diversification, local economic development, employment and land lease payments. As the project will drive speculative forces on both the supply (land-holder) and buyer (project developer) sides, the project will place particular attention to effectively and equitably balancing the needs and interests of these players.

A consultative process has already begun on providing important information to local community members and leaders in understanding characteristics of wind farms and negotiating equitable leasing arrangements. As a result of community interest and concerns, the State of Oaxaca, through the

Secretariat of Industrial and Commercial Development (SEDIC), requested USAID/Mexico support to conduct a study that would provide *ejidos* and other communities in the region objective information on the types and agreements and contracts typically used in developing wind farms, including magnitude of payments, structure of agreements, and methods for verifying generation and power sales. Concurrently, these communities wanted to improve their understanding of local impacts, employment opportunities, and impacts on local land use and mixed-uses compatible with wind farms. A detailed study addressing these issues has been prepared by Winrock International, Global Energy Concepts, and the American Wind Energy Association, and has further benefited from inputs by the Instituto de Investigaciones Electricas (IIE). This document will serve as a resource for continued local and national consultations on balancing the energy contributions of renewable energy development with broader community interests. A summary of this report is provided in Annex entitled "Policies to Stimulate the Market for Renewable Electricity: International Experience and Lessons Learned."

4. Institutional and implementation arrangements:

Implementation Period: Phase I of the project is expected to be approximately 30-36 months in length; initiation of Phase II will be a function of the success of activities in Phase I and meeting trigger conditions. Phase II is expected to be approximately 5 years.

Program Oversight and Management: The Ministry of Energy (SENER: Secretaría de Energía, responsible for policy, regulation, strategy and coordination of the energy sector) will serve as the Executing Agency for the project, and will take a lead role in project development, interagency coordination, policy coordination, and project monitoring and evaluation.

BANOBRAS will be the implementation entity (under a project implementation legal agreement between SENER and BANOBRAS) which will be responsible for all procurement for the technical assistance activities and under the Financial Mechanism, and for financial management and disbursement activites. It will provide central implementation role in two areas:

- Development and execution of the Financial Mechanism, where it will coordinate with SENER and CFE on preparation, issuance, and review of the competitive tenders for renewable capacity, and will execute contracts for delivery of incentive support under agreed conditions;

- Providing coordination and technical/financial assistance for private RE generators and their private and municipal clients in closing projects under the ‘self-generation’ window permitted under the 2001 CRE regulations.

As a Mexican Development Bank, BANOBRAS is an important government instrument providing financing and technical assistance services for the Federal government, State and Municipal Governments, and the private sector in conjunction with infrastructure investments (roads, water, sanitation, etc.). With these entities, and increasingly with the private sector and other credit institutions and various social organizations, it works to promote and support financial mechanisms for social welfare, housing, urban regional development, and environmental protection. BANOBRAS has worked as a finance agent for other World Bank and GEF projects, including the recent successful implementation of the WB/GEF Landfill Gas Capture Project in Monterrey.

Project Financial Management:

By project appraisal, BANOBRAS (with the WB, SENER, CFE, and other agencies, and through activities supported under the GEF PDF-B funds) will prepare a detailed project implementation plan addressing:

- Detailed procedures and operational manual for the financial mechanism.
- Detailed work plan for technical/financial assistance to 3rd party self generators.
- Financial management.

It is proposed to set up a Special Account in the Mexico Central Bank in the name of BANOBRAS. The account will be used to support BANOBRAS' procurement of primarily consulting services under the Technical Assistance component. These procurements will follow standard Bank consultant services guidelines and will be subject to the Bank's *ex ante* procurement review for amounts exceeding thresholds to be established at project appraisal.

The account will also support BANOBRAS' procurement of renewably-generated power under the terms and conditions to be established in the detailed rules for operations and bidding under the Financial Mechanism. BANOBRAS will conduct the tariff support subsidy reverse auction using bidder pre-qualification and bid award criteria to be specified in the fund design. Bid awards, initially in the form of an letter of intent (LoI) and then formalized in the form of a green energy power purchase contract once evidence towards sub-project financial closure is presented, will be subject to a pre-award review by the Bank for consistency of the bidding process and bid evaluation with agreed fund management criteria. Following bid award clearance and commencement of sub-project operations, BANOBRAS will process periodic (quarterly or semi-annual) payments to the awardee project sponsors on the basis of CFE-certified invoices for delivery of renewable power. BANOBRAS will then apply for drawdown and replenishment of the Special Account on the basis of procedures to be defined by appraisal, i.e., either through submission of SOEs or based on submissions under the Bank's LACI financial management and disbursements framework.

Other key entities involved in the effective development and implementation of the program will include:

- Energy Regulatory Commission (CRE: Comisión Reguladora de Energía).
- National Comission for Energy Conservation (CONAE).
- Ministry of Finance and Public Credit (SHCP: Secretaría de Hacienda y Crédito Público).
- Federal Electricity Commission (CFE).
- Ministry of the Environment and Natural Resources (SEMARNAT).
- Institute of Electric Research (IIE: Instituto de Investigaciones Eléctricas).
- National Waters Commision (CAN: Comisión Nacional del Agua).
- Private Actors in Renewable Energy: Asociación Nacional de Energía Solar (ANES), Asociación Mexicana de Economía Energética (AMEE), and Cámara Nacional de Manufacturas Eléctricas (CANAME).
- Academic Institutions: Universidad Nacional Autónoma de México (UNAM), Insituto Politécnico Nacional (IPN), and Universidad Autónoma Metropolitana (UAM).

D. Project Rationale

1. Project alternatives considered and reasons for rejection:

Given the broad opportunities available for renewable energy development efforts in Mexico, the more traditional GEF approach to investment in the sector would include packaging of a set of pre-identified sub-projects, individually appraised, with a GEF incremental cost analysis developed for each one. While this alternative could potentially aggregate measurable scale in development of Mexican RE resources, it was rejected for the following reasons:

- It provides no particular policy leverage or expression of GoM commitment, and as such fails to address key barriers for stimulating RE on a sustainable basis;
- It does not explicitly provide for competition, which is considered important both to maximize the effectiveness of available GEF funds and to encourage a commercial mindset in the developing RE industry;
- It fails to provide for mainstreaming projects into the Mexican electricity system – while there is a potentially significant deal flow, a conventional approach of aggregating free-standing projects would not in itself create the market framework and access to commercial financing required for sustainable and replicable projects.

A key obstacle in opening up the renewable energy market has already been addressed by the program. Through an agreement in principle with CFE, they are willing to acquire renewably generated power under conditions of competitive procurement, provided that acceptable offers do not exceed an agreed reference price determined (on a regular basis) on the basis of agreed system marginal cost-based methodologies.

The function of the GEF-supported tariff incentive financed by the financial mechanism would be to ensure that all bids would result in a net price to CFE at, or less than, the reference price, up to the limits of the financial mechanism resources available for a given bidding round and a per unit tariff support ceiling to be established as part of the fund operational criteria. This approach enables CFE to retain adherence to the 'least-cost' principle in acquisition, but facilitates a genuine internal analysis of their cost structure that will reveal system costs, not just marginal acquisition of the cheapest resources (which have been but may not always remain CCGT's).

Working with SENER and the Bank team, CFE would determine a base price for energy, reflecting their analysis of their system short-run marginal cost. In order to protect the competitive integrity of their IPP bid system, CFE would not divulge this price, but it would be balanced with available GEF support (which will have an upper cap of approximately 1.5 cents) to create a combined offer price as the maximum tariff available for the renewable energy tender.

For example, if the CFE marginal cost was assumed to be approximately 4 cents per kWh (current estimates are that it would be between about 3.5 and 4.0 cents), and the tariff support available from GEF was capped at 1 cent, then the market would 'see' 5 cents as the composite price available but would compete to minimize costs. Based on current knowledge of the market, developers given a clear tariff and contract can currently offer projects at approximately 4.6 cents; thus the competitive response would be expected to be less than this level.

In addition, CFE's future recognition of system capacity contribution could significantly reduce GEF incentive requirements. For conventional projects in Mexico, where gas costs and risks are covered by CFE, it is the capacity payment that pays for the majority of the amortization of developers' project financing. For renewable projects, where there is no fuel cost, the base tariff covers amortization of capital costs, which for renewables tend to be higher and weighted up-front. The payment to renewable producers of a capacity payment of even a portion of what would normally be paid as a capacity payment for a conventional project would make a significant difference in project financing for renewables. The level of this capacity payment will be subject to further analysis by the program; it is expected that as RE capacity increases, and as more experience is gained on both the overall availability of these resources and the impacts on the CFE system, that capacity payments would likely increase over time.

The Technology Experience Model in Mexico – Learning from Organizational Experience:

The availability of additional tariff consideration from CFE and GEF provides a significant opportunity to accelerate wind energy development in Mexico, with associated learning effects and cost reductions over time.

The basic theory of learning-by-doing and experience curves is likely to appear in Mexico adjusted for the particular characteristics of the local market. Applying the theoretical models in the case of Mexico, cost reductions will be driven by the combination of: (i) experience obtained with increased installed capacity in Mexico, and (ii) manufacturing and technology improvements in wind energy technology internationally. Initial projects will be more expensive than the average international wind energy projects as initial prices from the wind turbine manufacturing industry are likely to be higher. This is normal industrial behavior for companies that enter an uncertain new market, with unknown growth prospects. Furthermore, capital costs for initial projects are often higher due to the 'soft' costs of specialized engineers and technicians needed at the first stages, and more expensive financing because of early risk perceptions. However, as companies become more experienced in the development and construction of projects, and the manufacturing industry perceives a growing and competitive market for wind energy in the Mexico, costs of wind energy projects should converge with, or even surpass, international levels. The emergence of local manufacturing will likely result in further reductions of the capital costs.

Wind energy has been the fastest growing electricity production technology for the last few years at annual rates of more than 30%, and annual sales of about $5 billion. Global cumulative capacity installed is expected to double by 2005-2006, and should these high growth levels continue, it might double again by 2008-2009. Observed learning rates observed in the last five years show a reduction of about 18% in prices for every doubling of capacity, which if it continues at the same pace should bring global prices at an average of **$820/kW in 2005-2006** and **$650/kW in 2008-2009.** Adjusting for a projected inflation of 2%, international nominal prices would be **$890 in 2005-2006** and **$750 in 2008-2009**.

Accumulated experience in producing and using wind turbines has not only resulted in a reduction in the cost of wind turbines, but also improved wind capture. A significant force pushing down the costs of wind energy produced electricity is the steady increase in the size of the wind turbines, combined with electromechanical breakthroughs and the introduction of new materials. The availability of wind power plants has recently reached 98%, and lifetimes of wind turbines are estimated at 20 to 25 years. O&M cost of a *new* wind turbine is estimated to be approximately 1% of the investment cost; due to the use of advanced control systems this is significantly lower than the 2-3% experience with older technology.

In Denmark, the average cost of wind-generated electricity was reduced by 60% in the period 1979–1994. Moreover, wind turbines installed at windy sites were already generating electricity at a cost lower than 4.5 US¢/kWh in 1998, and new projects in 2002 were *selling* electricity in the USA at 4.0 US¢/kWh without any price subsidy. Mexican project developers appear to be ready to sell electricity at 4.5 US¢/kWh today.

Actual cost reductions for wind energy prices in Mexico will be a function of how fast the market grows, and the expected learning rate for the local wind energy industry. As there is very limited wind power installed in Mexico at present, cost estimates for early projects there are based on communications with project developers who expect to proceed with the 'self-generation' projects in 2003. Their expected capital project costs are about $1,200/MW, with approximately 75% of this cost related to the cost of wind turbines. A model assuming an initial capital cost of $1,200/MW, an average price reduction of 20% for every doubling of capacity and an annual growth rate of 30% would result in costs of $1,000/MW in 2005-2006, and around $720/MW by 2009. In nominal figures assuming an inflation rate of about 2%, these would be $1,000 in 2005-2006 and $750 in 2009. Assuming a robust rate of growth of installed capacity in Mexico, at the best wind sites in Mexico it is to anticipate electricity prices from wind around 4.0 US¢/kWh by 2005 and around 3.5 US¢/kWh by 2009. Additional details are provided in Annex 7 on *Cost Reduction and Sustainability in Wind Energy.*

Portfolio Approaches To Energy Planning In Mexico

Least-cost approaches have been the mainstay of electricity planning in most western countries for at least a half century. The underlying idea is that by adding "least-cost" incremental capacities, planners will maintain a minimum cost generating system. Least cost probably worked sufficiently well in a previous technological era, marked by relative certainty, low rates of technological progress, homogeneous generating alternatives and stable energy prices. Today's electricity planner, by contrast, faces a broadly diverse range of technological and institutional options for generating electricity and a future that is highly dynamic, complex, and uncertain. In such an environment attempting to identify long-lived "least-cost" alternatives is nearly impossible. Clearly, more powerful techniques are required in order to develop robust generating strategies that remain economical under a variety of possible future outcomes.

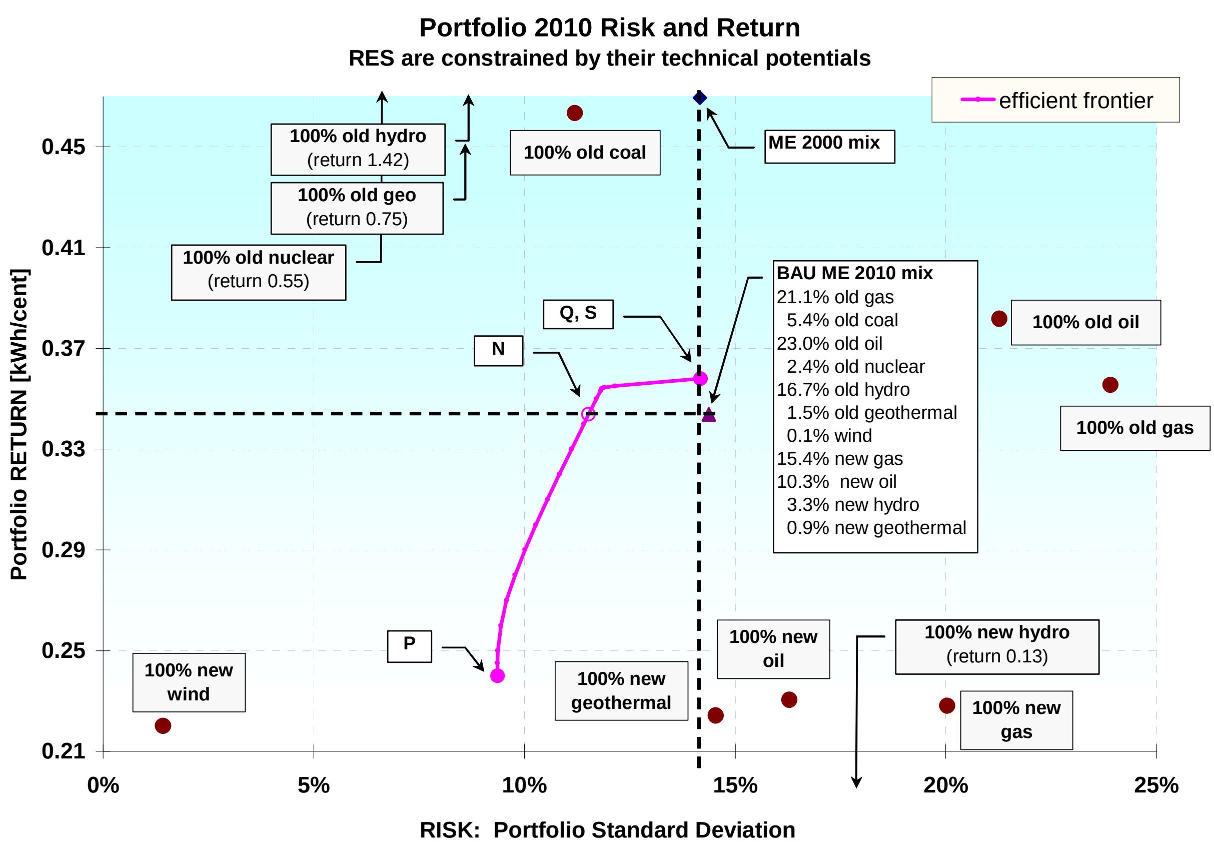
Financial investors are used to dealing with uncertainty. They have learned that a *portfolio* of assets provides the best means of hedging possible future outcomes. Investors would not conceive of investing all their funds in a single a stock on the basis of 30-year forecasts of market conditions and stock performance. Yet this is what least-cost procedures imply. Given the rapidly changing environment, it makes sense to shift energy policy from its current emphasis of evaluating alternative *technologies,* to evaluating alternative generating *portfolios* and *strategies*.

Portfolio theory, an established part of modern finance theory, is based on the pioneering work of Nobel Laureate Harry Markowitz nearly 50 years ago. Portfolio theory has been applied to capital budgeting and project valuation, valuing offshore oil leases, and quantifying climate change mitigation risks. Recently, the approach has been used to value generating alternatives and energy diversity and security objectives.

Applying Portfolio Theory to Renewables Valuation and Energy Security Issues: In Europe and the US policy makers are considering or have already implemented renewables targets or portfolio standards. Underlying these targets is the widespread belief that their adoption will *increase* overall generation costs since renewables "cost more" on a stand-alone basis. However, portfolio-based analyses in the US indicate that adding wind and other fixed-cost renewable technologies (RETs) to a fossil generating portfolio serves to *lower* overall generating cost and risk, even though these alternatives may cost more on a stand-alone basis. This counter-intuitive result stems from the *portfolio effect* which, in part, implies that all efficient (i.e. optimal) generating portfolios must contain some portion of fixed-cost renewable generation.

Illustrative Evaluation of the Mexican Generating Mix: The figure below presents some preliminary, illustrative results that, with refinement, could help policy makers evaluate existing and projected Mexican generating mixes. The figure shows the *Technically Feasible Efficient Frontier*, which reflects practical Mexican resource constraints for wind and other renewables. Along this line (depicted in the upper left quadrant of the graph) lie all *technically feasible*, optimal generating mixes incorporating renewables. The feasible portfolios incorporating renewables are either less risky or less costly (or combinations thereof) than the "Business as Usual" (BAU) generation mix forecast for Mexico for 2010. These results suggest that greater emphasis on locating and expanding renewable resources, which would allow additional wind, geothermal and other capacity additions by 2010, would serve Mexico's economic and energy security interests.

Risk-Return for current and projected Mexico Generating Mixes
Showing "Technically Feasible" Efficient Frontier



Outputs of the Financial Mechanism

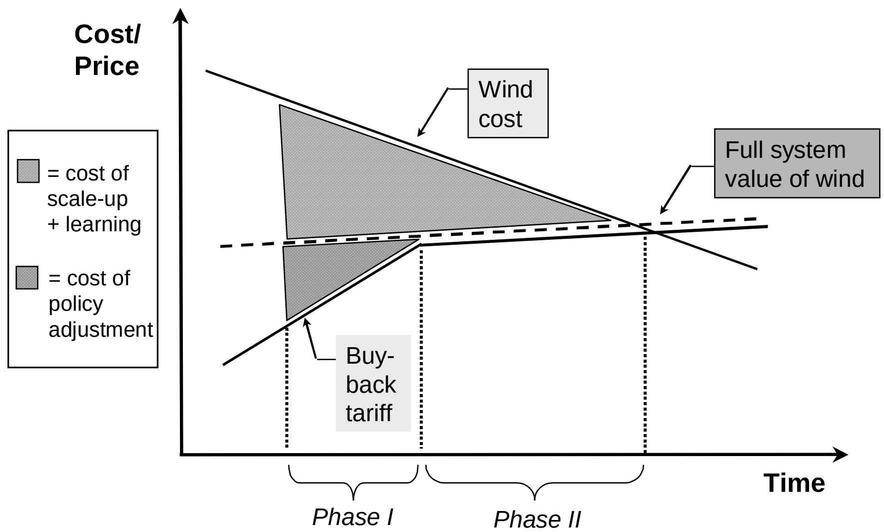
Based on the willingness by CFE to determine and apply tariff prices that reflect various values for diversification, capacity, and environment, the project will introduce CFE tariff offers in a composite price with additional GEF incentive support. Financial modeling of this support resulted in the following conservative assumptions:

- The price of wind technology renewable in Mexico would be expected to be approximately $1,200 per installed kW for initial projects, and could drop to approximately $900 per kW over 8 years (reflecting introduction of current world best practice to Mexico and new organizational learning resulting from the program).
- The tariff offered by CFE could grow over the program period from its current level of approximately 2.7 cents (85% of the 3.2 cents currently calculated as CFE's base price per kWh based on fuel and O&M costs of CCGT) to at least 4 cents. This tariff level growth

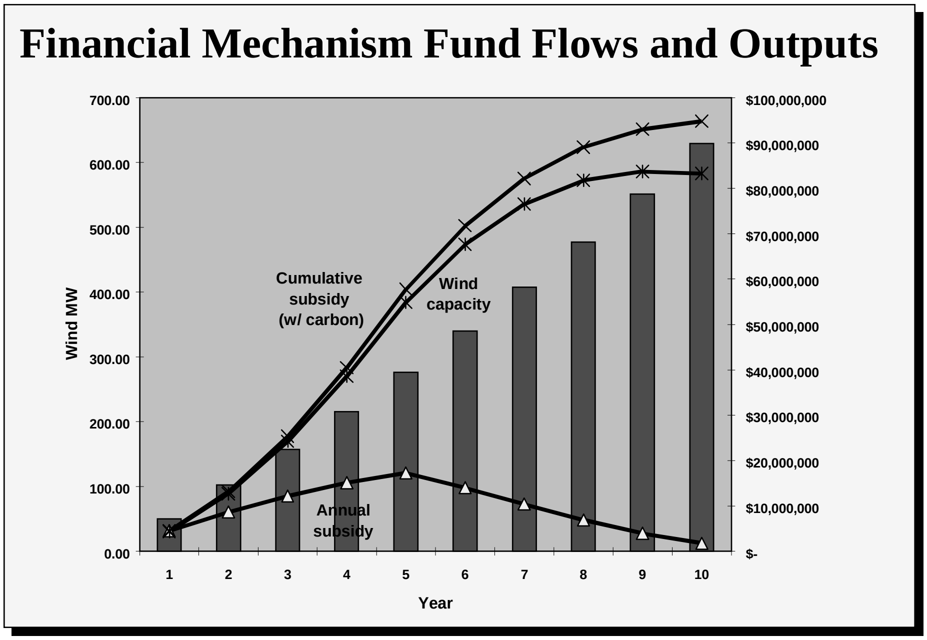
would reflect in part expected increased costs of natural gas as well as a partial capacity credit for intermittent renewable energy sources.

As represented in the chart below, the reductions in wind energy costs resulting from cumulative organizational learning (primarily supported by GEF funds) would be coupled with policy and tariff adjustments (with technical assistance from GEF in extracting information on real system costs) to converge over time toward a full system value of wind competitive with other conventional sources in CFE's portfolio.

Uses of Financial Mechanism Resources



The expected pattern of GEF expenditures, to be more fully detailed during appraisal, is represented below. Tariff support per kWh would be highest in the first competitive tender in Phase I, and would be reduced thereafter due to expected increases in the base tariff offered by CFE, organization learning reducing installed costs, and the competition introduced by subsequent tenders. With tariff support delivered as part of the Power Purchase Agreement for the first five years (the period considered most critical for developers in project finance), the GEF expenditures through the Financial Mechanism would decline to zero by year 10 of the program.



Key risks are that calculations of the CFE tariff will remain too low (and thus require too large a GEF contribution), and/or that the total CFE tariff offer and GEF contribution remain too low and there are no bids. The **key benefit** of this approach is that it draws CFE into a rationale calculation of its cost and tariff structure and offering it in a stable, predictable contract, remaining within the least-cost procurement mandate while exploring broader interpretations of the least-cost definition. In tenders, competition would be expected to drive the price down to the minimum; theoretically this would still be above CFE's marginal cost point but below the maximum offer price.

The structuring of the project was also enhanced through the agreement in principle reached with BANOBRAS, an experienced handler of Bank funds, to manage the Financial Mechanism and provide financial structuring and technical assistance to renewable energy project sponsors.

2. Major related projects financed by the Bank and/or other development agencies (completed, ongoing and planned).these would generally be a cascade of Bank in-country projects, related Bank projects further afield, and other project by other agencies that offer lessons.

Sector Issue	Project	Latest Supervision (PSR) Ratings (Bank-financed projects only)	
		Implementation Progress (IP)	Development Objective (DO)
Bank-financed			
Renewable Energy Power Generation	India: Renewable Resources Development	S	HS
Renewable Energy Power Generation	India: Second Renewable Energy Project	S	S
Renewable Energy Power Generation	China: Renewable Energy Development Project	S	S

Renewable Energy Power Generation	Mauritius: Sugar Bio-energy Technology Project	S	S
Renewable Energy Power Generation	Mexico: Landfill Gas Methane	S	S
Renewable Energy Power Generation	Mexico: Agricultural Productivity	S	S
Renewable Energy Power Generation	Sri Lanka: Renewable Energy for Rural Development	HS	HS
Renewable Energy Power Generation	Tunisia: Solar Water Heating Project	S	S
Under Preparation:			
Renewable Energy Power Generation	China: Renewable Energy Scale-Up Program		
Other development agencies			
UNDP-GEF	Morocco: Market Development for Solar Water Heaters		
IDB-GEF	Costa Rica: Tejona Wind Power Project		
UNDP-GEF	Mexico: Actions for Removing Barriers to the Full-Scale Implementation of Wind Power in Mexico		

IP/DO Ratings: HS (Highly Satisfactory), S (Satisfactory), U (Unsatisfactory), HU (Highly Unsatisfactory)

3. Lessons learned and reflected in proposed project design:

Lessons learned at the international or OECD level, including those of Renewable Energy Portfolio Standards, Feed-In Laws, Non-Fossil Fuel Obligations, Systems Benefit Charges, and other incentive programs, have already been described in this document and are reflected in the project design. These include the impracticality of introducing an RPS or mandated market in the Mexican single-utility system, the high costs and political difficulty of supporting feed-in laws or systems-benefit funding sources in Mexico, and the specific need in Mexico to address the institutional narrow focus on least-cost power procurement. Additional lessons from World Bank projects co-financed with GEF sources are described below.

