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Barriers to Increasing Clean Energy Investment and Consumption in Latin America and the Caribbean

CENTER FOR CLEAN AIR POLICY

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Prepared for the Inter-American Development Bank

Prepared by the Center for Clean Air Policy

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About the Center for Clean Air Policy

As a recognized world leader in air quality and climate policy since 1985, the Center for Clean Air Policy, an independent non-profit entity, seeks to promote and implement innovative solutions to major environmental and energy problems, in a way that balances both environmental and economic interests. The Center's work is guided by the belief that market-based approaches to environmental problems offer the greatest potential to reach common ground between these often conflicting interests. CCAP staff have participated in the Framework Convention on Climate Change negotiations, helping to shape the Joint Implementation provisions of the Rio Treaty and the Kyoto Protocol Mechanisms. CCAP has developed a series of papers: the *Airlie Papers* on domestic carbon trading in the US, the *Leiden Papers* on international emissions trading, and the *Clean Development Mechanisms Papers* on the design of CDM. For more information on CCAP, see www.ccap.org

Executive Summary

It is generally accepted that considerable technical potential exists for both renewable energy and energy efficiency improvements in the Latin America and Caribbean (LAC) region. However, even in cases where they make economic sense and might be profitable, such investments are not supported by the unassisted market. With the exception of Central America, the combined contribution, in the LAC region, of non-renewable energy (primarily fossil fuels and non-sustainable biomass) to total primary energy supply is between 70 and 80 percent, and higher if large-hydropower is included in the total. Wind and solar energy together account for less than 1 percent.

This paper is one of several background papers commissioned by the IADB to investigate the issue of why clean energy investments do not occur, and the role the IDB can play in eliminating barriers. The purpose of this paper is to lay out the barriers to increasing clean energy—including renewable energy and energy efficiency—investment, with examples of barriers in countries in the LAC region, and examples of projects that have been funded by development banks, the GEF, the UNDP, national governments, NGOs, and other groups, to mitigate these barriers. Companion papers examine classes of actions that the IDB and other development banks can take to address major barriers.

Barriers

Investment and market development in clean energy technologies is hampered by a variety of barriers in the LAC region. Some of these barriers reflect broad economic and financial market conditions in the countries, and some reflect legal and regulatory structures. The characteristics of clean energy technologies and their market conditions can also contribute to slowing investment

Inadequate Financial Markets. The structure of financial markets in LAC poses particular problems for clean energy financing, due to insufficient capital, financing instruments that favor traditional and large-scale projects, and a lack of transparent criteria for making loans. Access to capital is of more concern to small enterprises and poorer households, as well as those in more remote areas, because commercial banks are not equipped to offer necessary finance mechanisms, such as micro-credit or micro-financing. Broad macroeconomic conditions—e.g., political instability, high inflation, or high interest rates—can also contribute to poorly functioning capital markets.

In some financial markets, such as in Mexico, bankers are reluctant to consider lending for projects outside of a narrowly defined set of project types, due in part to risk aversion of the banking system.

Financing Renewable Energy. Clean energy projects tend to have characteristics that make them less attractive to potential investors and more difficult to secure financing. These characteristics include high upfront capital costs, long payback periods, small project size, high transaction costs, and resource risk. Clean energy often involves newer technologies, which may be unfamiliar to investors and financial institutions.

A number of countries in Latin America and the Caribbean have among the highest interest rates in the world. In 2005, base lending rates (similar to the prime rate) in several countries—such as Costa Rica, Dominican Republic, Honduras, and Uruguay—exceeded 20%, with Paraguay's rate exceeding 30%. Only a few countries—such as Argentina, Chile, Ecuador, El Salvador, Mexico, Panama, and Trinidad and Tobago—had rates below 10%, approaching the rates in more developed economies

Policies, Regulations, and Legislation. National, regional, or local economic and regulatory policies can put clean energy at a disadvantage. For example, subsidies for conventional energy supplies, exemptions for fossil fuels from domestic taxes, and high import duties that discourage the importation of new technologies all put clean energy at an economic disadvantage relative to conventional energy. Both the presence and absence of relevant laws and regulations can present a barrier. For example, laws governing the production, distribution, and access to power, preferential tax treatment (e.g., accelerated depreciation) or standards for equipment efficiency or fuel content, can play an important role in the official posture towards—and economic standing of—clean energy technologies.

Market Conditions for Clean Energy. Clean technology—particularly renewables—may in some circumstances be higher cost than conventional technologies, and so difficult to bring to market, even where access to capital exists. In some cases, national or other monopoly power in the markets for generation, transmission, and distribution of electricity impedes competitive behavior. Clean energy markets may fail to function because of a lack of small and medium sized enterprises to disseminate the technology, insufficient demand to take advantage of economies of scale (as in electricity generation), lack of domestic manufacturers to produced the technology, lack of information and technical expertise to encourage buying and selling of technologies, or a lack of infrastructure needed to support the technology.

Institutions, Cultural Barriers, and Capacity Building. Developing an environment that fosters clean energy technology includes overcoming institutional and cultural barriers as well. These include biases against the technologies in preferences and business practices or political decisions, and a lack of supporting institutions. These barriers can be reduced by assessing national and local technology needs, increasing local participation, and building capacity within national government, financial institutions, and community groups.

The importance of these different types of barriers will vary with the level of development in the country, with the state of its financial sector, with regulations/policies that are in effect (both discriminatory and supportive of clean energy), and with the availability of natural resources. In general, financial barriers are among the most critical to overcome, so that the investment capital is available for purchasing technologies. In recent years, however, attention has turned to other barriers that may be equally critical, since investors and users must also have access to the technologies at a reasonable price, and the technical know-how and infrastructure to use them. The structure of the electricity sector will also be a critical factor, including the organization and structure of the electricity sector, ownership of utilities and natural resources, and rules governing access to the grid, pricing and charges, and power purchase agreements.

Building a favorable environment for clean energy technologies requires addressing barriers by means such as:

- ✓ *Building local skills—sharing information and strengthening the technical capacity of the labor force*
- ✓ *Engaging the private sector—creating a healthy business environment and providing incentives for clean technologies*
- ✓ *Using development assistance effectively—enhancing government efforts to stimulate the market and improve coordination*
- ✓ *Developing innovative financing—pooling resources and sharing risks*
- ✓ *Reducing institutional, legal, economic, and regulatory barriers that impede technology transfer*

Source: CTI (2001a)

Efforts to Mitigate Barriers

By far the greatest amount of effort, particularly by the large multilateral institutions and development banks, has historically focused on financial barriers. Numerous programs have been designed to facilitate financing for clean energy projects by providing fresh capital and debt for investment in enterprises, by providing loan guarantees, or by providing direct technical assistance and capacity building, with mixed success. For example, the World Bank has established a number of energy-environment funds, joining their funding with that of other organizations and sources of funding, including the GEF. Other development banks—such as the IDB—and the investment arms of the development banks (such as the International Finance Corporation (IFC) of the World Bank group and the Multilateral Investment Fund (MIF) of the IDB), other multilateral institutions, NGOs, and national governments, have also been involved in various initiatives and funds. Problems have been observed with several of these funds, either because of the difficulty of finding qualified projects or (the flip side) the difficulty that small enterprises, in particular, have in accessing these funds.

More recently, international efforts to increase investment in clean energy in developing countries, including the LAC region, have recognized the importance of focusing on multiple barriers, and have taken a broader view of market transformation and development. Both top-down and bottom-up approaches are evident. Following a top-down approach has resulted in regulatory and legal reforms, in large-scale projects for grid expansion and provisions for engaging renewable energy in the expansion, in programs to purchase and distribute equipment, or in funding for large-renewable energy generation facilities. Several countries in LAC, including Mexico and Brazil, have funds or national programs that combine policies, subsidies, and (in some cases) both domestic and multi-lateral contributions, to finance clean energy projects and to develop markets. Electricity sector privatization, often a necessary (but insufficient alone) first step towards expanding renewable energy electricity generation, has occurred in many LAC countries. Some countries, such as Honduras, have further adopted policy reforms that should provide additional incentives for clean energy investment.

Several funds and facilities are adopting a largely bottom-up approach to market transformation. The USAID sponsored FENERCA program has been in operation since 2000. With the assistance of E+Co (an independent private sector company focused on both investment and entrepreneurial capacity building), this program works on developing robust, small-scale energy enterprises, especially in rural areas, by the provision of “seed” capital that is later repaid, and by business development assistance. The relatively new Sustainable Energy Facility (SEF) of the IFC uses funds from the Global Environment Facility (GEF) and other donors and will leverage financing from other lenders. The SEF will similarly focus on debt and equity investments in small and medium businesses requiring seed capital and growth funding, as well as technical assistance to provide business development services. The GEF’s Small Grants Program (SGP), which is administered by the United Nations Development Program (UNDP), provides small (less than US$50,000) grants directly to community groups and NGOs. These small grants frequently combine financial support with a focus on removing barriers due to income constraints, lack of familiarly or comfort with technologies, training, and other sources of barriers. The United Nations Environment Program (UNEP) also has several initiatives that work with small-scale entrepreneurs, including those in rural areas.

Lessons Learned

The case studies and examples described in this paper suggest several general lessons about methods for taking action to transform these markets:

- Clean energy should be allied with other development goals—clean energy options need to make sense for other reasons as well
- Capacity building and information provision is needed throughout the clean energy “chain”—including government, community groups, financial institutions, investors, business, and consumers

- A key goal is creating a viable market for the long term, which may require addressing multiple barriers simultaneously
- Poorly functioning capital markets, limited access to credit and capital, and financing instruments that favor traditional investments are key barriers
- Resource and project risks should be addressed by financial instruments
- Productive and technical capacity is needed within countries for manufacturing, repair/maintenance, and use of clean technologies
- Policy-based CDM may be an emerging option to address these barriers, by creating new financial incentives for energy projects and support for programs
- Both top-down and bottom-up approaches may be needed—in order both to effect policy, regulatory, and legislative reform, and to develop institutional support at the national government level on down, as well as to strengthen enterprises, entrepreneurs, and markets from the ground up.

In developing strategies, attention must be paid to country-specific barriers and conditions, including the structure of the electricity sector, and to local needs. Macroeconomic conditions and policies, for example, vary considerably within the LAC region, depending, in part, on the degree of development, geography, rural/urban population splits, natural resource endowments, and other factors.

Making Tough Decisions

Actions to address barriers, such as those described in this paper, can improve the position of clean energy options that are economic, or near economic, in today's market framework. In the long-term climate context, policies must spur technological innovation in developing as well as developed countries. Thus, there is an additional challenge of assisting new and developing technologies, which may be higher cost currently, to reach the market place and ultimately become competitive. Because of the current higher costs of these technologies, grants, subsidies, loans, and loan guarantees—and other mechanisms to offset financial and cost barriers—will be critical to the success of these measures. A key question, therefore, is how far funds and facilities should be expected to go in directly offsetting the cost disparities and limitations in financial markets, and how to combine these financial mechanisms with regulatory instruments, such as targets or caps.

TABLE OF CONTENTS

1 INTRODUCTION

The Inter-American Development Bank (IADB) in September 2005 launched its "Action Plan for Renewable Energy, Energy Efficiency, Greenhouse Gas Mitigation, and Carbon Finance," in response to urging by member countries that the IADB expand its activities in these areas. The intent of the Action Plan is to facilitate mainstreaming clean energy considerations in the Bank's lending practices and to increase the volume of the Bank's clean energy investments, in line with regional needs and priorities.

The IADB is also participating in the post-Gleneagles "G8+5" effort with the World Bank, the International Energy Agency, and other regional development banks, the aim of which is to put in place the foundations of a new international investment framework for clean and lower-carbon energy investment. The IADB is taking the lead in the context of the Latin America and Caribbean region in developing an understanding of key challenges and building agreement on necessary steps. This paper is one of several background papers that were prepared (with the assistance of funding from the government of the United Kingdom) for a workshop held in Washington DC on 13 – 14 March 2006. This paper identifies the barriers to increasing clean energy investment, with applications to countries in the LAC region, and examples of projects that have been funded by development banks, the GEF, the UNDP and other groups, to address these barriers.

It is generally accepted that there is considerable technical potential for renewable energy and energy efficiency in LAC, and that renewable energy can in circumstances compete economically with conventional energy sources. Moreover, energy efficient investments may often be sensible economic choices, but are often not undertaken. Barriers to expanding the use of these forms of clean energy may occur throughout the economy, including the structure of financial markets, national policies that favor fossil fuels, the lack of institutions to disseminate and implement technologies, and cultural and behavioral practices that discourage new technologies, to name a few.

This paper presents an overview of the types of barriers to expanding clean energy in the LAC regions, with examples of barriers in selected countries. After a brief summary of energy sources in the LAC region, the paper turns to a review of the literature on barriers to increasing investment and use of clean energy technologies. Rather than conducting a comprehensive review of barriers in LAC countries, this paper takes the approach of identifying the general types of barriers to clean energy, and then providing examples of barriers in selected countries and sectors, in some cases by describing a particular project that demonstrates the barrier. Following this discussion, the paper presents several longer case studies that address in more detail the process of defining and addressing barriers to clean energy in LAC. Finally, the paper concludes with a short summary of key lessons and priorities in addressing barriers.

2 Background

About 1.6 billion people in the world have no access to electricity, and 2.4 billion are using traditional biomass in unsustainable and inefficient ways for cooking and heating.[1] In the developing world, energy priorities are concerned with extending modern and affordable energy services, solving immediate human health problems caused by use of inefficient, outdated combustion technologies, and facilitating economic development. Moreover, the current high price of imported energy, mainly oil and natural gas, places a particular strain on poorer countries' economies. The increased use of clean energy—particularly higher energy efficiencies, renewable resources, and better energy technologies for supply—may make it more possible to satisfy basic energy needs without increasing pollution and greenhouse gases and, in some cases, decreasing them.[2]

In LAC, non-combustible renewables account for about 9 percent of total primary energy supply (TPES), with combustible renewables (including traditional biomass) and waste accounting for an additional 15 percent. Hydroelectric power accounts for almost 70 percent of electricity production, with other forms of renewable energy being negligible (see Figure 1).[3,4] The bulk of hydro in LAC is produced by four countries: Brazil, Mexico, Paraguay, and Venezuela.

Clean energy technologies encompass both renewable energy sources and energy efficiency.

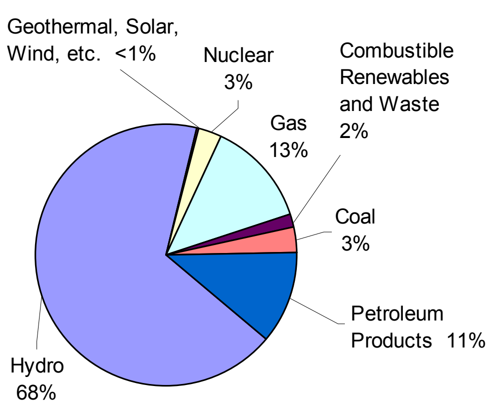
Renewable energy (RE) sources include:

- ✓ *Photovoltaics (PV)—solar cells that convert solar energy directly into electricity*
- ✓ *Solar thermal—high temperature solar thermal systems use reflective surfaces to concentrate solar radiation, and low temperature systems collect solar radiation to heat air and water for industrial and household applications*
- ✓ *Small-scale hydro (SSH)—hydro developments today are increasingly focused on smaller scale project, usually meaning less than 10 MW of capacity, and going to less than 100 kW*
- ✓ *Wind power—a wind turbine converts the energy in the wind into electrical or mechanical energy*
- ✓ *Geothermal—energy is extracted using wells (commercial applications) or, more widely, using "ground source" heat pumps*
- ✓ *Biomass and Biogas—industrial and agricultural wastes, organic wastes from animal husbandry, or energy crops converted into heat, electricity, biogas for use as a gaseous fuel, or methanol, ethanol, or other liquid fuels*

Energy efficiency (EE) is the process of ensuring that the least amount of energy is used to perform a function. EE includes buildings, end use efficiency, industrial efficiency (e.g., more efficient motors or cogeneration), electric power generation, storage, and distribution, and transportation.

