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Report No:ICR000044

IMPLEMENTATION COMPLETION AND RESULTS REPORT
(MULT-23251)

ON A

GRANT FROM

THE GLOBAL ENVIRONMENT FACILITY TRUST FUND

IN THE AMOUNT OF US$ MILLION 8.90

TO

THE UNITED MEXICAN STATES

FOR A

RENEWABLE ENERGY FOR AGRICULTURE PROJECT

January 29, 2007

Sustainable Development Department
Mexico and Colombia Country Management Unit
Latin America and Caribbean Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective 01/29/2007)

Currency Unit = Peso

Peso 1.00 = US$ 0.091

US$ 1.00 = Peso 11.04

Fiscal Year

January 1 - December 31

ABBREVIATIONS AND ACRONYMS

AMPER	Mexican Association of Renewable Energy Suppliers
ANCE	Association of Normalization and Certification
ANES	National Association of Solar Energy
Alianza	Alliance with you (Alianza Contigo)
CIE-UNAM	Energy Research Center of the National Autonomous University of Mexico
CMU	Country Management Unit
CONAE	National Commission for Energy Saving
FIRCO	Trust Fund for Shared Risk
FOFAE	State Trust Funds for Distribution of Funds
GEF	Global Environmental Facility
IPR	Independent Procurement Review
NAFIN	Nacional Financiera
REAP	Mexico's Renewable Energy for Agriculture Program
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fishing and Food
TA	Technical Assistance
UNAM	National Autonomous University of Mexico
USAID	United States Agency for International Development
USDOE	United States Department of Energy

Vice President:	Pamela Cox
Country Director:	Isabel M. Guerrero
Sector Manager:	Abel Mejia
Project Team Leader:	Michael G. Carroll

Mexico
Renewable Energy for Agriculture Project (GEF)

CONTENTS

1. Basic Information

Country:	Mexico	Project Name:	Renewable Energy for Agriculture Project (GEF)
Project ID:	P060718	L/C/TF Number(s):	MULT-23251
ICR Date:	01/29/2007	ICR Type:	Core ICR
Lending Instrument:	SIL	Borrower:	NAFIN
Original GEF grant amount	USD 8.9M	Disbursed Amount:	USD 8.9M
Environmental Category:	B	GEF Focal Area	B
Implementing Agencies SAGARPA			
Cofinanciers and Other External Partners			

2. Key Dates

Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	03/04/1999	Effectiveness:	06/30/2000	
Appraisal:	07/26/1999	Restructuring(s):		
Approval:	12/21/1999	Mid-term Review:		06/03/2004
		Closing:	06/30/2004	06/29/2006

3. Ratings Summary

3.1 Performance Rating by ICR

Outcomes:	Satisfactory
Risk to Global Environment Outcome	Moderate
Bank Performance:	Satisfactory
Borrower Performance:	Satisfactory

3.2 Quality at Entry and Implementation Performance Indicators

Implementation Performance	Indicators	QAG Assessments (if any)	Rating:
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA):	None
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA):	None
GEO rating before Closing/Inactive status	Satisfactory		

4. Sector and Theme Codes		
	Original	**Actual**
Sector Code (as % of total Bank financing)		
Animal production	5	5
Central government administration	45	45
Renewable energy	50	50
	Original Priority	**Actual Priority**
Theme Code (Primary/Secondary)		
Rural services and infrastructure	Primary	Primary
Other rural development	Primary	Primary
Climate change	Secondary	Secondary
Environmental policies and institutions	Secondary	Secondary

5. Bank Staff		
Positions	**At ICR**	**At Approval**
Vice President:	Pamela Cox	David de Ferranti
Country Director:	Isabel M. Guerrero	Olivier Lafourcade
Sector Manager:	Abel Mejia	John Redwood
Project Team Leader:	Michael G. Carroll	Michael G. Carroll
ICR Team Leader:	Michael G. Carroll	
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6. Project Context, Global Environment Objectives and Design

6.1 Context at Appraisal

This project was the first project in the World Bank to be funded by the GEF's Climate Change program. It was also the first to concentrate on improving productive uses of renewable energy in order to catalyze the use of carbon neutral energy sources. Despite its success, it remains one of the very few examples of Bank projects that have intended to promote the use of renewable energy for productive uses (see for instance the project's prominence in the renewable energy toolkit (http://retoolkit.worldbank.org/). The GEF contribution was essential for the project to achieve a reduction in carbon emissions as, without this incremental contribution, the project would simply have promoted productive uses in agriculture through using conventional energy sources.

At the time of project preparation, the World Bank Group's Country Assistance Strategy for Mexico discussed a development agenda with three core themes: (i) social sustainability; (ii) removing obstacles to sustainable growth and maintaining macro-economic stability; and (iii) more effective public governance. The project was designed to contribute directly to all three themes. The social theme was to be addressed by increasing the income of farmers and thereby improving the standard of living in rural areas. The growth theme, as well as its key element of protecting the environment, was to be addressed by improving the productivity of farmers using environmentally-neutral, least-cost renewable energy technologies. Finally, the public governance theme was to be addressed by assisting the Government in its decentralization efforts and building the capacity of government agencies to provide farmers with technical assistance.

In addition, the project was designed to promote the World Bank Group's strategy on the environment in Mexico, under which “priority will be given to identifying “win-win” investment opportunities, where global environmental benefits and national economic benefits can be generated through an integrated and mainstreamed approach to development priorities”.

The project mainly sought to address these issues in the agriculture and energy sectors.

Agriculture:
At the time of appraisal, agriculture remained a weak sector of the Mexican economy, whilst at the same time being a primary emitter of carbon, mainly through the use of internal combustion engines for motive power and for generating electricity for heating and cooling. Rural poverty had also been increasing in previous years and many farmers had limited options to cope with income and consumption fluctuations. Nevertheless, agriculture had the potential to remain an important economic sector provided: a) its commercial sector continued to be competitive through the use of modern technologies and increased yields; and b) the productive potential of small-scale farming could be fully developed.

Improving the delivery of financial services to the rural population was also a key constraint to development of the agricultural sector. Financial services were severely deficient in rural areas and access to financial resources for productive investment continued to be limited, especially for small farmers.

In 1996, the Government launched a national agriculture and rural development initiative – the Alianza para el Campo (Alianza) Program – to increase capitalization in the agriculture sector with the aim of promoting improved agricultural productivity and production and increased farmer incomes. The Program fostered, and continues to foster, agricultural productivity improvements by financing productive investments (under a matching grant scheme) and by providing support services (research, extension, information and training) for a wide range of agricultural activities. In providing matching grants for the acquisition of capital equipment, Alianza essentially substitutes for absent rural finance services. The cornerstones of the Alianza program are its decentralized approach, with administration and decision-making delegated to the States, and its demand-driven nature, providing financing and support services only in response to requests from farmers. This project was designed to build on Alianza's engagement with farmers.

In tandem with this, the Government developed the Agricultural Productivity Improvement Project (ALCAMPO) to support and improve Alianza's delivery of financing and technical services. The project was approved for a loan of US$445 million from the World Bank in December 1998 and began implementation in early 1999.

The Government was also engaged with the World Bank on a number of initiatives to improve rural finance. In 1994, the Government worked with the Bank on a study of rural financial markets. In 1996 it initiated the Rural Finance Technical Assistance and Pilot Project with World Bank assistance to encourage private banks to increase their services in rural areas. Through the Bank-supported Rural Development in Marginal Areas Project, the Government was experimenting with community-based revolving loan funds and cost-recovery within Alianza. SAGAR was also working with the Bank on a new study of the potential for savings mobilization and deposit instruments in marginal areas and exploring the possibility of a World Bank loan to finance its Micro-Credit Fund for Rural Women.

Energy:
Approximately 5 percent of Mexico's population remained without access to electricity including an estimated 5 million people, 88,000 villages and 600,000 livestock farms. While governments at all levels recognized the productivity and social development benefits of rural electrification, and especially of the electrification of farms, budget limitations and rural poverty prevented this for the vast majority of these people and were expected to continue to do so for the foreseeable future.

Nevertheless, the Federal Government supported rural electrification through transfer payments to state and municipal governments for infrastructure and social development investments. Several states had used these federal funds to support the electrification of

rural households with renewable energy by providing matching grants towards the purchase of solar home systems. However, the decision about whether to use these funds for rural electrification or other purposes, was left to state and municipal governments.

In 1994, the Federal Government began to further support the electrification of farms with renewable energy in 8 of the country's 32 states through FIRCO's participation in the USAID/USDOE-supported Mexico Renewable Energy Program. The experience gained by FIRCO through this program enabled the government to expand the scope of Alianza to cover the electrification of farms with renewable energy systems and by the time of project preparation, farmers could receive matching grants from Alianza towards the purchase of renewable energy systems to pump water and power farm equipment. Further, farmers could receive proportionately larger grants for renewable energy systems than for conventional farm equipment and infrastructure. However, this experience demonstrated a number of barriers which were preventing the development of a self-sustaining market in farm-based renewable energy systems. These barriers included:

a) a lack of awareness among unelectrified farmers of renewable energy technologies;

b) a lack of trained technicians and vendors that could design, install and service renewable energy systems and a lack of agricultural extensionists that could advise farmers on their proper operation;

c) a lack of technical specifications and certification processes for renewable energy equipment;

d) uncertainty within the Mexican renewable energy industry regarding the potential market for renewable energy systems in the agricultural sector and potential applications of renewable energy technologies on farms;

e) farmers’ perceptions of renewable energy technologies as risky, simply because they are novel; and

f) the high initial cost of renewable energy systems, relative to conventional alternatives, coupled with deficient rural finance services that prevent farmers from spreading this higher initial cost over time.

6.2 Original Global Environmental Objectives (GEO) and Key Indicators (as approved)

Project global objectives were:

1. To promote the use of renewable energy for productive purposes in Mexico's agriculture sector by removing barriers and reducing implementation costs; and

2. To reduce greenhouse gas emissions in the agriculture sector.

Project development objectives were:

1. To provide unelectrified farmers with reliable electricity supply for productive purposes in a least-cost and sustainable manner using renewable energy technologies;

2. To increase the productivity and income of unelectrified farmers by supporting the adoption of productive investments and improved farming practices; and

3. To improve FIRCO's ability to catalyze the penetration of renewable energy technologies in the agriculture sector.

Key Impact Indicators were:

1. National sales of RE systems for productive agricultural aplications;

2. Change in average price of RE systems;

3. Carbon emissions avoided by project-supported RE systems; and

4. Change in average net income of participating farmers.

The project document did not assign a specific indicator to measuring FIRCO's ability to catalyze the penetration of renewable energy technologies in the agriculture sector. However, the indicators of "percentage of direct beneficiaries surveyed who learned of the equipment through FIRCO's promotional activities" (86%), "number of replica renewable energy systems installed" (847 documented replicas) and "total number of technicians and extensionists trained in renewable energy technologies" (3,022 or 121% of the original goal of 2,500) give a good measure of how the project achieved this objective.

6.3 Revised GEO and Key Indicators (as approved by original approving authority), and reasons/justification

There were no revisions to the Global Environmental Objective or to the key indicators.

6.4 Main Beneficiaries, original and revised

Environmentally, the project was designed to avoid the emission of greenhouse gases from gasoline-powered or grid-connected systems by substituting these with solar- and wind-powered systems. It was anticipated that by the end of the project, the demonstration and vendor financed systems installed would abate roughly 30,000 metric tonnes of carbon per year (in fact it abated in excess of 36,292 tonnes - the equivalent of over 544,380 metric tonnes over the 15 year average life span of the renewable energy systems). More importantly, the project was designed to catalyze a national market for farm-based renewable energy systems among Mexico's estimated 600,000 unelectrified livestock farms leading to sustained and increasing reductions in carbon emissions in the future.

The project was also planned to catalyze the penetration of renewable energy systems among one-third of the country's unelectrified farms within ten years, a development that would avoid an estimated 0.73 million metric tonnes of carbon annually. In addition, the project was expected to reduce local air, water and soil pollution associated with gasoline-powered farm equipment. The reduction in water and soil pollution was regarded as particularly significant because gasoline-powered pumps are typically located at or in wells that serve livestock and human populations.

The project's target population was both the estimated 600,000 unelectrified livestock farms in Mexico and the industry of renewable energy vendors and service providers that could cater to this market. The project was designed to target all farmers whether or not they participated in Alianza. However, farmers that were not participating in Alianza were considered wealthy enough to purchase renewable energy systems without financial assistance and so only those participating in Alianza were eligible to benefit financially from the project's "demonstration" component. Nevertheless, the other components of the project were designed to benefit all farmers by increasing their awareness of, and confidence in, renewable energy systems and thereby increasing their purchase of these systems.

Poorer farmers that would be unable individually to purchase a renewable energy system, even with the project's financial assistance, were encouraged to participate by combining with neighboring farmers to purchase a renewable energy system that would serve them as a group. For example, several farmers with adjacent properties could construct a central watering trough connected to a solar-powered pump. Many of the solar-powered pumps installed by the USAID/USDOE-supported Mexico Renewable Energy Programs supplied water to two or more farmers. Market research was carried out early in project implementation in order to improve information about this target population.

Ultimately the criteria for eligibility for gaining funding under this "demonstration" component were: i) being eligible to obtain funding from Alianza; ii) being situated more than 1 km from the electricity grid; iii) having a potential water supply of at least 2 liters per minute and iv) being able to fund at least 50% of the costs. Section 7.1 explains further how proposals for receiving funding were handled.

The project was planned to benefit these farmers economically by increasing their incomes through providing renewable energy systems that have superior reliability and lower life-cycle costs in comparison to conventional gasoline-powered systems. Experience under the USAID/USDOE-supported Mexico Renewable Energy Program indicated that solar-powered pumps are more reliable than gasoline-powered pumps, in part because they have fewer moving parts. Fuel costs make up roughly half the life-cycle cost of gasoline-powered pumps and since solar- and wind-powered pumps have no fuel costs, this meant an immediate saving among participating farmers and an average 16 percent return on investment. Further increases in participating farmers' incomes of between 85 and 190 percent were expected to result from production increases made possible by the lower operating costs - since additional operation of solar- and wind-powered pumps is essentially free, some farmers had been observed to pump more water and use the excess to irrigate a small field for forage or fruit and vegetable production.

While the overall financial benefit to participating farmers was seen as substantial, demonstration systems and the project's financial assistance was necessary in order to overcome the perceived risk of investing in renewable energy technologies and to get these systems into the field where they can have a demonstration impact among other farmers. In social terms, the project was designed to lead to improvements in overall food security and quality of life in rural areas.

6.5 Original Components (as approved)

The project was developed at a time when it was usual to have many components. In reality, these components were not separate activities but were implemented together with significant synergies and collaboration occuring among them. If the project were developed today, it is likely that many of these would be concatenated as "subcomponents" within fewer main "components" and in effect, this is what was achieved.

The components were.

1. Promotion – to carry out a promotion campaign targeting renewable energy for productive purposes in the agriculture sector.

2. Institutional Strengthening – to provide training to technicians, agricultural extensionists and renewable energy system vendors.

3. Specifications and Certification – to introduce technical specifications and certification procedures for farm-based renewable energy equipment and its installation.

4. Market Development – to carry out studies on the potential market and productive applications for renewable energy systems in the agriculture sector.

5. Demonstration – to install renewable energy systems (such as solar- and wind-powered water pumping systems and solar-powered refrigerated milk storage tanks, etc.) among participating farmers as demonstration units.

6. Technical Assistance – for renewable energy-trained agricultural extensionists to advise participating farmers on the proper operation of their renewable energy systems.

7. Vendor Financing – to implement a pilot program to test innovative vendor financing mechanisms for farm-based renewable energy systems in four states.

8. Project Management – for FIRCO to carry out or coordinate project administration, auditing, monitoring and evaluation.

6.6 Revised Components

The components of the project were not revised during implementation.

6.7 Other significant changes

There were no significant changes in the project's design, scope or scale during implementation.

7. Key Factors Affecting Implementation and Outcomes

7.1 Project Preparation, Design and Quality at Entry

Rating of quality at entry: **Satisfactory**

The project design was thoroughly researched and developed and built directly on the experience of Mexico's Renewable Energy Program (www.re.sandia.gov/index.html; PERM for its Spanish acronym), a USAID and US Department of Energy sponsored project coordinated by Sandia National Laboratories. Between 1994 and 2001 the PERM project installed 206 Photovoltaic water pumping systems in 4 states of the country (Baja California Sur, Chihuahua, Quintana Roo and Sonora). The satisfactory results of this program were noted at appraisal, and to this day continue to yield satisfactory benefits. (See Espericueta *et al*. 2004.)