GEF Experience

The Global Environment Facility, the primary partner of the World Bank in efforts to remove barriers to the development of renewable energy and mainstream these technologies into Bank operations, has sponsored a number of studies that review world-wide experience.[2]

The main lessons derived from these reviews are:

- Policies that promote production-based incentives rather than investment-based incentives are more likely to spur the best industry performance and sustainability.
- Power-sector regulatory policies for renewable energy should support IPP/PPA frameworks that provide incentives and long-term stable tariffs for private power producers.
- Utilities and regulators need skills to understand the complex array of policy, regulatory, technical, financing, and organizational factors that influence whether renewable energy

producers are viable.
- Financing for renewable power projects is crucial but elusive, and requires that key risks (clear and stable power purchase contracts, capacity payments, and up-front capital requirements of renewables) be addressed in to level the playing field and allow renewables to compete with conventional sources.

Specifically for wind power, direct lessons can be drawn from previous GEF projects:

India: During the 1990's, under the Renewable Resources Project, the GEF and the World Bank directly financed 41 MW of wind turbines and 45 MW of min-hydro capacity in India. The project also strengthened the capabilities of the India Renewable Energy Development Agency (IREDA) to successfully promote and finance additional private sector investments.

GEF support for wind power occurred in parallel with the explosive market growth that emerged in the mid-1990's fueled by favorable investment tax policies and a supportive regulatory framework. As a result, and in keeping with international trends, installed costs for wind declined from around $1,200/kW in 1991 to $815-1,010/kW in 1998.

In the 1990's one-year 100% investment tax depreciation provided large economic gains for installation of wind farm capacity, regardless of the electricity generation that resulted. This incentive helped drive the installation of the almost 1,200 MW of wind capacity in India, virtually all by the private sector. However, a number of these turbines are currently not operating, substantiating the lesson that output-based incentives are preferable to investment-based incentives.

China: The emerging experience from the World Bank/GEF Renewable Energy Development project in China highlights the pressing need to address regulatory frameworks and find ways to reduce risks to project developers, The project was designed to finance four newly formed wind farm companies for construction of 190 MW of wind farms in Inner Mongolia, Hebei, Fujian, and Shanghai provinces. These companies were to be jointly owned by the State Power Corporation and subsidiary electric power utilities (at regional, provincial, or municipal levels) and would sell power to utilities under power-purchase agreements developed through the project.

The costs of wind-generated electricity from the wind companies would be higher than those of conventional generation, but utilities in three provinces (Hebei, Fujian, and Shanghai) were initially willing purchase this wind power because the added costs of wind power were marginal relative to total utility revenue for these three utilities. This willingness to bear the higher costs disappeared after power sector institutional changes. As a result, plans for 170 MW of the initial 190 MW wind capacity additions were cancelled.

The general lesson offered by this experience was that some explicit mechanism must be in place to finance the difference between renewable energy and conventional power generation costs, and that relying on the power utility's willingness to bear the higher costs is not sound policy. These lessons have been incorporated in the current China Renewable Energy Scale Up Program (CRESP) which seeks to introduce a mandated market policy in China that will commit all utilities to the same targets and introduce certificate trading mechanisms to facilitate their meeting these objectives at least cost for the country.

Costa Rica: In Costa Rica, a significant private-based wind-power industry has emerged from new dialogues and policy frameworks promoted by an IDB/GEF project. The private sector installed a 20

MW wind farm and began operating in 1997. Early project preparation activities, including institutional and technical feasibility studies, engendered favorable perceptions and regulatory frameworks for wind, including very strong power purchase agreements. Under the project, an additional 20 MW of wind capacity has been installed.

While the project took longer to develop than anticipated, and was thus unable to achieve all outcomes, key lessons resulted. Among these are that regulatory frameworks, technology perceptions, and studies that address non-technical issues and risks may be more important than mitigation of perceptions of technical risk through hardware demonstrations. This lesson is similar to that suggested by the Mauritius project described below.

Bagasse Power in Mauritius: In Mauritius, a World Bank/GEF bio-energy project indirectly catalyzed dramatic changes in electricity generation in the country. From 1994 to 1996, the project dispersed $6 million for efficiency investments in sugar mills to provide surplus bagasse for power generation. The project also provided technical assistance and technology demonstrations to promote private/public sector cooperation in power plant ventures and evaluate ways to decrease the transport costs for bagasse and to optimize the use of sugar cane for power generation. This TA helped to formulate a framework for independent power producer (IPP) development and an administrative focal point for private/public partnership in IPP development.

Small Hydropower in Sri Lanka: The World Bank/GEF Energy Services Delivery project begun in 1997 points to the difficult and time-consuming nature of evolving business and regulatory models suitable to a given country and the flexibility needed to support approaches that show promise. The project financed more than 21 MW of small hydro by IPPs, along with development of a regulatory framework, including standardized power-purchase tariffs and contracts (PPAs).

The key lesson from this project is that the power purchase tariff offered to IPPs must be carefully structured so that tariffs have some stability over time, and are able to pay for both the energy as well as capacity that they provide, recognizing that power generation from renewable sources can vary significantly.

A Distillation of Key Lessons: These GEF and international lessons have been incorporated into project design, and reflect both the high level of commitment by SENER and CFE in accurately valuing renewable energy sources and currently available sources of financing to stimulate these markets. The combination of clear policy and tariff commitments with competitively sourced incentives represents a hybrid of other international approaches uniquely suited to the Mexican context.

4. Indications of borrower and recipient commitment and ownership:

SENER, CFE, and other Mexican agencies have demonstrated significant commitment in preparation of the project and engagement in key dialogue on the least-cost energy procurement issue, and have already agreed on key conditions for addressing this market barrier in the context of a larger stimulus program. These commitments in themselves are expected to enable leverage of GEF funds with private renewable energy project investments on an approximately 10-1 basis. SENER is also preparing to issue a policy directive on accelerated depreciation for environmental technologies, including renewable energy – this represents significant commitment and implicit government expenditure in the development of clean energy technologies.

In addition, Mexico has agreed on key linkages between the proposed project and the Environment Structural Adjustment Loan I. These include: (i) SENER will approve the design and preparation for implementation of a National Fund for Renewable Energy Promotion (the Financial Mechanism referenced in this GEF project); (ii) SENER will carry out a study to examine incentives for independent renewable energy producers, including policy options for the pricing and transmission of renewable energy; and (iii) SENER will develop environmental regulations for renewable energy sources. These linkages will be further developed in the second tranche of the operation, the Environment SAL-II, for which the above condition (i) serves as one of the principal triggers.

5. Value added of Bank and Global support in this project:

The World Bank and GEF, in collaboration with other bi-lateral agencies, have engaged a broad array of Mexican policy, technical, financial, and environmental agencies and actors in building consensus on the need for diversification of the Mexican energy sector, the potential benefits of developing in-country renewable energy resources as a means to achieve such diversification, and the technical assistance and program approaches required to stimulate and sustain long-term renewable energy development. SENER and other agencies have acknowledged the World Bank and GEF value added in (a) providing objective information on international experience and tailoring it to Mexican circumstances, (b) identifying and collaborating with a range of technical, financial, and policy experts both within and outside of Mexico, and (c) defining and carrying out key analyses required to inform the decision-making process.

Based on relationships and mutual trust developed during this process, the World Bank and GEF are well positioned to further development of the project while incorporating its broad experience in power sector reform, renewable energy technologies and markets, and emerging financing potential from carbon mitigation sources, making the project an example of international best practice for large scale renewable energy development. The key role of the World Bank will be to continue to provide oversight on coordination of the various TA components, and keeping a sustained focus on the least-cost power issue to ensure cost-effective use of GEF funds applied through the Financial Mechanism.

[2] These include (i) Eric Martinot and Oscar McDoom, "Promoting Energy Efficiency and Renewable Energy, " June 2000, GEF, Washington, DC, (ii) Alan S. Miller and Eric Martinot, "The Global Environment Facility: Financing and Regulatory Support for Clean Energy," Natural Resources and Environment, Vol. 15, No. 3, 2001, (iii) Eric Martinot, "The GEF Portfolio of Grid-Connected Renewable Energy: Emerging Experience and Lessons," 2002, GEF, Washington, DC, (iv) Eric Martinot, "Grid-based Renewable Energy in Developing Countries: Policies, Strategies and Lessons from GEF, "2002, GEF, Washington , DC, and (v) Eric Martinot, A. Chaurey, D. Lew, J. Moreira, and N. Wamukonya, "Renewable Energy Markets in Developing Countries," Annual Review of Energy and Environment, 2002.

E. Issues Requiring Special Attention

1. Economic

☒ Summarize issues below ☐ To be defined ☐ None

Economic evaluation methodology:
- ○ Cost benefit
- ○ Cost effectiveness
- ● Incremental Cost
- ○ Other (specify)

A full differential system analysis (with/ without a model project) will be completed by appraisal. Methodologies for assessing diversification value have not to date been applied to project analysis in the World Bank context, but will be guided by a knowledge management project led by Richard Spencer (EWDED).

Incremental Cost Analysis (see Annex)

Basic cost and output data on the proposed investments in wind were analyzed using a simulation model of Mexico's power system. This model calculates the cost of meeting electricity energy and capacity demand under a wide variety of assumptions regarding Mexico's economy, oil sector, gas supply and power technology.

For the purposes of this project, the base case was taken as the SENER/CFE expansion plan, including demand forecasts, economic growth forecasts and technology expectations. The only change vis-à-vis the SENER *Prospectiva* is that this analysis covers a period of 20 years subsequent to the commissioning of the proposed wind investments, unlike the 10-year horizon of the SENER *Prospectiva*.

The proposed wind sub-projects will entail a present value of investment and operation of approximately $120 million, the overwhelming proportion of which is the initial investment cost. The generation cost from the proposed wind facilities varies from $45.5-53.2/MWH, depending on assumptions regarding dispatch hours and operational costs.

This compares with the present value of costs of generation of the equivalent energy from the in-place and planned CFE system of approximately $98 million.   The resulting incremental cost of $22.1 million is added to the estimated incremental cost of the technical assistance activities to obtain a summary incremental cost estimate of $30.1 million.

2. Financial

☒ Summarize issues below ☐ To be defined ☐ None

(see Financial Analysis Annex)

The main financial objectives of the project is to enable RE technologies to reach long-run sustainability. This will require particular attention on:

- Accurate forecasts of RE cost reduction progress
- Accurate estimation of RE values to the electricity system

From the CFE perspective, a key issue is to retain their engagement and readiness to incorporate renewables into the CFE grid, and to make sure that they fully understand the financial and operational aspects so as to avoid being saddled with take-or-pay contracts on power that they cannot accommodate in their system.

3. Technical

☒ Summarize issues below ☐ To be defined ☐ None

There are no significant technical issues. The project will initially seek to develop wind technology on a proof-of-concept basis, given the particular strength of this resource and its proximity in price to current CFE energy procurement. Following Phase I, the project will seek a technology neutral approach to renewable energy development.

4. Institutional

Overall project management will be performed by SENER, with day-to-day operations managed by BANOBRAS.

4.1 Executing agencies:

SENER.

4.2 Project management:

BANOBRAS.

4.3 Procurement issues:

Use of GEF funds for procurement of renewable energy generation sources will be performed under the competitive financial mechanism described earlier in this document.

4.4 Financial management issues:

Funds for Technical Assistance activities as well as the funds for the Financial Mechanism itself will be channeled through BANOBRAS, with the operational framework and responsibilities further defined through appraisal. BANOBRAS is an experienced manager of World Bank funds.

4.5 Others:

A key institutional issue will be the effectiveness of sustained engagement with CFE on completing technical assistance and analysis components of their system-based costs and their continued willingness to express this base tariff through the Financial Mechanism in competitive tenders for renewable energy capacity.

5. Environmental

5.1 Summarize significant environmental issues and objectives and identify key stakeholders. If the issues are still to be determined, describe current or planned efforts to do so.

There are no major negative environmental issues expected to result from the project. In general, impacts from the project will result in environmental improvement in terms of reduction of SOx, NOx, particulate, and global carbon emissions that would otherwise be generated by fossil-fuel fired plants. The environmental impacts that do result from renewable energy installations can be effectively managed and potentially include:

- Visual, bird-strike, and land-use impacts that can result from wind turbine operation. The project will employ international best practice in minimizing these impacts. The land-use impacts will be addressed also as part of the social issues of the plan and will seek to permit most effective mixed-use of the sites to retain traditional grazing and agricultural activities in conjunction with wind generation.
- Impacts from biomass, small-hydro power, and small geothermal installations expected to be addressed in the second phase of the project will general be small and local, and will similarly be managed according to best practice. Small hydro installations will typically utilize existing impoundments so significant new impacts are not anticipated.

5.2 Environmental category and justification/rationale for category rating: **F - Financial Intermediary Assessment**

Environmental and Social Assessment

1. EA/EIA framework requirements: The project will set up a financial mechanism that will stimulate the development of multiple private sector-developed, grid-connected renewable energy projects (a large amount of wind capacity, and probably also small hydro and biomass projects). Thus the project functions as a Financial Intermediary project. By appraisal, Mexico will establish and document an EA framework that meets Bank requirements applicable to FI operations.

2. Indigenous peoples: Most of the wind development will be concentrated in Oaxaca and surrounding states, much of these hosting indigenous *ejido* populations. (see social impact assessment below).

3. Social impact assessment: As traditional cattle raising and farming activities can normally coexist with windfarms and the projects will pay an annual resource/land rent, the wind projects will provide net economic benefits for rural and indigenous communities in terms of employment and revenue streams. Establishing fair levels of rental payment in a negotiation with inherent information asymmetries will remain important in ensuring equity for locally impacted populations. The land-use and social issues are already being addressed in Oaxaca through an analysis coordinated with the state by SEDIC, IIE, and Winrock International (a summary of this document is included in Annex entitled "Policies to Stimulate the Market for Renewable Electricity: International Experience and Lessons Learned"). This document is expected to serve as a broad resource for public consultation and representation in Oaxaca and other states. (See also the Integrated Safeguards Data Sheet).

5.3 For Category A and B projects, timeline and status of EA

EA start-up date:

Date of first EA draft:

Expected date of final draft:

5.4 Determine whether an environmental management plan (EMP) will be required and its overall scope, relationship to the legal documents, and implementation responsibilities. For Category B projects for IDA funding, determine whether a separate EA report is required. What institutional arrangements are proposed for developing and handling the EMP?

TBD.

5.5 How will stakeholders be consulted at the stage of (a) environmental screening and (b) draft EA report on the environmental impacts and proposed EMP?

TBD.

5.6 Are mechanisms being considered to monitor and measure the impact of the project on the environment? Will the indicators reflect the objectives and results of the EMP section of the EA?

TBD.

6. Social

6.1 Summarize key social issues arising out of project objectives, and the project's planned social development outcomes. If the issues are still to be determined, describe current or planned efforts to do so.

Primary social development impacts are those related to employment and revenue impacts associated with land leases for wind projects; these issues are addressed earlier in this document, in Annex entitled "Policies to Stimulate the Market for Renewable Electricity: International Experience and Lessons Learned," and in the Integrated Safeguards Data Sheet.

6.2 Participatory Approach: How will key stakeholders participate in the project?

Project sponsors will determine their own participation in competitive tenders under the Financial Mechanism and for 3rd-party self-generation affiliations with industrials and/or municipals. Participation of additional public stakeholders is addressed immediately below.

6.3 How does the project involve consultations or collaboration with NGOs or other civil society organizations?

Public consultations have focused on wind as it is the primary technology to be addressed in Phase I. Its impacts are broader and more visible, and its benefits in terms of both land lease revenues and local development are more direct. Small hydro, if it is developed in Phase I, will typically use existing dams and water courses and will have small local impacts. To the degree that other technologies are addressed in Phase II, appropriate consultative procedures will be put in place.

NGO involvement – The Mexican Government, through CONAE and in conjunction with the Center for Clean Air Policy, participated with private, government, international, and NGO participants at a Renewable Energy Policy Dialogue meeting in Mexico City in February 2002; topics addressed by this meeting included green power certificate and trading programs, and incentive support mechanisms that are now being modified as part of the proposed project. In April 2002 the World Bank supported dialogue on renewable energy and the GEF effort through an NGO/Government/Private Sector forum organized by the NGO Musica y Tierra. Additional Government and World Bank communications were established with NGO and *ejido* representatives at 3rd Colloquio Internacional Corredor Eolico del Istmo, a wind power conference held in October 2002 in Huatulco related to the promotion of wind energy development in Oaxaca. SENER expects to expand its outreach and dialogue with the NGO community during project preparation and further definition of project options.

On Friday, February 28th 2003, a public consultation in relation to the conceptual design of the WB/GEF Large Scale Renewable Energy Development Project was organized and conducted by the SENER's Sub-Secretariat of Energy Policy and Technology Development. The consultation was attended by the World Bank and approximately 40 national and international stakeholders. The following issues were raised and will be further responded to during project preparation:

Electricity Tariff Structure

- There is concern on the fact that electricity pricing in Mexico is still not considering environmental costs and/or externalities.
- Agents believe that the role of *Secretaría de Hacienda y Crédito Público* (Hacienda) will be key on the future success of the project (e.g. future resolutions with regards to increases in electricity tariff). In particular, it was said that although there is political will with respect to tariff increases as of today there has not been any concrete action.
- There is concern on the *structure* of the electricity tariff that CFE will apply to on-grid renewable source based projects during the operation/functioning of the Fund.

Consideration of other Technologies: A representative of the Colegio de Arquitectos (College of Architects) asked whether it was possible to include solar panels used in the architectural design of residences in the GEF/WB project given their potential for contributing to diversification and demand side management.

Financial Mechanism Operations and Disbursements:

- One commenter stated that there should be a mechanism for additional support (e.g. guaranteeing an accelerated amortization of more than 5 years), and that the Financial Mechanism should be flexible enough to respond to the financing needs of different projects in terms of depreciation periods.
- Another stated that the GEF funds should consider financing investments (equity or debt) as opposed to only payments against production (i.e. kWh delivered).
- The question was raised whether the World Bank could provide - through BANOBRAS - financing instruments (e.g. guarantees, financing loans) to assist in the financing of specific projects.

Compatibility Between PCF/GEF: Various participants believed that the project should also allow for the possibility of benefiting from carbon emissions transactions with PCF.

Emissions Baseline - Concern was stated on the need for institutional coordination in development of the carbon emissions baseline associated with the electricity industry.

EIA Requirements - Standards/norms on the specific requirements for EIA to guide developers of renewable source based projects are needed.

6.4 What institutional arrangements are planned to ensure the project achieves its social development outcomes?

At the end of the Third International Colloquium for Wind Energy held in Huatulco in October 2002, landowners from the Isthmus of Tehuantepec expressed their concern due to a lack of information that would help them negotiate efficiently with project developers. Based on these discussions, the Secretary of Industrial and Commercial Development of the State of Oaxaca made a direct request for a study to address landowner's questions. In response, a USAID-financed study for the State Government of Oaxaca was initiated by Winrock International, under the review and coordination of Instituto de Investigaciones Electricas (IIE).

This study (in progress; a summary is provided in Annex entitled: "Key Issues Related to Wind Energy Project in Mexico: Land Leasing, and the Potential for Job Creation") is intended to provide *ejidos* and other communities in the affected regions with objective information on the types of agreements and contracts typically used in the U.S. and elsewhere between wind power project developers and landowners. The report will also examine the land lease process for wind energy projects, land uses compatible with wind farms, and potential job creation from the introduction of wind farms. Several wind farm developers have also expressed strong support for this activity because they think that an objective approach to this issue will be much more effective than information a wind project developer could provide (given perceptions of bias).

Several consultation workshops took place in Tehuantepec, Oaxaca, and in six communities in the Ixtaltepec, Juchitan and Santo Domingo municipalities in the Isthmus of Tehuantepec region. The objectives of the workshops were to give community members brief technical overviews of wind power stations, and to solicit their opinions, priorities and questions about the introduction of wind farms on their land. Following the completion of the report, the Government of Oaxaca will organize a series of local 'road shows' and workshops to disseminate the findings in both Spanish and the local dialect. Additional similar consultations will be performed in the course of project development and summarized by appraisal.

6.5 What mechanisms are proposed to monitor and measure project performance in terms of social development outcomes? If unknown at this stage, please indicate TBD.
TBD

7. Safeguard Policies

7.1 Do any of the following safeguard policies apply to the project?

Policy	Applicability
Environmental Assessment (OP 4.01, BP 4.01, GP 4.01)	● Yes ○ No ○ TBD
Natural Habitats (OP 4.04, BP 4.04, GP 4.04)	○ Yes ○ No ● TBD
Forestry (OP 4.36, GP 4.36)	○ Yes ● No ○ TBD
Pest Management (OP 4.09)	○ Yes ● No ○ TBD
Cultural Property (OPN 11.03)	○ Yes ○ No ● TBD
Indigenous Peoples (OD 4.20)	○ Yes ○ No ● TBD
Involuntary Resettlement (OP/BP 4.12)	○ Yes ○ No ● TBD
Safety of Dams (OP 4.37, BP 4.37)	● Yes ○ No ○ TBD
Projects in International Waters (OP 7.50, BP 7.50, GP 7.50)	○ Yes ● No ○ TBD
Projects in Disputed Areas (OP 7.60, BP 7.60, GP 7.60)*	○ Yes ● No ○ TBD

7.2 Project Compliance
(a) Describe provisions made by the project to ensure compliance with safeguard policies which are applicable.

(b) If application is still to be determined, describe current or planned efforts to make a determination.

8. Business Policies

8.1 Check applicable items:
- ☐ _ Financing of recurrent costs **(OMS 10.02)**
- ☐ _ Cost sharing above country 3-yr average **(OP 6.30, BP 6.30, GP 6.30)**
- ☐ _ Retroactive financing above normal limit **(OP 12.10, BP 12.10, GP 12.10)**
- ☒ _ Financial management **(OP 10.02, BP 10.02)**
- ☐ _ Involvement of NGOs **(GP 14.70)**

8.2 For business policies checked above, describe issue(s) involved.
The project is designated as a *Financial Intermediation* project.

SENER and BANOBRAS are discussing details of assigned responsibilities for implementation and will prepare a detailed financial management plan by appraisal. This plan will address financial management, accounting and audit policies, and controls applying to financial flows under the projects.

It is expected that SENER will retain overall program management responsibilities and will lead, in conjunction with CFE and other agencies, several key Technical Assistance components. BANOBRAS will implement the Financial Mechanism and provide project development assistance for projects under the FM and for the self-generation market. BANOBRAS is an established financial intermediary and already has significant experience in implementation and execution of World Bank projects.

F. Sustainability and Risks

1. Sustainability:

The renewable energy sub-projects resulting from the WB/GEF project are expected to be operated as IPP generation facilities under a clear tariff and contractual relationship with CFE or industrial/municipal customers, which will provide clear incentives for private sector developers and operators to maintain and operate their facilities in a financially sustainable manner.

Key issues underlying the sustainability of the project include:

- The continued commitment by the Government of Mexico, and CFE in particular, to engage in pricing on a system basis and to incorporate a broader analysis of costs of benefits of renewable energy generation to create market entry points for renewables while remaining consistent with the intent of 'least-cost' power procurement guidelines expressed in Mexico's Constitution.
- The ability of the program to bridge the gap with available GEF funds between an expressed CFE base offer price and the prices required initially by wind developers to open the market.

Subject to these conditions being adequately addressed, it is expected that the trajectory of the project will bring wind and other renewable energy technologies into approximate price parity with conventional sources by the end of the project, making the effort self-sustaining.

1a. Replicability:

The project is designed to create a favorable environment for initial market activity in renewables, to stimulate investments through targeted and competitive incentive support, and repeat this process through subsequent 'reverse auctions' that will result in organizational learning and cost reduction over time. Parallel activities in 'self-generation' markets will build additional experience in project development, finance, and operation, further supporting replicability within Mexico.

Given the broad renewable resource availability in Mexico, the high level of technical ability and potential for learning and cost reduction, and the project's strong foundation in policy and tariff analysis, the project offers significant potential for countinued expansion and replicability of renewable energy experience in Mexico. Further, as a regional technology and market leader, Mexico is well positioned to help effect broader replicability of project experience and cost reductions throughout Latin America.

In general, replicability will be a Phase II activity. However, during project preparation, and throughout implementation of Phase I, Technical Assistance activities and the framework developed for Monitoring and Evaluation will specificially address documentation of the base case environment for renewable energy in the country, lessons learned, metrics for measuring price reductions and impacts of policy changes. Another form of documentation of results will be through case studies of projects addressed directly through the financial mechanism or stimulated through the self-generation business development assistance services. These experiences, including results of collaboration with the UNDP project, will be documented in the Monitoring and Evaluation report that will serve as the World Bank appraisal document for Phase II. Based on this analysis, mechanisms and work products will be identified for Phase II to perform additional outreach and dissemination activities.

2. Critical Risks (reflecting the failure of critical assumptions found in the fourth column of Annex 1):

Risk	Risk Rating	Risk Mitigation Measure
From Outputs to Objective		
Loss of political commitment (in existing and new administration)	S	Phased approach protects level of GEF investment based on performance
Difficulty in arriving at agreed base tariff and bridging incremental costs with available funds	S	Strong technical assistance focus, strong analytical partners (e.g. USAID, other bi-lateral partners). Phased approach to recognition of system values.
Self-generation market niche is eliminated through other policy changes	M	Strong TA to reduce risk and transactions costs to make market viable.
Adequate capacity is not identified and developed at SENER, CFE, and BANOBRAS	M	Key role for BANOBRAS (which is already experienced in key project capacities). Phased approach stimulates commitment, assisted by clear TA approach to build institutional capacity.
From Components to Outputs		
Insufficient and/or non-competitive bid responses	M	Knowledge of market, strong dialogue with partners, supported by strong analytical approach. Careful calibration of financial mechanism in a design that is not overly complex, including base tariff and protections for GEF incentive support. Targeted business development facilitation services created through BANOBRAS.
Unavailability of bilateral co-financing	M	Wind development objectives very likely still attainable; range of other technologies may be constrained. Timely and targeted approach to cofinanciers known to have interest in both RE and Mexico.
Overall Risk Rating	S	

Risk Rating - H (High Risk), S (Substantial Risk), M (Modest Risk), N(Negligible or Low Risk)

G. Project Preparation and Processing

1. Has a project preparation plan been agreed with the borrower (see Annex 2 to this form)?

☐ Yes - date submitted: ☒ No - date expected: 04/30/2003

An outline plan for project preparation, including a GEF PDF-B work program and budget, has been agreed with the client.