Sources: E+Co (2006), NREL (2006).

Figure 1. Shares of Electricity Production in LAC Region, By Source, 2001



Source: WEA (2004).

The role of renewable energy—including sustainable biomass—in total primary energy supply varies considerably across the region. The results of a recent study from the Economic Commission for Latin America and the Caribbean (ECLAC) that separated sustainable resource use from potentially renewable resources are summarized in Table 1.[5] In Central America, the contribution from renewables to Total Primary Energy Supply (TPES) is considerable, approaching 50 percent. The contribution of unsustainable biomass also stands out for this region, at 21.0 percent. The other three regions are heavily dependent on oil, with hyrdoenergy playing a significant role in the Andean Community of Nations and the expanded Mercosur region. Cane products are a source in Central America, in the expanded Mercosur region and in the Caribbean (due primarily to the sub-region containing Cuba, Dominican Republic, and Haiti).

Table 1. Total Primary Energy Supply, by Source and Sub-Region of LAC (2000) (percentage)

Sub-Region	Coal	Oil	Natural Gas	Non-Sustainable biomass	Renewables***					
					Hydroenergy	Geothermal	Sustainable wood fuel and charcoal	Cane Products	Other biomass	Total Renewables
Central America	1.7	29.6	--	21.0	10.1	6.4	21.6	9.3	0.3	47.7
Caribbean	0.3	51.2	27.9	2.4	0.9	--	7.6	8.8	--	17.3
Andean Community*	1.9	49.8	27.6	0.8	15.3	--	2.2	1.6	0.6	19.7
Mercosur and Chile**	6.0	43.1	17.2	2.8	13.0	--	7.4	7.3	2.2	29.9

*Venezuela, Colombia, Ecuador, Peru, and Bolivia
**Includes 1% Nuclear.
***Wind and solar do not reach 1% in any of these regions.
Source: ECLAC (2003).

A number of countries in the region are implementing structural reforms in the electric power sector, by privatizing electricity generation and distribution. Transmission and distribution networks are generally regulated. In addition, the governments in Central America are creating and gradually expanding a regional electricity market, the “Electricity Market Framework Treaty of Central America.”[6] However, renewable energy still faces many constraints and barriers in the LAC region, especially in countries without a highly developed energy market, and with poorer, rural areas.

3 Barriers to Increasing Clean Energy

Energy technologies and practices are being transferred continually, with the private sector, governments, and multilateral organizations all playing important roles. The challenge in spurring expansion and diffusion of clean energy technologies, such as energy efficiency and renewable energy, is to create an environment that attracts investment in clean technology, to raise awareness of clean technology options, and to find technologies that are compatible with other national development and environmental agendas.[7]

In both developed and developing countries, barriers or obstacles can hamper the expansion or transfer of clean energy technologies, such as energy efficiency and renewable energy. Barriers to a given technology may be embodied in financial markets, technology market structures, public policies, and institutions that inhibit the diffusion of the technology.[8] Social and cultural conditions also present barriers to the diffusion of technology. In addition, the technology itself may be at a disadvantage from a cost perspective, independent of institutional, cultural, or other barriers.

While these barriers do not necessarily exclude these technologies from the marketplace entirely, barriers can restrict a technology's ability to reach its full potential. That is, barriers may prevent demonstrated technologies from being implemented in cases where they make economic sense, as well as in more limited circumstances where they are feasible, but may not be as economical as conventional technologies.

Building a favorable environment for clean energy technologies requires addressing barriers by means such as:

- ✓ *Building local skills—sharing information and strengthening the technical capacity of the labor force*
- ✓ *Engaging the private sector—creating a healthy business environment and providing incentives for clean technologies*
- ✓ *Using development assistance effectively—enhancing government efforts to stimulate the market and improve coordination*
- ✓ *Developing innovative financing—pooling resources and sharing risks*
- ✓ *Reducing institutional, legal, economic, and regulatory barriers that impede technology transfer*

Source: CTI (2001a)

Types of barriers can be loosely grouped into the following categories.

- ***Financial Barriers***—insufficient capital, financing instruments that favor traditional and large-scale projects, risks for foreign investors
- ***Macroeconomic and Political Conditions***—poor or unstable macroeconomic conditions (such as unstable and/or inflation or high interest rates), macroeconomic policies (including tariffs and taxes) that discourage clean energy investment, and political conditions that discourage investment (instability and corruption)
- ***Institutional Barriers***—lack of technical standards and supporting institutions, lack of local participation and inadequate understanding of local needs, insufficient assessment of technology needs and implementation plans at national level
- ***Legal/Regulatory Barriers***—inadequate legal and regulatory frameworks, uncertain ownership, lack of intellectual property rights protection, and unclear arbitration procedures
- ***Inadequate Information/Capacity***—inadequate access to technical and financial information and poor dissemination of information to technology users, low technical capabilities and technology knowledge base
- ***Social/Cultural Barriers***—consumer preferences, social biases, business practices

- ***Cost and Technical Barriers***—higher costs of some clean energy technologies, inadequate infrastructure
- ***Market Barriers***—lack of competition, transparency, or other market condition

3.1 Financial Barriers

Financing considerations are perhaps the most pervasive obstacle facing clean energy projects. Characteristics of clean energy projects themselves, as well as the nature and availability of financing sources can impede financing for clean energy projects.

Characteristics of clean energy projects. Many clean energy projects have common characteristics that make it difficult to secure financing:[9]

- high upfront capital costs and long payback periods
- large "soft" components (feasibility studies, energy audits, hiring overseas and local consultants, conducting training programs, and travel)
- small collateral value for projects, which makes it difficult to use project finance mechanisms
- small project size relative to transaction costs borne by the financial institution
- for renewable energy projects, there may also be uncertainty and, thus, investment risk, arising from the uncertainty of natural resource supplies
- clean energy technologies will be unfamiliar to financing institutions and therefore less likely to receive financing
- frequently newer technologies and less experienced sponsors

The nature and availability of financing sources. The structure of financial markets in LAC can pose particular problems for clean energy financing:

- lack of transparency in loan criteria and decision making
- high interest rates favor projects with short payback periods and lower capital requirements
- technologies for downstream end users generally (e.g., households) are difficult to finance because commercial banks are not

Policy guidelines from the Colombian government clearly indicate support for renewable energy generation. However, private investors give higher priority to thermal generation because of the lower risk involved in these projects, the predictability of rules to sell this power to the grid, and more readily available financing from the commercial finance system (and even sometimes development banks).

In more developed countries in Latin America, such as Mexico and Brazil, limited access to credit and loan guarantees hampers action by existing ESCOs in promoting energy efficiency in commerce and services

In Brazil and Chile, financial constraints hamper investment in the expansion of more energy efficient cargo and passenger transportation options. This is the case in Brazil for several transportation types (including railways and subway systems), and is the case for cargo railways and urban/suburban railways in Chile.

In Chile, the railway system is further disadvantaged by explicit policies that, since the 1970s have dismantled the railway system in favor of private road transportation systems. While efforts have been made in recent years to begin to recover the system, policies are far from being consistently supportive.

In some financial markets, such as in Mexico, bankers are reluctant to consider lending for projects outside of a narrowly defined set of project types, due in part to risk aversion of the banking system. In addition, favorable terms provided by the government for new market entrants reduce the revenues that financial institutions can earn from credit provided in new markets, and so increases their reluctance.

equipped to offer necessary finance mechanisms (e.g., micro-credit or grants to low-income households without assets)

- effective financing delivery mechanisms for businesses, such as micro-finance, are unavailable particularly in rural areas
- risk aversion on the part of lenders leading to significant collateral and guarantee requirements for specialized projects
- lack of financing instruments that adequately address risks
- general lack of funds for capital investment
- a gap in communication between the large, major financial institutions (who interact with high level policy makers) vs. smaller firms who assist and interact with project developers

In addition, potential projects face a lack of access to relevant and credible information on potential financial partners to allow for the timely formation of effective relationships which could enhance the spread of clean energy technologies.

Addressing financial barriers. Much of the effort directed at alleviating barriers to clean energy in LAC (particularly for renewable energy) has focused directly on these financial constraints, particularly the lack of availability of investment capital and the difficulties that clean energy projects have competing with conventional technologies for available financing. Among the approaches that have been used to address financial barriers are

- Funds (financed by multilateral development banks, other multilateral institutions, NGOs, and national governments). Often these funds include concessional[10] financing in the form of direct grants, subsidized loans, or loan guarantees to improve the attractiveness of clean energy projects to financial institutions. In other cases they use innovative methods, such as revolving funds, to substitute for credit that is unavailable.
- Building capacity—familiarity with the technologies, costs, and risks—at financial institutions for dealing with clean energy and small-scale projects.
- Using financial intermediaries to finance equipment purchases at small and medium sized enterprises. For example, Energy Service Companies (ESCOs)--businesses that develop, install, and finance projects designed to improve energy efficiency for customers and assume the technical and performance risk associated with the project—can and do act as financial intermediaries.
- Providing risk-finance instruments that enable projects to cover revenue losses from particular risk events.[11]

While a comprehensive review or assessment of these approaches is beyond the scope of this paper, the experiences of a few of the funds and programs may be instructive in indicating the importance of financial barriers and various means of addressing them. As discussed briefly below, these programs and projects, which have been

The GEF and its Implementing Agencies have tested different strategies to expand the use, and improve the affordability, of renewables. These include:

- ✓ *Targeting small business, emphasizing renewable energy for income generation and social needs*
- ✓ *Offering contingent loans and grants*
- ✓ *Supporting project development costs*
- ✓ *Helping banks to understand renewables*
- ✓ *Hedging against resource and other risks using insurance and securitization of risk*
- ✓ *Combining credit lines for specific types of projects with promotional activities and technical assistance*
- ✓ *Lending to financial intermediaries*
- ✓ *Micro-financing for consumers*

Source: GEF (2005).

undertaken by a wide range of public and private sector entities, have met with mixed success. The record seems to suggest that, while addressing financial barriers head-on is critical, it is equally important to mitigate other barriers to market development, such as technical capacity.

Numerous programs have been designed to facilitate financing for clean energy projects by providing fresh capital and debt for investment in enterprises, by providing loan guarantees, or by providing direct technical assistance and capacity building. For example, the World Bank has established a number of energy-environment funds, joining their funding with that of other organizations and sources of funding, including the GEF. The Energy Sector Management Assistance Program (ESMAP) of the World Bank is a global technical assistance program intended to accelerate the delivery of energy services to the poorest populations by assisting government and the private sector, and is largely funded by bilateral donors and the World Bank. The World Bank has other donor-funded programs that are regional in focus, including the Asia Alternative Energy Program (ASTAE) and the Africa Rural and Renewable Energy Initiative (AFFRREI).[12] Other development banks—such as the IDB--and their investment arms (such as the International Finance Corporation (IFC) of the World Bank group and the MIF of the IDB), other multilateral institutions, NGOs, and national governments, have also been involved in various initiatives and funds. Problems have been observed with several of these funds, either because of the difficulty of finding qualified projects or (the flip side) the difficulty that small enterprises, in particular, have in accessing these funds.[13,14]

For example, the GEF recently conducted a review of its portfolio of instruments and approaches employed in engaging the private sector, including renewable energy and energy efficiency projects.[15] The renewable energy projects under review fell into three categories of approaches and financial instruments: (1) the setting up of private equity funds, (2) direct support to small and medium enterprise (SME) projects, and (3) the use of a multi-country and multi-instrument facility (the PVMTI). For the first category, the review found that two equity funds of the IFC (which also included donor funds from the GEF)—the REEF and SDG—were able to mobilize significant amounts of public and private funding.[16] However, the REEF focused on conventional, large, commercial grid-connected renewable energy projects (rather than smaller projects). Both funds faltered, in part, because of unrealistic expectations and the lack of available investment projects with high enough rates of return. Moreover, the need to develop technical and business capacities and skills of the investors, local banks, and financial institutions was underestimated by the GEF.

The GEF review also found troubling problems in some of the projects that were reviewed within the other two approaches—ranging from a slow pace of implementation for the PVMTI to unrealistic market assessments and a lack of successful market transformation. The review was unable to assess whether the direct support projects that were reviewed—and which were still relatively young—would achieve lasting changes. The study concluded that sound business plans for the ventures supported were more important for project results than the types of financial instruments used, although the mix of financial instruments—including debt, guarantees and other non-equity instruments—could prove critical in some individual cases.

Projects and programs that focus on market transformation and creating a sustainable environment, while recognizing the realities of financing renewable energy and energy efficiency projects and the need for capacity development, may prove to be more successful over the long term. More recent IFC efforts along these lines include the Sustainable Energy Facility (SEF), a facility to finance projects in Central America, Brazil, China and Southeast Asia, which will use donor funds from the GEF and leverage financing from other lenders, and was launched in

December 2005. E+Co, a public purpose investment company based in the United States and specializing in the financing of small-scale energy projects in emerging markets, will manage the fund. The fund will focus on debt and equity investments in small and medium businesses requiring seed capital and growth funding, as well as technical assistance to provide business development services.

Complementary to its grants program for medium- and full-sized projects, GEF's Small Grants Program (SGP), which is administered by the United Nations Development Program (UNDP), provides grants directly to community groups and NGOs. These small grants (a maximum of $50,000) frequently combine financial support with a focus on removing barriers due to income constraints, lack of familiarity or comfort with technologies, training, and other considerations. SGP projects have addressed financial barriers to purchases of technology by local people in several ways, including setting up revolving loan funds, a common micro-finance mechanism, and adapting it to the energy context.[17] SGP projects have also involved the private sector by forming micro-enterprises, or integrating improved energy technologies into existing business activity.

UNEP also has some recent initiatives designed to address some of the flaws in earlier approaches to addressing financial barriers to clean energy investment in the LAC and other regions.[18] An impediment to the adoption of clean energy technologies is the lack of appropriate finance available for entrepreneurs to create clean energy enterprises. To address this problem, UNEP is involved in the Rural Energy Enterprise Development (REED) initiative, a partnership with the UN Foundation and US-based non-profit clean energy investor E+Co, which works with rural communities in five African countries, Brazil, and China. The concept behind REED is to provide start-up capital and training to small-scale entrepreneurs who have identified a market niche for rural energy provision but cannot attract the necessary seed financing to begin or scale up their operations. Examples include businesses making fuel-efficient stoves, repairing wind pumps, or providing solar crop dryers.

Despite apparent market opportunities, REED investment, and similar small- and medium-sized enterprise centered development elsewhere, have had difficulty in leveraging local lenders to support clean energy investment.[19] A primary obstacle is the inability of many potential entrepreneurs to demonstrate proven credit records that are attractive to lenders. Nevertheless, the REED model has led to new SME-based funds in the LAC region—the SEF described above, and the Central American Renewable Energy and Clean Production Facility (CAREC), discussed again in Section 3.7.[20]

Another example of promoting financing for clean energy is a UNEP/World Bank project to increase energy efficiency investments by the domestic financial sectors in Brazil, China and India. With support from the UN Foundation, the project is developing the capacity of new and existing financial institutions to package energy efficiency investment projects by removing market barriers in each country. Project activities include technical assistance, training and applied research in four areas:

- Developing commercial banking opportunities for energy efficiency.
- Supporting energy service companies (ESCOs).
- Creating guarantee funds for energy efficiency investments.
- Developing equity funding for ESCOs or energy efficiency projects.

As one of the project activities, international exchanges will allow financiers from each of the three countries to learn from each other and jointly address the practical problems each face, thus overcoming barriers to increased investments in energy efficiency.

