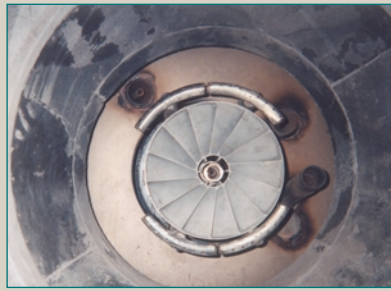


Energy and Water for Sustainable Living:

A Compendium of Energy and Water Success Stories



World Summit on Sustainable Development, Johannesburg, South Africa, 2002



U.S. Department of Energy



U.S. Department of State



U.S. Agency for International Development

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<http://www.usaid.gov/pubs/WSSDEnergyCompendium.pdf>.

Energy and Water for Sustainable Living:

A Compendium of Energy and Water Success Stories

Prepared by Argonne National Laboratory
for U.S. Department of Energy,
U.S. Department of State, and
U.S. Agency for International Development

July 2002



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FOREWORD

I am pleased to offer this compendium of sustainable energy and water success stories to the Delegates and civil society attendees of the World Summit on Sustainable Development.

Energy and water are necessary for building sustainable societies throughout the world, and this report illustrates many successful efforts toward that end. This report shows that sustainable development in the energy and water sectors is taking place where the principles of good government obtain.

This document describes energy and water projects, completed or underway, that are building blocks for sustainable development. Some of the projects described involve the U.S. Government or U.S. corporations; others do not. This report is complementary to a larger effort reporting on sustainable development activities in all sectors in 2002 supported by the U.S. Government: *Working for a Sustainable World: U.S. Government Initiatives to Promote Sustainable Development*.

I know that you will find this report informative.



Spencer Abraham
United States Secretary of Energy

ACKNOWLEDGMENTS

We would like to thank all of the project managers who submitted success story projects for inclusion in this report. Unfortunately, some submissions could not be included in this compendium because incomplete information was provided, the basic criteria for inclusion were not met, or, the candidate essentially duplicated another submission.

Our appreciation also goes to Argonne National Laboratory for preparation of this report, and particularly to Principal Investigator Deborah Elcock.

This compendium was conceived and managed by David O. Moses, U.S. Department of Energy. He will accept any praise and is responsible for all errors. He is grateful for assistance provided by Ann Stewart, U.S. Department of State, and Dr. Griff Thompson, U.S. Agency for International Development. Financial support for preparation of this document was provided by the three organizations just mentioned.

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NOTATION

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

ACUACAR	Aguas de Cartagena
AED	Academy for Educational Development
AEP	American Electric Power
AFV	alternative fuel vehicle
APS	Arizona Public Service Company of Phoenix
ARENA-ECO Ave.	Agency for Rational Energy Use and Ecology avenue
BAL	Bajaj Auto Limited
BCS	Baja California Sur
BNL	Brookhaven National Laboratory
BP	British Petroleum
CABEI	Central American Bank of Economic Integration
CAGECE	Companhia de Água e Esgoto do Ceará
CCM	Cerveceria Cuauhtemoc Moctezuma
CCT	clean coal technology
CEGCO	Central Electricity Generating Company
CENPEEP	Centre for Power Efficiency and Environmental Protection
CEP	Código de Endereçamento Postal
CETAR	Consejo Transitorio de Administración Regional
CFA	Corporación Financiera Ambiental
CFE	Comision Federal de Electricidad
CI	Conservation International
CLASP	Collaborative Labeling and Appliance Standards Program
CNG	compressed natural gas
CO	carbon monoxide
CO	Colorado
Co.	company
CO ₂	carbon dioxide
CONAMA RM	Comisión Nacional Del Medio Ambiente, Region Metropolitana
CORFO	Corporación del Fomento de la Produccion
Corp.	corporation
COS	carbonyl sulfide
D.F.	Distrito Federal
DC	direct current
DC	District of Columbia
DEP	Dirección Ejecutiva de Proyectos
Dept.	Department
DLPC	Davao Light and Power Company
Dr.	drive
EAST	Environmental Audits for Sustainable Tourism
ECLWM	Environmental Center for Livestock Waste Management