2. Advice/consultation outside country department:

☒ Within the Bank: Within the Bank, staff from East and South Asia regions have been consulted in relation to their experience in renewable energy development in China and Sri Lanka.

Peer reviewers are: Richard Spencer, (Renewable Energy Specialist, EWDEN);
Walter Vergara (Energy-Environment Specialist, LCSES); and
Clive Harris (Private Sector Development Specialist, PSAPP)

☒ Other development agencies: The project has included discussions with USAID/Mexico on emissions baselining analysis related to the project and with CFE's engagement, and with Winrock International wind farm feasibility study activities and on land-use issues. The client has also exchanged views and information on the project with KfW and GTZ representatives on possible co-financing.

The Government of Mexico has also submitted a GEF project request through UNDP on development of wind energy (endorsed by the GEF Council at their October 2002 meeting). This UNDP proposal is viewed by Mexico as an initial phase of a larger effort to develop large-scale grid connected renewables, and the proposed program described in this document is viewed as a logical continuation of that continuum. Further program development activities will be coordinated closely among the GOM, UNDP, and the World Bank. SENER will serve as a primary point on coordination through its expected role as a steering committee participant on the UNDP project (implemented by Instituto de Investigaciones de Electricidad, IIE) and its role as the responsible agency for the World Bank project. Both UNDP and the World Bank will be expected to participate in tripartite reviews evaluating the World Bank project.

UNDP will be undertaking initial resource identification, information development, generic barrier removal activities, and associated analysis, and will seek to cultivate some of the municipal projects which are generally attractive because of the high tariff structure in this sector. While useful in stimulating industry experience in Mexico, these are opportunistic projects which UNDP itself acknowledges are not by themselves a strong basis for a sustainable industry. In contrast, the World Bank project will specifically be developing a competitive incentive mechanism to stimulate large, private projects, connected to the national grid; further it will extend its specific analysis into identifying the capacity, diversification, and environmental values inherent in development of wind, biomass, waste recovery, and small hydro sources. The World Bank's project proposal will thus be for more specific analytical work, particularly on CFE resource valuation and tariff issues, and financial intermediation on projects. The proposed second phase of the UNDP project, considered for making investments in a limited number of wind farms (with the precise delivery modality and level of support not specified) is generally expected to be subsumed into this larger program.

☒ External Review A review by a representative of GEF's Scientific and Technical Advisory Panel (STAP) has been completed and is included as an Annex.

3. Composition of Task Team (see Annex 2):

Team Members – Bank Staff:

Charles Feinstein	(Task Manager)
Demetrios Papathanasiou	(Renewable Energy Specialist)
Oscar Avalle	(Operations Officer)
Juan David Quintero	(LCR QAT Coordinator)
Lea Braslavsky	(Procurement)

Dan Boyce	(Financial Management)
Victor Ordoñez	(Financial Management)
Mariangeles Sabella	(Legal)
Joseph Paul Formoso	(Disbursement Officer)
Environmental Specialist	(TBD)
Social Specialist	(TBD)

Team Members – Consultants

Donald Hertzmark	(Energy Economist)
Ted Kennedy	(Renewable Energy Specialist)

4. Quality Assurance Arrangements (see Annex 2):

Assurance of Project quality will be provided by Peer Review and STAP Review, and further defined by the GEF Secretariat's Climate Change Team prior to consideration of the project by the GEF Council at their May 2003 meeting.

5. Management Decisions:

Issue	Action/Decision	Responsibility

Total Preparation Budget: (US$000) **Bank Budget:** **Trust Fund:**
Cost to Date: (US$000)

To PCD: $100,000 GEF Administrative Resources
PCD to PAD: $100,000 GEF Administrative Resources; plus $350,000 GEF PDF-B resources

☐ **GO** ☐ **NO GO** **Further Review** [Expected Date]

Charles M. Feinstein	Susan Goldmark	Isabel M. Guerrero
Team Leader	**Sector Manager**	**Country Manager**

Annex 1: Project Design Summary

MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

Hierarchy of Objectives	Key Performance Indicators	Data Collection Strategy	Critical Assumptions
Sector-related CAS Goal: Contribute to stability and economic growth through expansion of clean energy sources.	**Sector Indicators:** Volume and diversity of renewable energy in generation growth.	**Sector/ country reports:** 'Prospectiva' (SENER's annual indicative energy plan and report).	**(from Goal to Bank Mission)**
Economic/social development for low-income populations.	Land-lease arrangements with project developers.	Financial statements in awards from Financial Mechanism.	Legal/commercial framework enables land-holders to negotiate equitable land/lease agreements.
GEF Operational Program: Promotion of renewable energy and carbon emission reduction by removing barriers and reducing implementation costs.	**Outcome / Impact Indicators:** Total electricity generated from renewables (GWh/yr) Total renewables capacity (MW) Emissions reduced (tons/year): • CO_2 • NOx • SOx • Particulates Costs of renewable generated electricity ($/MWh) competitive in grid system.	CFE/CENACE analytical work on system short run marginal cost. Development of CFE offer price in tariff bid document. Results of Initial Tender. Project Closure and Installation Documentation.	**(From Purpose to Goal)** • Analytically based 'flexibility' in interpreting 'least cost' resource acquisition. • Commitment of GoM and CFE to renewables development and is effectively focused. • Environmental externalities increasingly incorporated in electricity price. • Sufficient number of potential developers and investors are attracted by policy and incentives. • Developers able to secure adequate financing for renewable electricity projects. • Projects are built and maintained to best international best practice standards. • Organizational learning occurs and reduces prices for subsequent projects. • No sharp drop in fossil fuel prices in medium term. • Continued macro-economic stability. • Continued growth in electricity demand. • Cost reductions and technology development continue internationally. • Adequate commitment from the power sector (CFE and CENACE in particular).
Global Objective: To develop a commercial renewable	**Outcome / Impact Indicators:** Increase of GWh of electricity	**Project reports:** Government information.	**(from Objective to Goal)** Continuing commitment of GoM,

energy industry as a significant source of economically least-cost electricity.	supplied to the electricity system from renewable energy sources. Installed GW of renewable electricity plants. Competitive levelized costs for grid-connected renewable energy systems. Growth of private sector investment in renewable energy projects. Power Purchase Agreements.	Project Information (Financial Mechanism). Survey Information.	SENER, and CFE to RE develop-ment under agreed project terms. Financial Mechanism support and 3rd-Party Self-Generation scheme terms sufficient to attract private interest and investment. Program efforts enable market without critical distortions. **(Phase 2)** Organization learning results, reducing hardware and project costs. Experience with project finance grows, increasing market confidence, reducing perceived risks/costs. Green Power/CDM opportunities exist.
Output from each Component:	**Output Indicators:**	**Project reports:**	**(from Outputs to Objective)**
Functioning mechanism for the auctioning of tariff subsidy support.	Operational Manual for the auctioning mechanism. Number of qualified bids received at each auction round. Volume of proposed capacity installed; number and capacity size of winning bids.	Law/ regulation Project survey Project statistics Progress reports Tariff and contract conditions published.	See above.
Methodologies for calculating periodically a reference price for auctioning renewable energy procurement reflecting System Marginal Cost.	Published least-cost methodologies for the calculation of System Marginal Cost. Reference prices for auctions, reflecting agreed System Marginal Cost.	Co-financing agreement and description of application. Operational Manual, tender responses. Assistance reports.	Organizational learning and financial experience reduce costs and increase performance.
Least-cost investments in network upgrades and operational control to incorporate renewable energy projects.	Transmission planning and dispatching practices.	Progress reports, Surveys.	
"One-stop shop" that provides assistance with permitting issues, financing facilitation, and business advisory services to sponsors of renewable energy projects.	Letters of Intent indicating capacity installed of renewable energy projects. Financing leverage indicators.		Companies understand that other key elements of a conducive environment (financing, resource data, etc.) are available.

Green Power Market domestic and for export of green power.	Green power sales, domestic and cross-border.		
Project Components / Sub-components:	**Inputs: (budget for each component)**	**Project reports:**	**(from Components to Outputs)**
Technical Assistance for development of methodologies that establish system marginal costs incorporating diversification value and environmental value of renewable energy.	$1.5 M	Agreed base tariff for system marginal cost. Operational Information System. Defined TA Services.	Continued political commitment (in existing and new administrations). Additional co-finance achieved. Analyzed and negotiated basis can be agreed by WB, SENER, CFE, and CENACE.
Technical Assistance for capacity building in system operations to incorporate renewable energy resources: • Transmission expansion planning to accommodate renewable energy plants. • Dispatching models for intermittent renewable energy; complementary dispatching of hydroelectric resources. • Development of interconnection standards for renewable energy plants.	$2.5 M	Operation Manual, Initial Tender. Awards for GEF Support. Operations Manual, reports on delivery of financing & matchmaking services. Operational Manual, staffing.	Base CFE tariff can be bridged to required incremental costs with available GEF support. Self-generation market niche is not eliminated through other policy changes. Adequate capacity is identified and developed at SENER, CFE, and Banobras. Additional co-finance from bi-lateral sources is identified to broaden range of RE technologies addressed in Phase II.
Technical Assistance for renewable energy projects development: • Development of streamlined procedures for permits. • Development of business advisory services capacity (financing facilitation, market information, credit and risk management).	$2 M		
Technical Assistance for Green Power market development: • Development of green certification mechanisms. • Marketing for green power. • Mainstreaming of carbon emissions reductions certification.	$1M		
Technical Assistance for detailed design and development of financing mechanism: • Funds allocation criteria over time, volume of power purchases and technologies • Development of auctioning procedures and accompanying legal documentation	$1 M		
Tariff Support Funds	$ 17 Million (Phase 1) $ 45 Million (Phase 2)		

Program Costs: Phase I : Phase II: **Total**	 $25M $45M **$70M**		

Annex 2: Incremental Cost Analysis
MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

Global Environmental Objective

This analysis of the incremental costs of adding 100 MW of wind to the Mexican interconnected system highlights the potential for fuel savings and greenhouse gas reduction. The proposed first phase of the GEF project would be commissioned in 2005, constructed at a cost of $115 million. GEF proposes to support the initial development of this energy source with tariff support subsidies to the wind energy producer of some $17 million over a period of five years. The goal of the GEF support is three fold:

1. Support financially the development and installation of renewable energy in Mexico;
2. Assist in the creation of a larger market for local wind machine manufacturers and installers, thereby bringing down the investment cost of wind energy; and
3. Improve the ability of CFE and the dispatch agency, CENACE, to manage both intermittent and firm power sources in a manner that provides enhanced reliability to the wind energy producers through new system simulation and management software.

There are two important measures of merit for this analysis. The first is the incremental cost of the wind generation in the system. The second is the economic rate of return for the proposed wind generation plants, given the alternatives to those plants in the Mexican system.

Broad Development Goal and Baseline

Energy policy in Mexico has been marked by overall stability. In recent years a series of small steps toward liberalization has resulted largely in additional purchases of electricity and fuel (mostly natural gas) by the national electricity entity, CFE. Early efforts at liberalization have slowed, leaving the current structure of both fuels and electricity likely to remain stable for the foreseeable future. Until the past few years the abundant energy reserves of Mexico were sufficient to provide both self-sufficiency in all forms of energy as well as significant export earnings. The country is still a major exporter of oil, but those exports now represent less than 10% (~$15 billion) of the country's total exports of $176 billion in 2001.

Virtually all of the country's hydrocarbons production is in the hands of the state-owned Pemex. The Government relies heavily on Pemex for income, netting about $30 billion from the sector in 2001, about 20% of government revenues. Little progress has been made in liberalizing the country's hydrocarbons sector and investment decisions for new exploration and production are largely in the hands of the Mexican Congress. Congress has not yet decided whether and to what extent to allow new participants in the country's hydrocarbons sector.

The reliance on the hydrocarbons sector to supply cash to the Government has resulted in a 30-40% reduction in the country's proved oil reserves over the past decade, to less than 30 billion barrels.[1] Natural gas reserves have also stagnated over the past decade, and stand at 26 trillion cubic feet (Tcf) and represent about 22 years of production at current rates. Current gas production has proved inadequate for the needs of Mexico's industry and electricity generation sectors and gas and imports from the U.S. now represent almost 10% of current demand. The Government of Mexico projects growing gas imports in the future, primarily through LNG regasification terminals on the Gulf and Pacific coasts of the country.

In the 1990s there was an effort to open up some segments of Mexico's gas industry. Private firms are permitted to supply services to Pemex, the sole producer, and companies can also invest in transmission and distribution. With inadequate domestic supply, these incentives have proved insufficient to dramatically restructure the gas sector. The other major energy sector opening has been in the provision of electricity to CFE and local distribution companies through independent power producers (IPPs). A more extensive restructuring of the electricity sector planned for the Fall of 2002 was postponed and may not come up again during the term of the current President.

Energy policy decisions in Mexico are the responsibility of the Secretaria de Energia (SENER), with executing authority in the hands of the Comision Federal de Electricidad and Luz y Fuerza Centro for electricity, and Pemex for oil and gas. Regulatory authority in the energy sector is in the hands of CRE for electricity and fuels.

Electricity

Mexico generated about 197 terawatt hours (GWh) of electricity in 2001, 21% of which was geothermal and hydropower. About 73% of Mexico's installed power generation capacity of 42 GW is fossil-based, with oil-fired plants, including combustion turbines, responsible for the largest share of both capacity (43%) and generation (49%). Coal plants account for 12% of total generation and 7% of capacity. Combustion turbine plants comprise less than 8% of total generation and are used largely for meeting demands at peak and in isolated areas. Gas-fired plants represent more than 19% of generation, about the same share as hydro, with just under 14% of total generation capacity.

The sector is organized around two state enterprises, CFE and Luz y Fuerza, with 92% and 4% of generating capacity respectively. Pemex controls another 2% of generation capacity and the remaining 2% is in private hands. There are three distinct grid systems in the country. One system covers the northern end of the Baja, the second covers the southern end of the Baja peninsula. The remaining national interconnected system (SEN) covers the rest of the country, with interconnections to the USA and to Belize and Guatemala.

Peak demand has risen steadily in recent years, moving from about 18.6 GW in 1990 to 31.5 GW in 2000, an average annual growth rate of just over 5%. With reserve margins declining throughout the 1990s, the country has found it necessary to obtain new generating capacity from private sources. Initially CFE made use of the build-operate-transfer model (BOT) and obtained about 1,100 MW of new combined cycle capacity in the mid-late 1990s. Since then, the private investors have preferred the IPP approach, especially with the relative ease of using an approved contract model for purchase of power and building permits. Of about 6,200 MW of new generating capacity under construction, more than 60% uses the IPP contracting model. More telling, no new BOT plants have been contracted since 1998.

The total capacity of all plants in the construction or permitting process through 2005 is approximately 10,854 MW, about the same as the expected increase in peak demand. In other words, if *all* plants in process are completed before 2005, the system reserve capacity will not fall. However, not all plants in process can be completed before 2005 and the increase in peak demand is likely to be greater than the increase in generation capacity.

With a declining reserve margin as a most likely case, the Government continues to encourage the construction of new power plant projects, most of them IPPs based on either new Pemex gas output or imported natural gas. To meet projected demand for electricity and gas to fuel new generating capacity, the country is currently putting two LNG regasification complexes out for initial design work.[2]

Table D1: Projected Electricity Generation, 2001-2011

Capacity (MW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SEN	38,519	41,095	44,918	46,002	46,877	49,463	51,865	53,109	56,311	59,915	63,214
Other	3,892	4,687	5,256	5,256	5,256	5,919	5,839	5,839	5,799	5,799	5,799
Total Capacity	42,411	45,782	50,174	51,258	52,133	55,382	57,704	58,948	62,110	65,714	69,013
Generation (GWh)											
SEN	197,106	201,821	211,658	220,400	232,345	245,305	259,929	275,872	293,459	311,964	331,218
Other	12,520	14,212	19,937	22,666	23,798	28,340	29,249	29,265	29,377	29,426	29,403
Total Generation	209,626	216,033	231,595	243,066	256,143	273,645	289,178	305,137	322,836	341,390	360,621

Figure 1, below, shows supply from major sources for 2001-2011, according to the SENER *Prospectiva*, while Figure 2 shows projected consumption by major category.

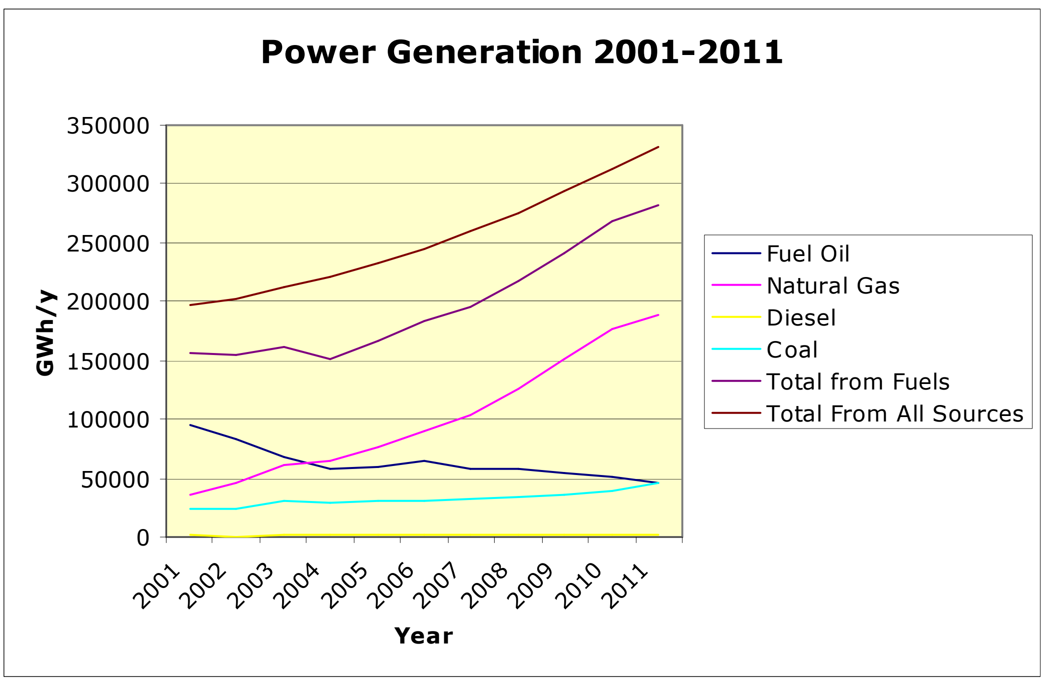
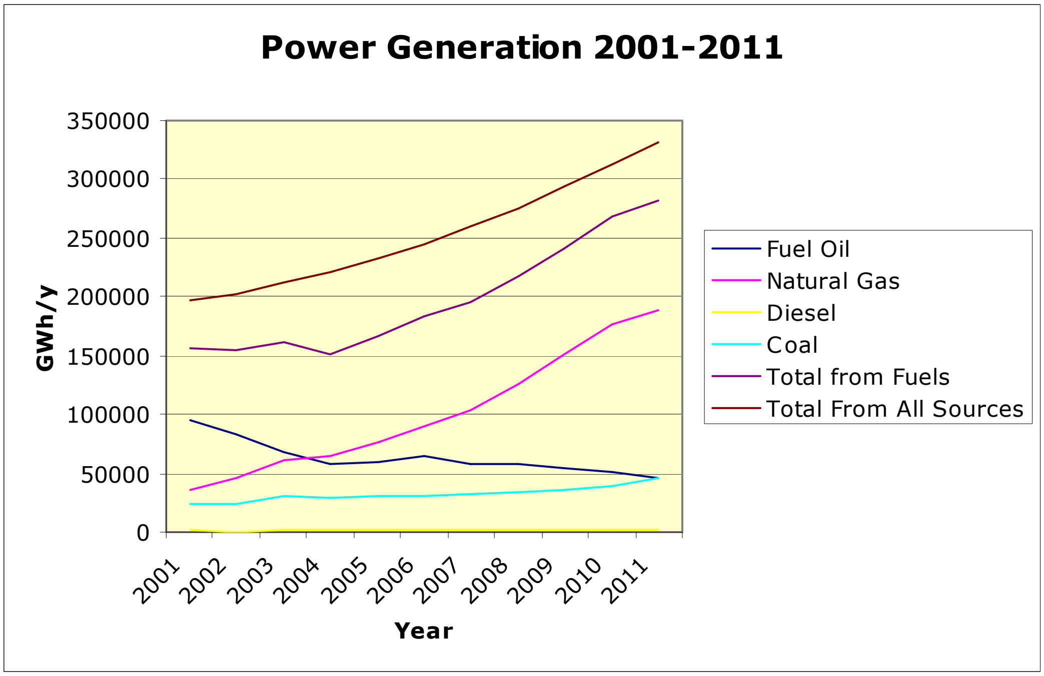


Figure 2: Projected Electricity Demand in Mexico by Sector



Oil

Mexico produces about 3.2 million barrels/day, mostly from fields in and around the Campeche Bay in the Gulf of Mexico. Reserves, which once stood above 40 billion barrels, are now rated at 28-30 billion bbl (end 2002). In the twelve months between January 2001 and January 2002, reserves fell by 1.4 billion bbl.[3] Pemex, the national oil company, must produce virtually all of its output from existing reserves. Of the current production total, about 2 million b/d, or 55% of total output, is consumed domestically.

Exploration and production development activities must be authorized by the Mexican Congress. In recent years the Government has looked to Pemex as a source of funds, not a recipient. Without substantial investments annually, the country cannot replace reserves lost due to production, pressure drops and field maintenance problems. A recent burst of upstream activity, resulting in an additional 100,000-150,000 b/d of output in 2000 has run its course and additional investment will be needed just to maintain production at current levels. Current production is maintained increasingly by resort to enhanced recovery techniques, a useful stopgap until more reserves can be proved up. However, the country is still far from a consensus on the role of Pemex as the sole entity for oil production versus greater reliance on private and foreign companies in the oil sector.

The lack of investment extends over to the refining segment of the industry as well. The government-owned refineries have capacity to meet about 75% of demand and about one-third of gasoline demand with the remainder met through imports. A major refining technology program is planned, given funding from the Government. One of the country’s major refineries, at Cadereyta, has already been fully upgraded to properly handle the country’s heavy crude oil slate. The Government plans to increase refining capacity in coming years, but the funding for such projects is not yet assured.

Gas

Mexico's current gas production of about 1.25 Tcf (35.3 bcm)[4] in 2001 is an increase of 33% in the decade since 1991. However, production plateaued in 1998 and has actually declined a bit from the 1999 peak of 1.29 Tcf (36.5 bcm). This level of activity puts Mexico in the same output tier as Venezuela, Australia, and Argentina, among others. As with crude oil, Pemex has the sole right to produce gas and to explore for the fuel.

Gas reserves currently stand at 16.26 Tcf, down from 17.27 Tcf in December 2000.[5] Pemex's budget problems in gas exploration are virtually identical to the oil market situation. Simply put, gas reserves are being used up annually without significant replacement efforts. Unlike in the oil sector, Mexico appears to making some real effort to bring additional resources into the upstream gas industry, particularly for non-associated gas reserves. In addition, the Government has permitted private firms to enter the transmission and distribution segments of the gas industry. These modest initiatives in the gas industry are not expected to yield dramatic short-term results and the country has seen a rapid rise in gas imports from the U.S., now running at more than 700 million ft^3/d, about 14% of total use in the country. Both the industry and power sectors are increasingly dependent on natural gas. By 2020 the IEA expects Mexico to increase gas use in the power sector seven-fold, to 44% of all generation.[6] This level of gas demand for electricity would be equivalent to the entire *current* gas production of the country.

To meet this burgeoning demand for gas in the face of stagnant reserves and production, the country is planning to turn to liquefied natural gas (LNG) to provide additional supplies. CFE, the electricity company, has announced two LNG regasification plant tenders, each of which will increase domestic supplies by 10% over current levels. Eventually, four of these plants are to be built, supplying at least 2 billion ft^3/d.

Coal

Coal currently provides almost 7% of electric power system capacity and about 12% of total generation. The plant capacity is located in the Northeast portion of the country where there are some coal reserves. Current output of 10 million tonnes annually falls short of annual consumption, which now stands at 12 million tonnes. No new coal-fired power plants are currently shown as under development by CFE or private developers. However, the *Prospectiva* does show coal maintaining a 12-14% share of total generation through 2011. Generation from coal is shown to approximately double over the period 2001-2011, indicating that as much as 25% of the power plants shown as "other" in the CFE plan (>10 GW by 2011) are actually intended as coal units.

Other Energy Sources

The main source of renewable energy in Mexico today is hydroelectricity. Large hydro plants represent more than 25% of installed capacity and about 18% of total generation. The only other major non-conventional energy source is geothermal, with less than 5% of both capacity and generation. CFE plans to halve its oil use by the end of this decade, using large hydro in the short term and natural gas in the medium term. New hydro and geothermal plants are under construction and these sources could contribute as much as 30% of electricity supplies in 2004-2005. After that time, CFE projects that hydro and geothermal will gradually reduce their shares of generation to about 15%, with most hydro being used to meet peak demand, further replacing older combustion turbine units.

GHG Emissions in Mexico's Power System

Current emissions of CO_2 in Mexico's electric power system amount to about 115 million tonnes/year (equivalent to 31 MT/y of carbon). With the *Prospectiva* projections of 149 MT in 2011, the carbon intensity of Mexico's power system will decline by more than 30% by 2011, from 74 g/kWh in 2001 to 53 g/kWh in 2011. Figure 3 shows projected GHG emissions from the power sector for the SENER planning period. With the least efficient fuel oil and middle distillate plants retiring, replaced by gas-fired CCGT and hydro, the overall CO_2 emissions of Mexico's power sector actually falls in the first three years by about 7%. After that CO_2 emissions continue their increase. In 2001, about 60% of total CO_2 emissions were due to fuel oil use. By 2011, fuel oil responsibility for emissions will fall sharply, though natural gas will take up all of the differential and more, with gas accounting for more than 40% of total GHG emissions in 2011. As the figures below show, the increase in GHG is well below the increase in generation. The increasing efficiency of the power generation system is due largely to two factors, the replacement of intermediate oil-steam facilities with gas-fired CCGTs and the increasing use of hydro to meet peak demand instead of combustion turbines. Figure 4 shows the changes in generation efficiency over the SENER planning period. Figure 5 shows how CO_2 emissions have changed by fuel over the period of SENER and CFE planning.