Finally, the Clean Development Mechanism (CDM) has also been hailed as a potential source of funding to advance technology development and transfer to developing countries.[21] In addition to project-based CDM that promotes individual renewable energy or energy efficiency projects, policy-based CDM may be a means of providing an incentive for national governments to undertake programs that encourage renewable energy projects or energy efficiency improvements in particular sectors.[22]

Some specific examples of country-specific programs and projects to overcome financial barriers are discussed in more detail below.

Overcoming financial barriers through international alliances: Mexico's Green Fund. A Green Fund Facility was created (with funding from the GEF) to provide financing to supplement the limited domestic investment capital that was available in Mexico for renewable energy. This fund has been successful in developing new renewable energy generation capacity, particularly in wind. Although some of the projects are still in the construction phase, there is every reason to believe that the projects will be sustainable. The fund and its financing provided the needed incentives to overcome financial barriers, and so complemented domestic investors so that the facilities could be built. *For additional information on this case study, see Section 5.2.1 of this report.*

Addressing financial barriers: Contingent debt scheme in Mexico. A national fund, formed in Mexico after the passage of the 1992 law, provided loan guarantees for various forms of clean energy, and was quite successful in advancing investment in lower-carbon fossil fuels. This guarantee scheme illustrates how removing legal/regulatory barriers alone is insufficient, but requires also the removal of cost/financial barriers to increase clean energy. The fund was intended to be temporary, until reforms in the power sector provided additional impetus for private sector investment. Because the reforms have not been forthcoming, the scheme is coming under increasing pressure, because of the high expense and risk it imposes on the public sector. *Additional information on this case study can be found in Section 5.2.4 of this report.*

Using international funding to reduce financial and other barriers in Chile. In Chile, a successful rural electrification program has demonstrated how international funding can be used to reduce financial and other barriers and to create widespread electrification via renewable energy. This project, which began in 1994, has as its aim the provision of electricity to at least 90 percent of rural homes by the end of 2006. The program initially focused on investment expanding the national grid using a cost-sharing arrangement between the government and private enterprises and cooperatives. In 2000, it became clear that grid expansion was about to reach its limit, and that stand-alone units—mainly diesel-based—servicing off-grid areas would be needed to reach the remainder of the population. An agreement between the UNDP, the Chilean National Energy Commission, and the Foreign Affairs Ministry was signed at the end of 2001, setting up a program entitled, "Barrier Removal for Rural Electrification and Renewable Energy, which was funded using money from both the GEF and the national government. This program is addressing the problem on several fronts, including implementing individual renewable energy projects, developing standards and certification for renewable energy equipment, building technical capacity, and developing risk-management financial instruments, as well as collecting data in order to assess the feasibility of various renewable energy technologies in Chile. *For additional information on this case study, see Section 5.3 of this report.*

Strengthening financial markets and lenders' rights in Peru.[23] The judiciary occupies a key position in Western society and so their views matter. For various historical reasons, a legacy of debt non-repayment had developed in Peru and the country's judiciary had become increasingly unfriendly toward lenders rights. This ultimately works to the disadvantage of the borrowing poor when even their collateral is not considered secure by lenders. If all segments of society are to enjoy access to credit, some kind of balance between borrower and credit rights must be struck.

The Association of Peruvian Banks (ASBANC) decided to do something about this. What if Peruvian judges could get a glimpse into the problems that bankers encounter when they make loans and try to recoup these loans in the face of an antagonistic judiciary? ASBANC held a series of seminars for Peruvian judges on the need to recognize creditor rights. And the MIF assisted this effort.

Peru's financial system had recently been opened to foreign competition and domestic bankers were ill prepared to meet this challenge. ASBANC asked the MIF for help with the institutional strengthening of IFB and with the design of training courses for Peruvian bankers (PE-5879, Program to Assist the Bank Training Institute, IFB).

The judiciary training program was one of many training modules developed under this program and was a huge success. The judiciary training module has attracted widespread attention. The Federation of Latin American Bankers (FELABAN) has adopted the IFB judiciary training program. IFB is now developing a training module for its national Congress and is delivering (via internet and television) Latin America's first long-distance bank training programs.

This is a case of serendipity. Although the specific intervention was not anticipated in the original project document, the design of the project did allow for … "conceptualizing and delivering a range of banking and financial training services". It is an example of what is possible when resources are placed at the disposal of innovative people and they are free to experiment.

3.2 Macroeconomic Conditions and Policies

A key condition for technology diffusion is the existence of a market environment that attracts private sector investment in these technologies.[24] Macroeconomic policies can directly put clean energy at a disadvantage, relative to other energy technologies, in a number of ways:

- Subsidies that lower the price of conventional energy create a disincentive for consumers and business to adopt energy saving measures and renewable energy technologies.[25]
- Price distortions resulting from subsidies or other policy interventions that make resource consumption less expensive to consumers impede the diffusion of resource-conserving technologies.[26]
- Trade barriers—such as high import duties—that encourage inefficient technologies, or prevent access to foreign technology, can slow technology diffusion.[27]

Poor or unstable macroeconomic conditions—including high or uncertain inflation or interest rates, and uncertain stability of tax and tariff policies—can impede the diffusion of technologies by increasing risk

A number of countries in Latin America and the Caribbean have among the highest interest rates in the world. In 2005, base lending rates (similar to the prime rate) in several countries—such as Costa Rica, Dominican Republic, Honduras, and Uruguay—exceeded 20%, with Paraguay's rate exceeding 30%. Only a few countries—such as Argentina, Chile, Ecuador, El Salvador, Mexico, Panama, and Trinidad and Tobago—had rates below 10%, approaching the rates in more developed economies.

Source: EIU (2006)

to private investment and finance. Similarly, national conditions, including political instability, will affect the investment climate. While the macroeconomic outlook affects the range of foreign investment, clean energy investment may be particularly susceptible, because of the multiple barriers it faces.

Tax benefits for renewable energy in Mexico. Mexico has in place rules allowing investments in renewable energy technologies to take advantage of accelerated depreciation rules under the income tax. *For additional information see Section 5.2.6 of this report.*

LAC countries have various types of direct and indirect subsidies for fossil fuels. For example:

- ✓ *In Chile, imports of coal, oil, and natural gas are all exempt from tariffs*
- ✓ *In Brazil, the price of diesel oil is subsidized*
- ✓ *Bolivia has a diesel subsidy that covers 50% of the price of fuel; phase-out planned for 2006 of this subsidy has been delayed*
- ✓ *Bolivia and Colombia also have subsidies that cover a 25% of the fuel bill of low-income consumers, defined in terms of kWh consumption per month*

Overcoming trade and financial barriers: Improving domestic refrigerator efficiency by conversion to hydrocarbons, Dominican Republic. In the Dominican Republic, there are about 2.4 million domestic refrigerators, and about 7,200 refrigerator technicians. The domestic, commercial, and industrial sectors consumer about 269 tons of refrigerants. This project, implemented by the Asociación Dominicana de Técnicos en Refrigeración y Acondicionamiento de Aire (ADOMTRA) with funding from the GEF's Small Grants Program, focused on training refrigerator repair technicians to substitute a natural hydrocarbon that is more efficient and climate-friendly than either CFC-12 (being phased out under the Montreal Protocol) or its major substitute, R-134a (which is a greenhouse gas).[28] The program also concentrated on obtaining the refrigerant and the equipment.

Obtaining the refrigerant, which must be imported from the United States, turned out to be difficult because of new customs restrictions. This delayed project implementation, but the problem was ultimately resolved and now local Dominican firms import the necessary refrigerants. In addition, the grantee, ADOMTRA, has established a revolving fund in order to help repair shops obtain the equipment they need for converting refrigerators. Some SGP grant money was set aside to provide capital for this fund. With this money, ADOMTRA purchased sets of tools and equipment. Technicians and/or shops apply to receive equipment. If approved, they pay 30 percent of the cost up front, and repay the remainder within a year. The repayments are used to purchase new equipment for distribution through the fund. Failure to repay the loan results in the equipment being taken back and given to other technicians.

Government actions to engage the private sector and create a friendly environment for investment include:

- ✓ *Policies to stimulate markets for clean energy technologies*
- ✓ *Reducing or eliminating subsidies for fossil fuels*
- ✓ *Including environmental costs in the price for energy services*
- ✓ *Strengthening intellectual property rights*
- ✓ *Raising consumer awareness of benefits of clean energy technology*
- ✓ *Developing product standards, instituting industry codes and certification procedures*
- ✓ *Fostering research in climate technologies*
- ✓ *Adapting technologies to suit local needs*
- ✓ *Assessing local technology needs*
- ✓ *Making markets more transparent*

Source: CTI (2001a).

Removing macroeconomic barriers to renewable energy in Honduras. With the help of a local developer (Honduras Power Partner), Enron Wind selected Honduras for a technologically advanced wind project. This project would not have been possible without government incentives. The incentives were provided by a 1998 Honduras "renewables law" that provides several incentives for RE projects: (1) guaranteed pricing (set 10 percent over marginal cost), (2) exceptions from income tax, value-added tax, and important duties for first five years.[29]

3.3 Institutional / Legal / Regulatory Barriers

Institutional barriers can arise at all levels of government and community organization, and can represent both the existence—*and the lack*—of relevant legislation or regulatory standards. In many countries, national legislation governs the production, distribution, use, and access to power, and so may present a barrier to growth in renewables. Similarly, lack of legislation setting regulations and official standards in support of decentralized power schemes is a critical barrier to the adoption of renewable energy in many developing countries. A lack of national or regional standards for equipment or fuel content can also prevent energy efficiency in the household, commercial, and industry sectors from reaching its full potential. Institutional barriers can arise also from the way local government institutions are structured or operate (e.g., the rules or criteria that guide decision making), or can relate to the management and administrative structure of organizations and groups at the community level.[30]

In LAC, hemispheric-wide regional appliance standards are hampered by differences in product markets. Countries in close proximity to the US, including Mexico, Central America and the Caribbean, tend to use similar products to those in the US, and import many products from the US. In contrast, countries in the Southern Cone of America tend to use products similar to (and often imported from) Europe.

Source: Bleviss et al. 2006.

As discussed below, due to cost and other barriers, renewable energy technologies may find it difficult to compete with lower-cost fossil-fueled energy. Even in cases where small-scale renewable energy systems could connect to the grid, they often face policy-based discrimination or unclear regulation in gaining access.[31] The lack of long-term national energy strategies (including energy efficiency, diversification of the energy mix, and renewable energy) can also affect the investment environment for clean energy.

Regulations that require generating plants to deliver power at a constant potency and tension present barriers to the sale of energy by non-conventional renewables. Because wind and solar, and even co-generation plants, are marginal to the system, their operations are less economically feasible. An exception is the provisions for the Jepirachi project in Colombia, where the government has prioritized energy coming from renewable sources.

From the investor's perspective, bureaucratic procedures for project approvals, complicated legalities, corruption, and lack of co-ordination between different authorities are viewed as key barriers to the selection of alternative technologies.[32] Procedures (permitting and other) that result in high transaction costs can be prohibitive for small projects. especially per kWh. Both investors and consumers can be affected by split incentive problems: those who make the decisions the determine energy efficiency are not the ones who pay for the energy (as in the case of property-owners and renters, or vehicle manufacturers and owners).[33]

The oil industry has completed the process of privatization in Bolivia, Peru, and Colombia. Consequently, energy efficiency policies for petroleum refineries have fallen out of the scope of national policy, and the view is that privatization should provide the necessary incentives for efficiency. This tendency might be reversed in Bolivia and Peru in the near future, if a more regulatory-oriented government is elected, or with the impetus of CDM.

Addressing institutional, legal, and regulatory barriers with local community organizations in Costa Rica. The list of potentially distortionary policies (both economic and administrative) and institutions is long. Laws can be designed specifically to address obstacles, such as laws to protect intellectual property. However, it may be productive to think in more positive terms of how a country may commit to creating an attractive environment for technologies, which may lead to the removal of the barriers, as has been the case in Costa Rica.[34] For smaller scale projects, the creation of local community organizations that maintain a knowledge base and management skills and build social cohesion can help to overcome institutional barriers.[35]

Addressing regulatory barriers: Interconnection agreements in Mexico. In previous years, regulatory arrangements in the Mexican National Electric System provided capacity credits. Conventional electricity generation sources, which provide peak hour generation capacity, could take advantage of these credits, while renewable energy sources could not. Consequently, renewable energy, which was in many cases at remote locations, was at a disadvantage in possible interconnection agreements, which connected it to the grid. In 2005 these rules were changed, providing renewable energy with additional incentives. *Additional information on this case study can be found in Section 5.2.2 of this report.*

Addressing institutional barriers in Mexico. The National Commission for Energy Savings was formed as a technical advisory body to the Mexican government in 1989, with support from the World Bank and the European Union. Since its inception, a number of programs developed by the commission have been implemented and have been very successful in achieving energy savings and clean energy investment in the Mexican economy. The programs have addressed a number of barriers, including the lack of standards for energy efficiency, although institutional barriers still remain. *Additional information on this case study can be found in Section 5.2.5 of this report.*

Enabling regulations and legislation in Mexico. In Mexico, the transport system has been growing rapidly in recent years, and now represents over 40 percent of total national emissions. Regulations have been introduced to limit pollutant emissions and increase fuel-economy in the sector, including establishing limits for gas- and diesel-fueled vehicles, and fostering alternative vehicle fuels. In addition, the Mexican Congress is currently considering a legal initiative (LAFRE) that would provide several incentives for renewable energy. These incentives include an 8 percent minimum renewable energy

In Chile, as in many countries, end-user energy efficiency is hampered by lack of information and markets and by biases:

- ✓ *Little energy efficient equipment is imported, and even less is produced nationally*
- ✓ *Reliable information about characteristics and cost of energy efficient equipment is unavailable*
- ✓ *Purchasers base equipment decisions on initial cost considerations, regardless of long term operating and maintenance costs*
- ✓ *Energy efficiency is conceptually associated with lack of comfort, or with rationing*
- ✓ *The number of professionals specializing in energy audits, efficient engineering design, or other professionals that can advise users is inadequate*
- ✓ *For consumers, turnover in appliances is slow because of financial considerations*

In Bolivia, Peru, and Colombia, ethanol programs are hindered by the lack of supporting legislation. For example, the public sector or public transportation systems are not required to use ethanol, nor is it included as a strategic component in National renewable energy plans. Similarly, there are no incentives (such as subsidies covering the incremental costs) for the private sector to switch to ethanol compatible engines. Programs in Bolivia and Peru—for co-financing for natural gas kits in public transportation—reportedly failed because of lack of support from energy, environment, and transport agencies.

In Bolivia, Peru, and Colombia, the majority of construction codes do not include energy efficiency, and some codes date from the 19th century. For example, the cities of Bolivia, and some provincial cities in Colombia and Peru, do not provide regulations for central heating of households, thus doubling expenditures for heating individual household portions. In Bogotá and Lima, some neighborhoods have introduced mandatory regulation for energy efficient buildings. Such regulations are not high priority in Ministries of the Environment, because of competition with more pressing pollution and other environmental problems.

generation goal for 2012, the development of a carbon fund (financed by taxes on fossil fuels) to support renewable energy investment, and a number of other activities designed to reduce financial, institutional market, cost and technical, and capacity barriers in Mexico. *For additional information on LAFRE, see Section 5.2.7 of this report.*

3.4 Information / Capacity Limitations

Lack of, or inadequate, technical knowledge hinders the adoption of clean energy technologies. Information gaps and weak technical capacity can occur throughout the chain of agents involved in technology transfer for clean energy—from the government to financial institutions, down through business and consumers.