In particular, the program benefited by being able to access beneficiaries through the government's existing "Alianza" (Aliance with you) rural development program which delivers financial help to poor farmers to develop productive activities (see below). Alianza offered financial help to farmers in three broad subprograms: "fertilization-irrigation", "establishment of pastures and dairy farming" and later on "rural development". Approval by Alianza was a prerequisite for REAP funding and in order to get this approval, a farmer or consortium of farmers had to submit a request to Alianza, including an explanation of the proposed investments in renewable energy infrastructure.

This process was helped by FIRCO-trained technical advisors who ensured that the proposal was technically and economically feasible and met both Alianza and REAP criteria. Then, once initial approval from Alianza was received, FIRCO (The Trust Fund for Shared Risk - a department within the Secretariat of Agriculture, Livestock, Rural Development, Fishing and Food - SAGARPA) checked that the proposal conformed to REAP criteria (e.g. having a permanent reliable water source, being at least 1km from the electricity grid) before providing partial funding for the project.

Through this partnership, it was relatively easy to ensure that the GEF funding concentrated solely on co-funding the incremental cost of supplying panels to systems while other activities, including promoting production activities and other goods required to pump and store water, were funded through Alianza. In addition to funding from Alianza, beneficiaries were required to contribute 50% of funds in order to ensure ownership.

The appraisal report identified barriers preventing greater use of renewable energy and the project's design included specific components to help overcome these barriers. Through this it catalyzed the use of renewable energy thus offsetting significant carbon emissions immediately (36,292 tonnes per year) and creating an environment where renewable energy sources will continue to be used in place of carbon emitting sources and a replicable model for further applications in Mexico and beyond.

Barrier identified at appraisal	Components Addressing Barrier
Human capacity barriers: limited number of technicians and extension staff trained in renewable energy	Institutional Strengthening
Lack of awareness and limited information among farmers without electricity	Promotion, Demonstration Technical Assistance
Lack of information about the renewable energy market and viable applications for agriculture	Market Development
Farmers' high perception of risks regarding renewable energy	Demonstration Technical Assistance
Consumer confidence barriers	Specifications and Certification
High investment costs and limited financing options available	Vendor Financing

These components proved to be suitable for addressing the identified barriers (see Outcomes – section 8 below – and Annex 4). Operationally, four key lessons-learned informed project procedures and contributed to successful implementation of the components:

1. Flexibility and a demand-driven approach were considered key to building ownership, defining local priorities and facilitating implementation and sustainability. This led to the incorporation of the GEF project within Mexico's Alianza - a national comprehensive program of financial support to help Mexican farmers to invest in their farms that is run by SAGARPA but implemented in a decentralized manner by the Fideicomisos Estatales de Distribucion de Fondos (FOFAE) or the "State Trust Funds for Distribution of Funds".

2. Linking the GEF intervention with Alianza was expected to be useful for the following reasons (all of which proved well founded during implementation):
- it was expected to enable the use of an existing financial and accounting administrative structure that would facilitate project management and disbursements;
- it was expected to enable provision of complementary financing to support on-farm investments (such as fencing and pastures) that would enable significant increases in productivity;
- it was expected to provide a demand-driven mechanism whereby farmers could respond to the technical solutions offered by the project; and

- it was expected to facilitate decentralized and widespread project implementation engaging not only FIRCO staff located in the agency's 28 regional offices, but also other SAGARPA officials engaged in Alianza and thus institutionalize the spread of knowledge about practically useful renewable energy technology options.

3. The project sought to establish a critical mass of demonstrations – at least 34 in each state[1] – to catalyze the formation of local or regional markets for renewable energy systems. In practice, a total of 1,545 demonstrations were funded in 28 States. The average number of demonstrations per state was 55. The state that had the fewest demonstrations was Mexico D.F. with 6. Four states had between 10 and 20 demonstrations; another four had between 20 and 34, and 19 had more than 34. Most of the demonstrations were in Mexico's arid region (see table below). To some extent this was related to livestock populations given the dominant focus on water pumping for livestock; but it is considered that it is more directly related to greater demand for renewable energy in arid States.

Region	Cattle population		No of demonstrations	
	No.	% of Total	No.	% of Total
Arid	7,075,170	24.3%	1,545	65.0%
Temperate	8,755,975	30.1%	360	15.1%
Tropical	13,255,855	45.6%	473	19.9%
Total	29,087,000	100.0%	2,378	100.0%

4. The project also included a technical assistance component in order to ensure that participating farmers would satisfactorily operate the systems and reap maximum benefits from their use. After several trials with different forms of contracting the technical assistance[2], the project hired 48 technical advisors (at its peak) through a competitive process, to serve under the leadership of 28 FIRCO Regional agencies. Advisors played a key role in:
- promoting the technology among farmers and demonstrating how it worked and how it was maintained;
- helping farmers fill out forms and channeling their funding requests to FIRCO regional offices as well as to SAGARPA's regional offices managing the Alianza program; and
- advising farmers on how to benefit from their investments.

[1] Mexico has 31 states and a Federal District. The two states not included were Sonora and Quintana Roo which had already benefited from demonstrations funded by the USAID/USDOE project. The REAP project also supported 27 projects in Baja California Sur through financing, but not for demonstration purposes. Baja California had also received support from the USAID/USDOE project.

[2] One of these options, for example, provided for direct hiring of the advisers by the farmers themselves. See details in FIRCO (2006).

According to the Final Market Study survey of beneficiaries, advisors provided technical assistance to an estimated 73%[3] of beneficiaries executing demonstration projects. About 74% of farmers who benefited from this assistance rated it to be satisfactory; only 6% rated it as unsatisfactory (the remaining 20% did not respond). Survey respondents indicated having acted on specific recommendations received from their technical advisors in very concrete productive activities, such as vaccination schedules, animal husbandry and agricultural practices. About 55% of respondents indicated that technical advisors also helped in getting investment funding from other sources (including but not exclusively Alianza).

Out of the 70% who responded to questions regarding the impact of technical assistance, 94% considered it to have had a positive impact on their productivity and 91% indicated it had had a positive financial impact. Of those who said they had received positive economic benefits from technical assistance (984 beneficiaries in all), 24% said they had benefited significantly, 62% considered the benefit received as "medium", and 14% considered it to have been "little".

7.2 Implementation

The project's implementation is considered to have been satisfactory. The eight project components were mutually supporting lines of action implemented in an integrated fashion by FIRCO's implementation unit. Funds were used largely as planned including some considerable savings achieved in costs in some components such as Specifications and Certification (US$ 0.2 million) and Project Management (US$ 0.8 million). These savings were achieved without compromising the quality or impacts of these components. The Vendor Financing component did not receive the response from states that had been expected at appraisal (US$ 205,000 was disbursed in comparison with the anticipated US$ 2.5 million) but this nevertheless tested various financing options with the most successful occurring in Baja California Sur where funds were provided that enabled 22 renewable energy replications to be developed.

In total, cost savings of US$9.57 million were made in comparison to initial estimates. These were made without compromising achievement of the goals set at appraisal. In particular, cost savings were made in demonstration system through there being a lower cost for units than estimated at appraisal. This is because installation costs and costs of certain system parts were lower than estimated and this is considered to be due to economies of scale occurring following increased supply of such technology.

The project was not restructured during implementation. The only significant structural change was to extend the original project-closing date from June 30, 2004 to June 29, 2006 and to make minor reallocations of funding among components.

[3] The figure of 73% may be a low estimate. It is based on a survey of beneficiaries undertaken in connection with the market study. FIRCO records indicate that a total of 1,302 farms or about 83% of all demonstration projects funded received technical assistance.

The extension was mainly necessary due to delays in start up which occurred as prior commitments initially prevented the Alianza program from providing complete financial assistance to accompany the project's investments. Once these initial delays were overcome, the program evolved satisfactorily, with full disbursement of funds following an extension of the closing date.

The main modifications to the project concerned amplifying the technical assistance activities. Early on in implementation it was realized that in order to create demand for the installation of systems and for the systems to have the maximum impact on beneficiaries, dissemination of technology had to be closely allied to providing information about how to develop the productive processes that would be enabled by the technology. Close supervision at the project's start, combined with continuity of the Task Manager and Task Team and excellent collaboration with the implementing agency enabled these potential modifications to be identified and implemented. It is considered that this technical assistance was key to the project's success and that it is a key lesson learned for replication. As such it has been included as the key message from the project in the World Bank's "Renewable Energy Toolkit" (http://retoolkit.worldbank.org/).

7.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization

The project was implemented in a decentralized manner and close monitoring of field activities is considered to have been key to the project's success. Comprehensive monitoring was achieved by combining information on physical conditions (provided by FIRCO) and financial conditions (provided by NAFIN). This information was collected by each of the 28 decentralized FIRCO regional offices from which local Technical Assistance providers monitored each individual project both during the construction and, more importantly, the implementation phase when production data was collected for each of the units.

This monitoring followed the guidelines in the Operational Manual produced by the Project Coordination Unit at FIRCO headquarters and included diagnostic studies of every demonstration project, a program of technical assistance for every beneficiary, and a program of training events and demonstrations. Each regional office prepared State Energy Programs with detailed information on each demonstration unit[1], further information on overall plans and targets, periodic progress reports and a final evaluation report at the end of the project.This information was passed to FIRCO and is partially expressed in the project indicators which were regularly updated. In particular, for each Bank supervision mission, updated, comprehensive indicator values for both financial and physical performance were always presented to the task team.

The National Workshops undertaken helped to form a cohesive national project implementation team comprising regional and headquarters FIRCO staff and in the process these became a key mechanism for monitoring and controling project activities. The first two workshops took place in 2000 and helped launch the projects. Subsequent workshops – called "Monitoring and Control Workshops" – provided for the exchange ideas between headquarters and Regional office staff and gave FIRCO stakeholders the

opportunity to discuss basic operational documents regarding procedures (e.g. Guidelines for project disbursements, procedures for contracting external technical advisors, the Project Manual (prepared in 2002), the Operations Manual (2003), procedures for cost recovery in courses imparted). Key technical documents (e.g. Technical Specifications for Water Pumping Systems using Photovoltaic Energy), impart specialized training to staff (e.g. on Grundfos improved water pumping equipment) and review progress in the State Energy Programs that set out annual targets for the regional offices.

A very powerful Web based information systems was also developed and made available online by FIRCO (www.energiarenovable.com.mx) to provide a rapid means of interaction between the FIRCO and stakeholders. The system had the following attributes:

i. It provided comprehensive information about the project and its status for the **General Public** (description of renewable energy options; description of project components; number and location of installed modules, events and technical assistance; requirements for producers to qualify as beneficiaries, detailed description of procedures involved in the application process). This served not only to inform the public and disseminate knowledge about renewable energy, but also added transparency to FIRCO's operations through providing comprehensive reporting (e.g. the demonstration dataset is available through this system).

ii. It facilitated monitoring of **technical advisors** who were required to periodically report on their activities before receiving payments for their services.

iii. It made it easier for staff acting on behalf of **farmers** (or for farmers themselves if they had access to the web) to submit forms, request price offers from qualified suppliers and to choose quickly which of the suppliers they wished to perform the service for them.

iv. It described the process of certification of qualified **Photovoltaic Water Pumping System Suppliers** and the technical requirements of PV water pumping projects, and presents a list of all the companies (58 in all) regarded as "reliable" suppliers.

In addition, the Mid-Term Review contained a thorough assessment of the achievement of project objectives, progress of implementation and project indicators. Also the final borrower's report produced by FIRCO contains information and a thorough assessment of project implementation and achievements.

7.4 Safeguard and Fiduciary Compliance

The project was directed to benefit the environment and its environmental effects were designed to be overwhelmingly positive. The project was assessed as falling within Environmental category B and complied with all relevant safeguards policies throughout its operation. Compliance and overal benefits to the environment were ensured through each individual subproject being subject to an environmental checklist during design and implementation.

During preparation, concern was raised over the possible use of batteries to store power as the disposal of these could lead to pollution. In the final project design, this was avoided by ensuring that the systems promoted used only involved direct power and no storage. In other applications such as the pilot projects testing the viability of producing and using milk cooling equipment, care was made when reviewing plans to ensure all applications conformed to safeguards criteria.

The possibility of depletion of water in cases where water pumping systems were used was mitigated by ensuring that the farms where this was used had an adequate supply of groundwater and that the wells were sufficient to supply the pumping equipment. This was tested using standard criteria developed by Alianza and revised by the project team.

Although the primary objective of the project had to be environmental rather than social in nature, achievement of significant reductions in poverty were ensured as most of the beneficiaries were small farmers, located a long way from the electricity grid and classified as being below the poverty line.

Regarding other Bank safeguards, the combination of project objectives, the types of investments made and the monitoring and assessment of potential and actual effects ensured that none were triggered by the project.

Regarding fiduciary compliance, all aspects of disbursement, financial management and audit were fully complied with, mainly as a result of the diligence of NAFIN as the financial intermediary for the project and also due to the close assistance provided by the Financial Management team based in Mexico.

Overall FIRCO, with the support of NAFIN, maintained financial management systems (including accounting, financial reporting, and auditing) adequate to provide to the World Bank accurate and timely information regarding project resources and expenditures. FIRCO implemented the agreed action plan for strengthening of its financial management system and produced statements and progress reports used for project management and monitoring purposes.

The project was annually audited (including the Special Account) and with regard to procurement, in all cases, all contracts for works and services were conducted in strict compliance with Bank guidelines. This was verified throughout the project by the regular supervision missions conducted by the Bank. It was further documented by the independent procurement review concluded in 2006. This independent procurement review is also mentioned in Section 10.2 of this report and the review itself can be found in project files.

7.5 Post-completion Operation/Next Phase

Discussions with the Government of Mexico are continuing, following the recent elections and change of administration, about a possible follow-up operation.

Since 2004, one of FIRCO's formal objectives has been to develop and promote the use of renewable energy in rural areas and it is looking for programs and activities through which to do this. If no specific loan/grant-financed follow-up operation takes place then it is therefore, nevertheless, likely that the government will continue with certain aspects of the project, using its own resources, including:

- certification;
- demonstration;
- dissemination activities, particularly through the agreement with ANES; and
- education through the distance-learning diploma.

It does appear, however, that it might be possible for a follow-up operation to build on the project using an IBRD loan investing in a broad rural development strategy implementing integrated natural resource management activities aimed at developing productive processes and linking this with a GEF grant aimed at promoting the use of renewable energy within these productive processes. Such an approach could both promote the use of renewable energy directly (through GEF-financed activities) and create an environment where there is sustained increased demand for such renewable energy.

This would both facilitate supply of renewable energy and increase demand to ensure replication and long-term sustainability of interventions.

In addition to this, there is a further GEF / IBRD blended Integrated Energy Services project in the final stages of preparation which is planning to supply renewable energy for poor unelectrified people mainly in the southern states of Guerrero, Oaxaca, Veracruz and Chiapas. It is proposed that this would comprise a US$ 15 million GEF loan and a US$ 15 million IBRD grant and would be primarily implemented by SENER, the Ministry of Energy, but also building on the capacity built in FIRCO and the other work of, and lessons learned from, the REAP project. The Integrated Energy Services project is expected to be appraised with the new administration in early 2007.

8. Assessment of Outcomes

8.1 Relevance of Objectives, Design and Implementation

Rating: **Satisfactory**

The project was fully consistent with GEF Operational Program 6: Promoting renewable energy by removing barriers and reducing implementation costs. It has also been fully compatible with the Mexican government's national priorities, which are attaching increasing importance to developing alternative renewable sources of energy.

In the absence of the GEF contribution, activities would simply have concentrated on improving livelihoods through promoting productive uses in agriculture. Thus GEF funding was essential to produce the incremental effect of promoting renewable energy and subsequent carbon emissions reductions.

The project was also fully consistent with the Mexico Country Assistance Strategy and contributed directly to the three core themes of: i) social sustainability; ii) removing obstacles to sustainable growth and maintaining macro-economic stability; and iii) more effective public governance. It also contributed to the World Bank Group's strategy on the environment which gives priority to "win-win" investment opportunities where global environmental benefits *and* national economic benefits can be generated through an integrated and mainstreamed approach to development.