Figure 3: Total CO_2 Emissions by Source

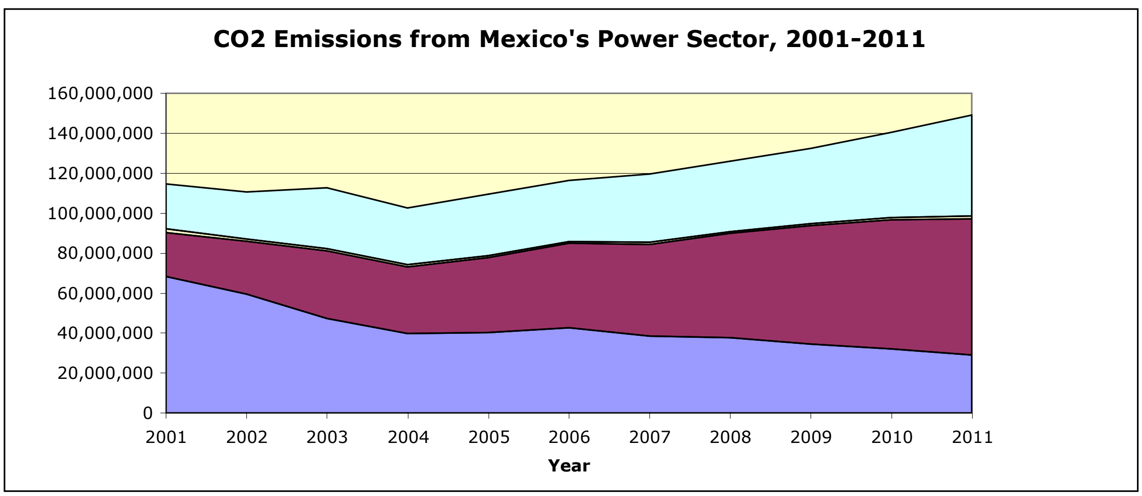


Figure 4: Efficiency Changes in Mexico's Power Sector

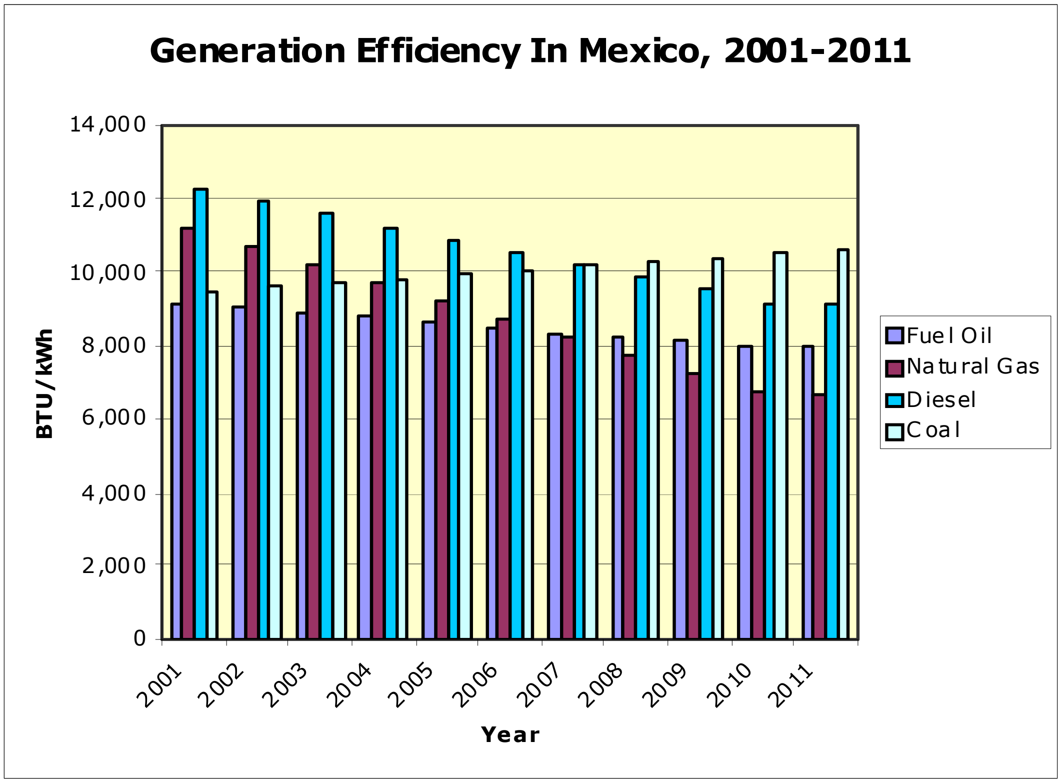
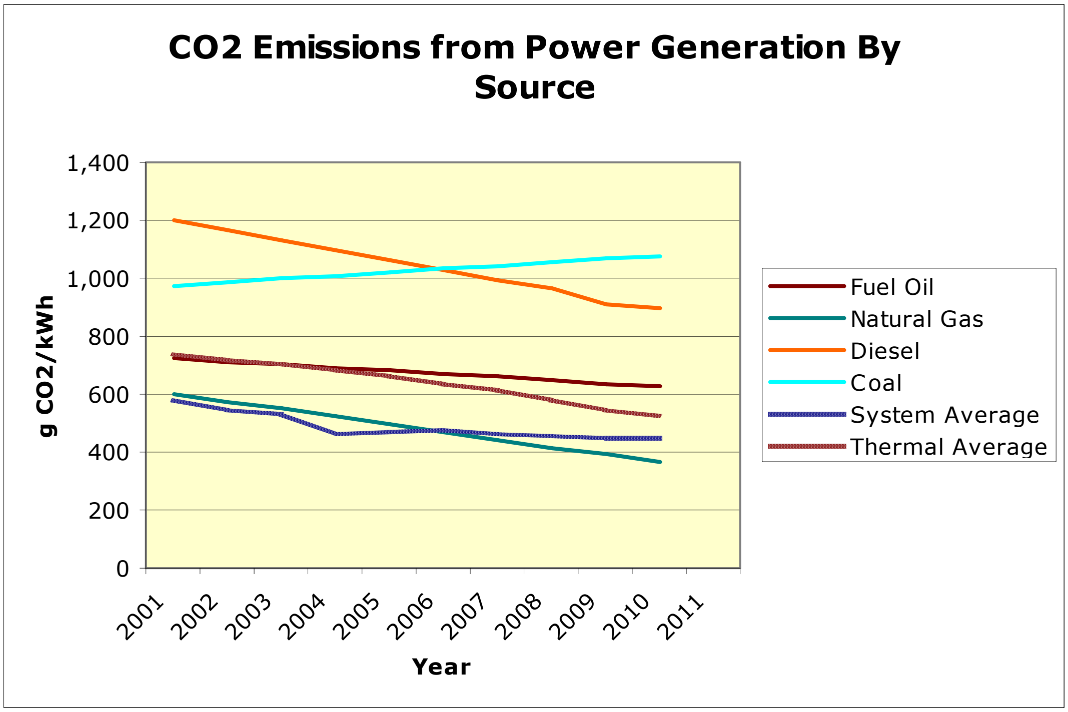


Figure 5: CO_2 From Mexico's Power Sector: g per kWh


CO2 Emissions from Power Generation By Source
1,400
1,200
1,000
800
600
400
200
0
g CO2/kWh
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year
Fuel Oil
Natural Gas
Diesel
Coal
System Average
Thermal Average

Impact of 100 MW of Wind Capacity on Power Generation in Mexico

Description of the GEF Project:

The Global Environment Facility proposes to support the construction of at least 100 MW of wind stations in Mexico to provide power to the SEN, the national interconnected electricity system. This set of wind installations is expected to be able to generate electricity approximately 40% of the annual hours, equivalent to about 350 GWh annually on an export basis.[7] The project is the first phase of a multi-year program culminating in the installation of as much as 1 GW of wind energy in Mexico, much of it concentrated in Oaxaca. This analysis is focussed on the 100 MW of wind capacity directly supported by the GEF project. An additional 100 MW of plants are expected to be assisted by business advisory services as part of the project but will not receive direct GEF tariff support.

Basic cost and output data on the proposed investments in wind were analyzed using a simulation model of Mexico's power system. This model calculates the cost of meeting electricity energy and capacity demand under a wide variety of assumptions regarding Mexico's economy, oil sector, gas supply and power technology.

For the purposes of this project, the base case was taken as the SENER/CFE expansion plan, including demand forecasts, economic growth forecasts and technology expectations. The only change vis-à-vis the SENER *Prospectiva* is that this analysis covers a period of 20 years subsequent to the commissioning of the proposed wind investments, unlike the 10-year horizon of the SENER *Prospectiva*.

A wind investment resulting in an additional 100 MW of power generation capacity represents about 0.33% of proposed CFE additions aver the period of the *Prospectiva*. Moreover, with the 40% plant factor, one that is lower than normal intermediate service plants, the proportion of system energy generated by the wind facility will be in the range of 0.3% of *additional* output, and less than 0.01% of *total* output during the period in question.

The GEF role in the proposed wind farm installations would be three-fold. In the first instance GEF would provide financial support to the power plant developers. Secondly, GEF would provide support to CFE and other institutions in Mexico to improve the tools available for system expansion planning and dispatch management of intermittent resources. Finally, the GEF program will provide for further development of the country's wind market, coupled with business advisory activities for promoting wind energy development.

CFE Baseline

The Ministry of Energy in Mexico, through SENER and CFE, has plans to construct 50 MW of wind energy plants over the period of the current SENER plan (through 2011). The proposed CFE plant will be commissioned in 2006. No other wind plants are envisioned through the end of the current SENER planning horizon. The output from that investment, about 175 GWh annually, will provide approximately 0.15% of additional output in the National Electricity System (SEN) through 2011.

CFE, through its Renewable Energy Directorate, is undertaking studies to assess the impacts of wind energy on the CFE system as well as ways to enhance the value of that energy once its enters the national transmission system. These studies, now ongoing, are intended to provide a better understanding of the system and power plant management efforts that are required to give wind energy the ability to contribute some degree of firm capacity to the Mexican power system. At the current state of understanding of these issues it is difficult to attribute firm power capacity to wind energy, given its highly predictable but intermittent nature. Thus the output from the planned CFE wind plant will be given an energy-only value, with a present value of $20.06 million for the period 2006 through 2011. Since the present value of project costs is approximately $62 million, the project is not expected to return net benefits to the owners of the plant, CFE, in the short run. The table, below, shows the economic analysis of the CFE wind energy baseline over a 20 year *economic* lifetime.

Table 2: CFE Wind Energy Activities, 2002-2011		
Item	**Unit**	**Baseline Value**
Annual Generation	GWh	175.2
Levelized Economic Generation Cost	$/MWh	48.01
Value of Energy Displaced	$/MWh	34.20
Value of Capacity Displaced	$/MWh	0.00
Present Value of Project Costs	$M	62.44
Present Value of Project Benefits	$M	48.48
Internal Rate of Return	%	6.77
CO_2 Displacement (2006-2011)	Tonnes	480,682
Source: Sener Prospectiva and CogenPro Simulation Model		

Impacts of the Proposed GEF-Supported Wind Energy Plants

As a general rule, a single 100 MW power plant (the aggregated value of the installations directly supported by GEF under this project) will not have a significant impact on a system the size of the CFE SEN. In planning terms, a plant can be considered a part of the least-cost plan if that plant can contribute capacity to the SEN. On its own, the proposed wind facility cannot contribute capacity to the SEN. Almost by definition, the plant generates electricity on a generally predictable, but not firm or dispatchable basis. Without a firm power rating, CFE cannot delay the construction and commissioning of some other firm power facility due to the commissioning of this wind plant. Therefore, most of the economic impacts of the wind facility discussed below will come in terms of displaced energy.

The issue of the precise value to the SEN of wind energy is still open. However, there are three distinct types of values that can be placed on wind energy output. These are:

1. Wind energy is worth the system marginal energy cost (MEC) at any given time less the cost of providing spinning reserve for that capacity;[8]
2. Wind energy is valued at exactly its energy replacement figure on the assumptions that (i) wind capacity is too small to affect the overall system output, and (ii) wind energy can be replaced almost immediately by some other generator if the wind speed falls; and
3. Wind energy is valued at its energy replacement value plus a capacity value that represents the ability to back up wind output to some, or possibly full, extent.

The primary locale for wind energy development in Mexico is the Oaxaca province, one that is blessed with abundant and relatively predictable wind resources. Given the relatively high plant factor and good predictability of power generation, the first valuation option seems overly restrictive. Perhaps if wind were a significant proportion of total output in the Mexican system, the Mexican wind resources were of a lower quality, and if there were little ability to quickly replace the wind output by some other generator, then this approach might have some validity.[9]

For the purposes of analyzing the value of output for GEF incremental cost analysis, the base cases for wind energy value were the following:

- Wind energy valued at its periodic MEC for the times that the unit generates energy;
- Wind energy valued at the MEC plus full capacity value for the times the unit generates energy;
- Wind energy valued at the MEC plus a partial capacity value for the times that the unit generates energy.

The third case, valuing wind at energy + partial capacity value, will indicate the potential returns to the country if CFE and CENACE understanding and management of wind energy's interface with the SEN is improved over the next several years. The capacity credit attributable to wind is approximately the same as the proposed GEF subsidy payment to the owner of the wind generation project above the regular CFE payment.

Methodology

A simulation model ("CogenPro") was used to calculate the impacts of the proposed wind energy investments. This model is able to reproduce most of the simulation results of the WASP III or WASP IV models as they pertain to Mexico's system expansion. Although the model works at a lower level of resolution than does WASP III, it contains several additional features that are useful for the GEF's analysis of projects. The user inputs a variety of economic and technical parameters regarding the power system and the host country's economy, as well as important technical parameters on fuel prices, operational efficiency, GHG emissions, system operation and fuel supply. In addition, the model embeds a proposed power plant investment in the system simulation and then produces key economic and financial measures of merit for that plant under a variety of assumptions.

The table in Appendix 1 describes briefly the operation of the key elements of the simulation model used in this analysis.

At the time of this writing other analytical efforts are under way and the results of these activities will be used to further refine and validate the current analysis. In particular, there are current simulation efforts at CFE and USAID that seek to provide additional light on questions of the capacity value of wind energy and the economic/GHG-reduction value of wind energy when operated in a large system with a variety of resources. Current results will be further discussed with SENER, CFE and CENACE to arrive at an appropriate validation of the suggested approach to valuing wind energy.

Results to Be Reported

The key outputs of interest concern the incremental costs and benefits of the proposed wind investments. Using the three general cases for establishing the value of the output, the following results will be reported below for each case:

- Generation cost of wind project

- System avoided generation cost, with specified levels of capacity value
- Economic rate of return
- Present value of benefits (as noted above)
- Net present value of project
- CO_2 displacement

In each case, the outputs will be provided for a base case and for three other cases – slow economic growth and power system investment, high economic growth and power system investment, and enhanced investments in LNG and coal-fired power plants on the base economic forecast – and two crude oil (WTI) prices will be used: $24 and $28 /bbl.[10]

Discussion of Results

Generation Cost of Wind Project: The proposed 100 MW of aggregate wind projects will entail a present value of investment and operation of approximately $120 million, the overwhelming proportion of which is the initial investment cost.[11] The generation cost from the proposed wind facility varies from $45.46-53.19/MWh, depending on assumptions regarding dispatch hours, and operational costs.

System Avoided Cost and Present Value of Benefits: An avoided cost is calculated for the prospective power generation system independently of any proposed investment contained in this analysis. That avoided cost represents the value of additional system investments and the marginal energy cost by season (dry and wet) and time of day (base, intermediate, peak) for each combination of oil price, economic scenario and investment scenario. For the base case, that is, the SENER/CFE expansion plan and economic growth forecasts, the system avoided cost of new generation falls into the range of $41-63/MWh, as crude oil ranges from $18-34/bbl. This discussion will focus on the $24-28/barrel cases.

The benefits that are calculated for *each case* represent the value of the energy displaced during the proposed plant's hours of operation plus the value, if any, of capacity displacement attributed to the plant. The energy figure depends largely on three elements: (i) hours of operation, including time of day, (ii) plants displaced, and (iii) fuel prices for displaced plants. For example, if the wind plant were to operate during a period in which the marginal plant on the system was a gas-fired CCGT (dry season), and a combination of CCGT and hydro (wet season), and assuming that the oil price was $28/bbl, then the value of the energy displaced by the wind plant would be that marginal energy cost, or $47.70/MWh[12] during dry season, and $41.40/MWh during the wet season. The value of capacity during this intermediate period is about $17.10/MWh.[13] If the plant gets full attribution of capacity displacement value, then the value of benefits attributable to the wind plant is $64.80/MWh in the dry season and $58.50/MWh in the wet season.

The present value of benefits (PVB) is simply the value of displaced energy and capacity that can be attributed to the plant's output over the simulation period expressed in present value terms. For energy displacement only, the PVB is the value of fuel not burned and ranges from $84-98 million. A full attribution of capacity displacement value to the plants is worth about $80 million in present value terms, bringing the PVB to $165-179 million.

The base case for this GEF Incremental Cost analysis uses an energy-only payment, whereas an economically efficient base case would recognize a partial capacity payment, representing 50% of the value of capacity in the system while the plants are operating. This figure will evolve with the idea that better management of overall CFE generation and system resources can permit a *predictable* energy source, such as the Oaxaca wind plants, to displace at least *some* firm capacity in the system some of the time. This capacity figure also represents the present value of the partial capacity payment ($17 million) over the five years of the Phase I of GEF's program. Throughout the economic life of the plants, this partial capacity payment would be worth approximately $39.6 million.[14] The difference between the energy-only payment case and the (partial) recognition of contribution to system capacity represents a cost of policy adjustment and learning in Phase I.

Economic Rate of Return: The ERR is the rate at which the project returns value to the investors and society, based on the real cost to Mexico of the resources used in the project and opportunity cost of the displaced energy and capacity that is attributable to the project. The results for this proposed project are uniformly negative for all cases and all oil prices if no capacity benefit is attributable to the project. If the project can displace some capacity (50% of its rated output in this case), then the ERR results indicate that oil prices above $24/bbl may allow the plants to break even and generate some returns for the society and investors.[15] If the wind facilities can be operated in such a manner that the CFE can attribute full capacity credit to the wind output, perhaps by some combination of wind and hydro twinning, then it is possible for the plant to show positive returns unless oil prices fall below $18/bbl. For a plausible range of oil prices, $24-28/bbl, a twinned wind/hydro facility can generate economic returns ranging from 10.52-12.05%.

Net Present Value of Project: Based on the project's present value of costs of $120 million and the PVBs, which range from $97-179 million, the NPV will be positive or negative as appropriate. In general, project returns are only positive when capacity displacement value attributable to the project is greater than 50%, or when oil prices are very high.

The Base Case results shown below correspond to the SENER/CFE reported expansion plan as contained in the *Prospectiva*.

Table 3: Summary of Key Economic Results for GEF Project

	Project NPV (millions)	**Project ERR**	**Value of Output ($/MWh)**	**Present Value of Benefits (millions)**
Base (Sener/CFE) Case - Crude oil Price ($/bbl WTI)	**Energy Value Only**			
24	($36.12)	5.53%	29.62	$83.81
28	($22.15)	7.35%	34.19	$97.78
Partial (50%) Capacity + Energy Value				
24	$4.51	10.52%	39.96	$124.44
28	$18.48	12.03%	44.53	$138.41
Full Capacity + Energy Value				
24	$45.45	14.79%	50.30	$165.08
28	$59.12	16.14%	54.87	$179.05

NB: the present value of costs is $119.93 million.

CO_2 Displacement: The project can displace as much as 230,000 Tonnes of CO_2 annually under current the system configuration, or 1.4 million Tonnes over the SENER planning period. Table 4, below, shows the CO_2 reduction attributable to the GEF-supported wind projects. If all of the output of the wind projects can be attributed to fossil plants only, then the pattern of output of the wind project can reduce CO_2 emissions from Mexico's power system by 231,194 tonnes in the first year of full operation, 2005. That value drops over the SENER planning period as new power plants replace older, less efficient units (see Figures 3 and 4). If management of system resources does not permit CENACE and CFE to distinguish among fossil and other system resources, then the effective CO_2 displacement would be lower, starting at 165,065 tonnes in 2005, falling slightly to 157,656 tonnes in 2011. The displaced CO_2 represents 0.15-0.21% of year 2005 expected CO_2 emissions from power generation. The figure falls to 0.11-0.12% by 2011. The actual displacement figure will probably depend on the ability of CENACE and CFE to upgrade their analysis and system management tools so that the maximum value is obtained from the output of the wind unit.

Table 4: CO_2 and Carbon Displacement From GEF Wind Project									
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2010**	**2011**
Average of All Plants									
GEF Wind (CO2)	165,065	166,519	161,326	159,928	158,139	157,796	157,656	157,796	157,656
GEF Wind (Carbon)	5,406	5,454	5,284	5,238	5,180	5,168	5,163	5,168	5,163
Fossil Plants Only									
GEF Wind (CO2)	231,194	221,747	214,214	202,667	191,790	182,941	184,934	182,941	184,934
GEF Wind (Carbon)	62,950	60,379	58,326	55,183	52,220	49,810	50,350	49,810	50,350

Incremental Costs

The table below, the Incremental Cost Matrix, shows the comparison of the CFE Baseline with the GEF proposed project.

Table 5: Incremental Cost Matrix			
	Baseline	**GEF Alternative**	**Increment**
Domestic Benefits	Produces 350 GWh of annual electricity output through in-place and planned fossil-hydro electricity system. CFE continues to work on assessments of value of wind energy & system management with existing tools and methods.	Produces 350 GWh of annual output, 0.5% of additional CFE output over Prospectiva period (2001-2011). GEF pays equivalent of 50% of the value of capacity during the period of GEF project Phase I. GEF supports technical assistance for CFE, CENACE, IIE and others to introduce new system management software. Implementation of this software should permit better management of wind and other system resources, adding value to the wind output.	Improvements in system management techniques and valuation of intermittent energy resources. Improvements in energy valuation and dispatch management of all new energy sources for electricity system. Provision of a larger domestic market for wind machines, inducing greater domestic supply and installation and reducing future investment costs for wind.
Global Environmental Benefits	1.61 – 1.91 M tones of CO_2 for 2006-2011.		1.61 – 1.91 M tones of CO_2 for 2006-2011.
Costs by Component (US$M)			
Present Value of Costs (Investment + O&M)	97.8	119.9	22.1
Technical Assistance	0.75	8.75	8.00
Total Costs (US$M)	98.6	128.7	30.1
GEF Incremental Costs (US$M)			**25.00**

Note: All figures will be subject to confirmation at Project Appraisal.

Technical Assistance: The technical assistance component of this project is intended to improve the ability of the Mexican electricity institutions CFE and CENACE to manage the value of their system resources. Of particular interest is the issue of how much a predictable energy resource, such as wind, can displace firm system resources such as hydro or combustion turbines. Right now, many people in the energy community believe that the predictability of good wind resources, such as those in Oaxaca, should permit an overall reduction in capacity needed to meet peak and shoulder demands. However, the fact is that we do not now know whether and to what extent this supposition is true.

To obtain the answers to these questions, and to satisfy the entirely proper concerns of a utility with a service reliability obligation, it is necessary to use techniques and tools that can combine the least cost planning and system expansion work now done by CFE, with some of the dispatch simulations performed by CENACE. The proposed technical assistance for this project will bring such simulation tools to CENACE and CFE.

If there are good data on wind and if the generation of wind can be projected with some reasonable probability, then a multi-year dispatch model should be able to come up with the expected backup requirements for wind generation units over the course of a year. If the need for backup to wind can be know with some degree of certainty (or probability), then CFE can compute the fractional capacity contribution of the wind resource. In more concrete terms, this means that if wind can replace hydro during shoulder and peak periods with, say, 80% certainty, as verified in multi-year resource studies, then the water thus saved can be used as (i) backup for the wind when that resource fails, or (ii) as a replacement for combustion turbines at peak with the water saved from intermediate periods. In general, such energy resources will not need to be employed to meet less critical demands.

Other technical assistance activities are intended to reduce the costs of future wind energy development by providing a larger internal market in Mexico. This market development activity will consist of both market expansion and business advisory services.

Process of Agreement

The methodology for determination of incremental cost was reviewed and agreed with the CFE Renewable Energy Sources Division and presented and discussed with CFE senior management. The initial estimation is based on modeling performed in the "CogenPro" model described herein which was originally developed for the analysis of grid-connected cogeneration projects, but is adaptable to other generation forms.

During the course of project preparation, the initial results will be validated and refined in comparison with a USAID/CFE feasibility study of the CFE "La Ventosa" 54 MW wind project. The economic evaluation incorporates the results of differential runs of the CFE least-cost system planning/expansion model (i.e., with/without wind). Preliminary results have been shared with the GEF project team, and final results are expected by April 2003.

For project appraisal, a similar "with/without wind" analysis of the impact of wind will be performed using upgraded CFE system planning models that will more precisely capture the value of intermittent renewable sources.