Government agencies responsible for overseeing energy may also be less likely to encourage newer, renewable energy technologies, since they often do not have a long history in their use and deployment and so will be less knowledgeable about, and less confident in, them (especially compared to conventional sources of energy). Similarly, many financial institutions simply avoid renewable energy projects because they lack experience evaluating them.[36] Potential investors or consumers may lack information and knowledge about existing and emerging technology options, including how to select, use, and maintain an appropriate technology. [37] Smaller enterprises, particularly those located in more rural areas, or that are part of unorganized or informal sectors, may have less than adequate access to information, as well as to financing, technical support, and other requisites for project development.[38]

Projects for the rational use of energy in public transportation, such as the Transmilenio S.A. in Colombia, are difficult to replicate, although in concept they should be feasible in at least some cities. Main barriers to implementation in Bolivia, Peru, and Colombia include the risk inherent in the system, the lack of debt, equity, and mezzanine financing, the lack of political will by city governments, and the limited technical know-how to replicate the projects.

More generally, in many developing countries, increased use of clean technologies is further impeded by a lack of broader institutional capacity—specifically, the expertise and personnel to analyze energy and emission futures, identify mitigation opportunities, integrate climate efforts with other development priorities, execute economic reforms, and cultivate investment opportunities.[39]

Capacity building is important not only among policy makers and regulators, but also all along the energy supply and consumption chain. A number of small scale projects have been successful by focusing on technical capacity development and training local people to produce and/or use technology.[40] Thus, projects can address these barriers, at least in part, by strengthening the installation, repair, maintenance, and operational capability of technicians, institutions and community members and/or the capacities of educational institutions to train people to carry out associated jobs.[41] Involving local schools and universities, or the creation of media resources, can help to address knowledge barriers. [42] Building confidence through

According to one study of the provision of solar panels in Bolivia, the main barriers to private entrepreneurs producing solar home systems in rural areas are:

- ✓ *lack of information about the number and geographical distribution of potential rural consumers*
- ✓ *low income/ability of households to pay for systems*
- ✓ *lack of knowledge about costs and potential of solar home systems technology*
- ✓ *lack of consumer credit or subsidies to cover relatively high investment costs*

Source: World Bank (2005).

demonstration projects may be key, as well as the dissemination of best practices, training/education and exchanges.

Capacity building at the community level in Colombia. The Jepirachi Carbon Offset Project was implemented in 2001 under the auspices of the Prototype Carbon Fund. The purpose of the project is to develop a wind generation facility in the Wayuu Indian Territory, and includes a participatory social program of institutional and community strengthening for the indigenous population, including the design and construction of a water de-salinization plant powered by the wind energy facility, and rehabilitation and other services for the local school and health center. Despite studies estimating significant potential for renewable energy in the country, official plans have exclusively focused on thermal facilities. Thus, a number of barriers had to be overcome in designing and implementing the project. These barriers included the lack of any preferential treatment for renewable generating units when competing on the spot market with thermal and large hydroelectric plants, institutional considerations, and needed technical capacity building. *Additional information on this case study can be found in Section 5.5 of this report.*

Capacity building and removing institutional barriers at the community level in Bolivia: Solar-powered outdoor lighting in Arampampa.[43] The project, implemented by Agrobioenergy Assistance Program for Small Farmers and funded by the GEF's SGP, focused on remote areas in the high regions of the Andes Mountains, where villages do not have access to electricity. The villages currently depend on candles, batteries and diesel for energy and, due to the remote location, it is unlikely that the grid will reach them any time in the near future.

The Project was carried out in three stages: (1) the community was organized for the project; (2) the equipment was installed; and (3) community members were trained in system management. All activities were conducted via participatory workshops, including design of the network, administration and management systems, and cost calculations and rate setting. The project established an Energy Services Committee in the community, which managed the installation of outdoor lighting for the entire community, as well as indoor lighting for 30 percent of the community. The SGP cites this project as example of institutional capacity development, and states that adequate participation in decision making about design and rate setting by the community is essential. The formation of the committee made this possible.

The new electric system can be integrated into the overall plan for the development of the village. The community of Arampampa has distributed technical information about their system to 54 neighboring communities, and there are plans in the medium turn for the electric grid to extend to this region north of Potosi. The community plans to maintain its solar electricity generating system, and the solar mini-grid will be integrated into regional plans for electrification.

Micro hydropower in El Limón in Dominican Republic. The GEF's SGP has a number of projects that focus on capacity building and institutional development at the community level. In addition the Camata, Bolivia project, another example is this micro-hydro project in Dominican Republic.[44] This project was intended to provide electricity for isolated communities in rural areas of the Dominican Republic where the grid is not expected to reach in the near term. Currently, the population uses kerosene for lighting and costly batteries for other electricity needs. A physicist from Cornell, during a visit, came up with an innovative idea of using the existing crop irrigation system (built in the 1990s) for micro hydropower.

As a result of the irrigation project, the community had strong existing organizations, and so the community was able to integrate the project into other development projects (including school lighting and protection of forest resources, which help prevent degradation of the watershed). The infrastructure took 18 months to build, with all the people in the community giving one day a week to the project. Tariffs are approximately what each household paid for previously for kerosene. Interestingly, the system distributed electricity at 240V, instead of Dominican Republic standard 110 V, to reduce power loss, avoid the purchase of a step-up transformer for the powerhouse, and to reduce the likelihood of outsiders stealing power (because 240 V appliances are not widely available), which is a common problem in the Dominican Republic.

3.5 Social /Cultural Patterns and Business Practices

Current lifestyles, behaviors, and consumption patterns are all important cultural practices from the perspective of technology transfer. Some cultural practices relating to the use of energy or energy resources may hinder the adoption of energy efficient or renewable energy technologies. Practices vary, depending on a community's belief and/or traditions. For example, while some communities will not use human waste to produce biogas, others will not use cow manure.[45] In some cases, cultural practices dictate cooking methods and influence the type of stove or fireplace a household will acquire.[46]

Consumers or investors may have cultural biases or practices that limit the adoption of clean technologies. For example, they may mistrust new or unfamiliar technologies, or lack confidence unproven technologies. Business or financial institutions may be highly averse to risks (perceived or real), tending to favor large projects and familiar technologies.

Addressing social and cultural barriers: "Sol de Vida:" Solar cooking in Costa Rica.[47] This project was implemented through Fundación Sol de Vida (an NGO). In the Guanacaste region of Costa Rica wood is the primary cooking fuel. The project is largely oriented towards capacity building. The technology used is a solar cooker, which consists of a wooden box that is set inside another box, surrounded by insulation, and covered by two panes of glass through which sunlight passes to heat the cooker to an average inside temperature of 150°C. The cookers have been installed in a number of communities using a 5 steps process (1) assessing feasibility by lending a cooker for 6 months; (2) demonstrating interest by holding a workshop; (3) holding a construction workshop in which solar cookers are built (4) follow-up training on maintenance and use (5) establishing an independent organization in each community that can seek funding and support.

This SGP project overcomes barriers in several ways. Cultural barriers are overcome by demonstrating the technology and holding educational and participatory workshops; because the women build the cookers themselves, investing time and energy, there is a great chance that the new form of energy use will be integrated fully into the lifestyle of the community. The project builds institutional capacity not only in solar cooking, but also has created a community organization—an autonomous women's group—that can take leadership in other projects to benefit the community, including micro-enterprises, community gardens, and chicken and pig-raising cooperatives. The cooker can be built with $100 to $150 worth of locally obtainable materials. As of 2003, 130 families had switched primarily to solar cooking from wood, electricity or gas. Sol de Vida's model has been spread to other countries in Latin America by the Central American Solar Energy Project (CASEP).

3.6 Cost and Technical Barriers

A fundamental challenge to renewable energy technologies is that there are circumstances in which technologies cannot compete with conventional alternatives in the marketplace. Difficulties may arise because newer clean technologies are not yet sufficiently demonstrated and developed, because of economies of scale in production that initial demand cannot justify, or because of local circumstances and available resources. This is particularly the case in many parts of Latin America, where renewables must compete with lower cost fossil-fueled sources and with cheap, large-scale hydropower in an open market. In addition, tax and subsidy policies in countries that favor fossil fuels and conventional energy supplies compound fundamental cost differentials.

An ESMAP study found that the greatest barrier to the widespread development of the biofuel industry was economics. For example, feedstock costs account for 58 to 65 percent of the cost of ethanol in Brazil, and so the commercial viability of ethanol is critically dependent on the cost of cane production. In other countries, costs are higher than in Brazil, primarily due to different production structures. Thus, developing a viable bioethanol industry will require both lowering costs of cane production and achieving a minimum scale in the market. .

Source: Masami and Johnson (2005).

Technical barriers, in the sense of feasibility and applicability, are exacerbated by network considerations. For example, the attractiveness of vehicles using alternative fuels depends on the availability of convenient refueling stations. At the same time, the needed infrastructure won't generally be developed until the demand exists for alternative fueled vehicles.[48]

Clean energy is not typically at the top of the political agenda in Latin America. Consequently, raising awareness at a national level requires connecting clean energy issues to sustainable development priorities. [49] Technology assessment can help countries identify technology needs that match development and environmental goals, and reflect differences in a country's capacity to adapt and absorb technology, infrastructure, human and natural resource availability, culture, policies, and economic environment. Often, the most effective technology transfers will focus on products and techniques with multiple benefits.[50]

The Brazilian petroleum industry was built to process light crude and to maximize the production of light oil products. Now, however, refineries must process heavy oil and maximize the production of medium distillates. The needed additional investment for the sector makes other changes—such as increasing the energy efficiency of existing refineries—a lower priority, given limited resources.

Lack of income can be a hindrance in the acquisition of clean energy technologies. Where potential users of new technologies are resource and cash-poor, they are unable to pay for and acquire cutting edge equipment.[51] The GEF SGP had a number of projects where owners of patent rights to technologies shared these technologies, or formed partnerships, with communities in developing countries.[52]

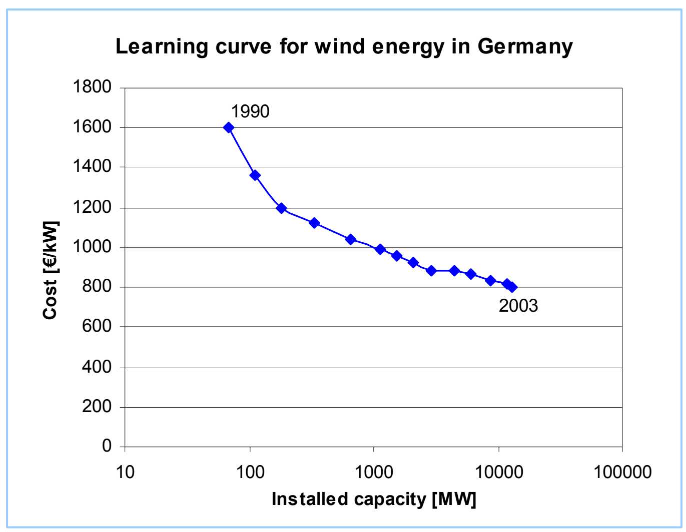
The electricity sectors in Peru, Colombia and Bolivia are very much alike. The state owns the resources, in the case of hydrological resources, or buys the fuel from private operators, in the case of fossil fuel plants. Generating plants and transmission / distribution networks are owned and operated by private contractors. In some cases, municipalities own some generation installations and some local distribution networks. In Colombia, some regional development corporations also own equipment and networks.

Addressing cost disparities with subsidies and political will: Brazil's Program to Encourage Alternative Sources of Energy (PROINFA). PROINFA began in 2004. The first phase of this program had as its goal the addition of 3,300 MW of renewable energy—wind power, biomass energy, and small hydropower—to the interconnected system by 2006. The program adopted a combination of approaches to achieve this goal, including long term contracts with Independent Power Producers, and reduced tariffs for access to transmissions and distribution systems for plants generating electricity from qualified renewable sources. The first phase was successful—particularly in promoting wind energy at an unprecedented level in Brazil—with a public bid process that resulted in projects delivering the 3,300 MW goal. The orientation of the second phase of public bids, which was intended to focus on longer-term goals for renewable capacity, has been altered by a new administration that took office in 2003. New rules aim to minimize the price of electricity to be paid by final consumers, and so it is unlikely that new power generation sources will include renewable energy sources.

The initial success of this program suggests that price subsidies combined with political will and regulatory/legal/institutional support can be successful in increasing the generation of on-grid renewable energy and doing so in a way that fosters the development of a local industry and brings down the cost of manufacturing over time. However, even the success of the first phase was limited, because the electricity price was insufficient to attract power generation from biomass (sugar cane bagasse), suggesting that additional incentives, such as CDM, will be needed to provide an incentive (given price differentials) to induce the initial necessary investment in new generation capacity. Moreover, the difficulties with the second phase indicate the importance of political will that persists over time. *Additional information on this case study can be found in Section 5.1 of this report.*

Overcoming technical infrastructure and cultural barriers: Transport corridors in Mexico City. This case study indicates how it is possible to reduce emissions and energy consumption by the transport sector in Mexico. The approach taken was to develop bus-only corridors on major city avenues, in order to reduce vehicle miles traveled for automobiles. To implement this system, designers needed to develop the infrastructure (the bus-only lanes), and gain support (and assistance) of former owners of low-efficiency buses. The project overcame several types of barriers—institutional and infrastructure, as well as cultural barriers. *Additional information on this case study can be found in Section 5.2.3 of this report.*

Encouraging innovation and bringing down technology costs. Some technologies may not be economically viable currently, but could become so over time, given technological innovation or a wider market that allows for the introduction of scale economies. Thus, while most funds and programs do not focus on the marginal or emerging technologies, or on encouraging innovation, these technologies will likely be essential to meeting long-term environmental and climate change goals. As illustrated in the chart, programmatic and financial support can bring down the cost of technology significantly over time. Germany instituted several incentives for wind energy, including a feed-in law fixing a guaranteed price for 20 years, government financing of low-interest loans, and income tax breaks.[53] Between 1990 and 2003, the cost of wind energy declined significantly, as the required technology improved and became more fully deployed.



3.7 Lack of Competitive Markets

The lack of open, competitive markets can be a barrier to increased use of clean energy, even in cases where technologies are commercially viable. Markets can be impeded from functioning efficiently by:[54]

- lack of market competition (e.g., monopoly-dominated markets, including cases where key energy resources are nationally owned), which prevents the emergence of more efficient production
- undefined property rights or no protection of property rights, which limits the incentives that developers have to sell technologies
- lack of confidence in economic, commercial, or technical viability, a particular problem for energy efficiency technologies
- lack of manufacturers of new technologies, and difficulties competing with mature technologies
- lack of consumer awareness and acceptance of technologies
- non-existence or lack of profitable operation of independent energy providers and project developers
- lack of small and medium-sized enterprises (SMEs) for demonstrating, disseminating, and deploying the technology
- Lack of environmental pricing, i.e., failure to include the full environmental cost in the prices of conventional fuels

In Mexico, one barrier is the state control and monopoly of energy, combined with the importance of the energy sector in Mexico's economy. PEMEX, the state owned oil company, is the largest in the country, and a large share of the Mexican national budget is generated from PEMEX revenues.. In 2003, nearly three-quarters of the national electricity total was produced by state-owned entities. The state is also the sole owner of the transmission networks.

FENERCA: Capacity Building. To help create viable markets in many developing countries, projects are now focusing on the development of robust small-scale energy enterprises, especially in rural areas. These projects provide start-up or "seed" capital funds—a loan that is later repaid—and entrepreneurial and business development assistance. The loan is made at interest rates and repayment periods suitable to small scale energy enterprises. The underlying concept is to help establish a viable business, which can later induce investment from more traditional financing sources.