NOTATION

EEC	Energy Efficiency Council
EEPP	Egyptian Environmental Policy Program
EERP	Egyptian Electric Regulatory Program
EESBA	Egyptian Energy Service Business Association
EETP	Energy and Environmental Training Program
EJEDSA	Empresa Jujeña de Sistemas Energéticos Dispersos Sociedad Anónima
EMS	environmental management system
EPT	Electric Power Institute
EPT	Electric Power Technologies
Eximbank	Export-Import Bank of the United States
Ext.	extension
FENERCA	Financiamiento de Empresas de Energia en Centroamerica
FIRCO	Fideicomiso de Riesgo Compartido
GEF	Global Environment Facility
GEP	Greenhouse Gas Pollution Prevention
GFZ	GeoForschungsZentrum
GHG	greenhouse gas
GHP	geothermal heat pump
GmbH	Gesellschaft mit beschränkter Haftung
GPS	global positioning system
GSC	Geological Survey of Canada
GSC	greening the supply chain
H ₂ S	hydrogen sulfide
HPE	Hidroeléctrica Papeles Elaborados
ICE	Instituto Costarricense de Electricidad
IFC	International Finance Corporation
IGCC	integrated gasification combined-cycle
IIE	Instituto de Investigaciones Electricas
ILZRO	International Lead Zinc Research Organization
Inc.	Incorporated
IREDA	Indian Renewable Energy Development Agency Limited
ISO	International Organization for Standardization
IZET	India Zero Emissions Transportation Program
JIP	joint industry project
JNOC	Japan National Oil Consortium
KEMCO	Korean Energy Management Corporation
LA	Louisiana
LBLN	Lawrence Berkeley National Laboratory
LLC	Limited Liability Company

NOTATION

LLNL	Lawrence Livermore National Laboratory
LPG	liquefied petroleum gas
Ltd.	Limited
MA	Massachusetts
MCA	Millennium Challenge Account
MD	Maryland
MEM	Ministry of Energy and Mining
METROGAS	Chilean company
MNES	Ministry of Nonconventional Energy Sources
MOA	Memorandum of Agreement
MOPNG	Ministry of Petroleum and Natural Gas
N	north
NC	North Carolina
NE	Nebraska
NEA	Nepal Electricity Authority
NEES	National Energy Efficiency Strategy
NETL	National Energy Technology Laboratory
NGM	New Generation Motors
NGO	nongovernmental organization
NJ	New Jersey
NM	New Mexico
NMPC	Niagara Mohawk Power Corporation
No.	number
NO _x	nitrogen oxides
NPTO	National Petroleum Technology Office
NPUST	National Pingtung University of Science and Technology
NREL	National Renewable Energy Laboratory
NTPC	National Thermal Power Corporation
NW	northwest
NY	New York
ODA	official development assistance
OEP	Organization for Energy Planning
Org.	organization
PA	Pennsylvania
P.A.	Public Accountant
PCS	power conversion system
PEMEX	Petroleos Mexicanos
PEPP	Philippines Energy Partnership Program
Ph.D.	Doctor of Philosophy
PNNL	Pacific Northwest Laboratory
PROCEL	Programa Nacional de Conservação de Energia Elétrica
PV	photovoltaic

NOTATION

RAJAC	Regia Autonoma Judeteana de Apa-Canal Iasi
RAPS	Remote Area Power Supply
REACH	Reduced Emissions and Advanced Combustion Hardware
REEF	Renewable Energy and Energy Efficiency Fund
RES	Rural Electrification Services
RESPAR	Renewable Energy Systems in the Peruvian Amazon Region
RRD	Renewable Resources Development
S.A.	Sociedad Anonima
SARI	South Asia Regional Initiative
SATWQM	South Asia Transboundary Water Quality Monitoring
SCADA	Supervisory Control and Data Acquisition
SCNG	Strategic Center for Natural Gas
SDC	Swiss Development Corporation
SEIA	Solar Energy Industry Association
SLCA	Solar Light for the Churches of Africa
SLU	Southeastern Louisiana University
SME	small and medium-sized enterprise
SO ₂	sulfur dioxide
St.	street
TPS	thermal power station
TX	Texas
UBB	United Bulgarian Bank
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNF	United Nations Foundation
Univ.	university
US	United States
US\$	United States dollar(s)
USA	United States of America
US-AEP	United States-Asia Environmental Partnership
USAID	United States Agency for International Development
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USJI	United States Initiative on Joint Implementation
UV	ultraviolet
VA	Virginia
VSD	variable speed drive
VSP	vertical seismic profiling
WEF	Water Environment Foundation
WET	Water Efficiency Team
WWF	World Wildlife Fund