Appendix 1: Description of the CogenPro Simulation Modeling System

Module	Description	Analytical Output
System Expansion	Future expansion of the power system can be simulated in two ways: (i) a least cost expansion plan is generated consisted with a given (or generated) demand forecast, fuel prices, operational parameters, or (ii) a least cost expansion plan is adapted from the host country and used as a basis for further analysis and discussion.	Plant capacity by type and year of commissioning, investment costs, plant output, variable and fuel costs, average and marginal costs of output, plant retirements
Dispatch	The existing, new and retiring plants in the system are dispatched on the basis of economic merit for each daily time period and season. Changes in the least cost plan will be reflected in dispatch results as will changes in fuel prices. This module also contains a subroutine for specifying economic and system operation conditions to produce different scenarios for comparison with a base case.	Plant dispatch merit order, MEC by time period, season and year, MEC by plant type, various weighted average MECs and energy generation values. In addition, this module produces a summary by scenario of different operating and economic conditions.
Investment	A proposed power plant investment can be included in the LCP and dispatch models. The user can specify very detailed assumptions regarding the operational, financial and economic characteristics of the proposed plant. This power plant will than be subject to economic dispatch as appropriate and a variety of economic and financial measures of merit will be produced. Comparisons of PPAs and pool payment schemes can be made.	All of the usual economic and financial measure of merit are produced, including 7 different rate of return calculations, present values of all cost and revenue streams, fuel values (netbacks), returns for different payment schemes (PPA, pool, partial capacity, etc.)
Fuel Prices	A simulation of oil and refined product markets, including interaction with LNG, pipeline gas, alternative hydrocarbon fuels, provides the fuel prices for the various power plants in the system. The model works from a specified forecast of a marker crude oil price, or a forecast can be produced by the model, with full stochastic variation of key price factors. This module is liked to a gas production module for pipeline gas supply and to a gas processing module for LNG and LPG supply or export comparison.	Annual prices of crude oil and major refined products (naphtha, mogas, diesel, jet, kerosine, IFO, HFO, LNG, pipeline gas, methanol, LPG), prices in all common units (T, bbl, mmbtu)
Gas Production and Supply	This module calculates the cost of gas supply (if appropriate) by pipeline, provides comparisons of export v. domestic supply options and pricing options for different pipeline and supply modes.	Gas supply investments, pipeline investment and tariffs, returns to upstream investors, alternative investment and legal regimes.
Gas Processing	This module simulates the construction and operation of a gas processing complex, with options to produce LNG, LPGs, methanol and ammonia. It is used if LNG is a significant consideration for fuel supply for the power system and can be used on its own to evaluate investments in gas processing for export.	All of the normal economic and financial results are produced, along with alternative fiscal regimes for the government's take from proposed gas system investments. Upstream and gas transportation are internal, or the user can specify an interface with the external gas supply model.

Operation of the model uses a combination of spreadsheet (Excel), Visual Basic program routines, and optimization programs to calculate results. User-definable parameters exceed 1,000 and data needs are consistent with a simulation model of this scope.

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[1] There is some controversy over the actual levels of oil reserves, with the *Oil and Gas Journal* putting the December 2001 figure at just over 26 billion bbl., a significant drop from December 2000. The U.S. Department of Energy places Mexico's December, 2002 reserves at 30.8 billion bbl., a drop of 1.8 billion bbl. From the previous year. Mexico does not publish official reserve totals.

[2] Mexico has announced plans for four LNG terminals, two on the Pacific coast and two on the Gulf. Two of the terminals will be built very close to the US border in order to facilitate the sale of natural gas to the US (California and Texas, respectively). Large electric power complexes will be constructed proximate to the regasification facilities.

[3] The amount by which reserves fell is almost exactly the annual output volume of Pemex, indicating no net reserve increases in 2001. In 2002 reserves fell further.

[4] Equivalent to 4.51 billion ft^3/d.

[5] As with oil there is significant uncertainly about the true level of reserves. The *Oil and Gas Journal* puts the reserve level at 29 Tcf, while different divisions of the US Department of Energy put gas reserves at 30.1 (*Energy Overview of Mexico*) and 16.3 Tcf (*Mexico Country Analysis Brief*).

[6] The *Prospectiva* shows gas-fired generation already at 56% of total output by 2011.

[7] This is after deducting relatively modest host demands for electricity of less than 1%.

[8] This method is the basis of the current CFE buyback approach to renewable energy generators.

[9] If this approach were to be accepted, then the value of wind energy would be approximately 85% of the periodic Marginal Energy Cost. All measures of merit, NPV, ERR, would fall into the unacceptable range.

[10] Cases using both $18 and $34/bbl were also examined. The other case results will be shown in an appendix.

[11] The PVC is calculated based on a project start date in 2004, with commissioning in 2006. If the project were to get under way immediately, then the PVC would rise to about $115 million.

[12] This figure includes both Pemex gas and LNG imported at the Gulf of Mexico regasification stations.

[13] This figure averages $20.70/MWh for the operational hours of the proposed wind plants.

[14] It is expected that the outcome of the technical assistance component of the project will provide system management and valuation methods that can enable CFE to provide a capacity payment to the wind plant.

[15] A capacity attribution above 80% is required for the project to break even at oil prices of $20/bbl.

Annex 3: STAP Roster Technical Review
MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

STAP Review

Mexico: Large-scale Renewable Energy Development

Dr. Ausilio Bauen
3/6/03
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This is generally a technically sound and innovative project with good potential for enhancing the commercial competitiveness and stimulating the renewable electricity sector in Mexico. Its approach, providing assistance with policy and regulatory measures and in designing and funding financial mechanisms, is potentially very effective. The project also has a good potential for replicability in other regions of the world. A numbers of issues that require more detailed consideration and that may be important for the success of the project are discussed in the following detailed review.

Scientific and technical soundness of the project

Has the most effective and appropriate approach been used to remove the barriers?

Dr. Bauen: The approach is generally sound. The measures suggested appear appropriate and potentially effective. The approach of stimulating renewable energy uptake through the introduction of financial mechanisms while providing assistance in addressing key policy and regulatory issues appears most appropriate and applicable to many countries, Mexico in particular. Although an indication of the measures to be developed is provided, the actual appropriateness and effectiveness of the project will depend on how the financial mechanism is designed and how the policy and regulatory barriers are tackled in parallel. This may require a clearer plan.

<u>WB Response:</u> Upon GEF Council's approval and during the final project appraisal stage the project components will be finalized in consultation with the Government of Mexico. Basic agreements have been reached describing the specific tasks to be undertaken by different entities during project preparation. Some of these key activities include: development of standard bidding and contractual forms for renewable energy projects, establishment of agreed methodologies for least-cost calculations, detailed operations manual for BANOBRAS, development of a framework for identifying, assessing, and managing potential environmental impacts related to the program and sub-projects, establishment of technical standards for interconnection and assessment of networks to accommodate renewable energy systems.

Dr. Bauen: The 'strategic choices' which are being pursued by the GoM are considered to be valid (IPP project contracted to CFE and integrated with the grid, tariff support mixed with other financial mechanisms, implementation of National Fund for promotion of renewable energies). However, these strategic choices will only be effective if complemented by a number of other actions aimed at removing technical and institutional barriers.

The current policy and regulatory framework in Mexico for the promotion of renewable energy is weak. Technical assistance will be key in resolving electricity pricing and third party access issues. While a lot of emphasis has been placed on the issue of least-cost pricing, a number of other issues require careful consideration, such as technical standards and commercial regulations for grid interconnection, upgrading of transmission and distribution networks for integration of renewable energy projects into the grid, and opportunity awareness of relevant stakeholders.

<u>WB Response:</u> We agree. In fact, specific technical assistance components and funding --ear-marked for CENACE/CFE and IIE-- will be directly addressing these issues (see table of components and financing, section C.1, item: Systems Operations 2.5 million).

Dr. Bauen: There is also a need to design systems that keep transaction costs low while promoting renewable energy project proposals that are financially and environmentally sound and that have a good chance for successful implementation.

Tariff support has the advantage of providing a good degree of comfort to renewable energy investments, but its design is crucial to the success of the scheme. In some cases tariff support schemes may lead to little competitive pressure and lower than expected cost reductions over time. This aspect should be considered in designing the scheme. Since tariffs provide no obligation on the introduction of renewable energy, there may be no strong incentive to remove barriers to renewable energy penetration. Their removal is crucial to the success of the project and strong technical assistance efforts need to be aimed at addressing them. Also, the removal of institutional and regulatory barriers need to be more strongly addressed and milestones set with regard to the design of suitable policy and regulatory measures, which should be reflected in the trigger points and key indicators.

<u>WB Response:</u> The project is designed to introduce competitive pressure and cost reductions, by providing the tariff support on a <u>competitive basis</u>, and on subsequent rounds of bidding rounds. While it is probably impossible to avoid some degree of "gaming" of the system, anticompetitive behavior protections --as learned in the UK, Irish and California best practices-- will be built into the auction system design (see annex:" Policies to Stimulate the Market for Renewable Electricity: International Experience and Lessons Learned"). Even though at present tariffs provide no obligation to introduce renewable energy, the combination of: the growing demand for electricity, the availability of local resources, the potential for capital cost reductions, the increased in technical capacity to absorb renewable energy projects and the GEF support, are expected to result in such production costs for renewable energy that within the project's timeframe will allow them to compete directly with alternative generation options. This will result in a sustainable renewable energy industry for the longer term.

Dr. Bauen: Although the five year length of tariff support appears to be suitable for some wind projects, it may not be suitable for the promotion of a mix of renewable sources of electricity. A more detailed discussion of the requirements of a tariff support scheme supportive of a variety of renewable energy sources is desirable. An advantage of a tariff structure is that it offers an opportunity for supporting renewable resource diversity and this should be taken advantage of from the beginning of the programme.

WB Response: Most of the renewable technologies that are to be supported through the financing mechanism (e.g. small hydro, wind energy, biomass, small geothermal) have the common characteristic that their up-front capital costs are high and pose a significant challenge to bring the projects to financial closure. The five-year period proposed for wind projects provides good incentive for project developers to operate their plants at maximum efficiency while providing a cash-flow stream that can accommodate debt service coverage targets for the first years of operation, that can then facilitate additional financing. Moreover this timing is close to the estimated number of years needed for projects to approach the break-even point for the payback of investments.

Longer support periods could spread thin the financial support needed in the first years of operation, where perceived risks are higher and raising capital for financing is harder. For particular cases where project developers may need to extend the payments, the Mexican financial sector is sufficiently advanced to use project financing arrangements that may restructure the tariff subsidy payments to longer periods. Shorter support periods might create sustainability issues if plant operations focus disproportionately in the two or three first years where subsidy benefits would be much higher.

A similar evaluation of financing needs appropriate to each technology will be made once sufficient capital and experience is acquired to enable organization of auctions along technology banding lines.

Dr. Bauen: The focus of phase 1 of the project uniquely on wind energy appears restrictive and not properly justified. Many opportunities exist for other low cost renewable sources of electricity, biomass in particular. Mexico has a large sugarcane industry with an important potential for cogeneration and power exports to the grid. Other relatively low cost biomass opportunities may be available, including co-firing with fossil fuels. A more detailed discussion on how the project will assist in promoting a diverse renewable energy supply would be helpful. The proposal provides little indication of the opportunities and costs associated with a variety of renewable sources of electricity.

WB Response: We agree. Mexico does have good potential for renewable energies in general, and the project is designed to support a range of renewable energy technologies. As stated in the project document (Section C.1.): " **Phase I** of the program would target renewable energy technologies on a least-cost basis in terms of minimizing the level of GEF tariff support required, both initially and over time. Initially these projects are expected to be primarily wind, and potentially small hydro. Given the high quality of the wind resource, and high prospects for organizational learning and cost reduction, wind is viewed as particularly responsive to GEF Operational Program guidance (OP#6) which targets long-term technology cost reduction. If additional cost prospects for other technologies are identified, and/or additional co-financing is identified, other renewable energy technologies may be supported in Phase I. **Phase II** is expected to continue tenders under the Financial Mechanism to amplify and replicate renewable energy installations under the program. Incentive support will be 'banded' to expand support to other technologies (including small geothermal, biomass and small hydro) and differentiate support to levels required to stimulate these applications."

Dr. Bauen: GEF funds leverage deserve a more detailed discussion. A 10:1 leverage may be high depending on the level of tariff support provided and the level of financial incentives from the GoM. However, what is important is how the leverage ratio of GEF funds will increase over time and in relation to different renewable technologies. Greater GoM support may be required to gain fuller advantage of the GEF funds, for example in assisting the development of a local renewable energy-based industry. Also, greater GoM support may be required to promote the longer term commercial viability of a broader range of renewable sources.

WB Response: As the financial analysis section indicates, during the first phase, $17million of the financing mechanism are likely to support capital cost investments of about $120m. This is a ratio of 1:7 for the first stage where higher support is needed and where barriers are higher. Over time, because of cost reductions and organizational learning the ratio improves significantly in terms of leveraging the GEF funds.
The case for support of broader range of renewable energy sources and GoM is addressed in comments above.

Dr. Bauen: In order to ensure the appropriateness and effectiveness of the approach it is fundamental to ensure that it is integrated with other policies (e.g. environmental and agricultural) and that it is coherent with sectoral reforms. Greater links with other policies can enhance the effectiveness of the project.

Has the most appropriate and effective approach been used to reduce the costs of the technologies?

Dr. Bauen: If suitably designed, the tariff support and other financial mechanisms are an effective and appropriate approach to achieving cost reduction of renewable energy technologies. The programme proposed could lead to significant progress in the commercial viability of renewable electricity. In particular, the project could establish the commercial viability of wind electricity under favourable wind regimes. However, a better understanding is required of progress that would be made under the project with regard to the commercial viability of other renewable sources of electricity.

Was the potential market determined on the basis of RETs data and databases?

Dr. Bauen: Good information is available and has been used for understanding the cost evolution of wind electricity and calculating the financial viability of wind energy projects. It is also believed that a significant potential for wind electricity at relatively low costs exists in the Oaxaca region. However, little discussion is provided on the resource potential and cost of other renewable electricity sources. More information on these may be required to understand how they should be integrated in the project.

Has an evaluation of the demand-side mechanisms to support after-sales service been undertaken?

Dr. Bauen: The nature of the mechanisms proposed should ensure that servicing of the renewable energy projects is in the interest of the project developers. The project could be instrumental in developing a renewable energy service industry in Mexico. It is strongly encouraged that technical assistance activities, such as raising awareness in relevant domestic and international industries and development of relevant skills locally, and other support measures be aimed at its development.

Adequacy of the financing mechanism?

Dr. Bauen: The tariff support mechanism appears to be a suitable financing mechanism in the Mexican context. It should be aimed at stimulating a variety of renewable energy sources, and the establishment of different tariff bands for different renewable electricity technologies should be considered. Other financial mechanisms are discussed, such as accelerated depreciation. However, a more comprehensive discussion of other financial mechanisms may be required to understand what measures are needed to promote different renewable electricity sources. For example, capital grants may be useful in some cases and have been a common component of a successful mix of measures promoting renewable electricity in Europe. The financing mechanism proposed should be successful in creating satisfactory leverage of GEF funds and leading renewables along the commercialisation path. The GoM and the Bank may wish to make use of other programmes to exploit synergies in developing a Mexican renewable energy industry. The potential evolution of power sector reforms in Mexico needs to be carefully considered as it may affect the viability of the project.

WB Response: Renewable energy technologies quite often face the barrier of perception that they cannot deliver sufficient output. Capital grants were considered during project development but where deemed an inferior approach, because they reduce the incentives to project developers to properly address technical and operational risks during project design and to maintain high operational standards once the projects are commissioned. By conditioning the payments on electricity output, the project tackles the operational sustainability issue of renewable energy projects, as well as the notion that not enough energy is actually delivered.

Comments on the design the project?

Dr. Bauen: The project is shaping up well with an understanding of the key issues to be addressed well underway. There appears to be suitable involvement of key Mexican organisations, and their commitment is crucial.
The planning of the project phases could benefit from greater clarity and a more detailed project plan would be desirable. The establishment of clearer milestones may also be desirable. The question of programme duration, in particular with regard to the promotion of a variety of renewable electricity sources, also requires further attention.

WB Response: Further details of project design will be developed during the further preparation and appraisal stages as described above (see first comment and response). The project's duration and support for other renewable technologies however, is unavoidably defined by resource constraints. While it is highly desirable to support all renewable energy technologies, there is a still limited funding envelope available at this stage both from the GEF, as well as from complementary renewable energy support sources. Current costs and potential for cost reductions of the technologies will reveal an appropriate supply curve during the project's bidding rounds. The project does not preclude, or favor, in the long-run any technology in particular; it relies on competition to provide the best solutions at different points over time. Nevertheless, the technical assistance components of this project will provide an environment that would benefit future additional initiatives to support specific technologies should the energy policy strategy of the country point to that direction, and additional funding from other sources become available.

Will a process be put in place to monitor the project?

Dr. Bauen: A project monitoring process is envisaged, but little details are provided. Success measures should be put in place and applied regularly.

WB Response: The project has the monitoring function embedded in the design. Firstly, distinct auction rounds, and program phases, will provide interim information on the progress of the mechanism; actual payments are tied to energy outputs, therefore key project indicators will be recorded automatically during project implementation.

Secondly, different components related to technical assistance will have to produce required deliverables for the actual mechanism to take place, which will again be monitored essentially during project implementation. Finally, the detailed form of the monitoring plan and assignment of specific institutional responsibilities will be fully developed during the further project preparation and appraisal stages in conformity with World Bank and GEF guidelines and best practices.

Is the barrier removal supported by an underlying policy framework?

Dr. Bauen: The GoM has set out a strategy aimed at a greater promotion of renewable energy. The project proposed will be an integral part of the strategy and appears to have the support of the key institutional organisations.

Identification of global environmental benefits

Dr. Bauen: The project has a very large potential for greenhouse gas benefits through the realisation of renewable electricity projects and through the enhancement of their commercial viability and development of a renewable electricity market in Mexico. The CO2 emissions reduction calculations could benefit from greater detail (simple calculations I have performed lead to different results).

WB Response: Estimates of CO2 emissions may be reconciled once it is noted that USAID/CENACE/ATPAE (association of Mexican energy technical professionals) studies have estimated an avoided CO2 emissions factor of about 0.6-0.7 g/kWh for the Mexican grid. Remaining differences relate to differing assumptions on emissions horizon (e.g. planning horizon vs. physical project life) and capacity factors, etc.

Fit within the context of the goals of the GEF

Dr. Bauen: The project has a perfect fit with GEF Operational Policy 6.

Regional context and replicability of the project

Dr. Bauen: The project is possibly replicable in countries with a similar electricity market structure to that of Mexico, i.e. electricity markets dominated by vertically integrated utilities, at the early stage of liberalisation, and with a weak policy and regulatory framework for renewable energy promotion, and in countries at more advanced levels of liberalisation. The potential for replication is large. Technical assistance developed under this project could also be readily transferred to other projects.

Sustainability of the project

Dr. Bauen: The project is potentially sustainable. It tackles policy and regulatory issues that are fundamental to the promotion of renewable electricity. It aims at implementing financial mechanisms that will improve the commercial viability of a variety of renewable electricity sources and initiate a renewable electricity market in Mexico. The project will also stimulate some competition among renewable electricity sources. In order to prove sustainable the project will need to prove that that it is generating growth and cost reductions related to renewable electricity in Mexico. In particular, the project needs to demonstrate that the approach is promoting diversity in renewable electricity supply. The project needs to set targets in relation to key policy and regulatory measures needed to be adopted during duration of the project to reduce the technical barriers to renewable electricity penetration. The establishment of alternative funds and the modalities of their funding need to be addressed to complement GEF funds or ensure programme continuity. This should be done in the context of potential power sector reforms and development of other market based approaches for the promotion of renewable electricity.

WB Response: We agree. In terms of promoting diversity in generation sources, the reason for the Phase I focus on wind is that it is a technology that could relatively rapidly contribute to a level of RE generation that would be viewed by CFE as measurable and provide a level of system-based diversification. In a system currently operating about 36,000 MW (and anticipating the addition of as much as another 30,000 MW over the next decade), capacity additions of less than 100-200 MW would typically only be recognized at the 'background noise' level. Prospects of developing a significant portion of the 3,000 MW of high quality wind resources will, on the other hand, attract CFE's attention.

Spreading RE development efforts over a wide number of technologies in the early stages of the program, while technically proving broader 'diversity' in sources, would tend to dilute the other program objectives such as continuous cost reduction. While significant small-hydro development potential exists, cost reduction prospects are much lower, and it is expected that the primary benefit for this technology will be in establishing a clear policy and contractual environment.

Further, diversification of funds for program continuity is indeed of high importance, and additional sources will be sought throughout the project. GEF's early entry can greatly faciliate the creation of a credible operating program structure and a track record of results that will be indepensable in attracting additional co-financing. We acknowledge the importance of fitting project efforts into the context of potential power sector reforms; specifically, we believe that by highlighting benefits of diversification, the project will make a significant contribution to dialogue and action on larger reforms.

Linkages to other focal areas

Dr. Bauen: Given the potential broad range of renewable energy activities that may be covered by the proposed project, it is difficult to assess the exact linkages to other focal areas. It is encouraged that technical assistance be directed to the development and dissemination of guidelines for good practice, environmental in particular, in the development of renewable electricity projects.

WB Response: The development of environmental guidelines specific to renewable energy projects is a GoM commitment under the Environmental SAL.

Linkages to other programmes and action plans at the regional / subregional level

Dr. Bauen: The project proposal draws well on relevant development agency projects and international policies aimed at the promotion of renewable energy. This approach should be pursued in the project developments stages. A specific link is also made to the Programmatic Environment Structural Adjustment Fund (EnvSAL II).

Other beneficial or damaging environmental effects

Dr. Bauen: Not possible to comment

WB Response: Specific quantification of local/regional environmental benefits (reductions in SOx, NOx and particulates), and their valuation will be performed during the course of further project preparation and appraisal.

Degree of involvement of stakeholders in the project

Dr. Bauen: Key institutional stakeholders are involved in the project. Activities are being pursued to involve local actors that may be affected by renewable electricity projects. Some NGO and renewable energy industry involvement of has been achieved by workshops. A more active involvement of renewable energy industry players is desirable to understand the barriers they are facing. Also, a more active discussion with NGOs, such as WWF, that are launching major campaigns aimed at the promotion of renewable energy with energy companies and the public may be desirable.

Capacity building aspects

Dr. Bauen: Strong technical assistance is envisaged during phase 1 of the project, mainly to assist in designing and implementing financial mechanisms and policy and regulatory aspects. The establishment of a ‘one-stop shop’ for assistance to renewable electricity project developers is an important aspect of capacity building.

Innovativeness of the project

Dr. Bauen: The project is innovative in its approach providing assistance with policy and regulatory measures and in designing and funding financial mechanisms.

Additional GEF Annex 4: Financial Analysis
MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

This section presents an indicative analysis of financial aspects related to specific renewable energy projects that will receive financial support under the financial mechanism. The case of a wind farm is used as a detailed worked example based on information and appropriate assumptions applicable to Mexico. The project is assumed to be located in one of the good wind sites of the country which will provide a net effective capacity factor for the plant of about 40%.

For the financial analysis a spreadsheet model was constructed in real U.S. dollar values. In this analysis, project income is derived by two sources: electricity payments over the project's lifetime (20 years), and tariff subsidy payments over the first five years. Financial outflows relate to operating expenses, royalty payments for land use, insurance costs and taxes. Actual figures and other general assumptions used for the financial model are summarized in Table 1 below.

The project's capital costs are financed using a standard limited recourse financing arrangement likely to take place for this type of projects in Mexico at 30% equity and 70% debt financing. For the debt portion of financing plan an interest rate of 8% is assumed (in February 2003 this would correspond to LIBOR plus more than 6%, which should be comfortably sufficient for Mexico and the project's risk profile). Debt service coverage ratios are maintained at around 1.2 – 1.3 during the loan term.

To evaluate the financial viability of the project, net present values (NPV) of the project's (financial) rate of return figures are calculated for a range of discount rates (8-12%). In all of the cases the NPV is positive. The comparative parameter of the project's economic rate of return (ERR) for a range of discount rates is also calculated and presented in Table 2 below[1] on *General Assumptions and Parameters* . Return on equity (ROE) figures were also calculated and presented in Table 2 as well. The full cash-flow analysis for the project is presented in Table 3.

The above financial analysis has been extended for the second phase of the project adjusting for a "learning rate" that results in capital cost reductions for future projects. Key general assumptions regarding project characteristics and financing arrangements are as above and are summarized in Table 4. Results for the same type of analysis over the future stages of the project are presented in Table 5. As capital costs are reduced the projects are becoming increasingly attractive in financial terms which point to likely sustainable results. The final Table 6, and the accompanying Graph 1 show expected annual and cumulative outflows for the tariff support of the financing mechanism.