The Multilateral Investment Fund (MIF) of the Inter-American Development Bank has developed an innovative approach to SME investment. Using both grants and investment mechanisms, MIF supports small-scale targeted interventions that pilot new approaches and act as a catalyst for larger reforms. Features of MIF projects are:

- ✓ *Innovation—introducing new approaches*
- ✓ *Demonstration effects—potential for replication*
- ✓ *Sustainability—include a plan once MIF resources end*
- ✓ *Partnership—over 75% are with private sector partners*
- ✓ *Additionality—MIF resources must be critical to outcome*

Resources are targeted on four core activities: (1) small business development (2) market functioning (3) micro-enterprise (4) financial and capital markets.

Source: IADB (2005).

The USAID sponsored a project, "Financiamiento de Empresas de Energia Renovable" (FENERCA), to stimulate enterprise development and investment in renewable energy in several Central American countries, Brazil, and several African countries. The project, which is being implemented by E+Co, has been operating since 2000, with the assistance and support of the Central American Biomass Users Network (BUN-CA), and the UNDP/GEF-sponsored project "Creation and Strengthening of the Capacity for Sustainable Renewable Energy Development in Central America" (FOCER).[55] FENERCA provides loans (or small equity investments, in limited cases), and business services such as market studies, business planning, financial analysis and structuring, and the development of management capacity. FENERCA also works with financial institutions to evaluate the technical, financial, and business dimensions of specific renewable energy projects. If FENERCA is successful as planned, investors will increasingly participate in renewable energy projects, resulting in an independent and viable market.

The Central American Renewable Energy and Cleaner Production Facility (CAREC). An outgrowth of the FENERCA program, CAREC (also managed by E+Co) was initiated with core financial and institutional support from the Multilateral Investment Fund (MIF) of the Inter-American Development Bank, and expects to begin operations in April 2006. CAREC will invest in renewable energy, energy efficiency, and cleaner production projects in Central America. The focus will be on small- and medium-sized enterprises. The facility is structured to use mezzanine-financing mechanisms such as subordinated debt, convertible debt, and other quasi-equity instruments. In addition to MIF, CAREC's investors include the Central American Bank of Economic Integration (CABEI), and others. The USAID Development Credit Authority (DCA) has also approved a US$5 million loan guarantee to be used in support of private sector debt to the fund.

SMEs, such as Energy Service Companies (ESCOs) can help the market to function, and are lacking in many developing countries. In developing countries there are an estimated 305 ESCOs with a total value of products of US$191 million, compared to 991 ESCOs in developed countries (excluding the US), with a total value of US$401 million.

Industrial Co-Generation with Power Sales to the Grid in El Salvador.[56] In 1996, the electricity reform law in El Salvador set the stage for a competitive power market, by allowing privatization of electricity production, transmission, and distribution. The law allowed private companies to compete with the state-owned Comision Ejeutiva Hidroelectrica del Rio Lempa (CEL) and allowed foreign ownership of electricity companies. Ingenio San Francisco (Ingenio) owned a sugar refining operation that burned bagasse in a co-generation unit to provide electricity and steam. In 1995, the facility upgraded its facility and increased power production for sales to the grid, partly because of an incentive offered by the national electric company to purchase power from new sources under one-year renewable contracts.

Based on the success of this project, Ingenio decided to increase its electric generating capacity. The project was divided into 2 Phases adding 5 MW capacity each. The first phase was completed successfully and resulted in relatively low-cost electricity generation. Phase II, however, ran into a number of barriers. Initially, financing was difficult to obtain, and took about a year to put into place. Difficulties included finding collateral for a loan, and obtaining a loan with a long enough payback period. Subsequently, the project faced financial difficulty due to a financial crisis in the sugar industry, reducing the supply of bagasse to the power plant.

The Ingenio experience has several lessons:

- ✓ *Competitive energy markets can encourage renewable-energy development*
- ✓ *Portfolio requirements, tighter emissions controls and other measures that establish a value for environmental benefits can help renewables*
- ✓ *Power generation based on an agricultural commodity with wide cyclical price fluctuations is more secure if contracts for diversified and technically compatible fuel sources are put in place.*

Source: CTI (2001a).

Creating viable markets via the Prodeem Program in Brazil.[57] Brazil's Ministry of Mines and Energy undertook the Prodeem program to meet energy services demand for off-grid communities.

The quasi-monopoly status of Brazilian oil company Petróleo Brasileiro S.A (Petrobras) makes it difficult to regulate. While the company ceased to be Brazil's oil monopoly in the late 1990s, it remains a significant oil producer, with output of more than 2 million barrels of oil equivalent per day, as well as a major distributor of oil products. The company also owns oil refineries and oil tankers.

Initially, the program started as a “give away” project—government agents bought renewable energy equipment (such as PV panels, mini-hydro turbines, wind turbines, and biomass fuels), transported it to remote communities, and installed and demonstrated it. Because of the top-down and resource intensive approach it took, the program was expensive and ineffective. Consequently, government adopted a different approach, which was more effective: putting delivery into the hands of local entities, who are managed and trained by the government. These local entities work to aggregate the demands of several communities to create enough demand to support the technology, they design financing to match community buying power, and they buy related equipment (like water pumping equipment). The program also focuses on forming partnerships with local businesses, NGOs, utilities, manufacturers, and banks.

SIEPAC: establishing a regional energy market. The Electricity Interconnection System for the Central American Countries (SIEPAC) has two main objectives: supporting the establishment and consolidation of a regional energy market, and improving the power infrastructure of the region, which will allow transfers of energy among the participating countries.[58] Financing for the SIEPAC comes largely from the IDB, through similar $30 million loans to each member country.[59] The initiative is led by the energy authorities of the Central American Countries with the support of an interagency group including the General Secretariat of the Central American Integration System, the Secretariat of Central American Economic Integration, the Economic commissions for Latin America and the Caribbean (ECLAC), the Central American Bank for Economic Integration (CABEI) and other groups.

The premise of the SIEPAC project is that creating an integrated energy market across country borders requires both a common physical infrastructure and a common policy and regulatory framework to oversee the market. In the current context, it can be argued that a regional energy market is a precondition for created an integrated market for clean energy as well. [60] By lowering the costs and risks inherent to energy distribution, the construction of a regional power line is expected to stimulate sizable investments in additional energy generation through the construction of hydro-electric, geothermal, natural gas, and biomass power plants. Some consumer advocates and environmentalist have opposed SIEPAC, however, on the grounds that the potential benefits for poor households in terms of access to electricity will be outweighed by higher power prices and a lack of consumer protection, and by adverse environmental and social consequences, resulting from increased vertical and horizontal integration and concentration of power generation, distribution, and marketing activities across countries in a largely unregulated market.[61]

4 Barriers to Clean Energy: The Case of Electricity Generation in Selected Countries

Structural reforms in the electricity sector in many countries are rapidly increasing the participation of the private sector and changing the direction of investments.[62] The transition to more competitive energy markets in the region has had mixed impacts on grid-based renewable energy. On the positive side, it has helped facilitate investment in supply and improved efficiency, and offers new opportunities for independent suppliers to operate. However, the emphasis on economic efficiency, low energy prices, and short-term power contracts, tend not to favor investment in grid-connected renewable sources, which are capital intensive relative to conventional technologies and sometimes produce power intermittently.

Moreover, in some cases policy barriers restrict what sources can feed into the grid and at what cost. Regulations governing small energy producers, vs. large energy producers, may be unclear. For off-grid projects, while reforms have opened rural energy markets to increased private investment, the policy and regulatory framework to encourage such investment may be lacking. Below, we describe barriers to expanded use of renewables to generate electricity, in selected countries in Latin America.

Table 2. Barriers to Renewable Energy Sources in Central America

BELIZE	✓ Majority of domestic electricity generation is distributed by one company—Belize Electricity Limited (BEL)[63] ✓ The participation in the market of a subsidized electricity generator ✓ The lack of policies encouraging generation with renewable resources
GUATEMALA	✓ A 10 MW minimum generation capacity requirement ✓ Permit (required by law) costs are independent of size or type of project
HONDURAS	✓ Different procedures spread out across many agencies ✓ Instability of laws in the sector, which have gone through numerous changes over time
NICARAGUA	✓ Tax exemption for fossil fuel used in thermal generation plants ✓ Lack of clear guidelines for import taxes on renewable energy equipment, which taxes are interpreted subjectively
PANAMÁ	✓ Tax exemption for fossil fuel used in thermal generation plants ✓ Transmission tariff depends on the distance between point of generation and point of consumption (which tends to be greater for renewable generation which is located further) ✓ Time limits established for energy sale contracts are too short to ensure renewable project profitability ✓ Permitting procedures, even for small projects, is slow and costly
EL SALVADOR	✓ Procedures to exploit hydraulic and geothermic resources are time-consuming and expensive ✓ Permit (required by law) costs are independent of size or type of project ✓ A 5 MW minimum generation capacity requirement
COSTA RICA	✓ High interest rates, lack of training and knowledge of financial entities ✓ Lack of training in the supply chain: manufacturers, promoters, consumers, etc.

4.1 Central America

A recent study of barriers to the increased use of renewable energy sources for electricity production in Central America identified numerous barriers for individual countries (see Table 2 above).[64] Renewable sources of electric power face similar policy, economic, and institutional barriers in other countries in Latin America.

4.2 Andean Countries: Bolivia, Peru, and Colombia.

The electricity sector in these three countries is very similar. The state owns the resources (in the case of hydrological resources), or buys the fuel from private operators (in the case of fossil fuel plants). The generation facilities and transmission/distribution networks are owned and operated by private contractors (although legally, in the majority of cases, every transmission/distribution network is considered to be public property). Even in these cases, the state has the first option to buy these installations in case of retirement of the private operators. In some cases, municipalities (in all three countries) own some generation installations and even some local distribution networks. In Colombia, some regional development corporations also own equipment and networks. Prices are set by competitive bidding. All three countries have elaborate laws governing the electricity sector, and do not have preferential treatment for renewable energy in terms of financial incentives, pricing systems, or technological support.

Colombia and Peru have programs (sometimes referred to as cross subsidies)[65] that reduce the price of electricity for poor residential consumers. Bolivia has a direct subsidy on the diesel oil price, which is covered with public funds, and this also distorts the cost structure in favor of fossil fuel generation. A plan for a gradual phase-out of the diesel subsidy was passed in 2001, but has been stalled in its progress by political considerations.

The barriers described in Section 3 can be grouped into three categories, focusing on those that are most important to renewable energy and the electricity sector in these three countries: barriers that affect supply, demand and framework conditions (see Table 3 below).[66] Among barriers to supply, we distinguish the ones that derive from RE characteristics, the project sponsors, and the commercialization and marketing, as shown in the table below. To these barriers are added the necessary technical skills for establishing RE in the field, and an adequate provision of professionals in this area. Barriers that affect demand operate on the level of individual consumers and network operators. Finally, barriers that affect the framework conditions include policy and the legal regulations that affect the RE sector itself and the energy sector in its entirety. Further, the prevailing price structure does not take into account external cost and benefits in the electricity sector.

The constraints in Table 3 affect the RE sector in the three countries to different degrees, always taking into account that the energy market is more developed in Colombia than in Peru and, in both cases, much more than in Bolivia.

The major constraint for the establishment of new on-grid, full-scale hydroelectric plants is, especially in Bolivia and Peru, the size of the market, with the apparent paradox that in both countries the majority of rural population lacks electricity, but that the supply of grid-connected electricity to remote villages is not economically feasible. In Colombia, the major constraint is the availability of water resources for the expansion of the hydroelectric system, as well as terrorist activities that hamper greater investment in the sector, because of the risk of guerrilla warfare.

Table 3. Barriers to Renewable Electricity Generation in Peru, Colombia, and Bolivia

Supply	***RE characteristics***	✓ Newer technologies ✓ Higher operating risks ✓ Smaller project sizes ✓ Higher transaction costs ✓ Longer lead times ✓ Higher development costs ✓ Higher ratio of capital costs to operating costs ✓ Need for longer-term financing at reasonable rates ✓ present technologies not yet fully competitive
	RE Project Sponsor	✓ Less experienced sponsors ✓ Higher completion and operating risks ✓ Low level of own funds for investment cost contribution
	Commercialization and Marketing	✓ Commercialization barriers faced by new technologies competing with mature technologies ✓ Lack of commercial business models ✓ lack of established infrastructure of some RE technologies
Demand	***Awareness and Willingness***	✓ Society lacks of awareness or familiarity with renewable energy practices ✓ Limited cultural acceptance of renewable energy technologies ✓ Power grids operators are reluctant to deal with decentralized suppliers of energy
	Adequacy and Cost	✓ Electricity consumption too low for financial sustainability (not enough productive use) ✓ Low demand at relatively high initial cost for individual investor-clients ✓ Low demand from power grids on base of actual LRMC level
Framework Conditions	***Policy and Legal Framework***	✓ Independent power producers may be unable to sell into common power grids ✓ Transmission access and pricing rules may penalize smaller and/or intermittent renewable energy sources, Utilities may set burdensome interconnection requirements ✓ Permitting requirements and location restrictions may be excessive. ✓ Requirements for liability insurance may be excessive
	Energy Sector Competition and Bias	✓ Low cost of energy from conventional sources ✓ Price distortions from existing subsidies and unequal tax burdens between renewables and other energy sources
	Market Performance	✓ Failure of the market to value the public benefits of renewables ✓ Lack of environmental externality cost in the current price of fossil fuels - market barriers such as inadequate information
	Financing	✓ RE unfamiliar to financiers due to lack of information ✓ RE often considered not attractive, because high risk without adequate risk compensation in form of risk coverage instruments or higher returns ✓ Financing hardly available for projects and customers due to lack of funds and/or lack of instruments

On-grid mini-hydros are not the types of projects preferred by financing institutions or project developers, and there is no regulation to compensate for the relatively higher generation costs of these installations when their output is directed to the grid, unlike some other countries (such as Chile) where the dispatch regulation prioritizes power coming from renewable sources (up to a certain level).

For off-grid mini- and micro-hydro, the main constraints appear to be, on one hand, the scarce amounts of commercial investment available for small hydro projects, and the lack of technical expertise on these systems, with Colombia and Peru faring better in technical expertise than Bolivia. The most successful projects of mini- and micro-centrals are financed by grants or low-interest loans coming from international cooperation programs.

Case Study: Micro Hydro Power for Agro-Processing in Rural Areas, Bolivia.[67] In Bolivia, only about 25 percent of the rural population has access to electricity, and it is unlikely that the grid will be extended anytime soon. Micro-hydropower, where feasible, is the least costly of the renewable alternatives. However, most of the use occurs in the evening (domestic uses), while the electricity generated during the day is not fully used. Linking the power installation to productive applications both makes use of the power generated during the daytime and generates income for community members. This SGP project built a micro hydro power plant in Camata, a subsistence-level village where inhabitants make their living primarily from growing chilies, coffee, and corn. The project provides electricity for domestic and public needs, and powers an agro-processing unit that enables the community to process their own agricultural products and sell them directly to the market.

This project overcame barriers in several ways. First, it developing needed community institutions. Specifically, as part of the project the community organized a Committee for Electrification, which took the lead in constructing the micro hydro system and the processing plant. This cooperative organized the labor and supplies needed to build the project, and now manages both the power plan and the processing unit. Second, the project increased the capacity of community members since they have learned how to manage a micro hydro system and agro-processing plant. This example is discussed in more detail in Section 5, on case studies. *Additional information on this case study can be found in Section 5.4 of this report.*

4.3 Brazil

The bulk of electricity generation in Brazil is controlled by the government. Eletrobras[68] is a holding of regional utilities, with open capital but control retained by state governments (federal government in the case of Eletrobras). There are some private utilities that have power generation plants (both hydro and thermal). Transmission is owned and operated by a private body with the specific mandate of dispatching. Each of the 26 Brazilian states used to own a distribution facility, but all were privatized in the 1990s.