In addition, the project design reflected a pertinent diagnosis of a development priority that has continued to be relevant and is currently increasing in importance.

8.2 Achievement of Global Environment Objectives

Rating: **Satisfactory**

The project achieved all three project development objectives defined at appraisal.

As the World Bank's first experience of promoting productive uses of renewable energy, the project was also a pilot with the objective of testing the potential for such projects in the future and also of testing the market in Mexico for promoting renewable energy through such a project. Both these objectives were also fulfilled and project activities have been disseminated: i) throughout the Bank and GEF, particularly via the renewable energy toolkit and the golden plough award; ii) throughout the world, particularly via participation in the renewable energy congresses in Mexico and the global renewable energy "coloquio" in Mexico city in 2006; and iii) throughout Mexico via FIRCO's ongoing extension work, via the proposed World Bank renewable energy supply in Mexico project and via further planned World Bank activities in the country.

1) An estimated 2,312 farmers who previously had had no electricity were provided with a reliable electricity supply for productive purposes in a least-cost and sustainable manner, primarily (but not exclusively) through photovoltaic-energy water-pumping systems.

The principal indicator of achievement of this development objective identified at appraisal was national sales of renewable energy systems. FIRCO (2006) estimates of the number of PV systems established prior to the project and resulting from the project as follows:

Systems installed prior to GEF project (in 1994-2000 with support of USAID-USDOE project)	**195**
Systems installed as a result of the project:	
REAP supported demonstrations	1,545
Other systems (*réplicas*)*	867
Total	**2,312**
% Increase in sales of PV systems	789%

* Most of the replica systems were developed with funding from Alianza and other government programs. The number of replica systems reported does not include the 29 systems supported by the project's financing component in Baja California Sur

As these systems are only economically attractive in places far from the electricity grid, it is likely that almost all of them were installed in farms which previously were unelectrified. This is particularly true of the 1,545 REAP-funded installations for which being far from the grid was a precondition of getting funding.

2) A second indicator of achievement of this objective identified at appraisal was the change in the average price of renewable energy system. It is estimated that the average cost per watt installed of PV water pump systems sold in 2004-5 was 24-25% lower than those installed by the project in 2001-2002 (See Annex 13.4). The reasons underlying this reduction in cost are not entirely clear. A major driver in the cost of photovoltaic systems is the cost of the photovoltaic panels which are presently manufactured abroad and these have actually tended to increase in the past three years - considered to be because of strong demand in Europe. It would appear that project activities, in terms of: establishing service and equipment quality specifications; reducing unfamiliarity regarding the technology (and any risk premium that might be associated with this unfamiliarity); and stimulating start-up of new enterprises, have played a considerable role in reducing these costs.

3) A significant number of farmers saw their productivity and incomes increase as a result of their adoption of productive investments and improved farming practices. A rough preliminary estimate, based on an evaluation of three beneficiary farms, shows that in these cases average on-farm increases in income more than doubled (rising by 139%) – correcting for the distortion of receiving project income.

Survey results undertaken in connection with the second market study confirm that the benefits from demonstration projects were widespread among beneficiary farmers. 88% of beneficiaries surveyed stated that the equipment obtained through the project was useful for their productive activities. Only 2% said that it had not been useful. The remaining 10% did not respond to the question. When further asked why they felt the equipment was useful: most respondents (67%) said for water distribution; about 17% cited a reduction in cost; and 4% mentioned fuel savings. Evidence from studies of four farms used to model and project economic benefits suggest that net farm incomes with the project will have increased significantly as a result of the project (see section 8.3 and details in Annex 5).

4**)** FIRCO played a fundamental catalytic role in promoting, disseminating and identifying new productive applications of renewable energy technology. Furthermore, the agency's ability to continue to play such an effective role was systematically strengthened by the project. (See section 8.5 (b) on Institutional Change/Strengthening.)

The project also achieved both Global Environmental Objectives:

1**)** It promoted the use of renewable energy for productive purposes as demonstrated above; and

2**)** It reduced greenhouse gas emissions in the agricultural sector. As shown in annex 13.1, in its final year of implementation the project avoided more than 36,292 tonnes of carbon emissions (121% of its target figure of 30,000 tonnes). This reduction is expected to be sustained and increased in the future as further replication systems are implemented.

Annex 4 (especially Table 4-8) details how project implementation achieved and surpassed all outputs expected at appraisal.

8.3 Efficiency

Rating: **Satisfactory**

On-farm benefits are estimated to have been significant. In part this is because of government subsidies provided by the Alianza program and by this project, but also it appears that incomes have increased significantly following project-induced increases in production and productivity. Incomes in the four farm models studied increased five-fold in the arid region case-study (La Laborcita demonstration project), nearly three-fold in the temperate zone case study (El Porvenir), and about 64% in the tropical farm case study (Las Palomas).

Rates of return on farm investments are also considered to be positive and significant, although less than those anticipated at appraisal. (The rate of return on investment estimated at appraisal was 30.9%.)

	Arid		Temperate	Tropical
	Livestock	Mixed		
Appraisal Models	44%		19%	35%
ICR Models	18%	20%	17%	26%

The projected rates of return appear more realistic than those anticipated at appraisal. Photovoltaic water pumping systems are profitable relative to systems powered with conventional energy when: i. the investment lifetime is long (e.g. 15-20 years); ii. relatively low amounts of energy are required (e.g. less than 1,500 W); and iii. they serve remote places located far from the grid where the cost of transporting fuel is high. The last two conditions tend to limit the kind of on-farm investments that can be profitable

using PV systems, for example to watering livestock or to other products that are not disadvantaged through their being distant from markets (e.g. sorghum for fodder). Consequently, while PV systems can increase productivity and incomes, they are unlikely to yield very high on-farm returns.

Implementation by FIRCO was efficient and resulted in lower support costs than anticipated at appraisal (see Annex 5, Table 5.11). These lower costs will most likely enable the project to achieve a reasonable economic return on investment of about 15%.

These results are robust with respect to key assumptions. For the rate of return to be 12% or below, off-farm support costs would have to increase by 70%, or PV systems would have to be higher than 42%, or on-farm investment costs would need to be higher by about 19%, or product prices would have to be lower by 123%, or on-farm costs would need to be higher by 33%, or system breakdowns after the fourth year would have to be very rapid so as to reach and remain at 75.5% beginning in year 10 of the project.

8.4 Justification of Overall Outcome Rating

Rating: **Satisfactory**

As discussed in previous sections, the project was relevant, well-designed, achieved its global environmental objectives and was implemented effectively and efficiently. Overall economic impact on beneficiaries is likely to be lower than anticipated, but is nevertheless expected to be positive and significant. The overall outcome rating is therefore considered to be satisfactory.

8.5 Overarching Themes, Other Outcomes and Impacts

(a) Poverty Impacts, Gender Aspects, and Social Development

The eligibility criteria of the Alianza program were not differentiated by income or gender. Also the primary objective of the REAP project was to reduce carbon emissions rather than to achieve overtly social aims. Nevertheless, significant reductions in poverty were ensured as the criteria for beneficiaries defined in project documents (no electricity, at least 1 km away from the grid etc.) ensured that most of the beneficiaries were small farmers and classified as being below the poverty line. Such social benefits go beyond simply improving productivity to also improving living conditions through providing electricity for lighting and clean water for sanitation and other domestic uses.

Data on income of beneficiaries was not collected by FIRCO and although the data that is available is too fragmented and sparse to provide quantitative data regarding the income and social status of beneficiaries (see details in Annex 14), it nevertheless demonstrates that:

- a significant number of the beneficiaries of the demonstration component are classified as falling below the poverty line;

- the majority of demonstration beneficiaries would have found it difficult to gain access to commercial credit that would be necessary in order to overcome the initial high-cost limitation of the renewable energy technology; and

- although there is no evidence of gender targeting, women would have benefited in many cases (e.g. from reduced work gathering water for the animals, and in some cases from lighting made possible in connection with the project).

Indeed, the project is also considered to have had a positive impact on gender - although again quantitative data is not available. In particular, many of the 65 refrigerators supported by the project probably had a greater beneficial impact on women than on men.

(b) Institutional Change/Strengthening

(particularly with reference to impacts on longer-term capacity and institutional development)

The project helped develop the capacity of Mexico's agriculture and rural development agencies (SAGARPA and FIRCO) to carry out work relating to promoting the use of renewable energy in agriculture. In particular it helped develop the capacity of human resources within these agencies, and beyond to industry, academia and beneficiaries, to understand and share knowledge on viable applications of renewable energy in Mexico. The project was instrumental in leveraging financing for renewable energy investments through the country's principal rural development programs (e.g. *Alianza Contigo, Reconversión Productiva*).

The Institutional Strengthening component provided for:

- courses to train in-house trainers (4 courses - 39 trainees) who were subsequently used to conduct shorter courses, and specialized courses (8 courses – 221 staff-trainees);

- courses to expose Agricultural sector staff, extension agents and other stakeholders (e.g. farmer leaders) to elements of PV Water Pumping for agriculture (129 courses - 4,593 trainees) and Wind Energy applications (2 courses - 105 trainees);

- national meetings with vendors to engage them in the project and recruit their assistance in developing suitable specifications and certification procedures (6 meetings – 269 participants); and

- national 2-3 day workshops (10 – 447 participants) and regional workshops (7 – 221 participants), used to launch the project, develop teamwork, exchange experiences and introduce and discuss procedural and technical and administrative methodologies used by the project.

Many courses required the payment of fees by participants to ensure commitment in the learning process. In all, about US$ 60,000 were recovered. These provided funding for additional training.

Today FIRCO has 39 staff fully trained in renewable energy distributed throughout the country. It is also fully engaged in renewable energy activities, now incorporated within its agribusiness and micro-watershed programs.

An estimated 52% of all course trainees were technical staff working in rural development in various agencies, which now work offering techncal assistance to farmers. About 18% of participants were mid to top-level decision-making staff in various rural development programs (Alianza Contigo, Reconversión Productiva), another 15% were farmer leaders and the remaining were students, professors and researchers from the country's universities.

A specialized 4-week 6-module post-baccalaureat "diplomado" course has been developed in partnership with the Energy Research Center (CIE) of UNAM (http://xml.cie.unam.mx/xml). The course is aimed at university engineering and natural resources management students, as well as technicians interested in renewable energy applications in agriculture. It covers appraisal, design and installation of independent low-power PV systems for agricultural and rural development. It has been tested twice during implementation. It is intended to be conducted largely as a distance-learning course through the internet, thus keeping future costs relatively low.

The national meetings with vendors (mentioned above) engaged them in the establishment of specifications for renewable energy equipment and services, and the demonstrations (mentioned above) provided an opportunity for these vendors to build up their expertise and competitiveness in renewable energy.

Two high-visibility events organized by FIRCO helped participants strengthen networks and establish new links, and gave government officials an opportunity to discuss renewable energy options within a broad national strategic context. These events were:

- the World Renewable Congress (2004) with 2,000 participants; and
- the "International Colloquium on Renewable Energy for Rural Development: A Vision for the Future", 25-26 May 2006, with 500 participants.

The building of human capital achieved through these was supported by other project activities, in particular: the materials developed under the Promotion component; demonstration projects that enabled the practical observation of renewable energy in a practical setting; and technical assistance that facilitated execution and ensured that the renewable energy demonstrations had a significant impact on farm productivity. The market-development studies provided a serious assessment of what is possible and at the same time helped to identify and test other technology options. Funding provided under the specifications and certification component made discussions with vendors meaningful and practical, and helped enhance quality of service and thus increase consumer confidence. Furthermore, the specifications covered a broad range of uses of PV applications for broader rural development, not just agriculture.

FIRCO has also developed important institutional alliances that will help design and implement future renewable energy programs. These include agreements with: ANES to impart training; CIE-UNAM to develop the diplomado, help conduct training and help develop high quality technical guides; and AMPER and ANCE to assist with the certification of suppliers.

FIRCO and its staff have become known as a point of reference for renewable energy in Mexico, particularly, with respect to agriculture. One observer[4] noted: "Whereas in the past agriculture advisors might tell a farmer to disregard or discard renewable energy, mainly as a result of his or her own ignorance, this is hardly the case today. After the project and because of the GEF project, most agriculture specialists know the basic features, possibilities and viability of PV systems for agriculture, and if they need additional information they know where to find it".

(c) Other Unintended Outcomes and Impacts (positive or negative, if any)

No significant unintended outcomes or impacts were noted.

8.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops

The second market study (ANES 2006) and the final evaluation report (FIRCO 2006) present the findings of several very important surveys covering: REAP beneficiaries; Non-REAP farmers; Equipment Suppliers; Technical Advisors; and FIRCO staff.

The surveys are extensive and details are given in annex 12. The surveys also provide considerable material that will be very useful for any follow-up phase.

9. Assessment of Risk to Global Environment Outcome

Rating: **Moderate**

The table below summarizes the principal risks that could adversely affect the achievement of the project's development outputs.

The single most important risk to the Global Development Outcome is the possibility that a new government might not provide the continued support that is required. The technical and managerial expertise that FIRCO has developed, the experience and knowledge that staff and technical advisors have acquired and the expertise that businesses have acquired have combined to promote significant infrastructure and institutional capacity within the country. This will mitigate the risk that a change in government might bring about a reduced commitment to renewable energy.

However, because systems have high initial investment costs and most farmers have a limited planning horizon, the market alone will probably not provide sufficient stimulus for wide-scale future replications. Indeed, the single most important message given by both market studies undertaken by the project is that future investments in PV systems

[4] Ing. Simón Ortiz Gurrola, Operations Manager of Tecnología Solar y Energía Renovable de B.C.S., Tecnosol, Baja California Sur and former FIRCO staff member.

will require continued government support in the form of financial subsidies. Continued GEF support could provide the necessary encouragement to ensure the new government's commitment to renewable energy.

Risk factor	Rating	Observations
Government discontinues subsidy support to investments in renewable energy applications for production purposes in agriculture.	S	This risk is external to this particular operation. It is a significant risk because: i. there has recently been a change in government; and ii. future investments in PV systems will require continued subsidized funding. The GEF could help reduce this risk through continuing support through a follow-up project that includes financial subsidies (not necessarily GEF financed) for replications through Alianza or a similar program.
Rate of breakdown of systems and their repair is higher than anticipated.	L	This risk is real but the rate of breakdown would need to be high for the project to fail to deliver the expected development outcome. This is unlikely given the expansion in service providers encouraged by the project.
Projected increases in productivity on farm fail to materialize (e.g. reduction in output prices, increases in farm costs, poor farm management).	M	This risk is external to the operation. There is little that can be done to mitigate the risk. It is nevertheless important to monitor the productive evolution of farms and to profit from the extensive information that has been collected by FIRCO.

Rating scale: L: Low or negligible; M: Moderate; S: Significant; H: High

10. Assessment of Bank and Borrower Performance

10.1 Bank

(a) Bank Performance in Ensuring Quality at Entry

Rating: **Satisfactory**

The REAP project was designed using the latest knowledge about how to achieve its twin objectives of reducing greenhouse gas emissions in the agriculture sector and promoting the use of renewable energy for productive purposes in agriculture. As explained above, the project complied with all safeguards issues during preparation and its design was based on considerable technical knowledge of the project team, and identified need by the client and significant background work in the area. Subsequent implementation and close monitoring and evaluation revealed that these preparations had been meticulous and that the design had been appropriate for addressing these barriers and issues and promoting renewable energy and its productive uses. For these reasons, Bank performance in ensuring quality at entry is considered to have been satisfactory.

(b) Quality of Supervision

Rating: **Satisfactory**

A strong relationship with the implementing agency (FIRCO - The Trust Fund for Shared Risk within Mexico's Ministry of Agriculture) was developed during project preparation and the frequent early supervision missions involved multiple field trips and discussions with this agency. This supervision, combined with the operation of the monitoring and evaluation systems set up during preparation, was thus able to make the small-scale adjustments necessary to ensure continued optimal operation of the project. For instance, as originally designed, the Technical Assistance (TA) provided by the project focused mainly on assisting farmers to install renewable energy systems and would have been insufficient to achieve the project's development objectives. As a result a new dimension of TA was developed to not only assist farmers to install systems, but also to help them develop productive uses to take advantage of these systems.