NOTATION

UNITS OF MEASURE

A	ampere(s)
Ah	ampere-hour(s)
atm	atmosphere(s)
bbl	barrel(s)
Btu	British thermal unit(s)
d	day(s)
ft	foot (feet)
GW	gigawatt(s)
GWh	gigawatt hour(s)
h	hour(s)
ha	hectare(s)
kcal	kilocalorie(s)
kg	kilogram(s)
km	kilometer(s)
kV	kilovolt(s)
kKW	kilowatt(s)
kWh	kilowatt hour(s)
kWp	kilowatt(s) peak
L	liter(s)
lb	pound(s)
m	meter(s)
m ³	cubic meter(s)
Mg	megagram(s)
mi	mile(s)
MW	megawatt(s)
MW(e)	megawatt(s) (electrical)
MWp	megawatt(s) peak
rps	revolutions per second
s	second(s)
V	volt(s)
VDC	volt(s) direct current
W	watt(s)
Wh	watt hour(s)
Wp	watt(s) peak
yr	year(s)



INTRODUCTION

This report grew out of an April 2001 study on energy prepared by the U.S. Agency for International Development (USAID) for the ninth session of the United Nations Commission on Sustainable Development. That study, called *Energy for Life, A Case Study Compendium*, contained 35 examples demonstrating the variety of ways that energy technologies can improve quality of life and showing the dramatic impact these technologies can have on economic development.

This report presents case studies of energy and water technology applications to illustrate how sustainable development can flourish in developing countries when principles of good governance are present. It also illustrates that funding from both the private and the public sectors flows to areas where principles of good governance are operating.

A sustainable development project must meet three criteria. First, it must result in economic growth — a good or service must be provided, and jobs must be created. Second, it must encourage social development — the goods or services developed must promote or enhance communities and social systems. Third, the project must occur in a manner protective of human health and the environment.

Governance refers to the processes by which public, private, and civil society¹ participants organize themselves and coordinate with each other to make decisions, develop rules of behavior, and distribute rights, obligations, and authority. Good governance incorporates transparent,² accountable, and participatory practices designed to build consensus on priority needs and foster the more generalized building of civil society and cultures.

Some basic principles of good governance are listed here:

- Integrated, intersectoral, and multi-objective decision making;
- Informed and science-based decision making that includes adequate public input;
- Broad stakeholder participation and empowerment;
- Strong, effective, and culturally appropriate institutional, policy, and legal frameworks (including standards and regulations);
- Effective coordination among sectors;
- Emphasis on decision making and assignment of authority at the lowest appropriate level; and
- Commitment to create and strengthen strong human and organizational ties.

Although the water and energy projects highlighted in this report are diverse, they all have one thing in common: they attracted private-sector funding. While many also included public financing, the combination of sustainable development and good governance attracted the private-sector support.

The case studies represent instances where commercially proven energy and water technologies have been successfully applied. These success stories often could not have occurred without technology research, development, and transfer, or without enabling actions such as feasibility analyses and institution-building programs. Indeed, the process of technology diffusion and adoption begins with research and development and ultimately depends on the proper institutional environment of policies and regulations for ultimate commercialization. The appendix to this report provides examples of (1) energy and water technologies currently under development that have the potential to contribute to sustainable development and (2) programs that are contributing or have contributed to the development of an enabling policy environment in which sustainable development could occur.

In conclusion, this work is designed to complement a much larger U.S. government effort in support of the World Summit on Sustainable Development that is now underway. This larger effort will result in a profile of international activities by the U.S. government in support of sustainable development initiatives and programs across all sectors. The profile, *Working for a Sustainable World: U.S. Government Initiatives to Promote Sustainable Development*, should be available in August 2002.