In Brazil, two national programs—Programa de Incentivo a Fontes Alternativas de Energia (PROINFA) and Programa de Combate ao desperdício de Energia Elétrica (PROCEL)—are intended to increase electricity generation from renewable sources to be connected to the grid and energy efficiency, respectively. Eletrobras, however, places low priority on promoting clean energy sources, creating conflicts and lack of continuity in governmental efforts to promote clean energy. In addition, the “new regulatory framework for the power sector” aims to ensure the lowest tariff to final consumers, creating additional barriers to new renewable energy sources of power generation (see case study on PROINFA in Section 5 below). Moreover, a too-narrow definition of Independent Power Producers (IPPs) hampers the investment of larger groups on new renewable energy sources

In off-grid systems in the North and Northeastern regions of Brazil, which are isolated from the national grid), barriers include:

- subsidy to the price of electricity generated by diesel oil generators in isolated areas (a cross subsidy from consumers connected to the grid generally to consumers located in isolated systems)
- income from taxes imposed on diesel oil is important financial source for states, making it more difficult to replace diesel oil with new renewable energy sources
- *Light for All* program underway to supply all Brazilian households with electricity supply between 2008 and 2015 does not include new renewable energy sources for power generation

4.4 Chile

In Chile, the generation, transmissions, and distribution of electricity is carried out primarily by the private sector. State participation is limited to regulatory, supervisory, and subsidiary roles. Companies are, thus, free to make decisions concerning investments, marketing, and facility operation, as long as they comply with the regulatory framework for the electricity sector. The use of renewable energy and energy efficiency in Chile faces many of the institutional, policy, financial and other barriers described above.

Geography of Chile. The use of renewable energy for electricity generation in Chile is hampered by the geography and population distribution in Chile. For example, many renewable energy resources are "tied" to the place where the resource is, which is generally not where consumption centers are. The result is that many potential projects cannot be undertaken because they depend on local demand, which is insufficient. Further, Instead of being brought to market through a centralized grid, in most cases electricity generated from renewable sources can only be brought to market with the coordinated involvement of a wide and varied range of economic actors—to provide financing, training, and network support—not all of whom will be available in the geographical area where the technology is being applied.

A large quantity of biomass matter may be available in agricultural communities during the harvest season, but may become scarce during the growing season. Thus, capacity planning, not always present, is required in order to guarantee a continuous supply of biomass, and assure a steady output from the power plant.

Structure of the electricity sector situation. Whether for technical reasons relating to system reliability or for regulatory reasons, constraints have been placed on the maximum permissible capacity of electricity generating systems that use renewable energies, preventing these from being fully exploited. Further, because power output is subject to fluctuation in wind speed, wind-based projects are not regarded as “firm capacity” and thus receive lower prices.

In liberalized electricity markets, small and medium-sized projects capable of providing the electrical system with energy and capacity are faced with high costs of entry to wholesale markets. They also face another major barrier: the power threshold that a producer must meet in order to qualify for long-term contracts with large consumers. Below this threshold, producers must sell their electricity services via the spot market, which results in uncertain cash flow and so further constrains financing options.

Because they are situated at the end of the grid or, in the case of hydroelectric plants, can operate as voltage regulators, generating plants that use renewable resources contribute to the soundness and reliability of the electricity system, but this is not taken account of in political decision-making.

Financial market barriers. Projects to use renewable energy face higher development costs than conventional projects based on fossil fuels. This is due, among other reasons, to (i) their land use characteristics; (ii) a lack of experience in evaluating projects of this type; (iii) small-scale renewable energy projects have to go through all the same formalities as larger-scale ones, and (iv) environmental impact assessments are more complex than for projects using fossil fuels.

Renewable energy projects have high investment costs and low operating costs. For this reason they require high levels of financing and long repayment terms. However, in most electricity markets there are no contracts with terms of over three years, and this is a serious impediment to obtaining conventional financing.

Tax and subsidy policies. In cases where taxes are being levied on company investment, renewable energy projects are put at a disadvantage because they are highly capital-intensive compared with conventional energy that requires less investment per unit of installed capacity. Because cost allocation in Chile does not include externalities, the generating costs of renewable are notably higher than those for fossil fuels.

Institutional/legal/regulatory considerations. The need for economic development places environmental priorities lower than the development of low cost energy resources. Many of the benefits of renewable energy projects stem from aspects unrelated to the price of the electricity generated, which is the main and immediate concern of the energy authorities. Benefits resulting from the exploitation of renewable energy—for example, the protection and reforestation of river basins, stewardship of forests, the development of poor regions, the creation of well paid jobs, the protection of the environment or the development of production chains—are not part of the mandate of those who make the decisions or set the rules for participation in renewable energy projects, so that these benefits are not taken into account or are given insufficient weight in these decisions, most of which are taken by energy policy makers.

In addition, institutional weakness—the lack of a clear strategic framework and trained professionals—and politicized management of the needs of the population are major barriers to the economic sustainability of projects using renewable energies for rural electrification. It is frequently cheaper to provide electricity by creating stand-alone renewable energy systems than by extending the main grid, in areas where there is currently no electricity supply. However, policy makers continue to give priority to extending the grid often because this is the capacity and infrastructure that exists, whereas the cheapest option might require the development of new capacity.

Limitations in capacity and information. Because renewable energy projects are new and demand is limited, there is little expertise in project design and development in the country. This makes it necessary to engage foreign technicians with much higher labor costs, which makes projects more cumbersome and costly.

Cultural barriers. Despite their inherent environmental value, hydroelectric generation installations involving dams are unpopular due to the way projects of this type were implemented in the past, including non-negotiated expulsion of entire communities, chiefly indigenous ones, with little compensation, and the destruction of flora and fauna in zones adjacent to the dams, among other radical measures.

4.5 Mexico

Generation in Mexico is based predominantly on the abundant hydrocarbon resource allocation, and the extensive–although on occasion obsolete—generation infrastructure already in place to use it. Moreover, the state has a dominant market presence, and is the sole owner of the transmission network, and fuels are obtained from a state owned oil monopoly. The state lacks the resources to replace obsolete generation capacity, while existing resources must compete with other resources in the Mexican state. While there is extensive hydropower capacity, their use is hampered to an extent by water resource scarcity. Generation is allowed under a specific and rather limited set of figures, while transmission and interconnection tariffs have until very recently operated on a disadvantage for renewable generation, and have not considered (until last month) the creation of grid capacity for the renewable energy sources. Further, energy and electricity policy coordination mechanisms, while effective to insure fuel provision from the oil monopoly to the dominant electricity market player, has frequently been inadequate to promote energy diversification, enhancing difficulties in transmitting renewable energy due to state utility control over transmission grids and distribution.

The regulatory regime operates under a specific lower-cost mandate, and employs the short term marginal cost as a standard for pricing, which in fact implies comparing renewable energy with high efficiency gas turbines, No renewable portfolio standard exists. Long and medium term energy modeling includes marginal or no consideration for environmental externalities, while little if any consideration has been given in the past for fuel risks (although this is now changing), and no framework exists to evaluate costs of carbon and long term environmental impacts in energy modeling (these are considered later, as energy planning takes effect). Likewise, in spite of recent improvements, electric subsidies are usually not efficiently applied, and tend to gravitate to urban mid level to high-income users. This encourages higher energy consumption, while providing little protection against energy poverty.

Finally, there is incomplete knowledge concerning renewable energy resources, information on resource availability is scarce and one-stop-shops for clean energy opportunities, while existing, have not developed to the extent needed.

5 Case Studies for Selected Countries in Latin America

This section presents case studies illustrating barriers in five countries: Brazil, Mexico, Chile, Bolivia, and Colombia.

5.1 Brazil: PROINFA[69]

The Program to Encourage Alternative Sources of Energy (PROINFA) aims to increase the participation of wind power, biomass energy and small hydropower (SHP) in the supply of the Brazilian grid system. The first phase of PROINFA plans to add 3,300 MW (equally divided among wind power, biomass energy and SHP) to the interconnected system by 2006. The incentive is given through signed contracts[70] between Eletrobrás[71] and Independent Power Producers (IPPs), ensuring the purchase of energy for 20 years at attractive prices, i.e., prices high enough to cover the higher generation costs of renewable energy producers. The main features of PROINFA's first phase were established by the Law 10,438/2002 (altered by Law 10,762/2003), and are summarized as follows:

- The additional cost of this energy will be equally afforded by all household connected to the grid, excluding Low Income Consumers (up to 80 kWh/month, plus a second group under special conditions to be defined by ANEEL[72] - up to 220 kWh/month).
- The Law defines an Independent Power Producer as a company that is not controlled by any other company involved in generation, transmission or distribution of power
- Equipment manufacturers may participate as Independent Power Producers. However, a minimum of 60 percent of the equipment value must be manufactured in Brazil
- ANEEL was assigned the task to regulate tariff reductions of at least 50 percent for access to transmission and distribution systems for plants generating electricity from wind, biomass and qualified co-generation[73]

The price of the energy purchased was defined by the government as a specific economic value (premium price) assigned to each source, as shown in the table below:

Table 4. Energy Purchase Price in PROINFA

Renewable Energy Source	Economic Value – US$/MWh (March 2004) US$1 = R$2.89	Corrected Value by index IGP-M (inflation index) US$/MWh (July 2005) US$1 = R$2.35
Small Hydro Power	40.44	56.06
Wind Energy	62.27 – 70.62	86.32 – 97.90
Biomass		
Bagasse	35.66	44.92
Wood waste	35.02	48.56
Husk Rice	35.66	49.44
Biogas	58.43	81.00

Source: MME (2004)

Regulations implementing the first phase of PROINFA were promulgated in March 2004 and the public call for bids attracted projects that summed up 6,601 MW (3,681 MW of Wind; 1,924 MW of SHP; and 995 MW of Biomass). By early 2005, the public tender of the first phase of PROINFA was finalized through the selection of projects to deliver 3,300 MW (1,266 MW from SHP; 655 MW from Biomass; and 1,379 MW from wind power).[74]

PROINFA's second phase was initially projected to ensure that after 20 years, wind energy, biomass and SHP would supply 10 percent of the annual electric power consumption of Brazil. Public calls for tenders would be repeated ensuring that a minimum of 15 percent of the annual power market growth would be supplied from these three sources.

However, the law that launched PROINFA was an initiative of the previous government, and the new regulations of the power sector,[75] introduced by the new administration that took office in 2003, will require a change of PROINFA's second phase design. The expansion of the interconnected system is now ensured by a system of bids from public and private investors to get the concession for building the new power plants selected by the government, through EPE[76]. Winning bids are those allowing for the lowest tariff to recover the investment on the selected plants. As the new regulations aim to minimize the price of electricity to be paid by final consumers, EPE is not expected to select new power generation projects from new renewable energy sources. A possibility being considered is to dilute the additional cost of biomass, wind and SHP projects in the new power generation pool. The amount of new renewable energy projects would be established in order that the increase of the average electricity consumer's price would be limited to a given cap. It has been suggested by EPE that this cap should be fixed at 0.5 percent.

A preliminary evaluation of PROINFA's first phase shows that it was partially successful in overcoming the barrier of lack of demand, in order to have a critical mass of projects of power generation from new renewable energy sources able to foster the development of a local industry and to allow for cost decreases. Until December 2005, 144 contracts had been signed between Eletrobras and IPPs. Construction has started for plants adding up to 300 MW of SHP and 200 MW of wind energy. Many management problems have contributed to a number of delays in the projects' implementation.

PROINFA's first phase had limited success in promoting power generation from biomass, since the electricity price was not sufficiently attractive for projects using sugar cane bagasse as primary energy source. This may seem a paradox as this option is known to be more cost-effective than wind and SHP, but stems from the high profitability of alternative uses of bagasse (e.g., ethanol production), which makes it difficult to move this industry in the direction of electricity production. Interestingly enough, sugar cane bagasse-fired power plants were able to compete with conventional sources in the first open call for tenders run by EPE on December 2005, as the marginal cost of power generation reached surprisingly high levels (around USD 60 / MWh), demonstrating that this option may be already profitable enough to be excluded from PROINFA feed-in scheme.

PROINFA was successful in promoting wind energy in Brazil at an unprecedented level and in promoting small-hydro, although it was less successful in promoting sugar-cane bagasse as a fuel for power generation. In addition, it has helped to increase the share of investment on equipment manufactured in Brazil. Some components of wind generators (e.g. pales) can already be manufactured in Brazil now. However, the uncertainties still prevailing about the continuation of PROINFA have prevented more substantial investments in the country by foreign equipment manufacturers.

Lessons learned during the first phase of PROINFA suggest that a second phase of the program could continue as a feed-in scheme with a cap established according to the acceptable impact on the average electricity tariffs. A more careful definition of the premium price is required, and particularly to include in the calculations the ownership of carbon credits, in order to clarify and speed up the process to turn PROINFA projects into CDM and the carbon market.

5.2 Mexico

This section presents a number of individual case studies for Mexico, that indicate the potential for leveraging funds, changing national policies, developing financing instruments, and other means.

5.2.1 International Financial Alliances for Clean Energy

The Sectoral Energy Program (2000-2006) called for a 1000 MW increase in new renewable energy sources in the 2000–2010 period. As this expansion would require new sources of finance (and domestic sources were nil), financing was sought outside Mexico, from the multilateral community. In particular, the Global Environment Facility (GEF) through the World Bank, one of its implementing agencies, had been advancing Strategic Alliances with the governments of China and India. Meanwhile, basic CDM rules were being agreed at the Bonn and Marrakech COPs. SENER officers decided to take advantage of these nascent opportunities and reverse the traditional reactive energy sector position on climate change. This required an important change not only within Mexico, but within the Bank itself, as a core element of its policy on energy had been to have the economic fundamentals right before supporting incentive schemes. Discussions revolved around the possibility of providing a temporal incentive which could help both to support the development path of the Mexican energy sector, and to provide a signal that would make this change credible within private sector developers circles.

During 2002, several policy lines emerged. Discussions evolved towards creating a US$100 million (which would eventually turn into US$75million) Green Fund facility to create incentives and support domestic policy change; a rural electrification facility to promote renewable energies for off-grid applications; and their mutual integration with various other initiatives and policies across government, particularly at CRE (who was advancing a new interconnection and transmission agreement), and an accelerated depreciation scheme that the Ministries of Environment and Finance had been developing. It would also support joint policy initiatives with the Ministries for the Environment, Social Affairs, and the Indian Affairs department—who had a significant amount of resources for grid based rural electrification.[77] Breakthroughs at Bonn and Marrakech would potentially provide additional resources through the then recently-agreed-upon Clean Development Mechanism rules. Linked ministerial programs would help create momentum for the proposals with the ministry of Finance (who holds Mexico's GEF chair), and the Bank itself.

At the May 2002 council meeting, GEF approved a US$25 million dollar facility in a first stage, with a US$45 million second stage, which would support a temporal incentive over what the CFE was prepared to pay to private project developers.[78] This was explicitly created so it could be modelled upon a programmatic CDM structure, which was expected to arise as a subsequent derivation from the Bonn and Marrakech discussions. Currently, a first phase of the Green Fund would provide 20 million to la Venta III projects, a 101 MW Wind project in La Ventosa, Oaxaca, while the remaining 5 US$M will be technical assistance activities.[79] In April 2005, SENER requested CFE to include five 101 MWs projects each in its expansion plan.

Likewise, a new GEF funded rural electrification project based on the original idea of finance leveraging domestic with international resources is currently being deployed in Mexico.

5.2.2 Interconnection Agreements

Because renewable energy is usually produced in remote locations, it needs to connect to the grid in order to be transferred to another location where it can be used. Interconnection and transmission agreements become crucial for if renewable energy is to be used. They way in which these agreements are set up can foster—or hinder—the development of these energy sources.