In the case of water pumping systems, it was realized that supply of these could have a much greater developmental impact if farmers were simultaneously helped to expand and develop potential uses that arise following introduction of water pumping such as being helped to diversify cultivation and to market the increased output. This would both improve the development success of each individual installation and also stimulate sustained and widespread further demand, thus improving sustainability and replication of activities.

The monitoring and evaluation procedures then enabled further testing and modification over the following months to ensure that the optimal TA was provided. For instance, in the case of water pumping, some farmers found that the increased availability of water enabled them to undertake dramatic changes such as beginning livestock farming in addition to cultivation. This required further TA to ensure optimal returns to these new activities through marketing and processing. Following this, improvements to the TA were made, both by ensuring that the TA provided would meet these needs and ensuring that other project activities complemented this such as in the development of further uses of renewable energy including providing biogas and thermal heating of water for use in slaughter houses.

Since being developed and optimized, close supervision then enabled further integration of this TA throughout the project to complement other components such as pilot projects, education, market studies and dissemination. Recently, it has also been possible to partially outsource TA activities to an external agency ANES (The National Association for Solar Energy) which also carries out dissemination activities. This enables the TA to: i) be integrated with ANES's broader activities which occur throughout Mexico; ii) access synergies through being carried out alongside the demonstration activities that ANES undertook for the project's dissemination component; and iii) continue after the project closes as ANES is able to make a modest charge and recover some of the costs of its activities which increases its sustainability.

The project's monitoring work is also being continued by FIRCO, and is feeding into the work being done to develop further activities.

Through this work, the project has developed new understanding of how to conduct such renewable energy projects and is included as the key case study in the World Bank's Renewable Energy Toolkit (http://retoolkit.worldbank.org/) regarding the use of renewable energy in productive processes. For its outstanding supervision, the project was also shortlisted for a World Bank Golden Plough Award in 2006.

(c) Justification of Rating for Overall Bank Performance

Rating: **Satisfactory**

Both during preparation and implementation the project has been diligently and conscientiously supervised. It has been successful with regard to its key objectives and indicators. One aspect that is particularly being used as a model for other similar projects is the REAP project's concentration on stimulating demand by promoting the productive activities that arise from actually using renewable energy and supporting effective technical assistance to continue to promote such productive activities. The project also ensured it would be sustainable through developing stakeholder buy-in to pilot projects by requiring at least 50% cofinancing by beneficiaries, certification of providers to ensure quality of systems, education of potential providers through providing a distance-learning course and working towards developing a system of micro-credit.

Replicability was also a key part of project planning and of the outcome indicators used to measure effectiveness. This is particularly highlighted by the demonstration component that is aimed at enabling and encouraging replication throughout Mexico.

For these, and the above, reasons the overall Bank performance is considered to have been satisfactory.

10.2 Borrower

(a) Government Performance

Rating: **Satisfactory**

The performance of the government was excellent and at all times the project benefited from strong government support for promoting rural energy supplies. At times, however, internal disruptions occurred, such as the change of government in 2001 and these caused some temporary crises and a reduction in technical staff in the implementing agency. However, these challenges were always resolved and government performance overall was considered to be satisfactory.

In particular, NAFIN's diligence in financial and administrative aspects throughout the project was instrumental in enabling the project to function effectively in the complicated financial structures that Mexico has regarding receiving external funding. The exemplary manner in which fiduciary activities were carried out is demonstrated by the report of the

independent procurement review (IPR) conducted by the Bank in 2006 in the context of its regular ex-post procurement reviews. This review can be found in project files.

The IPR was made with the support of an accountant and was part of the regular IPR program for Mexico, as approved by the CMU through the sector leaders upon recommendation of the procurement team. The project was recommended for IPR by the procurement team for several reasons including: the need to include a trust fund in the IPR program; the volume of disbursement; the need to replace an ex post procurement supervision in the project; and the need to ascertain information received in a field inspection to a project using the related technology that there was excessive direct contracting from a source. The IPR did not show any of the latter concern. On the contrary, the IPR showed overall good procurement performance.

(b) Implementing Agency or Agencies Performance

Rating: **Satisfactory**

Implementing Agency	Performance
SAGARPA	The work of the implementing agency, FIRCO and key staff was exemplary. At times, however, there were some temporary crises such as during the reduction in technical staff following the change of government in 2001 that caused implementation to focus on process rather than results. However, these challenges were resolved and implementation during the final years of the project is considered to have been highly satisfactory. Implementation also benefited from FIRCO's highly decentralized nature which has 28 state offices distributed throughout Mexico. Each of these had a specialist working on this project and this enabled both comprehensive coverage, tailored activities in each region and assured sustainability through institutionalizing activities carried out under the project.

(c) Justification of Rating for Overall Borrower Performance

Rating: **Satisfactory**

For the reasons given above, the overall performance of the borrower is considered to have been satisfactory.

11. Lessons Learned

The project generated a considerable set of lessons that will be important for preparing and carrying out Renewable Energy and Rural Development programs and government policies in the future. The lessons will also be particularly useful for the design and implementation of future Bank projects. Particular lessons learned include:

- **Implementing the project through FIRCO within the department of agriculture rather than the department of energy.** In order to ensure the optimal impact of interventions, it was essential that the principal project implementing agency was related to the agriculture sector in order that it could promote productive uses of the energy. This is because provision of renewable energy appears to be mainly demand and not supply driven. It is considered that in other cases this will also be true and thus the implementing agency has to be related to the sector that will benefit from the renewable energy. In other projects this might be health or urban planning.

Implementing the project through FIRCO also enabled the project to be linked effectively with Mexico's existing government program offering financial support to farmers (Alianza). Linking the project with Alianza both enabled complementary funding to be easily provided and facilitated the selection procedure and methods for reaching beneficiaries.

- **Taking into account future livelihood changes.** In order to ensure the optimal impact of interventions, it became clear during implementation that it was essential to consider the livelihood consequences that will occur through provision of renewable energy and to integrate this into all components, including through investing in improving productive processes. This is particularly true for relatively complex technologies like water pumping for agriculture that have far-reaching consequences on livelihoods.

- **Dissemination.** It is important to ensure that dissemination is considered carefully in project design, is integrated in all components and project activities and that dissemination activities increase towards the end of the project as information becomes available.

- **Technical assistance.**
(i) Technical Assistance must focus on demonstrating the outcomes and benefits of using renewable energy technology, not simply on showing how to use it.
(ii) A wholesale approach to technical assistance, possibly achieved through contracting an agency, can increase efficiency and also may improve outreach to further potential users.
(iii) Integration of components is essential in order that technical assistants can use the knowledge gained through other project activities.

- **Implementation of subprojects.** Subprojects must be supported by cofinancing from beneficiaries. Such cofinancing could also be used to increase efficiency of procurement.

- **Replication.** Projects must plan how to keep track of replication systems installed and take great care if trying to implement a vendor financing mechanism.

- **Financing scheme.** For renewable energy investments to have a high impact and broad replication, an effective financing scheme is very important and this will most likely have to involve subsidized financing.

- **Indicators.** In future similar projects, it might be suitable to explicitly monitor types of beneficiaries and changes in income alongside other indicators.

- Supervision.
(i) Close monitoring and tracking of Technical Assistance and its results through innovative use of the internet and GIS can help greatly to evaluate the success of activities and to modify and optimize them.
(ii) A close relationship developed with the client (itself helped through continuity of a project's Task Team Leader during preparation and implementation) was instrumental in helping both to identify and to develop improvements during project implementation.
(iii) Flexibility in project design and implementation can help to make subsequent modifications and fully integrate these with other parts of the project to improve efficiency.

12. Comments on Issues Raised by Borrower/Implementing Agencies/Partners

(a) Borrower/implementing agencies

No major issues were raised by the borrower and Annex 10 contains a copy of the borrower's response to the draft of this report.

Following receipt of the borrower's letter (see Annex 10) a mission has been scheduled for February 2007 to discuss the main findings of this report.

(b) Cofinanciers

No cofinanciers apart from the borrower have been involved in the project.

(c) Other partners and stakeholders
(e.g. NGOs/private sector/civil society)

Annex 1. Results Framework Analysis

Global Environment Objectives

The project's global objectives were:

1. To promote the use of renewable energy for productive purposes in Mexico's agriculture sector by removing barriers and reducing implementation costs; and

2. To reduce greenhouse gas emissions in the agriculture sector.

Project development objectives were:

1. To provide unelectrified farmers with reliable electricity supply for productive purposes in a least-cost and sustainable manner using renewable energy technologies;

2. To increase the productivity and income of unelectrified farmers by supporting the adoption of productive investments and improved farming practices; and

3. To improve FIRCO's ability to catalyze the penetration of renewable energy technologies in the agriculture sector.

Key Impact Indicators were:

1. National sales of RE systems for productive agricultural aplications;

2. Change in average price of RE systems;

3. Carbon emissions avoided by project-supported RE systems; and

4. Change in average net income of participating farmers.

The project document did not assign a specific indicator to measuring FIRCO's ability to catalyze the penetration of renewable energy technologies in the agriculture sector. However, the indicators of "percentage of direct beneficiaries surveyed who learned of the equipment through FIRCO's promotional activities" (86%), "number of replica renewable energy systems installed" (847 documented replicas) and "total number of technicians and extensionists trained in renewable energy technologies" (3,022 or 121% of the original goal of 2,500) give a good measure of how the project achieved this objective.

Revised Global Environment Objectives

There were no revisions to the Global Environmental Objective nor to the key indicators.

(a) GEO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	National sales of RE systems for productive agricultural applications			
Value (quantitative or Qualitative)	0%	50-80% increase		Over 700%
Date achieved	06/30/2000	06/30/2005		06/29/2006
Comments (incl. % achievement)	Achievement over 875% See calculation and explanation in section 8.2			
Indicator 2 :	Reduction in average price of RE systems			
Value (quantitative or Qualitative)	0%	20%		24-25%
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 120-125%. This target was surpassed despite a sharp rise in local and global prices of PV cells. See calculation in Annex 13.			
Indicator 3 :	Tonnes of Carbon emissions avoided yearly by project-supported RE systems by the end of the project			
Value (quantitative or Qualitative)	0	30,000 tonnes / year		36,292 tonnes / year (see calculation in Annex 13)
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 121%. This is a conservative estimate as it excludes undocumented replicas and further RE technology such as the 65 refrigerators installed.			
Indicator 4 :	Change in average net income of participating farmers			
Value (quantitative or Qualitative)	0	No target was assigned		25%
Date achieved	06/30/2000			06/29/2006
Comments (incl. % achievement)	No target was assigned. However, the increase was 25% (see calculations in Annex 5, Table 5.6)			

Indicator 5 :	Percentage of direct beneficiaries surveyed who learned of the equipment through FIRCO's promotional activities			
Value (quantitative or Qualitative)	0	No target was assigned		86%
Date achieved	06/30/2000			06/29/2006
Comments (incl. % achievement)	This, along with other indicators was intended to measure FIRCO's ability to catalyze the penetration of RE technology. No target was assigned. However, 86% clearly demonstrates the efficacy of FIRCO's dissemination activities.			
Indicator 6 :	Replica water pumping systems installed			
Value (quantitative or Qualitative)	0	No target was assigned		847
Date achieved	06/30/2000			06/29/2006
Comments (incl. % achievement)	Although no official target was defined, the goal for the total number of systems installed due to the project was 1230. This was clearly surpassed by 1,545 being installed directly and a further 847 documented replicas.			

(b) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Technician courses held			
Value (quantitative or Qualitative)	0	79		131
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 166%. Training, dissemination and technical assistance were give greater prominence than originally planned.			
Indicator 2 :	Videos produced			
Value (quantitative or Qualitative)	0	8		2 videocassettes (15 min duration) 6 video TV series
Date achieved	06/30/2000	06/30/2005		06/29/2006
Comments (incl. % achievement)	Achievement 100%. Videos were used as part of the expanded disseminataion activities.			

Indicator 3 :	Demonstration days held			
Value (quantitative or Qualitative)	0	1000		2891 (56,057 participants)
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 289%. Demonstration activities were expanded in response to realizing its importance to achieving the project's objectives.			
Indicator 4 :	Farmer workshops held			
Value (quantitative or Qualitative)	0	800		798 (18,834 participants)
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 100%			
Indicator 5 :	Market assessments completed			
Value (quantitative or Qualitative)	0	2		2
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 100%			
Indicator 6 :	Technical studies completed			
Value (quantitative or Qualitative)	0	5		4
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 80%. Despite not completing the target number of studies, this component is considered to have been fully successful, producing important results (see table 4-3).			
Indicator 7 :	Specifications issued			
Value (quantitative or Qualitative)	0	3		1
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 33%. Given the comprehensiveness of the original specifications and also the lack of interest in developing wind-powered pumping systems and milk-cooling tanks, one set of specifications was adequate.			

Indicator 8 :	PV pumps installed and operating correctly			
Value (quantitative or Qualitative)	0	1050		1545 (of which 1439 are still working correctly)
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 147%			
Indicator 9 :	Wind pumps installed and operating correctly			
Value (quantitative or Qualitative)	0	55		4
Date achieved	06/30/2000	06/30/2005		06/29/2006
Comments (incl. % achievement)	Achievement 8%. Due to seasonality of wind, greater abundance of year round sunlight, and easier installation and maintenance of PV systems, the demand for wind pumping systems was limited.			
Indicator 10 :	PV refrigerated tanks installed and operating correctly.			
Value (quantitative or Qualitative)	0	24		6
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	25%. There was very little demand among farmers for cooling tanks. This is mainly due to the fact that milk cooling needs to function on a 24 hour basis for which batteries would be required and the investment costs for such technology are unfeasibly high.			
Indicator 11 :	Other RE systems installed and operating correctly			
Value (quantitative or Qualitative)	0	0		88
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Due to the lack of interest in Wind pumps and refrigeration tanks a number of other systems were developed, as explained in the main text.			
Indicator 12 :	Total RE systems installed and operating correctly			
Value (quantitative or Qualitative)	0	1230		1670
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 136%			

Indicator 13 :	Extensionists trained by state			
Value (quantitative or Qualitative)	0	111		81
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 73%. Although Technical Assistance was expanded during implementation, only 81 extensionists were ultimately required.			
Indicator 14 :	Total technicians and extensionists trained by state			
Value (quantitative or Qualitative)	0	2500		3022
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 121%			
Indicator 15 :	Pamphlets/brochures distributed			
Value (quantitative or Qualitative)	0	54000		281000
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 520%. Dissemination was very important for achieving project objectives.			
Indicator 16 :	Demonstration day participants			
Value (quantitative or Qualitative)	0			
Date achieved	06/30/2000		06/30/2000	06/29/2006
Comments (incl. % achievement)				
Indicator 17 :	Vendors trained in vendor financing			
Value (quantitative or Qualitative)	0	12		2
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 17%. The challenges and responses to implementing the vendor financing component are explained in the main text.			

Indicator 18 :	RE systems purchased with vendor financing			
Value (quantitative or Qualitative)	0	403		29
Date achieved	06/30/2000	06/30/2000		06/29/2006
Comments (incl. % achievement)	Achievement 7%. The challenges and responses to implementing the vendor financing component are explained in the main text.			