¹ “Civil society” refers to the realm of society in which social institutions operate. These include families, churches, neighborhoods, civic groups, etc.

² “Transparent” means open access to information about procedures, policies, and decisions, whether by government, corporations, or civic groups. Access to information permits stakeholders to challenge authoritative actions with which they disagree and to seek redress for misconduct. Access to information also deters misconduct by reminding officials of their accountability.



Governance and Finance for Sustainable Energy and Water Resources Management

Sustainable development embraces the concept of meeting the needs of the present without compromising the ability of future generations to meet their own needs. The United Nations Conference on Environment and Development, or Earth Summit, held in Rio de Janeiro, Brazil, in 1992, addressed global environmental issues. A product of the Earth Summit was Agenda 21 — a comprehensive set of guidelines for achieving sustainability that was adopted by 172 nations at the conference. Since then, nations have been striving to incorporate principles of sustainable development (economics, environment, and societal equity) into new development projects, including energy and water projects.

Official development assistance (ODA) often plays a vital catalytic role in achieving development goals. However, in the past decade, ODA to developing countries has decreased, despite the fact that energy and water infrastructure needs in developing countries have increased. More than US\$1.5 trillion is needed each year to meet global energy demand. On March 14, 2002, President George W. Bush announced that the United States will dramatically increase its core assistance to developing countries by 50% over the next three years, resulting in a US\$5 billion annual increase over current levels by fiscal year 2006.¹ This increased funding will go into the new supplemental “Millennium Challenge Account,” or MCA. In announcing the MCA, the President stressed that this new money is *in addition* to the more than US\$10.8 billion per year the United States currently devotes to ODA. “The goal is to provide people in developing nations the tools they need to seize the opportunities of the global economy. In return for this additional commitment, we expect nations to adopt the reforms and policies that make development effective and lasting,” the President said.

ODA alone cannot meet the growing need for investment in the energy and water infrastructure of the developing world. Private-sector funds must help bridge this gap. However, without sound and predictable “good governance” principles in place, private funding is difficult to attract. Experience shows that private-sector funds flow to areas that have established economic, political, and legal foundations amenable to development. Such foundations, or prin-

ciples, include, among other things, policies that allow for capacity building, informed decision making, standard commercial practices, institution building, competitive environments, consistent and enforced regulations, and public participation in decision making.

ENERGY SECTOR

Fostering Governance in the Energy Sector

Economic growth and social development in developing countries are hindered by a lack of adequate, efficient supplies of quality modern energy. The energy sector in many developing countries is dominated by state-owned monopolies that are often not operated along commercial lines; they are commonly characterized by relatively low levels of efficiency and frequently undermined by corruption. The result is underperformance, which translates into high costs in terms of both overall cost levels and detailed cost structures. The high costs often lead to the adoption of untargeted, damaging, and distorting subsidies. This problem results in considerable economic waste and fiscal burdens at the macroeconomic level in many developing countries, and it also inhibits the provision of energy to other sectors that require supplies of quality modern energy at the microeconomic level.

The ability to create a business environment that will attract the investments necessary to provide adequate, efficient supplies of quality modern energy is constrained by problems that can be characterized as follows:

- Inefficient energy-sector institutions,
- Inappropriate energy-sector policies,
- Intermittent application of the rule of law,
- Immature markets for energy and environmental services,
- Weak local capital markets,
- Poor performance by business management in energy institutions,
- Lack of adoption of best practices and standards by energy institutions and the public sector,
- Lack of consumer knowledge about legal and commercial requirements for sustainable energy services, and

¹ “President Proposes \$5 Billion Plan to Help Developing Nations,” remarks by President Bush on global development, Inter-American Development Bank, Washington, D.C., March 2002.

- Lack of roles for civil society in formulating public policies for energy services.

Good governance, by addressing inadequacies in the administration of the energy sector by public and private sector institutions, can resolve these constraints. Generally, governance involves how decisions are made, implemented, and enforced within a sector as well as how disputes are resolved. Good governance embodies transparency, accountability, efficiency, and the rule of law. It leads to relatively low levels of corruption; consistent, cost-effective levels of service provision; and responsiveness to changing conditions and public needs.