In the past, Mexican RE regulation did not recognize electric peak hour generation capacity provided to the National Electric System. The recognition of this capacity provides an additional incentive in the form of a source of revenue. It also places intermittent energy (wind, flow of river hydro) sources at a disadvantage with regard to conventional energy production. The lack of capacity credits for the renewable energy produced within the interconnection and transmission contracts meant that the renewable energy producers could not take advantage of incentives which conventional energy did provide.

Previous discussions regarding a new regime for transmission and interconnection have suffered a number of false starts. Discussions that failed to agree on procedures for calculating this interconnection made it impossible to profitably use interconnections to transfer renewable energy from where it is produced to where it is delivered.

However, as of January 2005, the Energy Regulatory Commission (CRE) approved modifications to the interconnection contract model to determine self-supplied capacity calculations. This is the average of the mean capacities in the Interconnection Point presented in the 12 measurement intervals included within the hour of maximum demand for all the working days of a given month. The resulting self-supplied capacity can be credited to reduce charges for billable demand within the consumption centers of those requesting the permits. Additionally, electricity exchanges currently done through short term total cost will be done through variable electricity tariffs, increasing transparency when determining the amount of energy that the holder of a permit exchanges with his partners.

As a result, the new interconnection agreements provide an incentive for the development of renewable energy through the model contract employed in them.

5.2.3 Transport Corridors in Mexico City

Mexico City lacks efficient public transport vehicles and corridors. While enjoying an extensive underground system, its public urban transport system does not have the organization, technology, or efficiency required to make it an effective system. Further, bus owners and drivers are opposed to changes to improve the efficiency of the system, as they perceive their sources of income can be threatened.

This situation was addressed through a pilot exercise in creating urban corridors for high efficiency vehicles and stations in Ave. Insurgentes, a key avenue of the City. Between 2001 and 2005, a combination of policies and measures similar to those implemented in Curitiba in the early 1990s was examined and designed. This was formed by corridors exclusively used by high efficiency buses at the center of major urban transport roads, with stations, payment for kilometers traveled, and connections to other sources of urban transport. This model reduces per capita emissions both due to organizational improvements, and due to technology improvements in fuels and engines. Key reduction gains come from vehicle circulation reductions. Likewise, the frequency and circulation of buses is adjusted to variations on demand, which diminishes oversupply. Finally, circulation speed doubles, reaching almost 20 kilometers per hour.

The policy included creating a company from former owners of low-efficiency buses, and handing them control over new high efficiency vehicles. At the same time, the city government rearranged transport to create a bus corridor on a key (the largest, and one of the longest in the world) avenue in the city. The policy was designed and implemented by the Mexico City government, with support from the GEF, as well as a coalition of research institutions and organizations. It resulted in the implementation of the corridors, significant increases in speed for buses riding along the corridor, and the elimination of opposition from existing bus owners. The organizational component was as—or more—important than the technological aspect of the policy. It is expected that this mode of transportation will act as a demonstration of cleaner transport systems that can be replicated in other Mexican cities.

5.2.4 Contingent Debt Schemes

The predominance of state-owned companies created the need to develop a financial scheme tailored for the energy sector. Immediately after passage of the 1992 law, investments did not come in the degree in which they were expected. However, creating a financial scheme especially tailored to public sector energy sector companies provided quite a successful temporary solution. It was (and is) called PIDIREGAS (from its Spanish Acronym, which stands out for Proyectos de Inversion DIferida en el REgistro de GASto), a quite successful scheme to advance investment in lower carbon fossil fuels. The scheme allows for private sector companies to make investments in the energy sector under the post-1992 regime, while the state guarantees payments throughout the lifetime of the project, taking the payments from the national budget, and providing sovereign guarantee that the payments would be made. This was intended to be an interim arrangement while major reform in the power sector allowed for enhanced private sector investment. It resulted in quite an effective scheme, as most of the combined cycle gas projects since then have been financed under variations of these schemes.

However, as no structural reforms have been passed, these schemes are coming under increasing pressure, and are unlikely to be able to continue supporting a major expansion of cleaner conventional energies. They are increasingly attacked as they transfer all risk to the public sector, increase public debt, and unfavourably affect the credit ratings of the public utility. This illustrates the need to develop financial schemes that can operate within a long term and sustainable scheme for clean energy.

5.2.5 The National Energy Savings Commission

Mexico had an excessive emphasis on supply side management until the early 1990s, and few or no public sector entities devoted to coordinating energy savings and efficiency. This started to change as the National Commission for Energy Savings (CONAE, for its Spanish acronym) was created as an inter secretarial committee in 1989, with support from the World Bank and the European Union, to advance energy-saving and efficiency actions. It sought to operate as a consultative and technical assistance body for energy efficiency and demand-side management actions across government and the private sector. Since 1999, it has been a decentralized arm of the Ministry of Energy. It is a relatively small unit, with around 100 persons and a budget of about US$9 million.

Despite severe budget cuts in 2003, the application of its present electric energy saving programs accumulated in 2004 an estimated 15.5 thousand GWh, equivalent to 10 percent of the total sales in electricity for that year. A significant portion of these savings are attributable to energy standards in existence since the 1990s: 12,491 GWh savings in generation and 2,220 MW in differed capacity alone, avoiding the consumption of fuel of different types equivalent to 3.45 millions of petroleum barrels. An additional measure, the summer schedule, produced (between 1996 and 2003) energy savings of 8,545 GWh, and a decrease of 919 MW in coincident maximum demand, resulting in more than nine thousand millions of pesos in investment. For 2004 saving of 1,219 GWh in consumption were estimated and 929 MW in differed demand. Also, it is expected that in the year 2013 energy savings will be of 1,641 GWh and 1,023 MW in avoided demand.

CONAE has currently evolved to create a portfolio of actions relating to energy savings regulation, normalization, technical assistance, advisory services, promotion, design and program development. However, its relations with the rest of the energy sector could benefit from a clearer policy and institutional framework, as its impacts are potentially those with the most significant effect across the energy sector.

5.2.6 Tax Incentives for Clean Energy

Mexico's current legal framework allows power generation projects that may use renewable energy sources under self-supply, small production, independent production and export schemes. While environmental costs are not expressly considered in the Mexican power market pricing, proposals to create tax incentives for renewable energies, and for clean energy services and research (among others) were provided with a number of tax incentives. These started to be considered at the Ministry of Environment, and then at the ministry of Finance, where they were included within Income Tax regulation. They were developed in extensive consultations with the Ministries of Energy, Environment, and others. Thus, starting in December 2004, investments in environmentally-friendly technology, including renewable energy technology, could benefit from accelerated depreciation. Investors are thus allowed to deduct 100 percent of the investment after one year of operation, as defined in articles 21, 22 and 23bis of the General Law for Ecological Equilibrium and Environmental Protection. Currently, the equipment shall operate for at least five years, following the tax deduction declaration; otherwise, the taxpayer will be required to recapture the percentage of the deductions corresponding to those years in which the machinery was not operated and characterize the recaptured amount as taxable income.[80]

5.2.7 Law Initiative for Renewable Energy Sources

Following on the example set by the Green Fund included described in the case study above (section 5.2.1), the Mexican Congress is currently considering a Law Initiative for the Use of Renewable Sources of Energy (LAFRE). It calls for the creation of a Program for the Use of Renewable Energy Sources of Energy, and establishes a goal of 8 percent in renewable energy contribution to total energy generation for 2012 (not including big hydroelectric plants). SENER will develop and coordinate the program implementation. The initiative would combine a suite of incentives and federal taxes to produce this result, and seeks to accumulate around 600 million pesos per year (approximately US$55 million, at 2005 value) to achieve it. Incentives would include a set of Policies and Measures (P&M) to promote renewable Energies (RE). These include providing a new federal tax regime for fossils fuels, to feed the carbon fund,[81] accepting electricity from renewable energy sources provided to the National Energy System, at any time it is produced, providing capacity credits and interconnection incentives, reflecting operation costs avoided by the suppliers through the operation of the generation projects and other activities, including policy support, technology standards, and Multilateral contributions can be included or operate in tandem with the fund.

Resources will be channeled into a trust fund to support both different categories of projects, i.e. mature, rural, and emergent technologies (both electrical and others), as well as research.[82] Projects to be considered include those within CFE's expansion plans, a part from which shall be small scale projects (< 30 MW), other small scale not included in the CFE's expansion plans, self supply RE projects, and projects in isolated rural communities.

The project is innovative in that, following the green fund example, it combines policies and measures with carbon finance, as the Certified Emission Reductions (CERs) resulting from the reduction of emissions can be fed back into the fund created by the law to expand its use.

5.3 Chile: Rural Electrification Program

Since 1994, the Chilean Government has been carrying out an ambitious program aimed to provide electricity to at least 90 percent of rural homes in the country by the end of year 2006.[83]

The program has sought to motivate investment in rural electrification through the establishment of a state subsidy for fostering private participation in this undertaking. In this approach, state contributions represent between 60 to 70 percent of the project's investment, sharing the cost with final users (10 percent) and with enterprises or cooperatives that implement and then will manage these projects.

This program has been able to increase rural electricity coverage from about 54 percent at its beginning, to 86 percent for the year 2002, an increase corresponding to about 200,000 new houses in the country equipped with electricity.

From a technical point of view, this satisfactory result was achieved almost exclusively by the extension of the existing national grids. However, at the beginning of this decade it was already foreseen that little further improvement was possible by using this approach, and that diesel stand-alone units would be the predominant technology in coming stage of this undertaking.

In the light of the commitment that the country has with the UNFCCC and the funding opportunities offered by the GEF, an alternative approach was identified and explored in order to avoid this future scenario. At the end of 2001, the agreement CHI/00/G323, named "Barrier Removal for Rural Electrification with Renewable Energy", was signed between UNDP, the Chilean National Energy Commission and the Ministry of Foreign Affairs. The budget assigned by the GEF to this project was about US$6 million and the national contribution to it through the subsidy mechanism mentioned above, was estimated at US$26 million.

The aim of the Project has been the removal of barrier to use renewable energy technologies for rural electrification purposes in the country, by means of the implementation of a set of activities meant to create the bases for a renewable energy market. The activities include, in addition to the preparation and implementation of a pertinent portfolio of projects, the development of standards and certification procedure for renewable energy equipment, outreach and capacity building activities in the use of these technologies, implementation of financial mechanisms for reducing investment risk, and the development of programs for collecting the data required to assess the technological feasibility of renewable energy sources in Chile.

As of the end of 2005, under the auspices of this Project, 74 renewable energy facilities have been installed in the country, providing electricity to about 10,000 new houses. 35 percent of these installations are Photovoltaic, 50 percent hybrid Wind-Diesel and 15 percent Micro hydro. The total yearly generation of these facilities is 3.2 GWh, which represents avoided emissions of at least 3,000 tons of CO_2 per year. Correspondingly, significant progress has also been achieved in all the other activities designed to ensure the sustainability of these technological facilities along the time.

5.4 Bolivia: A Micro Hydro Power and Processing Plant

Camata, Bolivia is a village in the Muñecas Province of the Department of La Paz, 20 km away from Charazani. Its inhabitants make their living through agriculture, primarily growing chilies, coffee, and corn. However, without power people there live only at a subsistence level. The SGP program funded a project in Camata, with several themes or goals, renewable energy, technical capacity development, institutional capacity development and poverty alleviation. [84]

The technical name of the project was "*Micro Hydro Power and Processing Plant for Coffee and Chili Powder*". The implementing organization was the Camata Community, in the Department of La Paz, Bolivia. The SGP contributed with US$32,761.91, and the starting date of the project was set to December 2001.

The technology applied was a micro hydro plant, for the application on lighting, radio, television (domestic and public buildings), coffee roasting, a chili dehydrator, a grinding mill, a chili cutting machine, a bag sealer, and an electric scale. The capacity of the plant was of 27 kW, and the number of households served was of 70, plus the school, the police station and the agro-processing plant

This project built a micro hydro power plant in the village of Camata. The system provides electricity for domestic and public needs, and boosts the local economy by powering an agro-processing unit that enables people in the community to process their own agricultural products and sell them directly to the market. Both the power plant and the agro-processing unit are managed by a community cooperative.

The Hydroelectric Program of the Hydraulic and Hydrology Institute determined through an assessment of the region that Camata was a feasible site for a micro hydro plant. In discussions with the community and local authorities, the community expressed willingness to participate. The idea of starting an agro-processing plant to dehydrate local chilies and make chili powder, as well as roast coffee beans, emerged through discussions with the community. The community organized a Committee for Electrification, which took the lead in constructing the micro hydro system and the agro-processing plant. This organization is now responsible for running and maintaining both efforts, and sets the regulations for the use of power and the operation of the plant. The community contributed the labor for the project, while the local municipality contributed materials and transformers for the high-voltage distribution line, and the Prefecture of the Department of La Paz contributed the posts for stringing the distribution lines and outdoor lights in the central square of Camata.

The infrastructure constructed through this project relates to both micro hydropower generation and agro-processing, including chili powder processing and coffee roasting. The micro hydropower system uses a Pelton turbine and a tri-phase generator. High-voltage distribution lines are a total of 1km in length. In the agro-processing plant, there is an oven using re-circulating hot water to dry chilies, a grain mill, a chili cutting machine, a coffee roaster and dryer, and a package sealer.

The project illustrates one possibility for making use of the power generated by micro-hydro plant during the day. The project created a very targeted economic activity so that the community's raw agricultural materials could be processed and therefore sold at higher prices, improving the community's income generation potential.

One aspect to bear in mind is that the actual sale of the finished products on the market may take some time. As of May 2003, the plant was producing the products, but sales had not yet begun in the city of La Paz, since transportation still needed to be arranged. There are many factors to address in ensuring that such operations are sustainable businesses and managed such that they bring the greatest possible benefits to the community. Targeted technical assistance in this area is probably needed.

The project removed barriers on information and knowledge of renewable energy sources, at least in the local level, with a potential for replication in nearby communities. The project raised awareness among government officials about the possibilities offered by micro hydropower. Government officials contributed to the success of the project, but it is uncertain that this might result in an enhanced willingness to support or initiate other micro hydro projects in other areas, especially taking into account the high turnover of officials and technical personnel in the Bolivian Government. In addition, the awareness of these types of activities remains restricted to the local provincial level and is not easily spread among other rural communities. This will need a specific program in a larger scale.

According to the UNDP-GEF evaluation, the project does not appear to reduce financial barriers relating to this technology on a broader scale than this community, unless the government is motivated to contribute to the establishment of micro hydro systems or programs as result of this project.

5.5 Colombia: Jepirachi Carbon Offset Generation Project

The Jepirachi Carbon Offset Project was implemented in 2001 in Colombia, and was one of the first projects promoted by the Prototype Carbon Fund (PCF) of the World Bank in Latin America. The project is located in the Wayuu Indian Territory in the Northeastern region of the Atlantic Colombian coast, in the area between Cabo de la Vela and Puerto Bolivar, within the municipality of Uribia in the Department of La Guajira. The project is supporting the development of a wind generation facility that is expected to generate about 68 GWh/year during the first 21 years of operation, and in the process displacing at least 1.168 mtCO2e.

The project includes a participatory social program of institutional and community strengthening. The social program is designed to benefit the indigenous population in the area of the project, effectively linking the global aspects with local development issues.

The objective of the Jepirachi Carbon Offset Project (JCP or Jepirachi Project), according to the Project Information Document (PID) of the World Bank, is "*to reduce the greenhouse gas (GHG) emissions of the power sector in Colombia through the promotion of a 19.5 MW wind-based electricity generation facility*".[85] The Project contributes to the development of the international carbon market in Colombia through the supply of Emission Reductions (ERs), developed under the Clean Development Mechanism (CDM) as set forth under Article 12 of the Kyoto Protocol.

The wind energy facility has a nominal power capacity of 19.5 MW supplied by a series of aerogenerators to be linked to the national interconnected grid. The facility delivers its energy under a preferential dispatching scheme. A grid connection to the site with a length of 8 km was installed. The facility started operations at the beginning of 2004. The PCF will purchase the emission reductions caused by the operation of the Project. The total project cost was estimated in approximatelyUS$21 million, of which US$20.2 million was for the wind generation component and US$0.8 M for the social program.