Annex 2. Restructuring (if any)

Not Applicable

Annex 3. Project Costs and Financing

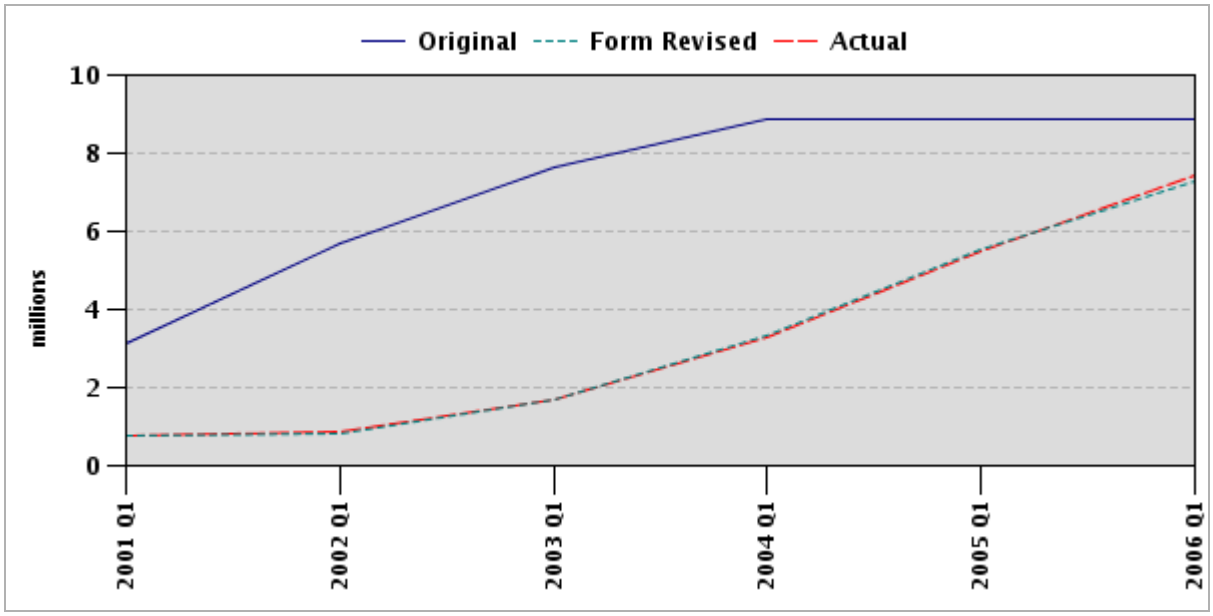
(a) Project Cost by Component (in USD Million equivalent)

Components	Appraisal Estimate (USD M)	Actual/Latest Estimate (USD M)	Percentage of Appraisal
INSTITUTIONAL STRENGTHENING	1.80	1.65	91.67
PROMOTION	1.60	1.48	92.50
MARKET DEVELOPMENT	0.30	1.00	333.33
SPECIFICATIONS AND CERTIFICATION	0.70	0.05	7.14
DEMONSTRATION	18.70	15.83	84.65
TECHNICAL ASSISTANCE	4.90	1.37	27.96
VENDOR FINANCING	2.30	0.21	9.13
PROJECT MANAGEMENT	1.00	0.14	14.00
Total Baseline Cost	**31.30**	**21.73**	
Physical Contingencies	0.00		
Price Contingencies	0.00		
Total Project Costs	**31.30**		
Front-end fee PPF	0.00	0.00	0.00
Front-end fee IBRD	0.00	0.00	0.00
Total Financing Required	**31.30**	**21.73**	

(b) Financing

Source of Funds	Type of Cofinancing	Appraisal Estimate (USD M)	Actual/Latest Estimate (USD M)	Percentage of Appraisal
Borrower	Central Government	22.40	12.83	57.28
GLOBAL ENVIRONMENT FACILITY		8.90	8.90	100.00

(c) Disbursement Profile



Annex 4. Outputs by Component

Table 4.1. Institutional Strengthening

Objective To develop the human capital in institutions that participate in the Project, particularly the staff of SAGARPA and FIRCO. Workshops also served as a critical management tool for team building and monitoring progress.		**No. of courses**	**Duration**	**No. of Trainees/ Participants**
Training courses in renewable energy Courses designed to train FIRCO headquarters and regional staff, SAGARPA staff and other institutional stakeholders including vendors and, occasionally, also farmer leaders.	Courses for instructors	4	3 weeks	39
	PV Water Pumping courses	129	3 days	4593
	Wind Energy courses	2	4 days	105
	National meetings with vendors	6	1-2 days	269
	Courses imparted abroad	8	varied	221
Workshops Used to launch the project, develop teamwork, exchange experiences and introduce and discuss procedural and technical and administrative methodologies used by the project, and review progress along State Energy Plans.	National Workshops	10	2-3 days	447
	Regional Workshops	7	2-3 days	221

Table 4.2. Promotion

Objectives -Disseminate the opportunities of using PV and Wind Systems -Inform the general public and prospective beneficiaries and staff of the requirements for participating in the project. - Show advantages of using renewable energy technology in agriculture. - Impart basic training to farmers. - Link technical staff with potential users - Promote the use of renewable energy.		
Dissemination Material Produced		**No.**
Printed materials		
Pamphlets (2 - 3 sheets each)		281,000
Posters		27,200
Books and Technical Guides		30,690
Field Notebook		1,000
Technical guides		11,590
Technical Guides (Wind)		100
Market Study		100
Sample Successful REAP Projects		2,100
Water Pumping PV Technology		3,800
Renewable Energy Applications for Agriculture		6,000
Solar Powered Heaters		2,000
Bioclimatic bases		2,000
Batteries: technology and use in PV systems		2,000
Technical Pamphlets for Demonstration Days 1 through 5		83,100
Other media		
Videocassettes (2 each 15 min. duration)		1,500
TV Series (6 videos in 3 CD set)		3,750
Presentations for Water Pumping course		3,750
Promotion	**Number of Events**	**Participants**
Demonstration days	2,891	56,057
Producer Workshops	798	18,834
Fairs and Exhibits	61	
Total	**3,750**	**74,891**

Table 4.3. Market Development

Objective:
Reduce uncertainty due to initial lack of knowledge regarding the present situation and the potential for expanding the market of renewable energy in agriculture in the country; and promote the development of this market.

Market Studies

First Market Study
The first market study:
i. gives an overview of renewable energy developments world wide and in Mexico;
ii. characterizes and quantifies the potential demand for renewable energy use in various applications for agriculture in Mexico;
iii. Describes the present industry supplying renewable energy equipment and services, including their technological capacity, location, and service scope within Mexico, and
iv. analyzes the potential for further development of the industry.

Second Market Study
The second market study:
i. analyzes the impact of the REAP project on the growth, development and expansion of the renewable energy market for agriculture in Mexico.
ii. examine and identify the impact that REAP has had on the development of renewable energy market for agriculture, including effects on marketing channels, costs, and spatial distribution.
iii. propose measures to further support market development in Mexico.

Technology Development
These research efforts sponsored the design, testing and validation of new equipment and applications of renewable energy in productive enterprises. In the case of refrigerators, a more mature technology, 65 demonstration units were installed.

	Prototypes developed & tested	**Demos installed**	**Results of research efforts**
PV milk cooling tanks	6		Questionable economic viability
PV Refrigerators to preserve agricultural and fisheries products	16	65	Very promising technology, ready for dissemination
PV water heaters for productive purposes	15		Promising technology
Thermal energy from biogas using organic by products of agriculture	9		Promising technology

Table 4.4. Demonstration

Objectives: Show farmers and technicians that significant productivity increases are readily achievable using renewable energy. Establish demonstration projects throughout the country to begin to foster a culture of familiarty, basic knowledge and acceptance of the technology in appropriate conditions.	
Demonstration systems installed	
PV water pumping demo systems for agriculture (mainly livestock) installed	1,545
Wind water pumping demo systems for ag (mainly livestock) installed	4

Further information on Watts installed and cost per Kilowatt Hour can be found in Annex 13.

Table 4.5. Technical Assistance

Objectives: The principal objective was to support demonstration systems installed with technical advice to help make sure that beneficiary farmers know how to use the systems and, more importantly, to ensure that the systems have a significant impact on farm productivity and income. In practice, technical advisors also helped implement the project, by assisting farmers to process their applications, obtain funding for productive investments from other government programs, and by conducting demonstration days and participating in other technology promotion activities.	
Technical advisors used (at project's peak level of activity)	48
Number of demonstration farmers assisted.	1,302
Number of visits to farmers by technical advisors.	14,546

Table 4.6. Specifications and Certification

Objective: This component sought to reduce any uncertainty from buyers that could arise from faulty equipment or from undue variations in the quality of equipment and service provided by vendors. It sought to set out clear requirements that should be met by renewable energy equipment vendors as they design, install, test and provide maintenance service to customers.
Technical Specifications
PV water pumping (coverage of specifications) - Warranties - Parts and components (PV modules, support and structure, electricity inverter and controller, pump and motor, cabling, grounding, surge protection, etc.) - Installation of system (cabling and electrical connections, hydraulic connections, PV arrangements, inverter, controller) - Acceptance tests - Customer training - After sales services - Technical documentation (technical offer, economic offer, operation and maintenance manual, electrical and mechanical diagram, results of acceptance tests)

Water Pumping with Wind Energy - A first version of specifications for this technology was developed. It will be revised and enhanced as the technology becomes more widely used.
Certification - Enterprises interested in being certified in order to demonstrate their capability, efficiency and reliability as PV equipment suppliers were identified. - A General Procedure was established for the Certification of Suppliers of PV Systems for Rural Development (covers not just agriculture but, more broadly, rural development applications) - Participation in the certification processes was made a requirement for participating as a supplier of equipment in demonstration projects. - An Agreement has been signed under project auspices whereby ANCE and AMPER agree to carry out a pilot test for the Certification of Suppliers. - As at end September 2006, 28 equipment suppliers have been certified.

Table 4.7. Vendor Financing

Objective: Testing of a pilot vendor financing scheme to cover the amouont of funding that is not provided by ALIANZA program in non-demonstration states.	
Systems funded	
Projects funded using Baja California Sur vendor financing scheme:	29
Note: Baja California Sur, Sonora, Quintana Roo and Chihuahua did not benefit from demonstrations, because the USAID-USDOE project had already established demonstration projects there.	

Table 4.8. Output Targets Specified at Appraisal and Realized During Implementation

A table on the achievement of output targets specified at appraisal is available in Annex 13.3.

Annex 5. Economic and Financial Analysis (including assumptions in the analysis)

The target population was further defined during project implementation. Out of the estimated 600,000 farms with no electricity (operationally, over 1 km away from the grid), many of these did not have access to suitable sources of water while others had water requirements exceeding the limits imposed by PV technology (i.e. of more than 2 liters per second). The target population was accordingly narrowed to estimated 80,000-100,000 predominantly livestock farms.

Most of the demonstration systems were installed in the Arid region (see Tables 5.1 and 5.3). To a large extent this follows the livestock population given the dominant focus on water pumping for livestock; but it is also directly linked to the greater demand for renewable energy in arid States.

Table 5.1. Distribution of Bovine Cattle and of REAP Demonstrations by Region

Region		Bovine cattle population			Number of demonstrations	
		No.	% of Total		No.	% of Total
Arid		7,075,170	24.3%		712	46.1%
Temperate		8,755,975	30.1%		360	23.3%
Tropical		13,255,855	45.6%		473	30.6%
Total		29,087,000	100.0%		1,545	100.0%

FIRCO categorized its farm investments into three types of activity: agriculture, mixed farming and livestock (Table 5.2). The dominant activity was bovine cattle, and this was true even in mixed farms. Agriculture was included as an investment component in these farms, partly to provide a small additional source of income, but more importantly, because the criteria for acceptance by Alianza enabled farmers to avoid having to pay taxes on their investments whenever an agricultural component was involved.

Table 5.2. Distribution of Systems Installed by Main Farming Activity

	Agriculture	Livestock & Ag.	Livestock	Total
Arid	13	211	488	**712**
Temperate	22	244	94	**360**
Tropical	6	187	280	**473**
Total	**41**	**642**	**862**	**1545**

Survey evidence of impact

The predominant uses of GEF investments for watering livestock is confirmed by the survey of REAP beneficiaries undertaken in connection with the second market study. Out of 1,313 respondents[5], 90% indicated watering livestock as the main purpose of their investment. The second most important activity was irrigation, but only for 9% of respondents. Water for domestic use was the main purpose of investment for only 1% of the beneficiaries surveyed.

Table 5.3. Distribution of Bovine Cattle Population by State and Distribution of States and Demonstrations according to 3 Agro-ecological Regions

	Re-gion	No. Heads (2003)	No. of demos	Arid (A)		Temperate (T)		Tr (Tropical)	
				No. of Heads	No. proy	No. of Heads	No. proy	No. of Heads	No. proy
Aguas-calientes	A	101,703	22	101,703	22	0	0	0	0
Baja California	A	231,936	57	231,936	57	0	0	0	0
Campeche	Tr	613,357	74	0	0	0	0	613,357	74
Chiapas	Tr	2,494,162	59	0	0	0	0	2,494,162	59
Coahuila	A	639,479	111	639,479	111	0	0	0	0
Colima	Tr	181,906	15	0	0	0	0	181,906	15
Comarca Lagunera	A	569,384	99	569,384	99	0	0	0	0
Durango	A	1,393,263	103	1,393,263	103	0	0	0	0
Guanajuato	T	855,162	39	0	0	855,162	39	0	0
Guerrero	T	1,282,144	12	0	0	1,282,144	12	0	0
Hidalgo	T	570,550	79	0	0	570,550	79	0	0
Jalisco	T	2,773,934	32	0	0	2,773,934	32	0	0
México	T	612,076	6	0	0	612,076	6	0	0
Michoacán	T	1,807,117	32	0	0	1,807,117	32	0	0
Morelos	T	123,879	67	0	0	123,879	67	0	0
Nayarit	Tr	705,541	25	0	0	0	0	705,541	25
Nuevo León	A	399,086	42	399,086	42	0	0	0	0
Oaxaca	Tr	1,695,583	65	0	0	0	0	1,695,583	65
Puebla	T	659,271	76	0	0	659,271	76	0	0
Querétaro	A	276,775	20	276,775	20	0	0	0	0
San Luis Potosí	A	907,412	57	907,412	57	0	0	0	0
Sinaloa	A	1,608,011	101	1,608,011	101	0	0	0	0
Tabasco	Tr	1,525,175	44	0	0	0	0	1,525,175	44
Tamaulipas	Tr	1,237,776	42	0	0	0	0	1,237,776	42
Tlaxcala	T	71,842	17	0	0	71,842	17	0	0
Veracruz	Tr	4,094,152	92	0	0	0	0	4,094,152	92
Yucatán	Tr	708,203	57	0	0	0	0	708,203	57
Zacatecas	A	948,121	100	948,121	100	0	0	0	0
Totals		**29,087,000**	**1,545**	**7,075,170**	**712**	**8,755,975**	**360**	**13,255,855**	**473**

Eighty-eight percent of beneficiaries surveyed stated that the equipment obtained through the project was useful for their productive activities. Only 2% said that it had not been useful. The remaining 10% did not answer the question. When further asked why they felt the equipment was useful, most respondents (67%) said for water distribution; about 17% cited a reduction in cost and 4% mentioned fuel savings.

FIRCO's promotional activities unquestionably influenced farmers regarding solar equipment and 86% of beneficiaries surveyed learned of the equipment through these. The next most important source of information was the municipality but this was only mentioned by 5% of the respondents.

On-Farm Benefits and Returns

Four farm models were developed to appreciate the likely project impact at the farm and project levels. Three of these are bovine livestock models. A fourth model includes a small agriculture component to simulate a typical farm categorized as "mixed". Field data gathered through FIRCO technical assistance advisors regularly updated notebooks for each project site. These notebooks were used to identify start-up parameters, as well as the evolution of these projects during the first two or three years. Data for the earlier investment projects, established in 2002–2003, are now mature and provide useful information that may used as a basis to project future costs and benefits.

Investment projects chosen by FIRCO staff serve as models of typical projects occurring in these three regions. Data available on the number of animals by project size and by farm size (Tables 5.4 and 5.5) were used to verify that the chosen models were consitent with typical investment projects within the region. The basic features of these four models and the financial results obtained are summarized in Table 5.6. Tables 5.7 through 5.10 present projections of herds, farm income and costs with and without project. All income and returns are expressed in equivalent of US$ in constant 2006 terms applying Mexico's consumer price index as deflator and the prevailing rate of exchange for the first 7 months of the year (US$ 1 = $10.866).

Results are positive, albeit, as shown below, rates of return on on-farm investments appear to be significantly lower than those anticipated at appraisal.

	Arid		Temperate	Tropical
	Livestock	Mixed		
Appraisal Models	44%		19%	35%
ICR Models	18%	20%	17%	26%

No attempt has been made to determine the reasons underlying the differences observed between appraisal and ICR values. Nevertheless, in general terms, photovoltaic water pumping systems are profitable relative to systems powered with conventional energy when: i) the investment lifetime of the project is long (e.g. 15-20 years); ii) relatively low amounts of energy are required (e.g. less than 1,500 W); and iii) they are intended to serve remote places located far away from the grid. The last two conditions tend to limit the kind of on-farm investments that can be profitable using PV systems, to watering for livestock and to other products that can withstand significant distance to their markets (e.g. sorghum for fodder). Consequently, while PV systems can increase productivity and incomes, they are generally unlikely to yield very high on-farm returns.