Energy-sector governance is the institutional scaffolding (i.e., transparent, predictable, and enforceable political, social, and economic rules) of public administration that enables transactions for energy products and services to be economically sustainable. Governance (both public policy and corporate governance) is a means to achieve the economic and financially viable provision of services by the energy sector. There is a growing international acceptance of several basic principles that can promote sustainable development by all countries, anywhere in the world. These include:

- Effective and democratic institutions that include an independent and fair judiciary;
- Sound monetary, fiscal, and trade policies that promote economic growth and encourage social development and environmental protection;
- Participatory roles for all members of civil society; and
- Sound policies informed by science and the scientific method.

A well-governed energy sector is characterized by utilities that operate under standard commercial practices. Commercialization refers to the wide range of activities necessary to bring a generation, transmission, or distribution company in line with commercial standards. These activities include, but are not limited to, forming a management team that is independent from the government; hiring or developing a staff with the appropriate skills for the job; releasing redundant staff; improving cost recovery; setting up metering systems; installing management information systems; and keeping financial records in line with international accounting standards.

With respect to the energy sector, reforms are the embodiment of improved governance. The reasons for implementing energy-sector reforms depend on the conditions of the particular country seeking the reforms. In developed countries, the main goal is to reduce end-user tariffs through increased efficiency within the sector. In contrast, in most developing countries unable to finance an energy supply infrastructure with state funds, the goal is to privatize state-controlled monopolies in order to attract sufficient private investment to upgrade and expand the inadequate infrastructure.

Experience has shown that energy-sector reform usually starts from a shared vision of the core objectives. These objectives typically include a reliable, affordable energy supply; commercially viable enterprises; tariffs that reflect costs; private-sector investment; maximized competition and deregulation; and an overall structure that meets international standards, best practices, and legitimate investor expectations. The benefits include improved service and quality for customers; more efficient use of scarce resources; technology transfers; foreign direct investment; increased trust in government institutions; macroeconomic growth; environmental improvement; and, most importantly, better living standards for people.

Energy-sector reform encompasses a number of elements, but these elements have common objectives: to increase access by users, increase the efficiency of energy services, decrease the cost of energy services, and introduce competition into the sector wherever feasible. The elements of energy-sector reform are generally implemented through a sequence of steps designed to achieve full private-sector involvement and competitive markets. First state-owned utilities are commercialized and corporatized. Then enabling legislation is passed, allowing the introduction of private ownership into the sector. Next, as private energy companies become interested in investing, a host state establishes the regulatory framework to supervise a competitive, privatized sector. Then the actual transfer of utilities into private ownership occurs, which requires the unbundling of existing power generation, transmission, distribution, and supply activities into separate activities. Finally, once unbundling of state-owned utilities has occurred, the resulting separated entities are partially or wholly privatized.

Implementation of successful energy-sector restruc-

turing typically follows three basic stages: (1) comprehensive legal and regulatory reforms, (2) commercialization and development of the existing dominant utilities, and (3) domestic and/or international private-sector investment and privatization. The linchpin for this vision is a comprehensive energy law that meets key global norms and standards. The law should define the basic structure of the sector; establish basic policies and priorities; separate the functions of policy making, ownership, and regulation; establish an independent regulator; and create a framework for private investment and ultimate privatization.

Therefore, the major aspects of energy-sector reform can be consolidated as follows:

- *Promulgation of legislation that allows unbundling and/or privatization of existing assets:* The establishment of a reordered regulatory framework and the introduction of competitive markets and commercial practices into the energy sector are preliminary steps toward privatization of existing assets.
- *Promulgation of legislation that allows private investment in the industry:* Enabling legislation is required to permit transfer of existing assets and concessions into private hands. Public access to the privatization process and information about privatization helps develop community acceptance of this step in energy-sector reform.
- *Establishment of an independent regulatory authority:* Institution building is a central aspect of energy-sector reform. Privatization of assets and competitive markets require a reordering of the regulatory framework to supervise the restructured energy sector. Critical aspects include the separation of the regulator from both the energy policy arm of government and state-owned power providers; the financial autonomy and independence of the regulator; the adequacy of the regulator's inspection and supervisory authority; and the ability of the regulator to address anticompetitive circumstances.
- *Corporatization and commercialization of existing utilities:* A considerable amount of data from many countries demonstrates that development benefits accrue when utilities are separated from other government functions and when utilities are exposed to the best commercial practices.
- *Privatization of existing assets:* The final stage in sector reforms is the implementation of privatization. A critical