The social program includes activities already defined in consultation with the local Wayuu community and was initiated over the course of the first two years of construction and operation of the project. The program will not be restricted to the activities already outlined but will also establish the basis and provide for the support of additional community development activities to be implemented during the duration of the project, focusing in the areas of health, education, economic and institutional development. The PCF will pay a premium on the value of the emission reductions based on the outputs of the social program.

The social program includes the design and construction of a water desalinization unit, located in the neighborhood of the wind facility, and powered by wind-energy; the construction of two water storage facilities (*jagueyes*) and rehabilitation of two existing facilities. It also includes the local school rehabilitation, the provision of equipment and refurbishing of school dorms and the local health Center rehabilitation.

Renewables, including hydroelectric projects, are not a priority in Colombia, at least for private investment, and the current structure of the sector tends to favor new investments in thermal generation, due not only to cost variables, but also the availability of commercial financing. After severe droughts, registered during the 1990s, that caused power shortages with associated forced rationing, the power system in Colombia has encouraged the development of more thermal generation capacity, specifically with the intention of increasing the share of firm capacity and enhancing the system's reliability of supply. The increase in thermal share of the sector has also been the indirect result of the withdrawal of the public sector in investments and the reluctance of private generators to enter the hydroelectric generation with the associated environmental and social requirements. Therefore, future additions to the power mix to attend the projected growth in demand are still anticipated to be thermal-based.

According to information drawn from document for another PCF project,[86] studies undertaken by the Government and third parties have indicated a significant potential of renewable energy in the country, including solar and wind. However, until very recently, renewable energy had not figured in the plans or official prospects for the power sector. While this situation has changed with the construction of the Jepirachi project (Wind energy), and others being proposed, the contribution of renewables to the power mix remains negligible. Many obstacles remain for these options to play an important role in the country, including lack of knowledge and practical experience, poor competitiveness for some applications, limited institutional interest and lack of awareness.

Wind parks are not specifically referred to in the current regulations. Any generation unit with an installed capacity of 20 MW or more are obliged to participate in the spot market on an equal footing with thermal and hydroelectric plants. If the capacity is less than 20 MW, however, the park qualifies as a "minor plant" (CREG Resolution No. 086 of 1996). A "minor plant" with a generating capacity of at least 10 MW has the right to participate in the pool and benefit from pool services under a preferential dispatching option (e.g. spinning reserve). In essence, small plants can access the electricity market by selling all their available output at the wholesale market price ("precio de bolsa"), which includes a "capacity payment" component (as a floor price for the bids), and are exempt from penalties on non-delivery of electricity. Precise rules for wind generation capacity when it exceeds the 20 MW limit are required to ensure that investments internalize the environmental and strategic benefits of renewable capacity in the country. For the project, it is anticipated that EEPPM will use preferential dispatching.

The project documents suggest that the involvement of the World Bank was instrumental in removing both financial and institutional barriers. The intervention of the Bank brought funding for technical studies and investment that would be difficult to find in Colombia, given the bias of financial institutions towards thermal generation projects. Together with the Ministry for the Environment, the Bank was able to reduce project risks, make funds and expertise available, and pass legislation allowing these types of projects (or at least Jepirachi) to sell power to the grid.

Further, according to project documents, the intervention of the PCF "*helps to ensure quality of the first carbon projects, as well as institutionalizing experiences and ensuring replicability of the projects, while providing necessary project due diligence and other fiduciary responsibilities.*" The documents also suggest that the Bank support brought in-house environmental economics and natural resources management expertise, an ability to mobilize global experts with long experience in the field, technical support for project preparation, supervision capacity, and development of linkages with other sources of expertise and funding, which would be missing if the project were to be implemented by private sponsors in Colombia alone.

Although Colombia is rapidly developing a strong expertise in renewable energies and carbon trading, the majority of these professional undertake analysis and project development that is linked to cooperation projects (World Bank, CAF, European Union, etc.). Therefore, we can deduce that the market for renewables like wind and solar has not yet reached a critical mass for its autonomous development in Colombia.

6 CONCLUSIONS: ADDRESSING PRIORITY BARRIERS

Energy technologies and practices are being transferred continually, with the private sector, governments, and multilateral organizations all playing important roles. The challenge in spurring expansion and diffusion of clean energy technologies, such as energy efficiency and renewable energy, is to ensure that markets to supply, disseminate, finance, and use these technologies are efficient and active. To accomplish this end, it is important to create an environment that attracts investment in clean technology, to raise awareness of clean technology options, and to find technologies that are compatible with other national development and environmental agendas.

First, a number of the barriers facing the increased use of clean technologies stem from the cost and technical characteristics of clean energy and from financial and technology market conditions in the LAC region. The case studies and examples described in this paper suggest several general lessons about methods for taking action to transform these markets:

- Given high priority development needs (economic development, alleviating poverty, improving education and health) in the LAC region, clean energy policies, programs, or investments that can be allied to other development objectives will receive more support and are more likely to be successfully implemented.
- Capacity building and information provision is needed to encourage understanding and to build technical capabilities throughout the chain of supply and demand, including multiple levels of government, financial institutions, investors and consumers
- Any effort to increase clean energy must keep in mind multiple important barriers, not only policy barriers, but also institutional, financial, market, and, frequently, cultural barriers. As such, successful efforts often address multiple barriers simultaneously.
- There are a number of examples of successful small scale projects, such as those of the Small Grants Program of the GEF, administered by UNDP. These small projects indicate the importance of working with local conditions to addressing multiple barriers and catalyze markets so they become self-supporting.
- Poorly functioning capital markets, limited access to credit and to finance, high transaction costs, small project size, and financing instruments that favor traditional and large-scale investors, are all critical barriers to clean energy investment. Resource and other risks associated with clean energy projects, make financing yet more difficult. New financial entities and financing instruments may be needed that address financial barriers and insure against project risks.
- Productive and technical capacity is needed within countries, so that technologies can be manufactured domestically rather than imported. In addition, dissemination of technology is impeded by the lack of small- and medium-sized enterprises (SMEs) that demonstrate, deploy, and otherwise help create a market for clean energy technologies.

Second, and at least as important, are the barriers that are specific to country conditions, particularly to the circumstances surrounding electricity and energy resource markets. For example:

- Macroeconomic conditions and policies—such as unstable or high inflation rates and interest rates, taxes and subsidy policies that favor conventional energy or trade policies that impede the flow of technology—will affect clean technologies.

- Country-specific circumstances that affect the functioning of capital markets and access to credit and financing for clean energy technologies, particularly in low-income and rural areas.

Consequently, enabling policies, legislation, and regulation may be needed at the national level—to set efficiency and/or technology standards, reduce favorable tax treatment for fossil fuels, promote competition and create electricity and energy systems that encourage innovation and improvement, and minimize trade obstacles to importing clean technology. Moreover, strategies for increasing clean energy will need to be tailored to country circumstances, including existing regulatory and legal structures, the level of development, natural resource supplies, and other circumstances. For example, it will be more difficult to raise energy efficiency as a national priority, or a priority for selected sectors, in countries in which energy markets are less developed.

Third, the most important of the in-country conditions are those affecting the electricity sector. How the electricity sector is structured, whether resources are nationally or privately owned, how access to the grid for energy sources is determined, and how it is priced, the rules governing power purchase agreements with independent power producers on third parties, the extent of deregulation—all these factors will be critical in determining the ability of renewable energy and energy efficiency to compete successfully in the marketplace. While electricity market reform is insufficient for ensuring a market for renewable energy and energy efficiency, nonetheless these rules are critical in determining the extent of the barriers to overcome.

Finally, while many clean energy options can compete economically in the market place, not all are commercially viable. In the long-term climate context, it is critical that policies also spur technological innovation in clean energy in developing as well as developed countries. A singular focus on deployment of existing cost-competitive technologies will be counterproductive in developing solutions to the long-term climate change problem. Even where profitable, existing clean energy technologies face limitations because of financial considerations that make it difficult to obtain financing. Grants to "write down" technology or development costs, guaranteed loans, subsidies to interest rates—all these are mechanisms to offset the financial barriers. Consequently, a key decision in addressing barriers will be the lengths to which financing mechanisms, funds, and other programs should go in directly addressing cost disparities between clean and conventional energy sources, and in remedying the limitations of financial markets in providing access to credit and financing. How much funding is needed? Where should the funds come from? What types of new financing mechanisms are needed? The critical question will be what methods, and what level of funding, to use in addressing these barriers.

ENDNOTES

[1] EU (2005).

[2] EU (2005).

[3] WEA (2004). Data are from 2001.

[4] These figures can be contrasted with world data: renewable energy sources accounted (in 2001) for less than 5 percent of primary energy use, and about 18 percent of electricity production (WEA 2004).

[5] ECLAC (2003).

[6] EEPCA (2003).

[7] Heintz (n.d.).

[8] Metz, et al. (eds.) 2001.

[9] Metz et al. 2001

[10] Concessional (or concessionary) financing is support that either takes the form of a direct grant, or contains a significant grant element (e.g., contains an interest rate subsidy for a loan).

[11] A study funded by UNEP's Sustainable Energy Finance Initiative (SEFI) looked at "financial risk management" instruments that could be developed to reduce uncertainty and facilitate more efficient and effective financing of RE projects. The study concluded (among others) that new financial risk management approaches can be adapted to meet the needs of the RE sector, including risk finance approaches, alternative risk transfer products, specialist underwriting vehicles, credit enhancement instruments, and indexed derivatives (UNEP 2004).

[12] Jeucken (2001) and World Bank (2002b).

[13] Heinz (n.d.)

[14] Other remedies for the financial constraints facing clean energy investment that have been suggested include banks that include ethical or environmental standards in their loan criteria, micro-credits or small grants facilities targeted at low income households, environmental funds, and green venture capital (Metz 2001).

[15] GEF (2004).

[16] IFC funds (which include GEF concessionary funding) to mobilize private sector investment in renewable energy include the PV Market Transformation Initiative (PVMTI), the Renewable Energy and Energy Efficiency Fund (REEF), and the Solar Development Group (SDG). Two of these funds—the REEF and SDG programs (both equity funds)—have been discontinued by the IFC.

[17] SGP (2003b).

[18] UNEP (2002).

[19] Bleviss et al. (2006).

[20] Bleviss et al. (2006).

[21] The GEF manages a $10.6 billion climate portfolio that supports more than 400 projects and enabling activities.

[22] The recent decision (UNFCCC 2005) on CDM strengthening at the UNFCCC meeting in Montreal found that, while a policy per se could not be registered as a CDM project, the set of activities under a particular program could be registered as a single project, providing that approved baseline and monitoring methodologies are used. This new decision could help to provide an avenue for broader clean energy projects to be eligible for CDM credits by enabling the generation of CDM credits from programs implemented to support government policies in developing countries (Schmidt 2006).

[23] IADB (2002).

[24] Heinz (n.d.).

[25] Metz et al. (2000).

[26] Metz et al. (2001)

[27] Metz et al. (2001).

[28] SGP (2003b).

[29] CTI (2001a).

[30] SGP (2003a).

[31] Iovanna (2005).

[32] Heinz (n.d.).

[33] The case of property owners and renters can work both ways, depending on how the property is set up. The property owner may have control over the insulation in the unit and the energy efficiency of the appliances and heating/cooling system, but the renter pay the utilities. Conversely, the renter may have control over the thermostat, but not pay the bills.

[34] Heintz (n.d.). Costa Rica has built a reputation as a country that takes environmental and climate change issues seriously. In doing so, it has generated business opportunities. Costa Rica has been active in Activities Implemented Jointly (AIJ), in promoting eco-tourism, and in developing infrastructure for the Clean Development Mechanism (CDM).

[35] SGP (2003b).

[36] Iovanna (2005).

[37] GDP (2003a).

[38] Heinz (n.d.).

[39] Chandler, et al. (2002).

[40] SGP (2003b)

[41] SGP (2003a).

[42] SGP (2003b).

[43] SGP (2003b).

[44] SGP (2003b).

[45] SGP (2003a).

[46] SGP (2003a).

[47] SGP (2003b).

[48] Metz et al. (2001).

[49] Heinz (2001).

[50] Metz et al. (2000).

[51] SGP (2003a).

[52] SGP (2003a).

[53] Hohne (2004).

[54] Metz et al. (2000).

[55] Iovanna (2005), E+Co (2005).

[56] CTI (2001a).

[57] CTI (2001a).

[58] Bleviss, et al. (2006).

[59] McElhinny (2004).

[60] Bleviss, et al. (2006).

[61] McElhinny (2004).

[62] Metz et al. (2000), Iovanna (2005).

[63] Belize PUC (2003).

[64] Modified from EEPCA (2003).

[65] Bolivia has also recently proposed to reduce power cost for poorer residential areas. If overhead and operating costs are not covered by this tariff, the difference will come from public funds.

[66] Lindlein and Mostert (2005).

[67] SGP (2003b).

[68] Centrais Electricas Brasileiras (Eletrobras) is a holding company for Brazil's electric companies. Through its subsidiaries, the company generates, transmits and distributes power to about 44 million customers. Eletrobras is headquartered in Rio de Janeiro. It is 52 percent owned by the Brazilian government.

[69] This section is based on Costa and La Rovere (forthcoming).

[70] PPAs, or power purchase agreements.

[71] Eletrobras is a state owned holding of utilities responsible for the bulk of power generation capacity in the country.

[72] ANEEL, the National Electricity Agency, is the federal regulatory body for the power sector.

[73] A previous regulation had already granted this reduction to SHP projects.

[74] The biomass sector did not respond as expected. Some projects were taken back by the entrepreneurs because they found the energy purchase price for biomass-based power generation was very low. It would seem that the sugar-alcohol industry works under high returns in the sugar and alcohol markets and investing in long-term power generation is not particularly attractive for this sector.

[75] The “reform of the reform”, under the so-called “new regulatory framework for the power sector”.

[76] EPE is the Energy Planning Agency, which is responsible for ensuring that capacity increases to meet the projected demand growth.

[77] The Ministry of Agriculture had additionally developed a Renewable Energy Trust fund for agriculture, which was mostly autonomous in its operation.

[78] In practice this turned into an amount which was estimated to be around and possibly less than US$0.01 per produced kWh.

[79] CFE will pay avoided costs, and the green fund will be given to private project developers.

[80] Additional proposed tax incentives presented during 2006 include a rate of accelerated depreciation equal to 100% of the cost of the investment made in machinery and equipment that (i) diminishes pollutant gases that produce a greenhouse effect, and (ii) substitutes the use of substances that directly affect the ozone layer, and b. Grant variable tax credits on taxable income to services on machinery maintenance, agricultural soil prevention, c) research, d) renewable energy.

[81] This tax requires that fossil fuels pay a tax based on the carbon dioxide (CO_2) emitted during their combustion. For liquid fuels, it proposes a tax of 0.52¢ to 0.97¢ peso per liter and a greater tax for solid fuels. For natural gas, it proposes a tax of 19.7¢ of weight per thousand cubic feet. Income generated will be earmarked for the promotion of RE. Additional contributions form other domestic and international sources can also feed the fund.

[82] These would include a “Green Fund”, to foster the use of mature RE (55%), (electrical applications), a rural electrification fund (10%), a biofuels fund (7%) an emergent technologies fund for electrical applications (6%) • an emergent and general Technologies Fund (for electrical 6% and non electrical 7% applications) and 15% for a Research and Technological Development Fund.

[83] Additional information on this rural electrification program can be found at the following websites: <www.cne.cl> and <www.renovables-rural.cl>

[84] SGP (2003b).

[85] World Bank (2001).

[86] World Bank (2002a).

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