Table 5.4. Average Head of Cattle per Beneficiary in Demonstration Projects under Private Property Management, by Region

Greater than	less than or = to	Arid		Temperate		Tropical		Overall		
		Ave.	No. proy.	Ave.	No. proy.	Ave.	No. proy.	Weighted Average	No. proy.	%
0	10	6.6	45	6.0	22	5.8	9	6.3	76	11.3
10	20	15.7	72	14.7	32	15.7	18	15.5	122	18.1
20	30	24.7	57	26.5	17	24.5	15	25.0	89	13.2
30	50	40	53	40.2	27	38.5	29	39.6	109	16.2
50	100	69.4	26	69.6	49	75.8	46	71.9	121	18.0
100	200	133.4	39	142.6	20	140.3	52	72.6	111	16.5
greater than 200		290.1	20	544.0	1	581.0	24	141.0	45	6.7
All projects		46.5	312	46.9	168	104.5	193	51.5	673	100.0

Note: Only projects managed under private property, with bovine cattle as their main livestock activity and for which herd and beneficiary data is available are considered here. These represent 43% of all demonstrations.

Table 5.5. Average Head of Cattle per Project in Demonstrations by Region

Greater than	less than or = to	Arid		Temperate		Tropical		Overall		
		Ave.	No. proy.	Ave.	No. proy.	Ave.	No. proy.	Weighted Average	No. proy.	%
0	10	8.8	5	9.0	2	3.8	5	6.8	12	0.9%
10	50	28.8	73	31.3	105	32.4	101	31.0	279	20.8%
50	100	78.0	117	70.1	94	73.9	113	74.3	324	24.1%
100	200	145.5	249	144.1	68	142.3	130	144.4	447	33.3%
200	500	280.8	154	308.9	24	299.4	66	288.6	244	18.2%
500	1000	682.2	12	572.3	6	611.3	8	446.9	26	1.9%
greater than 1000		11500	8		0	2646.3	4	8548.8	12	0.9%
All projects		309.0	618	102.1	299	153.1	427	190.7	1344	100.0

Note: Only projects with bovine cattle as their main livestock activity and for which herd data is available are considered here. These represent 87% of all demonstrations.

Table 5.6. Basic Features and Financial Results of On-Farm Investment Models Examined

Region	**Arid**	**Temperate**	**Tropical**	**Arid**
Name of Basis Project	La Laborcita	El Porvenir	Las Palomas	La Laborcita-Mixed
Project Installation Date				
Starting Heads of Cattle	85	55	99	85
Main Livestock Product	Calves	Steers	Dual purpose	Calves + Ag.
Ag. Product				Sorghum
Investment (US$ 2006)				
- PV System	11,340	6,189	7,044	11,340
- On-Farm Livestock	14,472	8,361	7,163	14,472
- On-Farm. Ag.				2,140
Total	**25,812**	**14,550**	**14,208**	**27,952**
Net farm income				
- Without project	393	408	3,506	393
- First 3 years of project	2,375	1,560	5,775	2921
%**change**	**504.3**	**285.5**	**64.7**	**643%**
IRR	**18%**	**17%**	**26%**	**20%**
NPV (12%) in US$ 2006	**7,233**	**3,281**	**9,830**	**10,169**
Note: Investment cost data for 2002 and 2003 have been converted into current US$ 2006 values using Mexico's consumer price index and the present exchange rate ($ 10.866 = US$1).				

Tables 5.7 to 5.10 containing detailed data on the case study farms can be found in Annex 13.4.

Economic Returns on Investment

The rates of returns and corresponding cash flows for the three livestock models were used to project rates of return to the on-farm investments of US$ 15,834,852 in the demonstration projects; assuming that demonstrations per year in each area type would yield a similar return as the corresponding model does. Nominal investment values were converted to comparable constant 2006 US$. The difference in return between the mixed and livestock models is small and did not warrant further consideration.

Project costs supportive of demonstration investments include those related to: technical assistance, promotion, market development, certification and project management. Without the critical inputs funded by these components it is doubtful that the on-farm returns on demonstration project investments could have been achieved. In practice, support costs were significantly lower than anticipated at appraisal.

Table 5.11. Project Costs Estimated at Appraisal, Implementation Costs Realized and Demonstration Support Costs

Component	PAD* (US$ 000)	Realized	
		All Costs**	Demo Support Costs
Institutional Strengthening	1,565	1,646,724	1,646,724
Promotion	1,795	1,479,938	1,479,938
Market Development	675	1,001,190	1,001,190
Specifications and Certifications	270	52,717	52,717
Demonstration	18,470	15,834,852	
Technical Assistance	4,840	1,365,900	1,365,900
Vendor Financing	2,225	205,303	
Project Management	950	138,923	138,923
Unallocated Contingencies	500		
Total	**31,290**	**21,725,547**	**5,685,392**
* Page 31 of PAD. ** Page 197 of REAP Final Evaluation Report			

From a strictly economic standpoint, solar energy is superior to conventional energy but over a long life span. PV panels require an initial significant investment that is compensated by benefits provided that the PV systems remain in operation over a relatively long time horizon (FIRCO-Sandia 2001, esp. pages 62-66).

Evidence of the likely duration of the PV water pump systems is available from two sources:

> A Survey undertaken by the Second Market Study found 8% of the systems out of service: 105 out of a total of 1,313 farmers surveyed with systems installed. The causes behind the malfunctions were: failure in the pump or panel (59 cases), theft (34 cases) and, to a lesser extent, insufficient water (10 cases) plus other minor causes. The average age since installation of all REAP systems at the time this survey was undertaken was about 1.7 years.
>
> A survey of 52 systems installed by the Sandia project showed that 28 were still in operation and 21 were out of commission; i.e. a 60% survival rate (40% "non-functioning" rate) after 6.5 years in operation. (Espericueta et al 2004)

In calculating rates of returns on the project investments, farm net benefit flows have been assumed to accrue until about the year 2010 (i.e. from 16 to 20 years, depending on the time they were installed. It has also been assumed that the incidence of non-performance starts with 4% beginning after the second year of any farm demonstration project, and reaches 8% by the third year in operation. This non-functioning percentage is assumed to increase slowly (mainly on account of theft), until it reaches about 50% in year 10 and stabilizes at this level subsequently (i.e. farmers value their systems and stolen panels occasionally get replaced). This is a rate of non-performance that is somewhat more positive than that experienced with the 52 Sandia systems surveyed by Espericueta et al (2004), but is considered reasonable because the present project has made significant strides in developing service to repair the systems. In any event, this is a parameter that

deserves continuous monitoring in the future.

The economic rate of return of the project thus calculated is projected to be 15%, and the net present value is a projected US$ 3.0 million. These are conservative estimates. They ignores the impact on the estimated 800 system replications that came about largely as a result of the project, as well as the positive effects on the environment from lower carbon emissions. This ICR rate of return is much lower than that estimated at appraisal, 39.9%.

Sensitivity Analysis

The project's overall profitability results are robust with respect to key assumptions. For the rate of return to be 12% or below, off-farm support costs would have to increase by 70%, or PV systems would have to be higher than 42%, or on-farm investment costs would need to be higher by about 19%, or product prices would have to be lower by 123%, or on-farm costs would need to be higher by 33%. System breakdowns after the fourth year would have to be very rapid so as to reach and remain at 75.5% beginning in year 10 of the project.

Table 5.12. Switching Values at 12.0%

Increase in off-farm support cost	70%
Increase in PC System Investment	42%
Increase in On-Farm Investment	19%
Reduction in product prices	123%
Increase in on-farm costs	33%
Faster breakdown of systems after year 4, reaching in year 10:	75.5%

Annex 6. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/Specialty
Lending			
Michael G. Carroll	Lead Natural Resources Management Specialist	LCSAR	Task Team Leader
Supervision/ICR			
Greicy C. Amjadi	Senior Program Assistant	SDV	Team Assistant
Michael G. Carroll	Lead Natural Resources Management Specialist	LCSAR	Task Team Leader
Mauricio Cifuentes	Team Assistant	CGFNB	Team Assistant
Edgardo M. Floto	Consultant	LCSAR	Economic Assessment
Efraim Jimenez	Lead Procurement Specialist	LCSPT	Procurement Supervision
Simon Nicholas Milward	Junior Professional Associate	LCSEN	Climate Change Specialist
Victor Ordóñez	Senior Financial Management Specialist	LCSFM	Financial Management Supervision
Jeannette Ramirez	Operations Officer	LCSAR	Supervision Support

(b) Ratings of Project Performance in ISRs

No.	Date ISR Archived	IP	GEO	Actual Disbursements (USD M)
1	05/04/2000	Satisfactory	Satisfactory	0.00
2	05/05/2000	Satisfactory	Satisfactory	0.00
3	12/07/2000	Satisfactory	Satisfactory	0.75
4	06/27/2001	Satisfactory	Satisfactory	0.85
5	12/13/2001	Satisfactory	Satisfactory	0.85
6	06/17/2002	Satisfactory	Satisfactory	1.31
7	09/05/2002	Satisfactory	Satisfactory	1.66
8	12/19/2002	Satisfactory	Satisfactory	2.01
9	06/05/2003	Satisfactory	Satisfactory	2.92
10	06/06/2003	Satisfactory	Satisfactory	2.92
11	12/18/2003	Satisfactory	Satisfactory	3.88
12	06/18/2004	Satisfactory	Satisfactory	4.79
13	12/23/2004	Satisfactory	Satisfactory	5.83
14	06/08/2005		Satisfactory	6.92
15	07/27/2006		Satisfactory	8.90

(c) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
Lending		
FY99	15	76.46
FY00	25	122.60
FY01		0.00
FY02		0.00
FY03		0.00
FY04		0.00
FY05		0.00
FY06		0.00
FY07		0.00
Total:	**40**	**199.06**
Supervision/ICR		
FY99		0.00
FY00		0.00
FY01	7	36.20
FY02	5	27.64
FY03	4	21.31
FY04	9	43.79
FY05	11	55.44
FY06	12	60.77
FY07	12	62.06
Total:	**60**	**307.20**

Annex 7. Detailed Ratings of Bank and Borrower Performance

Bank	Ratings	Borrower	Ratings
Ensuring Quality at Entry:	Satisfactory	Government:	Satisfactory
Quality of Supervision:	Satisfactory	Implementing Agency/Agencies:	Satisfactory
Overall Bank Performance:	Satisfactory	**Overall Borrower Performance:**	Satisfactory

Annex 8. Beneficiary Survey Results (if any)

The second market study (ANES 2006) undertaken by the project and the final evaluation report (FIRCO 2006) present the findings of several very important surveys covering: REAP beneficiaries; Non-REAP farmers; Equipment Suppliers; Technical Advisors; and FIRCO staff.

The surveys are comprehensive and are highly relevant to increasing the current use of Renewable Energy Technology. They also provide considerable material that will be very useful for any follow-up activities.

Annex 9. Stakeholder Workshop Report and Results (if any)

No stakeholder workshop has been held.

Annex 10. Summary of Borrower's ICR and/or Comments on Draft ICR

FINANCIERA RURAL
FIDEICOMISO DE RIESGO COMPARTIDO
DIRECCION DE ANALISIS Y SERVICIOS INSTITUCIONALES

FIRCO

SECRETARÍA DE AGRICULTURA, GANADERÍA, DESARROLLO RURAL, PESCA Y ALIMENTACIÓN

SAGARPA

México, D. F. a 22 de enero de 2007
Oficio N. 1000.1000.00.00.-067/07

MICHAEL CARROLL
LIDER DEL PROYECTO DE ENERGÍA RENOVABLE
PARA LA AGRICULTURA EN MÉXICO
P R E S E N T E

Me refiero a su comunicado telefónico del 18 del presente, en el cual solicita las observaciones al documento elaborado por el Grupo de Trabajo del Banco Mundial, referido como "Reporte Final de Resultados (ICR) del Proyecto de Energía Renovable para la Agricultura en México" (PERA), para incluirlas en su redacción final. Al respecto, en anexo encontrará comentarios puntuales al documento de referencia, de los cuales quisiera resaltar los siguientes:

- En lo general, el reporte presentado por este Grupo de Trabajo, es un documento analítico que explica la implementación y desarrollo del PERA y señala los resultados e impactos del Proyecto en forma adecuada, haciendo énfasis en la congruencia con los objetivos planteados en su concepción.

- El reporte resalta la importancia del Proyecto y lo conceptualiza como base y ejemplo para tomarse en consideración a nivel mundial para esfuerzos futuros dirigidos a la utilización de las energías renovables con fines productivos, en particular en el área agropecuaria y para el desarrollo rural.

- Dentro del apartado de "Riesgos para los Resultados Ambientales Globales", la cual señala la incertidumbre que pudiera derivarse del cambio de gobierno en México, comento el interés que tiene esta institución, en continuar impulsando el fomento de las energías renovables con fines productivos en México; política que es congruente con las acciones que se han realizado en los últimos 6 años por parte del Fondo Mundial del Medio Ambiente (GEF), el Banco Mundial y la SAGARPA, en la implementación del PERA.

Por último, externo la importancia de sostener, a la brevedad, una reunión conjunta con altas autoridades de la SAGARPA, para comentar los resultados expuestos en el reporte, además de explorar las posibilidades de convenir una Segunda Fase del PERA, sustentada en las experiencias pasadas, con un enfoque de Desarrollo Rural y de Agronegocios.

ATENTAMENTE
EL DIRECTOR GENERAL

ING. RODRIGO DIEZ DE SOLLANO ELCORO

c. c. p **Lic. Liliana Velázquez Correa.- Ejecutivo Sectorial NAFIN.- Presente.**
Lic. Ana Lilia Girón Gutiérrez.- Especialista Sectorial NAFIN.- Presente.

Av. Municipio Libre 377, piso 10 ala A Col. Santa Cruz Atoyac, Del. Benito Juárez México, D.F., C.P. 03310
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Annex 11. Comments of Cofinanciers and Other Partners/Stakeholders

No cofinanciers apart from the borrower have been involved in the project.

Annex 12. List of Supporting Documents

Asociación Nacional de Energía Solar (ANES), “Estudio de Mercado de las Fuentes de Energía Renovable en el Sector Agropecu ario”, May 2006 (and annexes with findings of surveys to REAP producers, non-REAP producers, equipment suppliers, technical advisors and FIRCO staff)

Berumen y Asociados, “Estudio de mercado de renovables en el sector agropecuario en México”, México, D.F. 2003

Espericueta, A. D. C., R. E. Foster, L. M. Gómez Rocha, M. P. Ross, C. J. Hanley, V. P. Gupta, O. Montúfar Avilez, A. R. P aredes Rubio, “Evaluación de 52 Sistemas Fotovoltáicos de Bombeo de Agua Instalados en México a Través del PERM”, 2004 (www.re.sandi a.gov/en/pb/pb-fs.htm)

Fideicomiso de Riesgo Compartido, “Proyecto de Energía Renovable para la Agricultura: Evaluación Final del Proyecto”, Sept iembre 2006

Fideicomiso de Riesgo Compartido y Sandia National Laboratories, “Guía para el Desarrollo de Proyectos de Bombeo de Agua c on Energía Fotovoltáca”, 2001

Skoufias, E. “Rural Poverty Alleviation and Household Consumption Smoothing: Evidence from PROGRESA in Mexico”, IFPRI, 200 2. (www1.worldbank.org/sp/safetynets/PDFfiles/Progressa_Mexico_Skoufias.pdf#search=%22Mexico%20rural%20household%20size%22)

World Bank, World Development Report 2007. (www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2006/09/13/000112742_20060913111024/Rendered/PDF/359990WDR0complete.pdf)

Annex 13. Additional Annexes

Annex 13.1. Calculation of Carbon emissions avoided by the end of the project

Yearly emissions of Carbon avoided by the end of the project.

This calculation uses the following data

Average volume of water pumped per system per day = ***11.37 m^3***
Average volume of water pumped per system per year = ***4153 m^3***
Average volume of gasoline required per m^3 of water pumped = ***6.2 l***
Mass of Carbon released per liter of gasoline = ***0.63 kg***

The number of systems directly installed by the project and operating correctly at Project closure = **1,439**.