Financial Analysis Table 1: General Assumptions and Parameters

GENERAL Assumptions		
Rated Capacity	100	MW
Net Capacity Factor	40%	%
Start Year	2004	Calendar Year
Project Lifetime	20	Years
Capital Cost	$ 1,150	$/kW
Total Project Cost	$115,000,000	
Annual Electricity Produced	350,400,000	kWh
EXPENSES		
Operating		
Fixed Operation & Maintenance (O&M)	*1*	$/kW
Variable O&M	*0.0001*	$/kWh
Site Owner Royalty (% of revenues)	*1%*	%
TaxRate (% of Net Income)	*20%*	%
Insurance (% of Equipment and Balance of Station Costs)	*1%*	%
Other Costs	*0*	$/year
Financing		
	Loan1	*Loan2*
Amount	$ 80,500,000	$ -
Schedule Type	Level Mortgage	Level Mortgage
Debt Percentage (%)	70%	0
Interest Rate (%)	8%	6%
Reserve Fund	$ -	
Deposit Interest Rate (reserve fund) (%)	2.00%	
Term (years)	10	10
Equity	$ 34,500,000	
INCOME		
Electricity Price (c/kWh)	3.7	cents/kWh
Tariff Subsidy (c/kWh)	1	cents/kWh
Subsidy Term	5	Years
DepreciationBase	7	Years

Financial Analysis Table 2: Results

IRR for NPV Calculations	8%	9%	10%	11%	12%
ERR	12.0%				
EconomicNPV	$33,191,411	$23,166,636	$14,366,369	$6,620,853	($213,331)
ROE	13.1%				
Project NPV	$70,653,943	$59,457,754	$49,478,587	$40,559,789	$32,567,862
Project IRR	18%				
Total Subsidies Paid	$ 17,520,000				

Financial Analysis Table 3a: Cash-Flow

Year	0	1	2	3	4	5	6	7	8
Calendar Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Revenues									
Energy Payment		$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800
Tafiff Subsidy Payment		$ 3,504,000	$ 3,504,000	$ 3,504,000	$ 3,504,000	$ 3,504,000	$ -	$ -	$ -
Interest on Reserves		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues		$ 16,468,800	$ 16,468,800	$ 16,468,800	$ 16,468,800	$ 16,468,800	$ 12,964,800	$ 12,964,800	$ 12,964,800
Operating Costs									
Fixed O&M		$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
Variable O&M		$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040
Site Owner Royalty		$ 164,688	$ 164,688	$ 164,688	$ 164,688	$ 164,688	$ 129,648	$ 129,648	$ 129,648
Insurance		$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000
Other Costs		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operating Costs		$ 1,104,728	$ 1,104,728	$ 1,104,728	$ 1,104,728	$ 1,104,728	$ 1,069,688	$ 1,069,688	$ 1,069,688
Operating Income	$ (115,000,000)	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072
Other Expenses									
Interest on Loan		$6,440,000	$5,995,450	$5,515,336	$4,996,813	$4,436,808	$3,832,003	$3,178,813	$2,473,369
Depreciation Percentage		14%	14%	14%	14%	14%	14%	14%	0%
Depreciation		$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ -
Total Other Expenses		$17,940,000	$17,495,450	$17,015,336	$16,496,813	$15,936,808	$15,332,003	$14,678,814	$2,473,369
Before-Tax Profits		($2,575,928)	($2,131,378)	($1,651,264)	($1,132,741)	($572,736)	$32,069	$685,258	$12,890,703
Income Tax Paid		$0	$0	$0	$0	$0	$6,414	$137,052	$2,578,141
After-Tax Profits		($2,575,928)	($2,131,378)	($1,651,264)	($1,132,741)	($572,736)	$25,655	$548,207	$10,312,563
Additions									
Depreciation		$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ -
Released from Reserve		0	0	0	0	0	0	0	0
Total Additions		$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ 11,500,000	$ -
Subtractions									
Loan Principal		($5,556,874)	($6,001,424)	($6,481,538)	($7,000,061)	($7,560,066)	($8,164,871)	($8,818,060)	($9,523,505)
Total Subtractions		($5,556,874)	($6,001,424)	($6,481,538)	($7,000,061)	($7,560,066)	($8,164,871)	($8,818,060)	($9,523,505)
Before-Tax Cash Flow		$3,367,198	$3,367,198	$3,367,198	$3,367,198	$3,367,198	$3,367,198	$3,367,198	$3,367,198
Taxes Payable (Benefit Received)		$0	$0	$0	$0	$0	$6,414	$137,052	$2,578,141
After-Tax Cash Flow	$ (34,500,000)	$3,367,198	$3,367,198	$3,367,198	$3,367,198	$3,367,198	$3,360,784	$3,230,146	$789,057
Cumulative After-Tax Cash Flow		$3,367,198	$6,734,396	$10,101,594	$13,468,792	$16,835,990	$20,196,774	$23,426,921	$24,215,978
ProjectCashFlow	$ (115,000,000)	$ 26,864,072	$ 26,864,072	$ 26,864,072	$ 26,864,072	$ 26,864,072	$ 26,857,658	$ 26,727,020	$ 12,785,931
Loan1									
Beginning Balance		$ 80,500,000	$74,943,126	$68,941,702	$62,460,165	$55,460,104	$47,900,039	$39,735,168	$30,917,107
Interest		($6,440,000)	($5,995,450)	($5,515,336)	($4,996,813)	($4,436,808)	($3,832,003)	($3,178,813)	($2,473,369)
Principal		($5,556,874)	($6,001,424)	($6,481,538)	($7,000,061)	($7,560,066)	($8,164,871)	($8,818,060)	($9,523,505)
Loan Total		($11,996,874)	($11,996,874)	($11,996,874)	($11,996,874)	($11,996,874)	($11,996,874)	($11,996,874)	($11,996,874)
Loan2									
Beginning Balance		$ -	$0	$0	$0	$0	$0	$0	$0
Interest		$0	$0	$0	$0	$0	$0	$0	$0
Principal		$0	$0	$0	$0	$0	$0	$0	$0
Loan Total		$0	$0	$0	$0	$0	$0	$0	$0
Debt Service Coverage Ratio (DSCR)		1.28	1.28	1.28	1.28	1.28	1.28	1.27	1.07

Financial Analysis Table 3b: Cash-Flow

9	10	11	12	13	14	15	16	17	18	19	20
2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800	$ 12,964,800
$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040	$ 35,040
$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648	$ 129,648
$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000	$ 805,000
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688	$ 1,069,688
$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072	$ 15,364,072
$1,711,488	$888,657	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$1,711,488	$888,657	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$13,652,584	$14,475,415	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072
$2,730,517	$2,895,083	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814
$10,922,067	$11,580,332	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
0	0	0	0	0	0	0	0	0	0	0	0
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
($10,285,386)	($11,108,217)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
($10,285,386)	($11,108,217)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$3,367,198	$3,367,198	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072	$15,364,072
$2,730,517	$2,895,083	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814	$3,072,814
$636,681	$472,115	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258	$12,291,258
$24,852,660	$25,324,775	$37,616,032	$49,907,290	$62,198,548	$74,489,805	$86,781,063	$99,072,320	$111,363,578	$123,654,836	$135,946,093	$148,237,351
$ 12,633,555	$ 12,468,989	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258	$ 12,291,258
$21,393,602	$11,108,217	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
($1,711,488)	($888,657)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
($10,285,386)	($11,108,217)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
($11,996,874)	($11,996,874)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.05	1.04	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Financial Analysis Table 4: Key Assumptions for project phases

PROJECT INPUT PARAMETERS					
	Phase 1	Phase 2a	Phase 2b	Phase 2c	**Total**
Capacity Installed (MW)	100	200	400	800	**1500**
Electricity Price (c/kWh)	3.7	4.1	4.3	4.5	
Tariff Subsidy (c/kWh)	1	0.6	0.3	0	
Start Year	2004	2006	2008	2010	
Learning Rate (%)	15%				
Capital Cost ($/kW)	$ 1,150	$ 978	$ 831	$ 706	

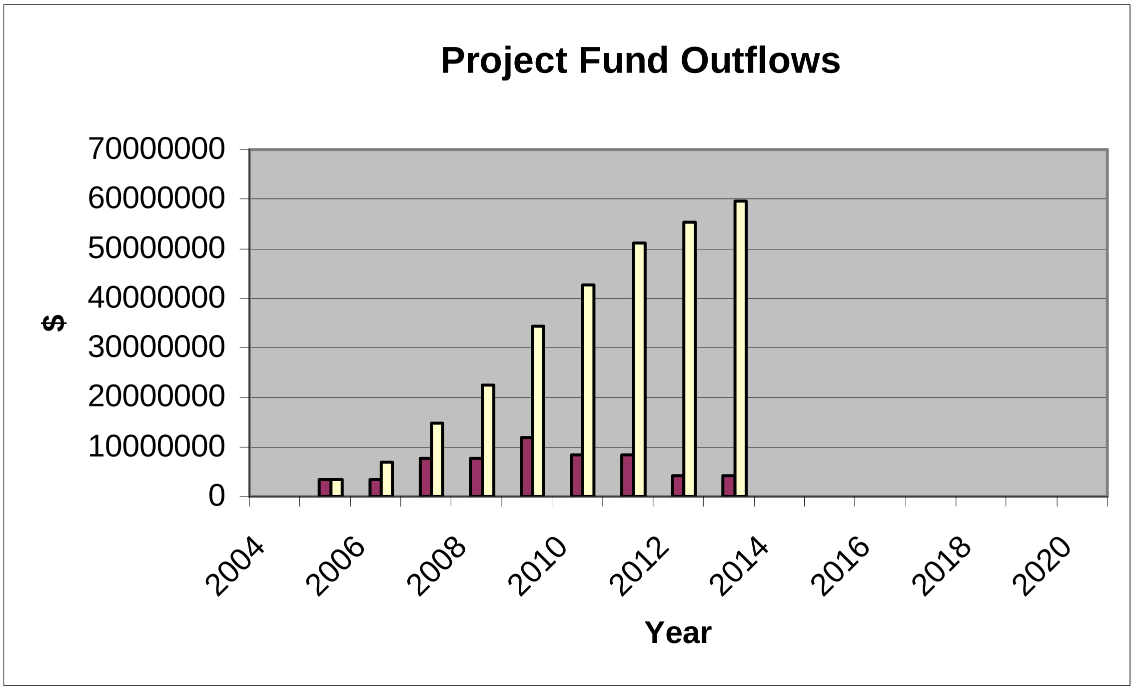
Financial Analysis Table 5: Key Results for project phases

PROJECT OUTPUT PARAMETERS					
TotalSubsidiesPaid	$ 17,520,000	$ 21,024,000	$ 21,024,000	$ -	**$ 59,568,000**
ERR	12.0%	13.7%	17.0%	20.7%	
EconomicNPV(@8%)	$33,191,411	$78,069,147	$224,015,319	$566,373,345	
EconomicNPV(@9%)	$23,166,636	$59,999,625	$185,631,653	$485,354,425	
EconomicNPV(@10%)	$14,366,369	$44,092,989	$151,814,804	$413,938,557	
EconomicNPV(@11%)	$6,620,853	$30,051,513	$121,935,292	$350,800,157	
EconomicNPV(@12%)	($213,331)	$17,623,534	$95,461,132	$294,819,164	
ROE	13.2%	24.1%	21.1%	30.7%	
Project IRR (FIRR)	19.4%	21.3%	24.6%	30.2%	
Project NPV (@8%)	$75,912,637	$148,120,912	$333,052,553	$738,697,474	
Project NPV (@9%)	$65,089,667	$128,794,354	$293,590,461	$660,589,970	
Project NPV (@10%)	$55,417,708	$111,498,886	$258,328,502	$590,879,730	
Project NPV (@11%)	$46,748,555	$95,974,280	$226,722,484	$528,459,199	
Project NPV (@12%)	$38,956,106	$81,999,020	$198,309,688	$472,388,925	

Financial Analysis Table 6: Overall estimated Project Outflows

Year	**SubsidyOutflows**		**CumulativeSubsidyOutflows**	
2004	$ -		$ -	
2005	$ 3,504,000		$ 3,504,000	
2006	$ 3,504,000		$ 7,008,000	
2007	$ 7,708,800		$ 14,716,800	
2008	$ 7,708,800		$ 22,425,600	
2009	$ 11,913,600		$ 34,339,200	
2010	$ 8,409,600		$ 42,748,800	
2011	$ 8,409,600		$ 51,158,400	
2012	$ 4,204,800		$ 55,363,200	
2013	$ 4,204,800		$ 59,568,000	
2014	$ -		$ -	
2015	$ -		$ -	
2016	$ -		$ -	
2017	$ -		$ -	
2018	$ -		$ -	
2019	$ -		$ -	
2020	$ -		$ -	
Total	$ 59,568,000			

Financial Analysis Graph 1: Overall estimated Project Outflows



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[1] It should be emphasized that for this model the ERR is defined narrowly because the only economic benefit it encompasses is the taxes; it does not account for numerous other economic benefits (avoided fuel costs at shadow values, land royalties, environmental externalities, employment, etc).

Additional GEF Annex 5: Cost Reduction and Sustainability in Wind Energy
MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

<u>Summary:</u> *Capital costs for wind power projects in Mexico are likely to be around* ***$1000/MW in 2005-2006****, and around* ***$720/MW by 2009****. In nominal figures, assuming an inflation rate of about 2%, these would be* ***$1000 in 2005-2006*** *and* ***$750 in 2009****. Actual costs will be a function of the effective learning rate of the local wind energy industry, and how fast primarily the local but also the international wind energy market will grow. Under such capital costs at the* best *wind sites in Mexico it is reasonable to anticipate wholesale electricity prices from wind around 4.0 US¢/kWh by 2005 and 3.5 US¢/kWh by 2009.*

Introduction

This background note aims to provide an estimate for wind energy costs in Mexico for the proposed partnership project between Mexico and the World Bank / GEF. The project is proposing to provide a financing mechanism for tariff support for electricity produced from renewable resources and wind in particular. For the purposes of budgeting for this financing mechanism the expected cost of electricity produced from renewables can provide a benchmark to assist in estimating the total cost of the project.

The analysis presented below is based on the thesis that costs of electricity generation from wind energy will decline with increasing installed capacity. This approach is based on the theory of "learning-by-doing" which is well presented in the earlier economic bibliography (Arrow 1962; Argote and Epple 1990; Solow 1997) and has been empirically verified extensively for a variety of manufacturing industries, as well as the energy and renewable energy sector (Watanabe 1995; IEA 2000; Organisation for Economic Co-operation and Development. and International Energy Agency. 2000; McDonald and Schrattenholzer 2001).

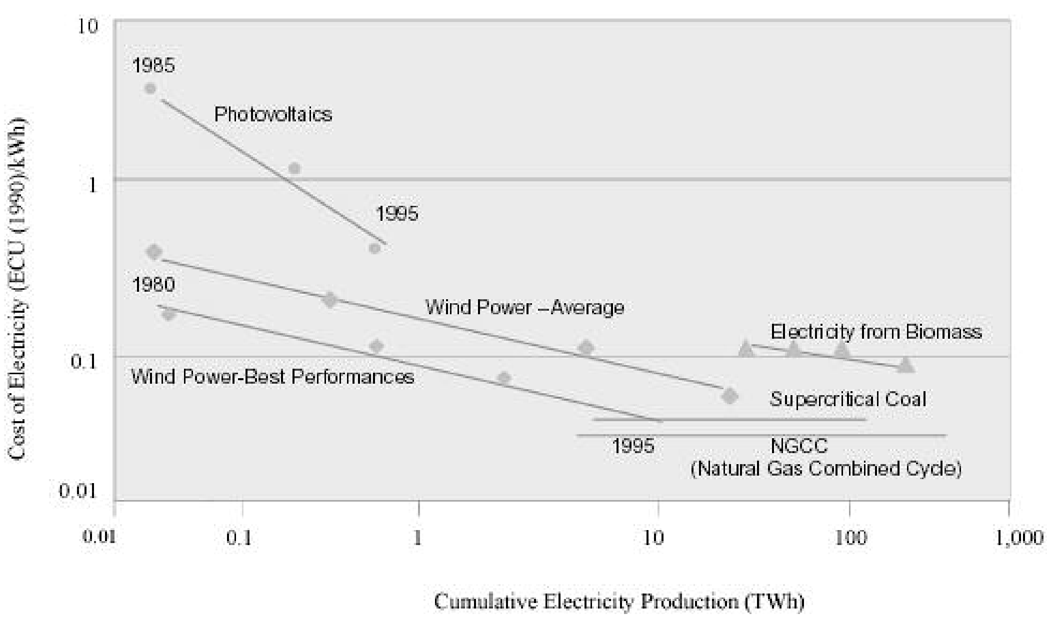

Figure 1: Experience curves for various electricity technologies (IEA 2000)

Costs of wind energy technologies have demonstrated a significant decline over the last two decades. Because of the success of wind energy technologies in producing electricity at increasingly competitive prices with fossil fuels a number of surveys explored experience curves for wind energy technology. These studies invariably demonstrate the effect of the learning-by-doing process, where increased installed capacity of wind turbines is followed by a reduction in installation costs. Where the market conditions are appropriate, these cost reductions have been followed by a drop in final electricity prices. While all of the studies conclude that cost reductions are taking place there are however differences on how fast energy prices have been reduced, and what have been the important factors that influenced the downward cost trend. (Neij 1997; Neij 1999; Junginger 2000).

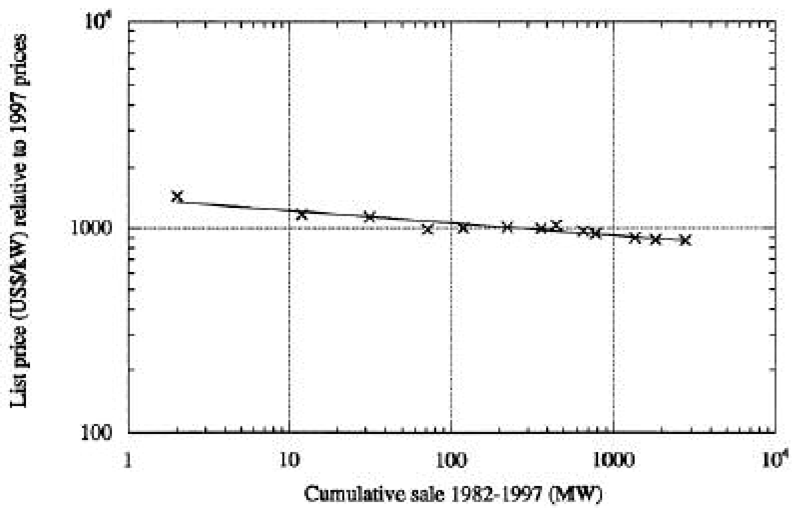

Figure 2: Experience curve for wind turbines produced by four major producers in Denmark. The progress ratio is 96%. Adopted from Neij (Neij 1999)

Costs for final electricity produced using wind energy are dependent on: (i) the capital cost of the project; (ii) the technology used (turbine efficiency); (iii) the financing arrangements; (iv) the available wind resource (capacity factor of the wind power plant); (v) the operation and maintenance expenses, and (vi) the lifetime of the project.

Learning effects are expected to influence all of the parameters related to costs of electricity from wind technology, however due to the capital intensive nature of wind energy projects this note examines in particular expectations regarding the capital costs of such projects. More specifically, the focus is on the expected cost per MW of wind turbines which (based on international experience) is estimated to comprise about 75-80% of the capital costs of wind power projects.[1] Forecasts regarding these capital costs can then be used as a main inputs to model levelized costs of electricity produced using wind. Some indicative results for final electricity costs are presented in the last section of this note and are compared with other published results at the international level.

The experience model in Mexico

The basic theory of learning-by-doing and experience curves is likely to appear in Mexico adjusted for the particular characteristics of the local market. Applying the theoretical models in the case of Mexico, cost reductions can be assumed to be driven by the combination of: (i) experience obtained with increased installed capacity in Mexico, and (ii) manufacturing and technology improvements in wind energy technology internationally. Initial projects will be more expensive than the average international wind energy projects as initial prices from the wind turbine manufacturing industry are likely to be higher. This is normal industrial behavior for companies that enter an uncertain new market, with unknown growth prospects. Furthermore, capital costs for initial projects are often higher due to the costs of specialized engineers and technicians (‘soft’ costs) needed at the first stages, and more expensive financing costs because of early risk perceptions. However, as companies become more experienced in the development and construction of projects, and the manufacturing industry perceives a growing and competitive market for wind energy in the Mexico, costs of wind energy projects are bound to converge, or even surpass, international levels. The emergence of local manufacturing will likely result in further reductions of the capital costs. A similar theoretical model has been proposed by the IEA to analyze the USA market as presented below:

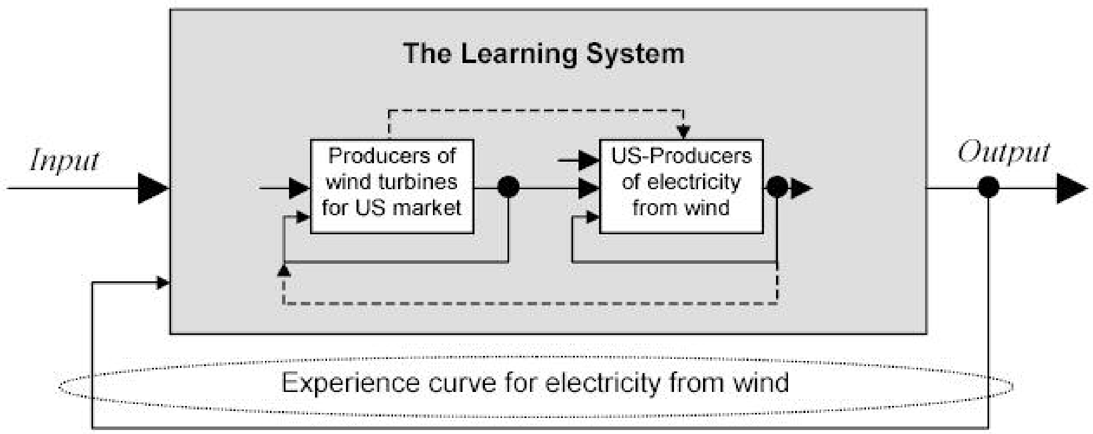

Figure 3: Learning System for Production of Electricity from Wind in the USA. The system contains two sub-systems, one producing wind turbines and one producing electricity from wind using wind turbines. Solid lines represent information feed-forward from one subsystem to another and information feed-backward within a (sub)system. Dashed lines represent information feed-forward or feed-backward between the two subsystems. Adopted from (IEA 2000)

According to the theory

An experience curve can be expressed as:

C(Cum) = a * Cum^ b (1)

log (C(Cum)) = log a + b log Cum (2)

where:

C: Cost per unit
Cum : Cumulative (unit) production
a: learning cost at Cum=1
b: learning index (constant)
Cum : Initial cumulative unit production (at t=0)
C0 : Initial specific cost (at t=0), equals a*Cum0^b

This formula implies a reduction of prices with an increase in installed capacity. In addition, from the learning index, the progress ratio and the learning rate can be calculated:

$PR = 2^b$ (3)
$LR = 1 - 2^b$ (4)

PR : Progress ratio
LR: Learning rate
N: The (assumed) maximum number of times the cumulative production will double

Both the progress ratio and the learning rate are parameters that express the rate at which costs decline each time the cumulative production doubles. For example, a learning index of -0.322 results in a progress ratio of 0.8 (= 80%) which in turn equals a learning rate of 0.2 (20%), and thus a 20% cost decrease for each doubling of the cumulative capacity.

In order to obtain an estimate of projected capital costs for Mexico, the above formula (1) will be applied for Mexico, and internationally. In the medium term international and local prices will eventually meet; the point of convergence will be a function of time and installed capacity. Current costs for installed wind power in Mexico are around $1200/kW for project sizes of about 40-50MW (personal communications with wind project developers). In contrast, costs for wind park developments in the US and in Europe have been quoted as low as $800/kW for projects of 100MW or more. Nevertheless, experts still use the rule of thumb of $1,000/kW; it should be noted however that this round figure has been quoted for projects since about 1995, which adjusted for inflation results in about a 15%-20% reduction in real figures since then.

International Wind Energy Price Estimation

Projections for the global wind power market are still very bullish. The sector has been the fastest growing electricity production technology for the last few years at annual rates of more than 30%, and annual sales of about $5 billion. Most experts anticipate this high level of growth to be maintained almost to the end of this decade. Global cumulative capacity installed is expected to double by 2005-2006, and should these high growth levels continue, it might double again by 2008-2009 (BTM Consult ApS 2001; Flowers 2002; Flowers and Dougherty 2002).

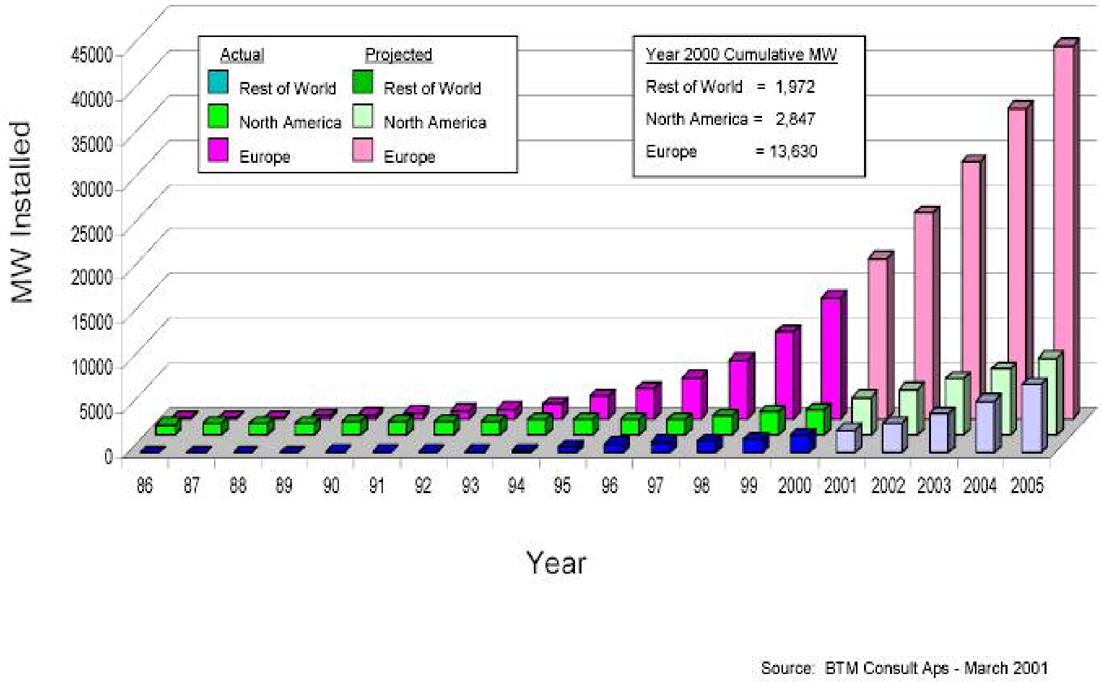

Figure 4: Installed and projected cumulative capacity of wind energy (BTM Consult ApS 2001)

World Market Growth rates 1996-2001

Year:	Installed MW	Increase %	Cumulative MW	Increase %
1996	1,292		6,070	
1997	1,568	21%	7,636	26%
1998	2,597	66%	10,153	33%
1999	3,922	51%	13,932	37%
2000	4,495	15%	18,449	32%
2001	6,824	52%	24,927	35%
Average growth - 5 years		**39.5%**		**32.6%**

Table 1: Global installed capacity of wind energy (BTM Consult ApS 2002)

Learning rates observed in the last five years show a reduction of about 18% in prices for every doubling of capacity, which if it continues at the same pace should bring global prices at an average of **$820/kW in 2005-2006** and **$650/kW in 2008-2009.** These figures are present day (2002) equivalents while adjusting for a projected inflation of 2% international nominal prices would be **$890 in 2005-2006** and **$750 in 2008-2009**. It should be mentioned that rates of learning for the wind energy industry have not been clearly established and validated, but the *range* of the effective learning rate quoted by a variety of authors ranges from a low range of 5% to a high range of 20% and in some cases to 30% (Junginger

2000). Other published study estimates using different evaluation methods indicate installed capital project costs of **$720/kW by 2005** and **$675/kW by 2010** (DeMeo and Galdo 1997).

It is important to introduce a number of caveats and assumptions that apply to the above estimates. High rates of growth have been possible due to supporting energy technology policies in Europe and the USA, which either guarantee payments at fixed relatively favorable tariffs for electricity produced from wind, and/or promote renewable electricity supply with other mechanisms (tax credits, green certificates, renewable portfolio standards, etc). Uncertainties about such policies may have significant effects in slowing the global markets. Unresolved issues about the production tax credit that has been a strong incentive for wind energy development in America for instance, have significantly slowed the rate of development in 2002 (Vestas 2002). Still most of the expected growth is expected to take place in Europe which seems to be supporting wind development at an unrelenting pace. The expected entry into force of the Kyoto Protocol should reduce some of the political uncertainties regarding the favorable treatment of renewable energy.

In terms of technology, a significant force pushing down the costs of wind energy produced electricity is the steady increase in the size of the wind turbines, combined with electromechanical breakthroughs and the introduction of new materials. Due to economies of scale in energy production and project design and implementation this will almost certainly result in further reductions in the final cost of electricity produced (EWEA 1997; Redlinger, Andersen et al. 2002).

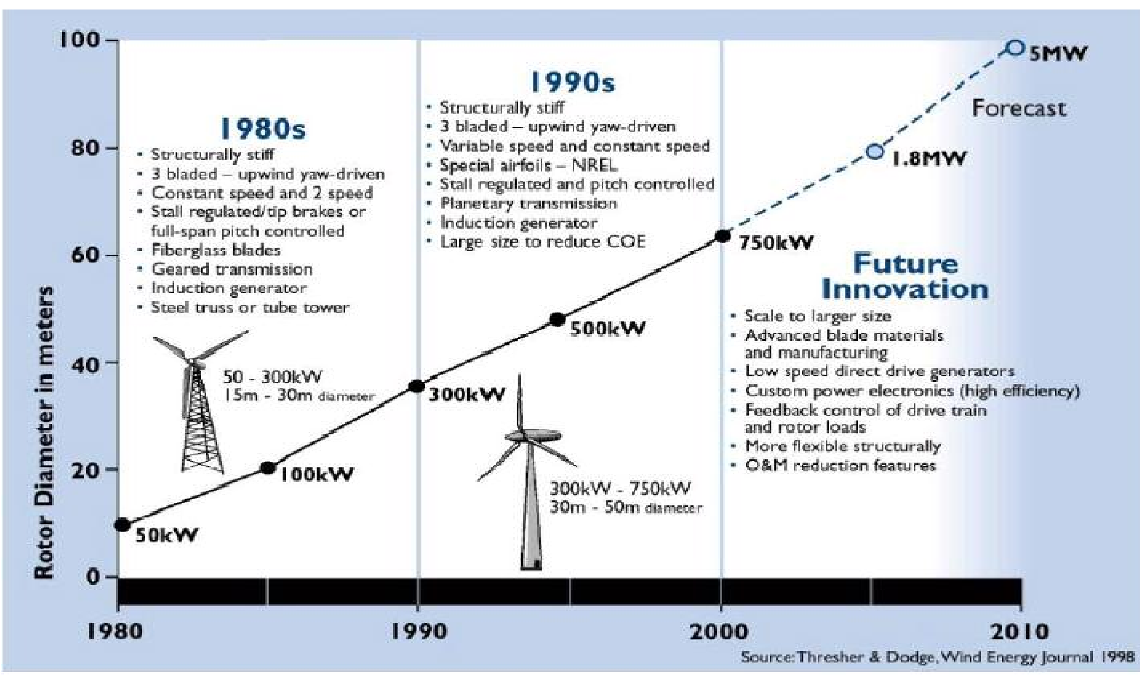

Figure 5: Note that this 1998 diagram is already dated. Wind turbine manufacturing has developed faster than this prediction and wind turbines of 1.8MW were already shipping commercially in 2002, while 3.6 to 5 MW prototypes where already being tested on sites.

Estimation for wind energy prices in Mexico

There is very limited wind power installed in Mexico at present, therefore costs for the installation of wind power plants can only be based on personal communications with project developers who are expected to proceed with the construction of projects within 2003. According to them total capital project costs are about $1,200/MW. Again, it is claimed that about 75% of this cost is related to the cost of wind turbines. An important factor for consideration is the size of the projects which for the initial projects is reported to be about 30-50 MW.

Actual cost reductions for wind energy prices in Mexico will be a function of how fast the market grows, and the expected learning rate for the local wind energy industry. A model assuming an initial capital cost of $1,200/MW, an average price reduction of 20% for every doubling of capacity and an annual growth rate of 30% would result in costs of **$1,000/MW in 2005-2006**, and around **$720/MW by 2009**. In nominal figures assuming an inflation rate of about 2%, these would be **$1,000 in 2005-2006** and **$750 in 2009**.

An indicative comparison of international and local prices can be found below.

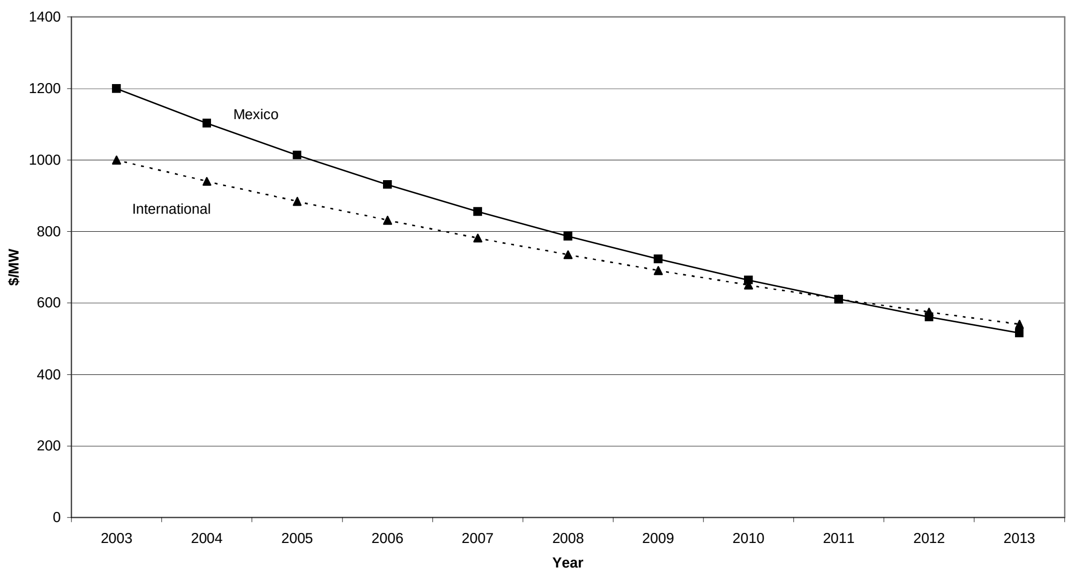

Figure 6: Comparative experience curves for wind energy prices in Mexico and internationally. Assumptions:

Rate of Growth of Installed Capacity Mexico	*30%*
Learning rate Mexico	*20%*
Rate of Growth of Installed Capacity Global	*30%*
Learning rate Internationally	*15%*

Review of projected estimates for electricity costs from wind energy

Final electricity costs from wind energy can only be calculated on a project-by-project basis taking into account specific characteristics of the project. This section presents some results based on the previous section and compares them with other studies. In addition, some 'rules-of-thumb' as quoted by experts in the literature are outlined as useful inputs to estimate levelized electricity costs.

Accumulated experience in producing and using wind turbines has not only resulted in a reduction in the cost of wind turbines, but also improved wind capture, and reduced operating and maintenance (O&M)

costs. This, in turn, has resulted in a reduction in the cost of wind generated electricity. In Denmark, the average cost of wind-generated electricity was reduced by 60% in the period 1979–1994. Moreover, wind turbines installed at windy sites were already generating electricity at a cost lower than 4.5 US¢/kWh in 1998 (quoted in (Neij 1999). New projects (2002) were *selling* electricity in the USA at 4.0 US¢/kWh, without any price subsidy (Flowers 2002). Moreover, Mexican project developers seem to be ready to sell electricity at 4.5 US¢/kWh today (personal communications).

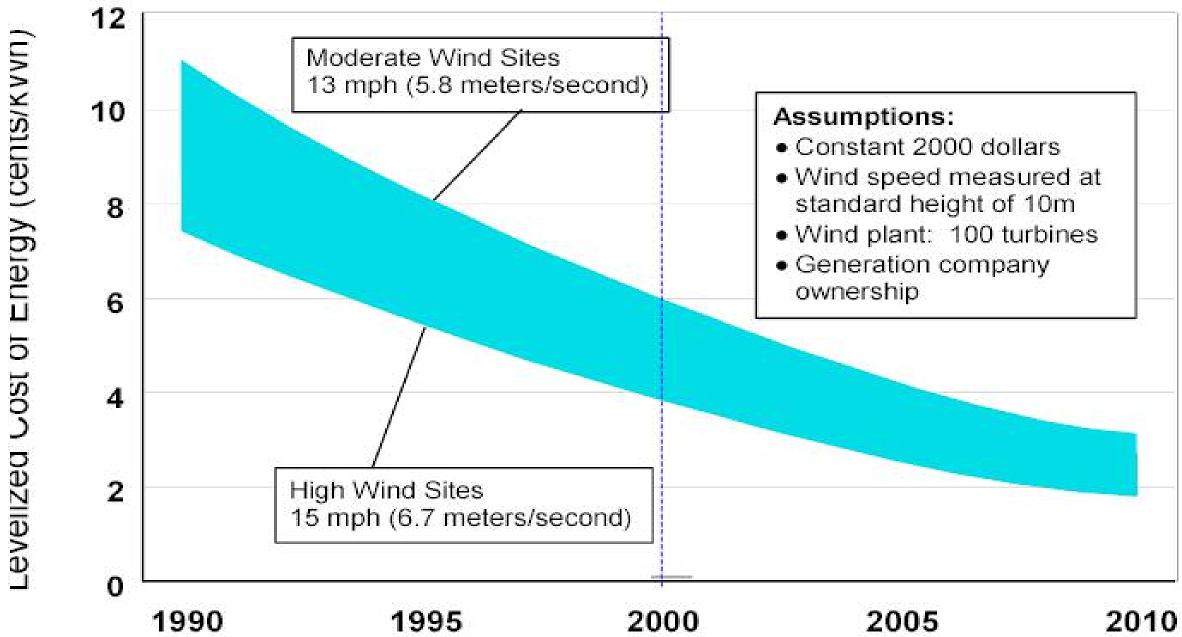

Figure 7: Wind resource is a critical factor for the final cost of electricity produced by wind energy (Flowers 2002).

As mentioned earlier the cost of the wind turbine accounts for approximately 75% of the total installation cost. Lifetime of wind turbines is estimated about 20 to 25 years. The O&M costs, including insurance, administration, service, and repair, have been shown to decrease with size and increase with age. The *average* O&M costs of installed wind turbines is approximately 2–3% of the investment cost per year. However, the O&M cost of a *new* wind turbine is estimated to be approximately 1% of the investment cost. The reduction in O&M costs will be the result of advanced control systems and a reduction in the insurance cost, which is likely to decrease due to experience in use of wind turbines. Moreover, the availability of wind power plants has recently reached 98% (EWEA 1997).

The site of wind projects has a decisive influence on the cost of the electricity generated. For example, an average 600 kW wind turbine (with a turbine cost of 820 US$/kW) will generate electricity at a calculated cost of 3.3 US¢/kWh in roughness class 0, 4.9 US¢/kWh in roughness class 1, 6.1 US¢/kWh in roughness class 2, and 8.7 US¢/kWh in roughness class 3 (using a discount rate of 6% and an economic lifetime of 20 years) (as quoted in (Neij 1999). It is estimated that an increase of average wind speed by 1 mph usually reflects about 0.5 US¢/kWh.
Assuming a robust rate of growth of installed capacity in Mexico, at the *best* wind sites in Mexico it is not unreasonable to anticipate electricity prices from wind around 4.0 US¢/kWh by 2005 and around 3.5 US¢/kWh by 2009. Such cost estimates are broadly in line with international experience and other studies (see Table 2). Nevertheless whether these prices will actually materialize will crucially dependent on the electricity system becoming able to absorb wind energy plants of a few hundred MW

and the development of projects that can capture economies of scale with capacities per project of at least 100 MW.

		Levelized COE *(constant 1997 cents/kWh)*				
Technology	Configuration	1997	2000	2010	2020	2030
Dispatchable Technologies						
Biomass	Direct-Fired	8.7	7.5	7.0	5.8	5.8
	Gasification-Based	7.3	6.7	6.1	5.4	5.0
Geothermal	Hydrothermal Flash	3.3	3.0	2.4	2.1	2.0
	Hydrothermal Binary	3.9	3.6	2.9	2.7	2.5
	Hot Dry Rock	10.9	10.1	8.3	6.5	5.3
Solar Thermal	Power Tower	--	13.6*	5.2	4.2	4.2
	Parabolic Trough	17.3	11.8	7.6	7.2	6.8
	Dish Engine -- Hybrid	--	17.9	6.1	5.5	5.2
Intermittent Technologies						
Photovoltaics	Utility-Scale Flat-Plate Thin Film	51.7	29.0	8.1	6.2	5.0
	Concentrators	49.1	24.4	9.4	6.5	5.3
	Utility-Owned Residential (Neighborhood)	37.0	29.7	17.0	10.2	6.2
Solar Thermal	Dish Engine (solar-only configuration)	134.3	26.8	7.2	6.4	5.9
Wind	Advanced Horizontal Axis Turbines					
	- Class 4 wind regime	6.4	4.3	3.1	2.9	2.8
	- Class 6 wind regime	5.0	3.4	2.5	2.4	2.3

* COE is only for the solar portion of the year 2000 hybrid plant configuration.

Table 2: Comparative future levelized costs for electricity production (DeMeo and Galdo 1997)

[1] This does not apply in general to off-shore projects. Such projects are out of the scope of this note; it is unlikely that off-shore wind energy projects will take place in Mexico in the next decade. While developments in Europe might improve the knowledge and experience for such projects Mexico appears to have excellent wind resources on-shore that are in general cheaper to exploit.

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Additional GEF Annex 6: Policies to Stimulate the Market for Renewable Electricity: International Experience and Lessons Learned
MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

Internationally, two main strategic approaches have been developed to stimulate renewable energy:

- incentives, mainly financial, that stimulate investment in renewables; and, more recently;
- mandated market policies to create a market demand for renewable electricity.

Supporting activities such as research and development, demonstration, standards, 'commercialization' and outreach are also commonly used to help encourage investment. Increasingly, incentive mechanisms and elements of mandated markets are being used as mutually reinforcing tools, and tailored to suit specific country circumstances, abilities, and objectives.

Financial incentives

Initial efforts to stimulate renewable energy development often included capital cost subsidies to support research and development and technology demonstrations, followed by more targeted incentives as the scale of installations has increased and the technologies have come down in prices. The range of tools has included capital cost subsidies, tax incentives (accelerated depreciation, investment tax credits, reduced VAT or sales taxes); subsidized interest rates for investment financing, and cost-shared demonstration programs and technology research and development. Tariff-based incentives have been used to directly incentivize renewables and/or as part of competitive tenders for tariff support. More recently, Green Pricing mechanisms have emerged in response to consumer desires and increasingly to Kyoto-based opportunities to utilize the carbon avoidance of RE technologies; some of these include tradable certificate mechanisms to facilitate allocation in the marketplace.

Where financial incentives have been used, they have usually been funded from government revenues (or revenues forgone). Such incentives must be carefully designed if they are to be well-targeted, cost-effective and not distort investment decisions. Predicting the total costs of a financial incentive and how much RE capacity will result is difficult. In order to stimulate and maintain a stable RE industry, financial incentives need to be provided in a stable manner, or the industry may collapse or the stop-start impacts may prevent learning and price reductions. Perhaps most importantly, financial incentives need to be accompanied by a clear set of policies, available tariffs, and capacity development to facilitate sustainable mainstreaming of renewable technologies into the state's/region's portfolio.

Up-front capital cost subsidies are generally not considered to be effective: while perhaps necessary in early stages of technology development, and get over the initial high up-front costs of RE, it is not based on power production, so the incentive can be distorting (i.e. projects are built for the 'wrong' reasons; reduced incentive for cost reduction and long-term maintenance and operation.

Accelerated depreciation, while a potentially useful tool to signal government policy intentions and stimulate investment, can have a similar effect if used on an extreme basis (such as the installation credits used earlier in California). Like feed-laws, this approach can make it difficult to estimate how much capacity will result, and the costs are similarly hard to predict. On a more restrained basis it can effective tool, and can be tied to other incentive programs to reduce the impact on treasury revenues.

Mandated Markets

Mandated markets may be adopted to address several barriers: first, the lack of any incentive to take electricity from renewable generators (particularly in a reformed and therefore competitive market); second, a natural preference for utilities to develop their own resources; and third (especially for large utilities) the buyers' negotiating power being much greater than that of the RE project sponsor.

Two broad categories of mandated markets attempt to reconcile these barriers, and include:

- **Price-defined Targets** to set a defined price at which renewable electricity must be purchased. In the U.S., an early example of this was the 1978 US Public Utility Policies Regulatory Act (PURPA) under which utilities had an obligation to connect and to pay the avoided cost. In Germany, Spain and France, **'Feed-In Laws'** have been used to set a specific price for favored technologies. If the price offered is attractive, such approaches can stimulate investment, but utilities may prove resistant and mainstreaming RE into utility operations may remain incomplete. The actual amount of RE power procured cannot be predicted accurately; too low an offer price will result in a low level of installation, and too high a level will result in over subscription and higher than anticipated costs. More importantly, this approach provides limited incentives to reduce costs, making continuation of the program an ongoing political and financial commitment.

Electricity Feed Laws

Focused on increasing installed capacity of RE, feed laws (such as in Germany and Spain) provide a premium price for electricity from RE sources (usually stated as a percentage of average prices). There is generally no cap on the amount of electricity qualifying, and there may or may not be a specification of the technology eligible to receive payment. One benefit of feed law approaches are that they are relatively easy to initiate and are continuous (if funding is available). Sponsors know the price they'll receive and thus have less market risk. This approach can also foster decentralized markets if that is an objective, but unless specified to include only large projects, may not achieve desired economies of scale.

The main drawback of feed laws is that there is an indeterminate effect on total supply, and consequently on total cost; if costs are higher than expected, the scheme may also be difficult to sustain politically. Further, feed laws do little to exert downward competitive pressure on prices over time. While cost caps may be imposed to manage overall program costs, this works against the higher level of installed capacity that is sought. As found in Germany, feed laws were found to create disproportionate impacts on utilities with different RE resources in their geographical region. A high producer surplus resulting from high feed law prices in German, Denmark, and Spain also resulted in high land-lease prices as land owners saw an opportunity; effectively reducing the share of the tariff support available to the project sponsors.

While feed-laws do tend to achieve rapid market development (which may offer learning curve benefits in terms of cumulative capacity) too rapid development may mean that learning effects (technological as well as procedural and institutional) aren't captured as part of a continuum of projects, and higher percentage of capacity is installed before cost reductions impact the market. A very rapid rate of growth in RE development may mean that the capacity value available in wind may be under-recognized if the rate of installation goes above the required rate of capacity requirements recognized in expansion planning. Thus, as an instrument of industrial policy to pursue technology expertise and market share, feed laws may suit country objectives, but are not the most cost-effective approach.

- **Quantity-defined.** These approaches set the quantity of renewable electricity to be purchased by the entity – either by placing an obligation on a set of utilities, or through a tender for capacity. Two broad categories include:

- **Renewable Portfolio Standard (RPS).** In an RPS, electricity suppliers are required to show that a certain amount of their electricity (kWh or kW) was generated from RE sources. Least cost acquisition to meet required targets is typically left to market mechanisms, with utilities either producing their own power, procuring it directly, or by engaging in purchase 'Green Certificates' representing qualifying RE power produced by another supplier. Such a certificate approach can facilitate cost-effective transactions across utilities or regions with differing abilities and RE resource.

- **Systems benefit charge (SBC).** In an SBC, utilities, the regulator or government call for competitive bids from private developers to build capacity up to a pre-defined level, normally stated in terms of installed capacity. Developers providing the least-cost bid or bids receive funds to make up the difference between their bid cost and the market price of electricity. Costs are generally paid from a pool of funds generated from a surcharge on consumer tariffs.

An early example of SBC approaches is the UK's Non-Fossil Fuel Obligation (NFFO). The California Energy Commission has been using a version of this approach, and is now attempting to expand it to include a Renewable Portfolio Standard.

Renewable Energy Portfolio Standards

Patterned after the SO_2 credit trading program from the 1990 U.S. Clean Air Act, and RPS uses sales of Renewable Energy Credits as a mechanism by which revenues are transferred from traditional generators to the least cost RE generators to assure their entry into the system and maintain their viability. By closing the gap between RE generation costs and market prices – technologies become more competitive.

Typically has a set rate or target date by which targets must be met, and is underscored with penalties for non-compliance. Various program offer buy-out options for utilities unable to procure qualifying capacity, set higher than the expected marginal cost yet somewhat lower than the penalty – in this way funds are still generated for the supervising entity to procure the RE/clean power.

An advantage is that it doesn't require centralized distribution of funds and is compatible with transition to retail electricity markets and lends itself to green markets expected to develop. A potential downside of this is that the impact on consumers – and potential backlash – may not be known until later on.

Mandated Markets: In employing a mandated market share approach, policy can specify either the price that must be paid for renewable electricity or the quantity of renewable electricity that must be bought; **it cannot do both**. In general, particularly when contrasting price-defined approaches (such as feed laws) and RPS approaches, this is true. Both feed laws (with a set price but an indeterminate subscription rate and costs) and RPS approaches (with set targets but indeterminate costs) can encounter higher than expected costs that could threaten their long-term political sustainability.

This either-or situation may be ameliorated to some degree by the NFFO/CEC type of approach. Unlike an RPS based on a percentage of RE targeted within the overall portfolio, the NFFO approach was quantity-specific only in individual tenders. The CEC mechanism is not quantity based except in the amount of funding available in the incentive pool for each auction. In both cases the programmatic intent was to reallocate funds from a pool of consumer surcharge funds. Neither approach specifies price, but both introduce competitive pressure to minimize price. The quantity requested in a tender can be specified incrementally and revised upwards if necessary and if funds are available. The amount paid per kWh can be capped to protect the program and fit the program within available resources. Both the penetration level attained and the price paid per unit may remain indeterminate, but can be estimated with reasonable accuracy and tested in the market. Total program expenditures can be defined - given a known level of resources, a known level of willingness by the utility to provide a tariff representing at least some of the value to the system (in terms of not only energy but also capacity, diversification value, and environmental benefits), and an expected level of price points offered by project sponsors in response to a tender, a competitive tariff support scheme can maximize the quantity available at any given set of financial resources. Thus, while the risk remains that the cost per unit and total RE generation purchased remains undefined until tenders are evaluated, the overall program approach can be open-ended. In terms of addressing the Mexican context (where a de facto single utility approach makes an RPS less suitable), the NFFO/CEC approach appears most practical.

Example #1 – the U.K. Non-Fossil Fuel Obligation:

The NFFO was a guaranteed market enablement mechanism that introduced an obligation on the regional power companies in England and Wales to purchase a certain percentage of their electricity from non-fossil fuels. The policy arose as a consequence of utility privatization and the need to subsidize nuclear resources that couldn't be sold; renewable energy was not the initial target. The program provided for a premium payment for non-fossil power derived from a surcharge on utility bills across the consumer base, and its objective was to use a series of competitive tenders within defined technology categories (or 'bands') to get a steady convergence between price paid for RE under successive NFFO orders and the market price that was needed.

Projects awarded contracts to generate at its contracted capacity for up to 15 years (8 years in the first 2 tenders). In NFFO-2 – a 'strike-price' rather than bid price was used – i.e. all suppliers were paid the bid prices for the most expensive contracted project in each band. Thus, some suppliers got more than they bid; some suppliers intentionally underbid knowing they would get the strike price. Any generation in excess of agreed capacity was sold outside the NFFO agreement.

NFFO Benefits: The largest benefit from NFFO was a dramatics decrease in supply prices, especially for wind, where the average bid price fell by 31% between 3rd and 4th tenders, making it close to conventional costs. The decline was for a variety of reasons, including longer contracts allowing investment to be written off over longer period, technology improvements (in part due to rapid experience gains in Europe under feed laws), and a decline in the cost of finance. However, various sources attribute much of this cost reduction to development activity in Europe in response to feed law support, and critics say that the NFFO merely squeezed profitability in the U.K. The Irish AER (Alternative Energy Requirement) is outwardly similar to the British NFFO, with five tenders launched since 1994. One result of the AER is prices among the lowest in Europe, with projects over 3 MW get up to 4.812 eurocents per kWh and local/community projects (below 3 MW - 10% of contracts) get up to 5.97 eurocents.

NFFO Problems: Rapid development pace resulted in some poorly conceived projects; as a result, procedures for 3rd tranche changed to give contracts for 15 years rather than 8. The period tender approach created project clusters with relatively heavy activity interspersed with inactivity, creating a stop-start situation that was difficult for sponsors to manage effectively. Administrative costs were high, in part due to peaks of activity. Even with awards and purchase contracts, delays due to planning restrictions or local opposition hindered many projects.

A significant criticism of the NFFO approach is a high number of bid winners unable to come to closure - out of 3,271 MW of awarded contracts in the NFFO, only 821 MW have been installed – success rate of 25%. The lack of penalties for non-performance and lengthy development periods remitted resulted in speculative pressures as bidders anticipated future technology cost reductions that they would benefit from if they delayed.

NFFO Lessons:

- A large pool of developers can be unlocked if institutional and financial barriers are relieved.
- Flexibility of legislation to permit procedural changes to account for unforeseen consequences can be very useful.
- Gas prices were an ongoing obstacle, both in that by remaining low over a long period, they made it difficult to justify higher cost renewables in the long run, and by continuing to inhibit cost reduction that would follow from increased penetration of RE.

Example #2 - The California Approach:

The California Energy Commission (CEC) is currently operating a renewable energy incentive program based on competitive tenders for electricity production-based tariff support. As a function of deregulation of the California utilities in 1996, the California Legislature created enabling legislation that underlies the current program. Assembly Bill 1890 provided the initial guidance for de-regulation, while establishing policy over 4 years to maintain and protect existing in-state RE capacity through the restructuring process;[1] it provided support for new RE capacity development, and created incentives to stimulate further penetration of emerging RE technologies. The bill required the CEC to submit a report to the Legislature outlining allocation and distribution recommendations. This report resulted in Senate Bill 90, which gave the State authority to administer funds totaling approximately $540 million collected from a small consumer surcharge collected through investor owned utilities. Other sources of funds included voluntary contributions from customers and municipalities.

Key features of the CEC program:

The CEC program includes distinct accounts for 4 categories - New Generation, Existing Generation, Emerging Technologies, and Consumer Applications.