At least 867 replicas have also been installed of which an estimated:

867 x 1439 / 1545 **= 808**

will still be working (assuming a failure rate similar to that for systems installed directly by the project).

Therefore the estimated total number of systems installed **= 2247 systems**.

Therefore the estimated volume of water pumped per year = 2247 x 4135 = **9,291,345 m^3**

Therefore the estimated equivalent volume of gasoline that would have been used =

6.2 x 9,291,345 = **57,606,339 l**.

Therefore the mass of Carbon emissions avoided per year =

0.63 x 57,606,339 = **36,291,994 kg**.

It is therefore estimated that **36,292 tonnes** * of Carbon emissions were avoided each year by the end of the project.

* (This is a conservative estimate as it does not take into account the other types of renewable energy systems that the project installed – such as the 65 solar refrigeration systems. Also it uses a conservative estimate for the number of replica systems installed as a result of the project. Nevertheless this is still 121% of the target figure expressed in the PAD.)

Annex 13.2. Cost of Installation per Watt and Average Costs per Kilowatt Hour

Table 13.2.1. Costs / Watt of installed generating power

Year	Total number of Watts for solar water pumping directly installed by the project / Watts	Average cost per Watt / US$
2001	86,715	15.46
2002	153,316	14.26
2003	229,927	12.70
2004	220,092	13.16
2005	190,924	12.33
Total	881,010	13.25

Costs / Kilowatt Hour for the 1545 systems directly installed by the project

On the assumption that the average life of each system is 15 years and that the average system runs for 12 hours a day, 250 days per year, this gives an average cost of US$ 13.25 for 45 Kilowatt Hours or US$ 0.29 per Kilowatt Hour for the 1545 systems directly installed.

Of this amount, the GEF invested US$ 3,148,624 (26.9%). The producers directly invested US$ 2,340,163 (20%). With help from Alianza, the producers further invested US$ 6,220,425 (53.1%) . This equates to a cost of US% 0.08 / KWh for the GEF and US$ 0.21 / KWh for the producers through direct investments and through investments helped with funding from Alianza.

Annex 13.3. Data on Output Targets Specified at Appraisal (Referred to in Annex 4)

Table 4-8. Output Targets Specified at Appraisal and Realized During Implementation

Project Outputs at Appraisal	Indicators and Targets Specified at Appraisal		Realized	% Change
	Unit	At appraisal		
1 Widespread increase in awareness of renewable energy systems among 600,000 unelectriried farmers.	Increased levels of awareness among 600,000 unelectrified farmrers			
2 Demonstration projects installed and operating correctly.	Target (max) no. of demo. projects installed and operating correctly.	**1230**	**1514**	**23.1%**
3 Installation of water pumping demonstrative modules for agriculture (mainly livestock) using **PV systems**	Target (max) no. of PV demonstration projects installed	1,050	1545	
	of which not working Dec 2005:		-106	
4 Installation of water pumping demonstrative modules for agriculture (mainly livestock) using **wind powered systems**	Target (max) no. of wind demonstration projects installed	55	4	
5 Installation of pilot milk cooling systems using PV or hybrid systems.	Target (max) no. of PV milk cooling demo. projects installed	24	6	
	Other demonstrations			
	PV Solar Refrigerators		65	
6 Technicians, agricultural extensionists and vendors trained in renewable energy systems.	No. of extensionists, technicians and vendors trained	**2,500**	**4952**	**98.1%**
	Trainees from courses for instructors		39	
	Trainees from courses for Technicians in Solar Energy		4539	
	Trainees from courses for technicians in Wind Energy		105	
	Trainees from courses for entrepreneurs (primarily vendors)		269	
	Trainees from courses imparted abroad (mainly staff)		221	
7 Participating farmers receive technical assistance in the operation of the renewable energy systems.	Farmers receive technical assistance			
8 Reduced uncertainty regarding the market for, and applications of, renewable energy in the agricultural sector.	Market assessment	**1**	**2**	**100.0%**
	Technology assessments	several		
	Dissemination of results of mkt & technology assessments			
9 Improved understanding of prospects for vendor financing of farm-based renewable energy systems.	Dissemination of lessons from vendor financing program.			
10 Introduction of specifications and certification procedures.	Successful introduction of specifications and certification procedures.			

Sources: Project Design Summary, Page 21 of PAD: and FIRCO (2006)

Annex 13.4. Detailed Data on the Case Study Farms Treated in Annex 5

Table 5.7 Arid Region

Investment Date: Nov. 2003 **Based on:** Rancho La Laborcita **Regional Office:** COMARCA LAGUNERA

Projection of Herd, Expenses and Income	Without Project	Project Years 2004	2005	Projections 2006	2007	2008	2009	2010	2011
Animal Inventory									
Cows	40	43	45	49	56	60	60	60	61
Heifers	14	15	19	22	21	17	17	17	17
Female Calves	15	19	22	24	26	28	28	28	28
Male Calves	14	19	22	24	26	28	28	28	28
Bulls	2	2	3	4	4	4	4	4	4
Number of Heads	85	98	110	122	132	137	137	137	138
No. of Animal Units	64	70	79	88	95	97	97	98	98
Purchases									
Cows									
Heifers									
Bulls			1	1		1	1	1	1
Death rates									
Cows	1	1	1	1	1	2	2	2	2
Bulls	0	0	0	0	0	0	0	0	0
Heifers	0	0	0	0	0	1	1	1	1
Calves	2	2	1	1	2	2	2	2	2
Sales									
Culled cows	9	10	12	13	14	15	15	15	15
Heifers	0	0	0	0	3	8	10	10	10
Calves	14	19	22	24	26	28	28	28	28
Culled bulls	0	0	0	0	0	1	1	1	1
Production Parameters									
Pasture area	750	750	750	750	750	750	750	750	750
Carrying capacity	75	94	107	107	107	107	107	107	107
Births	70%	75%	75%	75%	75%	75%	75%	75%	75%
Pre-weaning death rate, %	7%	5%	3%	3%	3%	3%	3%	3%	3%
Post-weaning death rate, %	2%	2%	2%	2%	2%	2%	2%	2%	2%
Adult death rate	2%	2%	2%	2%	2%	2%	2%	2%	2%
Breeding stock culling rate, %	16%	18%	20%	20%	20%	20%	20%	20%	20%
Price of culled cow, Kg 450	621	621	621	621	621	621	621	621	621
Sale price of heifers, US$ 690	690	690	690	690	690	690	690	690	690
Calve weight at time of sale, kg	170	175	185	185	185	185	185	185	185
Price of calve US$/kg	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84
Income									
Culled cows	5,367	6,212	7,455	8,076	8,697	9,318	9,318	9,318	9,318
Sale of heifers	0	0	0	0	2,071	5,522	6,902	6,902	6,902
Sale of calves	4,381	6,120	7,321	8,002	8,854	9,535	9,535	9,535	9,535
Sale of culled bulls						1,104	1,104	1,104	1,104
Sub-total	9,748	12,332	14,776	16,078	19,621	25,479	26,860	26,860	26,860
Costs									
Feeding	1,684	2,346	2,462	2,726	3,048	3,252	3,277	3,301	3,325
Medicines and vaccines	235	270	303	337	365	377	378	380	381
Fuel	2,351								
Pasture maintenance	1,726	3,451	3,451	3,451	3,451	3,451	3,451	3,451	3,451
Maintenance of equipment and infrastructure		1,291	1,291	1,291	1,291	1,291	1,291	1,291	1,291
Labor	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359
Bull replacement			1,657	1,657		1,657	1,657	1,657	1,657
Sub-total	9,355	10,717	12,523	12,820	11,514	13,387	13,413	13,438	13,463
Net income	393	1,615	2,253	3,258	8,108	12,093	13,447	13,422	13,397
Investments									
PV System 11,340									
Other on farm investments 14,472									
Sub-total 25,812									
With Project Cash Flow		1,615	2,253	3,258	8,108	12,093	13,447	13,422	13,397
Without Project Cash Flow		393	393	393	393	393	393	393	393
Investment Project Cash Flow	-25,812	1,222	1,860	2,865	7,714	11,700	13,054	13,029	13,004

IRR 18% NPV (12%): $7,233

Table 5-8. Temperate Region

Investment Date: Mar-02 **Model Based on:** Proyecto El Porvenir Regional Office: PUEBLA

Projection of Herd, Expenses and Income			**Without Project**	**Project Years 2003**	**2004**	**2005**	**2006**	**2007**	**Projections 2008**	**2009**	**2010**
Animal Inventory											
Cows			24	24	22	25	26	27	27	28	28
Heifers			6	5	10	10	9	9	9	9	9
Female Calves			5	10	10	12	13	13	13	13	14
Male Calves			6	10	10	12	13	13	13	13	14
Steers 1 - 2 yrs old			6	6	9	9	11	12	12	12	12
Steers 2 - 3 yrs old			6	6	6	9	9	11	12	12	12
Bulls			2	2	2	2	2	2	2	2	2
Number of Heads			55	62	68	77	82	85	87	87	90
No. of Animal Units			35	37	39	43	44	44	45	45	46
Purchases											
Cows											
Heifers											
Bulls								1	1		
Death rates											
Cows			1	1	1	1	1	1	1	1	1
Bulls			0	0	0	0	0	0	0	0	0
Heifers			0	0	0	0	0	0	0	0	0
Calves			1	1	1	1	1	1	1	1	1
Steers			0	0	0	0	0	0	0	0	0
Sales											
Culled cows			5	5	6	6	7	7	7	7	7
Heifers			0	0	0	0	3	4	4	4	4
Steers			6	6	6	9	9	11	12	12	12
Culled bulls			0	0	0	0	0	1	1	0	0
Production Parameters											
Pasture area			65	65	65	65	65	65	65	65	65
Carrying capacity			43	50	59	65	65	65	65	65	65
Births			60%	65%	70%	75%	75%	75%	75%	75%	75%
Pre-weaning death rate, %			7%	5%	3%	3%	3%	3%	3%	3%	3%
Post-weaning death rate, %			3%	3%	2%	2%	2%	2%	2%	2%	2%
Adult death rate			3%	2%	2%	2%	2%	2%	2%	2%	2%
Breeding stock culling rate, %			16%	18%	20%	20%	20%	20%	20%	20%	20%
Price of culled cow,	450		621	621	621	621	621	621	621	621	621
Sale price of heifers,	U690		690	690	690	690	690	690	690	690	690
Weight of steer at sale,		kg	400	400	400	400	400	400	400	400	400
Price of Steer US$/kg			1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
Income											
Culled cows			2,982	3,106	3,727	3,727	4,349	4,349	4,349	4,349	4,349
Sale of heifers			0	0	0	0	2,071	2,761	2,761	2,761	2,761
Sale of steers			3,313	3,313	3,313	4,970	4,970	6,074	6,626	6,626	6,626
Sale of culled bulls								1,104	1,104		
Sub-total			6,295	6,419	7,041	8,697	11,389	14,288	14,840	13,736	13,736
Costs											
Feeding			703	1,304	1,211	1,346	1,424	1,451	1,477	1,503	1,532
Medicines and vaccines			152	171	186	213	225	235	239	240	247
Fuel			1,411								
Pasture maintenance			598	598	598	598	598	598	598	598	598
Maintenance of equipment and infrastructure				728	728	728	728	728	728	728	728
Labor			3,023	3,023	3,023	3,023	3,023	3,023	3,023	3,023	3,023
Bull replacement								1,657	1,657		
Sub-total			5,887	5,824	5,746	5,908	5,998	7,691	7,722	6,093	6,128
Net income			408	595	1,294	2,789	5,391	6,597	7,119	7,643	7,608
Investments											
PV System		6,189									
Other on farm investments		8,361									
Sub-total		14,550									
With Project Cash Flow			-14,550	595	1,294	2,789	5,391	6,597	7,119	7,643	7,608
Without Project Cash Flow				408	408	408	408	408	408	408	408
Investment Project Cash Flow			-14,550	187	887	2,382	4,983	6,189	6,711	7,235	7,200

IRR 17% NPV (12%): $3,821

Table 5-9. Tropical Region

Investment Date: Mayo 2002 | **Model Based on:** Las Palomas | **Regional Office:** OAXACA

Projection of Herd, Expenses and Income		Without Project	Project Years 2003	2004	2005	Projections 2006	2007	2008	2009	2010
Animal Inventory										
Cows		43	49	52	56	56	57	57	57	57
Heifers		19	17	19	16	16	16	15	15	15
Female Calves		18	19	21	25	25	24	24	24	24
Male Calves		18	19	21	25	25	24	24	24	24
Bulls		2	3	3	3	3	3	3	3	3
Number of Heads		99	107	115	123	124	123	123	123	123
No. of Animal Units		73	79	85	88	89	89	89	89	89
Purchases										
Cows										
Heifers										
Bulls			1			1	1	1		
Death rates										
Cows		1	1	1	1	1	1	1	1	1
Bulls		0	0	0	0	0	0	0	0	0
Heifers		1	1	0	0	0	0	0	0	0
Calves		3	2	1	1	1	2	2	2	2
Sales										
Culled cows		10	12	13	14	14	14	14	14	14
Heifers		0	0	0	5	9	9	9	9	9
Calves		18	19	21	25	25	24	24	24	24
Culled bulls						1	1	1		
Milk (000 liters)		15,093	26,085	27,416	31,818	32,105	32,391	32,678	32,678	32,678
Production Parameters										
Pasture area		42	42	42	42	42	42	42	42	42
Carrying capacity		100	110	110	125	125	125	125	125	125
Births		60%	1	1	1	70%	70%	70%	70%	70%
Pre-weaning death rate, %		7%	0	0	0	3%	3%	3%	3%	3%
Post-weaning death rate, %		5%	0	0	0	2%	2%	2%	2%	2%
Adult death rate		2%	0	0	0	2%	2%	2%	2%	2%
Breeding stock culling rate, %		16%	0	0	0	20%	20%	20%	20%	20%
Milk, production/cow/year		900	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260
Milk price, US$/litro		0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Price of culled cow		497	497	497	497	497	497	497	497	497
Sale price of heifers		690	690	690	690	690	690	690	690	690
Price of calf, US$		250	258	265	265	265	265	265	265	265
Income										
Milk		3,334	5,762	6,056	7,028	7,091	7,155	7,218	7,218	7,218
Culled cows		4,930	5,964	6,461	6,958	6,958	6,958	6,958	6,958	6,958
Sale of heifers		0	0	0	3,451	6,212	6,212	6,212	6,212	6,212
Sale of culled bulls						884	884	884		
Sale of calves		4,381	4,896	5,434	6,494	6,494	6,361	6,361	6,361	6,361
Sub-total		12,645	16,622	17,950	23,931	27,639	27,569	27,633	26,749	26,749
Costs										
Feeding		3,071	5,110	5,375	5,783	5,834	5,884	5,934	5,934	5,934
Medicines and vaccines		911	980	1,054	1,132	1,137	1,132	1,132	1,132	1,132
Fuel		1,411								
Pasture maintenance		387	387	387	387	387	387	387	387	387
Maintenance of equipment and infrastructure			710	710	710	710	710	710	710	710
Labor		3,359	3,359	6,718	6,718	6,718	6,718	6,718	6,718	6,718
Bull replacement			1,657			1,657	1,657	1,657		
Sub-total		9,138	12,203	14,244	14,730	16,442	16,488	16,538	14,881	14,881
Net income		3,506	4,419	3,706	9,201	11,196	11,081	11,095	11,868	11,868
Investments										
PV System	7,044									
Other on farm investments	7,163									
Sub-total	**14,208**									
With Project Cash Flow			4,419	3,706	9,201	11,196	11,081	11,095	11,868	11,868
Without Project Cash Flow			3,506	3,506	3,506	3,506	3,506	3,506	3,506	3,506
Investment Project Cash Flow		-14,208	913	199	5,695	7,690	7,575	7,589	8,362	8,362

IRR 26% | NPV (12%): $9,830

Table 5-10. Arid Region with Agriculture Component

Year of project start up: Nov. 2003 (Based on La Laborcita model)

Projection of Herd, Expenses and Income		**Without Project**	**Project Years 2004**	**2005**	**2006**	**2007**	**Projections 2008**	**2009**	**2010**	**2011**
Animal Inventory										
Cows		40	43	45	49	56	60	60	60	61
Heifers		14	15	19	22	21	17	17	17	17
Female Calves		15	19	22	24	26	28	28	28	28
Male Calves		14	19	22	24	26	28	28	28	28
Bulls		2	2	3	4	4	4	4	4	4
Number of Heads		85	98	110	122	132	137	137	137	138
No. of Animal Units		64	70	79	88	95	97	97	98	98
Purchases										
Cows										
Heifers										
Bulls				1	1		1	1	1	1
Death rates										
Cows		1	1	1	1	1	2	2	2	2
Bulls		0	0	0	0	0	0	0	0	0
Heifers		0	0	0	0	0	1	1	1	1
Calves		2	2	1	1	2	2	2	2	2
Sales										
Culled cows		9	10	12	13	14	15	15	15	15
Heifers		0	0	0	0	3	8	10	10	10
Calves		14	19	22	24	26	28	28	28	28
Culled bulls		0	0	0	0	0	1	1	1	1
Production Parameters										
Pasture area		750	750	750	750	750	750	750	750	750
Carrying capacity		75	94	107	107	107	107	107	107	107
Births		70%	75%	75%	75%	75%	75%	75%	75%	75%
Pre-weaning death rate, %		7%	5%	3%	3%	3%	3%	3%	3%	3%
Post-weaning death rate, %		2%	2%	2%	2%	2%	2%	2%	2%	2%
Adult death rate		2%	2%	2%	2%	2%	2%	2%	2%	2%
Breeding stock culling rate, %		16%	18%	20%	20%	20%	20%	20%	20%	20%
Price of culled cow (US$ per KG)	450	621	621	621	621	621	621	621	621	621
Price of heifers	690	690	690	690	690	690	690	690	690	690
Calve weight at time of sale, kg		170	175	185	185	185	185	185	185	185
Price of calve US$/kg		1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84
Income										
Culled cows		5,367	6,212	7,455	8,076	8,697	9,318	9,318	9,318	9,318
Sale of heifers		0	0	0	0	2,071	5,522	6,902	6,902	6,902
Sale of calves		4,381	6,120	7,321	8,002	8,854	9,535	9,535	9,535	9,535
Sale of culled bulls							1,104	1,104	1,104	1,104
Sub-total		9,748	12,332	14,776	16,078	19,621	25,479	26,860	26,860	26,860
Costs										
Feeding		1,684	2,346	2,462	2,726	3,048	3,252	3,277	3,301	3,325
Medicines and vaccines		235	270	303	337	365	377	378	380	381
Fuel		2,351								
Pasture maintenance		1,726	3,451	3,451	3,451	3,451	3,451	3,451	3,451	3,451
Maintenance of PV & Livestock equip. and infrast.			1,291	1,291	1,291	1,291	1,291	1,291	1,291	1,291
Labor		3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359
Bull replacement				1,657	1,657		1,657	1,657	1,657	1,657
Sub-total		9,355	10,717	12,523	12,820	11,514	13,387	13,413	13,438	13,463
Net Income from Livestock		393	1,615	2,253	3,258	8,108	12,093	13,447	13,422	13,397
Agricultural Production										
Sorghum for feeding, t			40	40	40	40	40	40	40	40
Production Parameters										
Irrigated area, ha			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Yield, t/ha			80	80	80	80	80	80	80	80
Prece of Sorghum for feed, US$/t			46	46	46	46	46	46	46	46
Income from agriculture										
Sorghum sales (or savings)			1841	1841	1841	1841	1841	1841	1841	1841
Expenditures (US$)										
Land preparatin			69	69	69	69	69	69	69	69
Planting and fertilization			166	166	166	166	166	166	166	166
Labor			69	69	69	69	69	69	69	69
Harvesting			230	230	230	230	230	230	230	230
Maintenance of ag equip. and infrastr.			214	214	214	214	214	214	214	214
Sub-total			748	748	748	748	748	748	748	748
Net Income from Agriculture			1,093	1,093	1,093	1,093	1,093	1,093	1,093	1,093
Investments										
PV System	11,340									
Livestock related investments	14,472									
Irrigation system	1,529									
Silo	611									
Total Project Investment	**27,953**									
With Project Cash Flow			2,708	3,346	4,351	9,200	13,185	14,540	14,514	14,489
Without Project Cash Flow			393	393	393	393	393	393	393	393
Investment Project Cash Flow		-27,953	2,315	2,953	3,958	8,807	12,792	14,147	14,121	14,096
			IRR 20%				NPV (12%): $10,169			

Annex 13.5. Evolution of Costs of Solar Water Pumping Systems

FIRCO's database was used to estimate the evolution of the cost of photovoltaic water pumping systems over time (Table 13.4.1). Records used refer only to PV demonstration systems plus Baja California's systems financed with GEF funds. Replication records available were not used. A few projects with missing data on wattage of system were also left out, as well as 25 systems from Veracruz with suspect data (probably the result of mistaken data input) were also left out. In all a total of 1,490 systems were used in the calculations.

All size-year categories had sufficient numbers to regard the calculations as reliable (Table 13.4.2). Also, since there is no significant change in the distribution of systems by size over time (Table 13.4.3), system size is not driving the reduction in costs observed over time in Table 13.5.1 and depicted in the 2 charts below. Overall, the change in system costs between the start of the project in 2001-02 and by the end of project (2004-05) is estimated to be in the order of 25%, as an average across systems, or of 24% per total watts generated by all systems in the 2-year period.

Table 13.5.1. Distribution of Photovoltaic Water Pumping Systems Installed by Size of System and by Project Year

	(number of systems considered in calculations)					
Watts	**2001**	**2002**	**2003**	**2004**	**2005**	**2001-2005**
0-150	20	26	43	23	27	139
150-300	34	69	90	88	65	346
300-450	34	66	92	83	48	323
450-600	23	40	59	64	39	225
600-750	4	19	33	32	25	113
750-900	14	13	26	30	16	99
900-1050	7	15	31	21	19	93
over 1050	21	29	34	37	31	152
All	157	277	408	378	270	1490

Table 13.5.2. Evolution of Cost per Watt of Installed Photovoltaic Water Pumping Systems by Size of System

Watts	(US$/Watt)					**% change 2001-02 to 2004/05**	**Average cost per system 2001-05**
	2001	**2002**	**2003**	**2004**	**2005**		
0-150	32	35	33	29	30	-14.5%	32
150-300	27	24	22	22	24	-10.9%	23
300-450	19	19	17	16	18	-16.6%	17
450-600	20	17	14	14	14	-34.4%	15
600-750	19	15	12	12	13	-31.3%	13
750-900	18	13	11	11	12	-42.6%	12
900-1050	15	13	10	10	11	-30.1%	11
over 1050	14	11	8	7	7	-75.4%	9
Overall averages:							
across systems	**22**	**20**	**17**	**16**	**17**	**-25.2%**	
per generated watt	**18**	**17**	**15**	**15**	**13**	**-23.8%**	

Table 13.5.3. Distribution of Photovoltaic Water Pumping Systems Installed by Size of System and by Project Year

Watts	(number of systems considered in calculations)					
	2001	**2002**	**2003**	**2004**	**2005**	**2001-2005**
0-150	20	26	43	23	27	139
150-300	34	69	90	88	65	346
300-450	34	66	92	83	48	323
450-600	23	40	59	64	39	225
600-750	4	19	33	32	25	113
750-900	14	13	26	30	16	99
900-1050	7	15	31	21	19	93
over 1050	21	29	34	37	31	152
All	157	277	408	378	270	1490

Chart 13.5.1. Evolution of costs of installation of PV systems

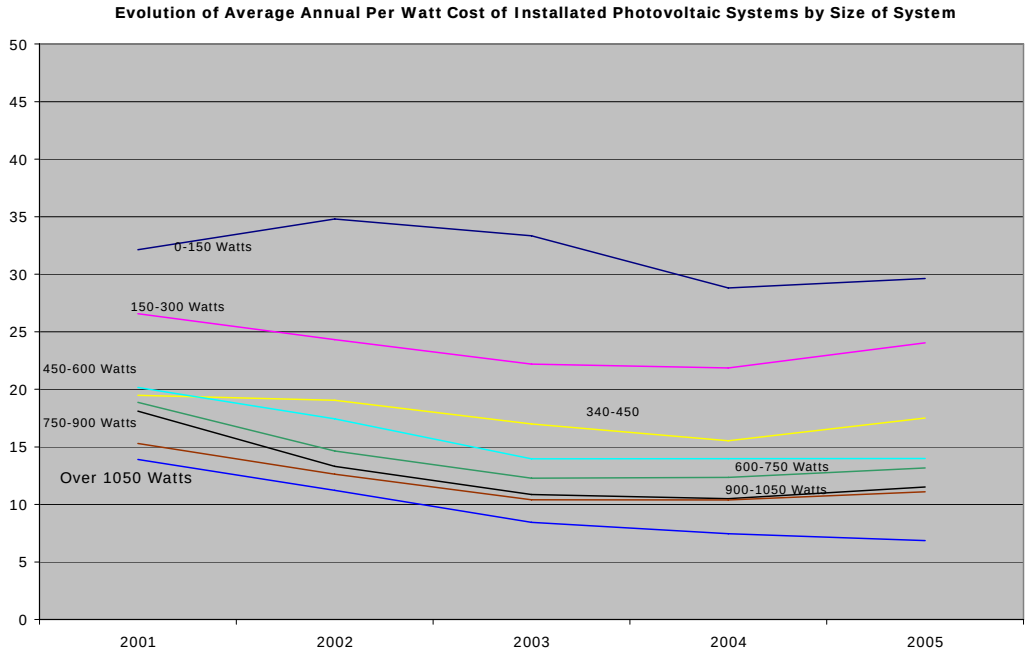

Chart 13.5.2. Evolution of costs of per Watt of PV systems

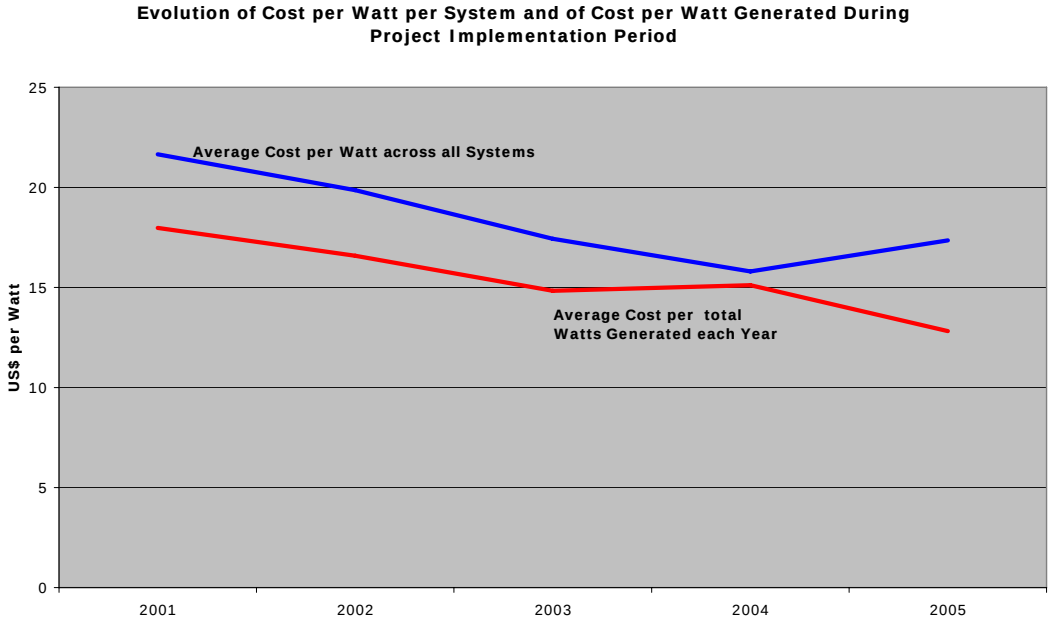

Table 13.5.4. Number of systems as a percent of total installed per period

Watts	2001	2002	2003	2004	2005	2001-2005
0-150	12.7%	9.4%	10.5%	6.1%	10.0%	9.3%
150-300	21.7%	24.9%	22.1%	23.3%	24.1%	23.2%
300-450	21.7%	23.8%	22.5%	22.0%	17.8%	21.7%
450-600	14.6%	14.4%	14.5%	16.9%	14.4%	15.1%
600-750	2.5%	6.9%	8.1%	8.5%	9.3%	7.6%
750-900	8.9%	4.7%	6.4%	7.9%	5.9%	6.6%
900-1050	4.5%	5.4%	7.6%	5.6%	7.0%	6.2%
over 1050	13.4%	10.5%	8.3%	9.8%	11.5%	10.2%
All	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Average size of systems requiring over 1050 watts

	2001	2002	2003	2004	2005
over 1050	1416	1940	2681	1416	1553

Annex 13.6. Evidence Available Indicative of Income Status of Beneficiaries

Presently, about 20% of Mexico's population has an income of less than $2 per day. The incidence of poverty is much higher in rural areas. The World Bank (2006) cites studies suggesting that 38% of the rural population had an income below the poverty line in 2002 compared to only 11% in urban areas.

The following two tables are based on information collected by the first and second market studies commissioned by FIRCO. The first one shows annual per capita income of livestock producers in 2002.[6] The second one covers a survey of potential REAP beneficiaries in Baja California Sur and Sonora[7] (but, surprisingly and regrettably, not of actual demonstration project beneficiaries[8]).

Nearly 60% of the 167 livestock producers surveyed by FIRCO's first market demand study (countrywide, 2002) had an overall per capita income of less than US$ 2/day; and about 43% of the 49 potential Baja California Sur and Sonora farmers surveyed in 2005 earned less than US$ 2/day. (Following Skofias (2002), both calculations assume an average family household size of 6 persons)

Table 13.6.1. Estimated annual per capita income in families of livestock survey respondents (2002)

US$ per capita per year				No. of respondents	
		up to	238	32	19.2%
from	239	to	714	67	40.1%
from	715	to	1,191	36	21.6%
		over	1,191	32	19.2%
			Total	**167**	**100.0%**

Source: Estimated based on data from Berumen y Asociados 2003.

Table 13.6.2. Estimated annual per capita income in families of non-pera producers in Baja California Sur and Sonora (2005)

US$ per capita per year				No. of respondents	
	less than	222		4	8.2%
from	223	to	665	17	34.7%
from	666	to	1109	11	22.4%
from	1,110	to	1552	5	10.2%
from	1,553	to	1996	5	10.2%
from	1,997	to	2439	1	2.0%
from	2,440	to	2883	0	0.0%
from	2,884	to	3326	1	2.0%
	3,327	and more		5	10.2%
			Total	**49**	**100.0%**

Source: Estimated based on data from ANES 2006

The following table covers predominantly livestock farmers who benefited from REAP photovoltaic Water Pumping demonstration funding. The number of bovine head of cattle these producers owned at the time that they joined the program is shown. Nearly 60% of these demonstration farmers had less than 50 head of cattle. A livestock producer with 55 head of cattle in a tropical zone would get an annual income in the order of about US$ 407 from livestock activities (See Model III in Annex 5, based on La Progresita demonstration project). This figure is not incompatible with the overall low income figures previously estimated for potential REAP beneficiaries based on surveys conducted by the market studies. (It should be noted, however, that off farm income is often a more significant component of income than farming – according to the World Bank 2004, page 71, income from independent agriculture accounted for only 12.6% of rural incomes in Mexico compared with 11.3% for agricultural salaried work and 76% for non-agricultural activities. Araujo (2003) cites estimates of 40-50% of income derived from off farm activities for Mexico.)

Table 13.6.3. Average Head of Cattle per Beneficiary in Demonstration Projects under Private Property Management

Number of heads of bovine cattle			No. of projects	%
Greater than	less than or = to	Average No. of heads		
0	10	6.3	76	11.3
10	20	15.5	320	18.1
20	30	25.0	121	13.2
30	50	39.6	111	16.2
50	100	71.9	38	18.0
100	200	72.6	5	16.5
greater than 200		141.0	45	6.7
All projects considered		51.6	673	100.0

Note: Only projects managed under private property, with bovine cattle as their main livestock activity and for which herd and beneficiary data is available are considered here. These represent 43% of all demonstrations.9 For details by subregion see Annex 5, Table 5.3.