New Renewables	50%
Existing Renewables	20%
Emerging Renewables	15% capital cost buy down, small scale
Customer Credit Fund	10%
Consumer Education	5%

Information here is based primarily on the New Generation support activities, which has spent a total of $241 million over three auctions ($161 million in Auction #1, $40 million for both the second and third auctions). The New Technologies Account has tendered $162 million in support in 3 auctions over 4 years and 3 auctions, based on following approach: Reverse auction - per kilowatt-hour incentive for power production incentive.

- Bids based on cents per-kilowatt hour request, cents bid (no finer than 1/100th of a cent in constant, nominal cents per kWh, paid monthly, over at most 5 year period).
- Bids ranked in order of lowest incentive required to highest until available funds are depleted or all bids have been accepted.
- Cap of 1.5 cents per kWh as an upper limit on bids.
- No project can receive more than 25% of total funds available.
- Minimum on-line date - projects on line before target date eligible for 10% bonus on top of original commitment (in no case can total incentive with bonus be more than 1.5 cents).
- 10% reduction basis for a range of incremental delays. By one year after target, award is reduced 50%; beyond that, to zero.
- New projects only; at least 80% of fair market value of project is from new equipment and output not sunder under previous contracts.
- Projects with fossil-fuel component not considered to be on-line as a RE generator until they meet requirement of no more than 25% of fossil in operations.
- Project must be located in California.

The CEC elected to let technologies compete within a common pool, and unlike the NFFO program, did not ‘band’ technologies to differentiate among different costs and operating characteristics.

Note that producers are generally also eligible for an approximately 1.7 cent Federal Production Credit for RE, bringing the potential for incentive to over 3 cents.

Estimated generation in bids is a key data input; it is hard to hard to define precisely, but important to determine level and allocation of incentive funding. Overestimation would tie up funds unnecessarily; underestimation would lead to insufficient funds in the program. Thus:

- Under-estimation of generation is discouraged by limiting incentive payments to no more than the generation proposed - i.e., extra generation will not receive incentive payment.
- Over-estimates are discouraged through reasonableness checks – if actual generation averages less than 85% of estimated generation over the first 3 years, cents/kWh reduced by 25% for remaining 2 years of payments.
- To avoid front-loading of payments, incentive payments in each of first three years limited to 25% of project’s total award fund.

Well Defined Timeline:

#1 - Preparation and adoption of a project award package
While winners are notified, they are not assured of payment until a Project Award Package is completed. This document designates bid status as a winner, documents understanding of permitting and regulatory requirements, and listing and schedule of applicable milestones for construction and operation, and expected schedule for payments. CEC must be notified in advance of any post-bid changes relevant to the project, the bid, or amount of incentives, paid. (i.e., the ownership of the project could change, the size could increase, but additional generation would not be paid for).

#2 - Project Applications Filed For	**6 months**
#3 - Project Approvals Obtained	**15 months**
#4 - Project Construction Started	**18 months**
#5 - Project Construction Progress Check	**24 months**

#6 - Project Completed and On Line 36 months

Forfeitable bid bonds are required (to ensure that bids are serious) as 10% of expected total incentive payments. These are not used to ensure construction or operation and are returned to sponsors after passing milestones 1 and 2 above.

Project late in coming on line forfeit payments beyond 5 years of expected on-line date - i.e. if it is a year late coming on line (but the CEC has permitted it to continue) it will be eligible then for only 4 years of payments. This protects the program against undue 'mortgages' of available funds, and incentivizes performance.

Cancellation of previous funding awards done only through irrevocable surrender of previous award, and cannot be conditional upon winning new award (in other words, if slow to perform on initial reward, can't reprogram with new funds and thus stall/keep commitment alive. Circumstances for canceling/reducing and award include:

- Material change in project
- Sponsor fails to satisfy terms, timing
- Commission loses contact
- False/leading info
- Project not making progress
- Funding not available

Observers have noted the need for flexibility to respond to changing landscape, which in California included both the need to support existing facilities that were 'orphaned' by industry restructuring, and by the overall power crisis in California – which also threatened existing projects while making it very difficult for CEC auction winners unable to reach closure on IPP contracts. Some stakeholders have suggested that there should be a limit on the amount of funding any single company (as opposed to project) can receive in auction. The drawback is that complexity of corporate structures makes this hard to determine; in addition, the CEC's view is that their aim of attracting the most cost-effective projects means that if a single company with multiple project is a successful bidder, then that is itself a measure of cost-effectiveness

Current Status: The CEC program is currently in flux with RPS legislation and the CEC program extension being passed at the same time. As SB 1078 (the RPS bill) is written, the CEC has authority only to set up a tracking and verification process, certify eligible renewables, and help the CPUC set the market price for energy to be used as a benchmark in utility solicitations for renewables. It currently appears that the utilities will actually conduct their own solicitations in response to their RPS targets under the aegis of the CPUC. The utility will not pay the bid price, but a 'market price' set by the Public Utilities Commission. Funding from the CEC program (i.e. the surcharge-supported fund) will then be used as "supplemental energy payments" to cover the difference between what new renewable projects bid into the utility solicitations and the benchmark set by the CPUC and CEC.

The challenge in this emerging system will be in determining the benchmark or market price that the utility must pay; the higher this is the more resistance there will be by the utilities; a lower benchmark will increase the costs incurred by the public use fund and at the extreme could exhaust this fund without reaching the RPS target. The provision in the RPS legislation that it should be evaluated on their 'least-cost best fit' remains ambiguous, as the real-world characteristics include level of production, firmness, impact on the transmission system, diversification and environmental values, etc.

Strategic Choices for Mexico:

Program Choices: While perhaps a viable option for development of early technologies, direct subsidies are generally not an effective way of garnering cost reductions and learning already developed and internalized in the market and would be considered outmoded for today's renewable energy markets. Similarly, given the modest level of RE experience in Mexico, and the de facto single utility that significantly limits options for trading and cost minimization across multiple utilities, a quantity-defined approach also has limited prospects in the current Mexican environment.

CEC approach and Mexico circumstances

In terms of developing and operating a renewable energy incentive program, the key differences between California and Mexico are the level of RE experience, the political environment, and the funding source for the proposed Mexico program. A key similarity that should be considered is the need for an incentive program to be linked to a clearly available IPP contract at specified conditions of price, capacity payment, and other supply requirements - the CEC reverse auction system has been successful, but nevertheless hindered by lack of contracts due to the poor financial condition of the sector. This experience with CEC incentive program has, in large part, stimulated political closure on an RPS. While an RPS is not currently a recommended approach for Mexico, this larger set of issues should be kept in mind for the long term and for the long-term sustainability of RE project and markets in Mexico.

[1] California has nearly 6,600 MW of utility and independently owned RE resources across solid-fuel biomass, geothermal, wind, small hydro (size 30 MW or less), solar, landfill gas, digester gas, and municipal solid waste. Producing 26,000 GWh in 1994, or 12% of California consumption, continued operation of these resources was considered critical.

Additional GEF Annex 7: Information about Some Key Issues Related to Wind Energy Project Development in Mexico: Land, Leasing, and the Potential for Job Creation
MEXICO: Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M)

Summary of a Draft Report
(Full Report Available from the Project Team)

January 29, 2003
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Prepared for
USAID/Mexico
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Secretariat of Industrial and Commercial Development (SEDIC)

Information about Some Key Issues Related to Wind Energy Project Development in Mexico:

Land Leasing, and the Potential for Job Creation

Summary:

Modern electricity-generating wind turbines are becoming a familiar site in windy regions of many countries, due to dramatic increases in wind energy development. Wind electric turbines vary widely in size and applications, from small machines with rotor diameters less than one meter wide that produce only enough electricity to light a few bulbs and charge batteries, to structures with a span bigger than that of a Boeing 747 passenger airplane that generate enough electricity for hundreds of homes. "Wind farms," or arrays of multiple large wind turbines installed in one location, can generate electricity that can be distributed by a utility to homes, businesses, municipalities, and other users on the grid. Wind farms can range in size from a few megawatts to hundreds of megawatts in capacity. Wind farms are "modular," which means they consist of small individual modules (the turbines). Projects can be expanded and turbines can be added as electricity demand or the ability to develop new facilities grows. Many countries have areas with strong winds and have excellent potential for wind farm development.

With conventional fossil fuel plants, owners or developers of projects are rarely involved in prospecting, developing, securing, or transporting the fuel supplies for their power plants, as the fuel is generally purchased and delivered by a third party. In the case of a wind farm, however, the project developer effectively secures "fuel supply" by securing the wind rights to a particular piece of land with favorable wind resources. Often land suitable for wind farms is owned by rural landowners or held by a communal entity. This requires negotiation between the wind developer and landowner(s) on various issues having to do with wind development, not the least of which are what and how the developer will pay the landowner(s) for the use of the land.

There are many reasons why rural landowners may be interested in leasing their land to wind farm developers:

- ***Income Diversification*** – Wind energy is a new kind of "crop" that is "harvested" under different weather conditions than agricultural crops. Year in and year out, on windy days the wind turbines generate electricity, whether the fields below them are fallow or in production.
- ***Increased Income*** – Leasing the wind rights on windy land to a wind farm developer can provide valuable additional income. At the same time, most of the leased land remains available for farming or ranching around the turbines.
- ***Economic Development for the Local Community*** – Wind energy development can bring a boost to the local economy, including through the creation of skilled jobs either manufacturing turbines or building and operating wind farms.
- ***Cleaner Air and Water*** – Wind energy is one of the cleanest energy options available today. It does not pollute the air and water, nor produce waste that must be stored or disposed of. Wind power can be used on a large scale for years to come, without damaging the health of local residents or affecting future generations.

The Isthmus of Tehuantepec in Oaxaca, Mexico, has been identified as having a high potential for wind farm development. As in other parts of Mexico, much of the land in the Isthmus is either owned by poor

rural communities and held by communal entities known as *ejidos*, or owned by communities under other traditional communal ownership structures. Developing wind farms in the Isthmus thus faces a major challenge: project developers will often need to negotiate with entire communities or large groups of landowners to approve wind farm development, rather than negotiate directly with a single landowner.

One notable impediment to wind power development is that many of the local community leaders and members lack important information to negotiate effectively with project developers. Specifically, community leaders and members often do not know how landowners elsewhere are compensated and what are prevailing rates. In other cases landowners may not have a clear understanding about how much of their land would be used for wind turbine installation, or how compatible certain types of ranching or farming operations such as sugar cane cultivation are with wind farm development on the same lands. In addition, the local communities are interested in a realistic assessment of the prospects for some community members to work on wind farms. Given the above, community leaders and members feel they are at a distinct disadvantage when negotiating with wind project developers.

In response to community leaders' and members' concerns about the lack of information, the State Government of Oaxaca, through the Secretariat of Industrial and Commercial Development (SEDIC), requested USAID/Mexico support to conduct a study that would provide ejidos and other communities in the Isthmus of Tehuantepec region with objective information on the types of agreements and contracts typically used in the U.S. and elsewhere between wind power project developers and landowners. Information requested included the typical magnitude of payments, structure of agreements, and means of verifying actual generation or power sales revenues. While several ejido representatives have explained their need for information and advice, several wind farm developers have also expressed strong support for this activity because they think that an objective approach to this issue will be much more effective than information a wind project developer could provide (given perceptions of bias).

The report addresses frequently asked questions from owners of windy land, and the types of agreements and contracts between developers and landowners typically used in the U.S. and two Latin American countries. Specifically, the report presents typical contractual arrangements, payment structures, verification methods, and advantages and disadvantages of different approaches. The report also examines the land lease process for wind energy projects, land uses compatible with wind farms, and potential job creation from the introduction of wind farms.

Wind Resource Requirements for Wind Farms

Wind resources are extremely site specific and, because there is a cubic relationship between wind speed and the power in the wind, small differences in wind speed result in significant differences in the power output from a wind project. As a result, securing the rights to the wind on the appropriate land is a crucial part of developing a successful wind project.

Not every site with relatively strong winds is adequate for wind farm development. For example, a site where the wind is strong from time to time may not be suitable for project development, as wind turbines do not operate efficiently in turbulent, swirling gusts of wind. Turbines operate best in steady winds of an average speed of at least six meters per second (m/s) (21 kilometers per hour, km/h).

Environmental and Noise Concerns

Although wind power is generally an environmentally benign technology, an environmental impact assessment (EIA) is often required before installing wind turbines, even on private land. This will help determine whether wind turbines at a specific location pose any environmental concerns, whether during the construction phase or during operation. Environmental assessments can help clarify any concerns members of the community may harbor, for example about potential noise or impacts on wildlife (two concerns that are often voiced). An EIA will confirm that today's large wind turbines are very quiet (at a distance of 180 meters or more, a wind turbine is no noisier than a kitchen refrigerator) and can determine whether any local bird species might be at risk from the turbines (this is often not the case). Lighting on the turbines is reportedly a nighttime nuisance for some local residents in the U.S. (lighting is required in the U.S. by the Federal Aviation Administrations for towers above a certain height, typically 60 meters). Some contracts specify the amount and manner of lighting that will be installed to prevent such a problem. Whatever the requirements, many developers place wind turbines at least 150-300 meters from houses and 45-75 meters from non-participating landowner property lines to ensure maximum safety and minimize the chances of a noise problem.

Developer-Landowner Agreements

The paper outlines three key issues regarding contractual agreements:

- the principal differences between leasing and purchasing agreements
- a comparison of the main options for land leasing mechanisms, including direct land leases and percentages of gross generation revenues.
- an analysis of the prices typically paid, according to the different mechanisms used.

The full paper reviews these issues in detail and provides ranges of lease revenues from other established wind markets.

Wind Energy Job Creation and Local Employment Opportunities

As in most business ventures, wind energy projects create jobs. In general, the employment opportunities associated with a wind power project are in manufacturing, construction, and operation and maintenance. Compared to conventional generation options, wind development creates more jobs per dollar invested and per kWh generated. A study conducted by the New York State Energy Office found that 10 million kWh of electricity produced by wind energy generates 27% more jobs in the state than the same amount of energy produced by a coal plant and 66% more jobs than a natural gas combined-cycle power plant.

Manufacturing

Wind power projects employ a number of manufactured components, including towers, wind turbines (including blades, generators, gearboxes, controls), electrical control equipment, cables, and others. Generators for large wind turbines are currently manufactured in Mexico, and certain components such as towers and electrical cabling could be sourced in Mexico. Transmission line and telecommunication towers have long been manufactured in Mexico, and wind turbine tower manufacturing has begun in northern Mexico (Monterrey). There is certainly a possibility of wind turbine tower manufacturing being initiated in Oaxaca if the wind power project development grows sufficiently in the Isthmus. It is estimated that a wind turbine tower manufacturing facility producing one hundred 65 to 75-meter towers annually would create employment for one hundred factory workers, roughly one job per tower per year.[1] Locally produced materials (e.g. cement) would likely be used in construction.

However, it is likely that in the early stages of wind power development in Oaxaca, there would not be significant local manufacturing-related employment, and employment would mainly arise from construction and operations and maintenance (see below). In the longer run, if wind power development in the state expands significantly, and if one or more of the industry members decides to establish a manufacturing base in Oaxaca, local manufacturing and related employment could increase.

Construction

Construction-related employment for a wind project usually involves short-term assignments during the construction phase of the development process. Construction time for a large wind project is generally a year or less, depending on the size of the project and other factors. In the U.S., for a 50-MW wind project, the equivalent of 40 full-time jobs may be created during the construction period. In Mexico, more jobs may be created, depending on different labor requirements for construction activities, such as excavation and road grading, and assuming that the general contractor for the work hires local labor. Typical personnel requirements include construction management, electricians, heavy equipment operators, security personnel, and general laborers for assembly and civil works. The numbers of these positions that are filled by local personnel depend on the skill base of the local population, and the contracting company location and policies.

Operation and Maintenance (O&M)

The number of people employed by a wind power project during commercial operation depends on the number of turbines and the administrative structure of the project. For instance, a 10-MW project composed of 10 1-MW turbines will require less maintenance than a 10-MW project composed of 100 100-kW wind turbines. Although some of the maintenance activities on the larger wind turbines may require more time or different equipment (for example, more sophisticated) to complete the repair, many maintenance activities require the same level of effort regardless of the turbine size.

An analysis of the staffing levels for the projects in the Turbine Verification Program (TVP) project mentioned earlier is shown in Figure 4, indicating the full-time personnel-to-turbine ratio. The data suggests that each turbine requires approximately 11 employees. Considering that the majority of the turbines in this project are between 500 kW and 750 kW, the analysis suggests that in this project, between 5.5 and 8.3 jobs are created for every MW of installed capacity.

Staffing levels were also reviewed for a number of other projects and the data confirm the analysis above. Specifically, for six large projects (between 25 and 100 MW) with turbines of 750 kW or greater, approximately one job was created for every 5-8 MW of installed wind capacity.

For wind projects in developing countries, the staffing levels are generally much higher due to varying labor practices and lower labor rates. In India, for example, 10-15 people may be employed to maintain a project of only a few turbines. For the one developing country project for which data was available, the staffing level was approximately 1 job for 2.5 MW of installed capacity (or 1 job for every 4.5 turbines). In Mexico, staffing levels would likely be slightly higher than those in the U.S.

Although a wind project operates automatically, operators may be employed to monitor the plant and address any system alarms. Operators may also function as maintenance dispatchers and record keepers. Their skills include computer literacy, inventory management, job and equipment scheduling, performance record keeping, statistical trend analysis and data processing. Requirements for these employees depend upon the sophistication and capabilities of the central control and monitoring systems and the size of the project. Some operation centers are located far from the wind project site. Smaller projects may employ only a limited staff that is responsible for both operation and maintenance.

Depending upon the ownership structure and proximity of the sites, maintenance crews and operations people can be used for several projects.

The construction and operation of a wind project results in the purchase of local goods and services such as construction materials and equipment, maintenance tools and supplies and maintenance equipment, and manpower essentials such as food, clothing, safety equipment, and other articles. Support services such as accounting, banking, legal assistance also are required. The Kern County Wind Energy Association estimates that approximately $11 million is paid annually to local businesses for goods and services as a result of wind energy projects in Tehachapi.[2]

Skills Training

Larger wind projects can optimize the mix of skills in their maintenance crews. It is desirable to have staff personnel trained in mechanical and electrical/electronic areas. Comprehensive training programs are available from most turbine manufacturers. Although the exact specifications will vary, a typical O&M training program consists of several weeks of training at the manufacturer's facility, with emphasis on wind turbine theory and familiarity with the equipment. Classroom work, practical work on the assembly lines with the mechanical equipment and control panels, and experience in the field on installed turbines is generally combined with quality assurance and safety training during this period. After completing a manufacturer's training course, personnel can be present during equipment installation to gain additional familiarity with the wind turbines. It is not necessary for all maintenance personnel to receive such comprehensive training. On-the-job training of additional personnel is common provided the experienced technicians are available to share their knowledge. It is important to have multiple qualified technicians available on a project so that the maintenance expertise is not lost if a single person changes positions.

Wind project maintenance personnel are often referred to as windsmiths. Most windsmiths have basic mechanical or electrical skills or experience. For the majority of the maintenance activities, the work is accomplished by climbing the tower and working within the confines of the nacelle. This type of physical activity requires agility and strength, similar to the skills of a utility lineman, combined with greater familiarity with mechanical systems and rotating machinery. As a result of the physical demands, in the U.S. there is often significant turnover in maintenance technicians.

As wind projects become more widespread, training programs are becoming more institutionalized. Some of the larger developers have instituted in-house training programs for new personnel. Several community colleges in the U.S. have also begun wind project operations and maintenance training courses. In Tehachapi, a local vocational school offers an adult learning class in wind project operations and maintenance. This program takes several months to complete. Annex E contains a sample course outline from this program. In some cases, however, programs have been discontinued due to funding limitations.

Conclusions:

The Isthmus of Tehuantepec in the State of Oaxaca has been identified as an area with a high potential for wind power generation. This is one of the sites with greatest wind power potential in the world. However, it is important to consider one of the key factors to be able to build wind farms in the area: the small landowners—mostly ejido owners—who should be included as an integral part in the development of wind farms.

Due to the important role of these landowners, it is important to provide information and advice for them to develop mutually beneficial contracts with project developers. These contracts must ensure fair payments and mechanisms that will promote economic benefits for the area. Lack of information is therefore an impediment for the successful negotiation between communities and developers.

This report attempts to integrate key information for landowners to help them learn about how land lease contracts are executed in other countries, in addition to the employment benefits that might derive from wind farm construction. The study looks at information from 23 wind farm contracts, mostly located in the U.S., and other wind power industry documents.

The study found that there are several wind farm land lease **types of contracts**. Particularly:

- The most common type of contract (13 out of 23) is the payment of royalties with a percent of gross revenue, or a percent over billing. This scheme has several important advantages, such as providing an incentive to both developer and landowner to ensure maximum wind farm productivity, as well as to represent an easy to verify mechanism when basing royalties on a percent of gross revenue, or a percent of total billing.

- To prevent the landowner from ending up with payments lower than expected due to aspects out of the landowner's control (e.g., technical failure in the turbines), the royalty scheme is often supplemented with a guaranteed minimum payment.

- Another widely used payment scheme is the payment of a fixed or flat fee (7 out of 23). This figure is determined either by hectare or by installed MW. However, most of the cases using a flat fee were smaller wind power projects (for example, 2-5 turbines), which represent demonstration or trial projects. In other words, flat fee agreements are not common in the market.

- There are several elements for land lease contracts, and landowners must go over them in great detail to ensure that there are no misunderstandings during the project's life. One of these elements, for example, might be the activities that can conducted simultaneously on the land around the turbines, which is often compatible with its previous use (for example, ranching and/or farming).

- In cases where the land has multiple owners, developers typically take one of two approaches. On one hand they base payments on the power generated by specific turbines located on the individual plots of land. On the other hand, they may base payments on the average output of all of the turbines in the project, multiplied by the number of turbines located on each plot of land. The second option is easier to verify and document, and carries the least risk for the landowner.

Regarding specific **payment sizes** for turbine installation, the study determined the following:

- The range of payments found under the royalty scheme for the U.S. is between one and four percent of gross revenue, with the majority between two and three percent. For Latin American contracts, this percent was between two and three percent.

- Considering royalty and flat-fee payments, the analysis suggests an average payment of $2,200 per MW, which represents a range of US $1,200 to US $3,800 per MW. The average rate equals a flat-fee payment of approximately $3,300 per 1.5 MW wind turbine per year.

- With regards to lease payments tied to a specific percentage of gross revenues, projects in the Tehuantepec region may produce higher revenues per hectare—and higher payments to landowners—than is typical because of the potential increased density of the turbines (compared to other projects in different terrain and a different resource make up), as well as due to the superior wind power resource. However, higher array losses may also reduce the energy output from a wind project in this region.

- According to the information reviewed for this report, land requirements for a wind power project can range from 7.7 ha/MW to 76.8 ha/MW. Approximate payments per hectare[3] range between approximately US $320 and $450.

- According to a financial analysis prepared for the study, energy price and capacity factor have a major impact on the profitability of wind power projects. Land lease payments also have an impact on project profitability, but this impact is more modest than that of energy price or capacity factor.

The payments mentioned above, however, have to be taken into account within the **context** in which they are being made. Particularly:

- In the United States there are various incentives to foster wind power energy generation. For example, a national production tax credit is available in the U.S. for wind energy projects. Some U.S. states also mandate “renewable portfolio standards” (RPSs) which require that a certain percentage of the electricity generated come from wind or other renewable resources. In other countries where the wind power sector is developing rapidly, similar incentives exist.

- In Mexico these incentives do not exist. However, the Mexican government has created a very favorable opportunity for the development of wind farms through a favorable scheme—the self-generation or self-supply scheme, which allows a large power consumer to buy directly from a third party, other than CFE. It is thought that self-supply projects will be the ones to initially foster the development of wind farms in Mexico, even though CFE projects will also play an important role.

The study also looked at data regarding possible **employment** generation from building, operating and maintaining the wind farms. Particularly:

- In the early stages of wind power development in Oaxaca, employment related to tower and turbine manufacturing will likely be minimal. However, there is certainly a possibility of wind turbine tower manufacturing being initiated in Oaxaca if the wind power project development grows sufficiently in the Isthmus.

- Job generation during wind farm construction might be significant and could reach up to 80 full-time jobs for every 50-MW wind farm. These jobs, however, are temporary in nature and last only throughout the construction stage, which generally lasts a little under a year.

- The longer lasting wind farm-related jobs are operation and maintenance positions, and the analysis indicates that one job is generated for every five to eight MW of installed capacity. Therefore, a 50-MW wind farm would generate between six and ten permanent O&M

positions.

The information contained in the report must be considered within its own context, as the development of the projects reviewed depended greatly on the incentives available for power generation with renewable energies and these incentives do not exist in Mexico. It is also important to acknowledge that Mexico has conditions that in turn would foster and hinder the development of wind farms. For instance, wind conditions in the Isthmus of Tehuantepec are among the best in the world. The wind generally blows in a single direction, has a considerable and consistent force, and the land is mostly flat terrain. These factors suggest a great potential for power generation at very competitive prices. On the other hand, there are constraints for the development of wind farms in the Isthmus, such as the unavailability of transmission and distribution lines to evacuate the energy that might be generated in the Isthmus and the industrial capacity derived from a reduction of power generation costs.

In spite of the complexity in the development of wind farms in the Isthmus of Tehuantepec, one thing is clear: landowners are key to the development of this industry. This study has attempted to provide useful information to landowners for them to be aware of the various elements that might come into play when negotiating a contract with wind power project developers.

The integration of landowners and their active participation in the development of wind farms in the Isthmus of Tehuantepec, will make it possible to install the first large-scale projects in Mexico, thus setting a cornerstone to begin using renewable energies for the benefit of future generations.

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[1] This estimate of employment in tower manufacturing in México is based on discussions by Winrock staff with tower manufacturing firms. Wind turbine generators have been produced in México by Fuerza Eolica for many years; many of these generators have been exported to the US and installed in projects there.

[2] Tehachapi, California is one of the three main wind development areas in the State of California. The first wind turbines in the area were installed in the mid-1980s; however, new wind farms and "re-powered" projects continue to be installed today. (Re-powering refers to the replacement of older, smaller wind turbines with newer, larger models). Wind development in Tehachapi includes approximately 500 MW of wind capacity and more than 3000 wind turbines, ranging in size from approximately 100 kW to more than 1 MW. Tehachapi is also the location of the company headquarters and/or the central operations and maintenance facilities for several developers.

[3] Assuming a 2% lease payment, 40% capacity factor, and energy price of $.035-$.05/kWh.