issue to consider is whether the process of privatizing existing utilities is transparent and open to foreign investors, thereby enhancing both public participation and capacity building.

The Energy Governance-Finance Connection

The growth of the energy sector that is required to meet human needs hinges on attracting investment. Both debt and equity are drawn to safe havens where funds are likely to grow and provide a return on investment. Legal, regulatory, and policy regimes that ensure a stable environment (i.e., transparent and predictable political, social, and economic market rules) characterize locations in which investments can flourish. Governance actions designed to mobilize investment in the energy sector include these:

- Promoting transparency in the formulation, promulgation, and implementation of rules, regulations, and technical standards;
- Establishing nondiscriminatory third-party access to and interconnection with energy networks and grids;
- Establishing independent regulatory authorities separate from and not accountable to any supplier of energy services;
- Establishing nondiscriminatory, objective, and timely procedures for the transportation and transmission of energy;
- Requiring parties to undertake measures designed to prevent certain anticompetitive practices from occurring in energy sectors (e.g., engaging in anticompetitive cross-subsidization or using information obtained from competitors that could lead to anticompetitive results); and
- Increasing the public's understanding of the market approach to providing energy services and its knowledge of ways in which it could effectively participate in this approach.

WATER SECTOR

Fostering Governance in the Water Sector

Good governance is recognized internationally as a critical centerpiece of effective, sustainable, and integrated water management. Water managers and users alike acknowledge the need for transparent, accountable, and participatory governance to build a consensus on priority needs today and to respond to an ever-changing context in the future. Beyond immediate benefits, effective water

resource governance also offers numerous opportunities to foster the more generalized building of civil society and a culture of democratic governance in many countries.

There is no universal model for water governance appropriate for all contexts. There is, however, a growing international acceptance of several basic principles that are shared by all “good water governance” participants anywhere in the world. The following aspects are involved:

- Integrated, intersectoral, and multi-objective decision making about water resources at the basin scale, in which the relationships between groundwater and surface water; weather, climate, and hydrologic resources; water quantity and quality; land and water; and freshwater and marine systems are recognized and in which the central importance of the ecological services provided by hydrologic systems is acknowledged;
- Informed and science-based decision making, in which the public has adequate access to water resources information for an improved understanding of the water cycle;
- Broad participation and empowerment of stakeholders in water resources decision making, across sectors and social/cultural groups and especially including women;
- Strong, effective, and culturally appropriate institutional, policy, and legal frameworks (including setting standards and regulations) that reinforce integrated, accountable, participatory, and sustainable management and that minimize corruption;
- Effective coordination among sectors, between public and private participants, and across multiple geographic and institutional scales;
- Emphasis on decision making and assignment of authority at the lowest appropriate level; and
- Commitment to creating and strengthening the human and organizational capacity for sustainable and integrated water management, in both the public and private sectors.

Mobilizing Financial Resources to Manage Water Resources

Mobilizing the financial resources necessary to manage water resources is often the first and major challenge facing managers and governments around the world. The responsibility for financing the water resource infrastructure and other needs often rests with the local or national govern-

ment, although investment from private and other external sources is also frequently required.

The greatest investment gap exists in the developing world, where the current annual investment of US\$75 billion pales in the face of the total water resource needs in all sectors, estimated to be as much as US\$180 billion per year. Financing to address water investment needs in developing countries is currently drawn from a mix of sources, including these:

- Domestic public-sector financing at the national or local level (from taxes, user fees, public debt, etc.) [64% of total expenditures];
- Direct investments from domestic private sources [19% of total expenditures];
- Direct investments from international private sources [5% of total expenditures]; and
- International sources of support and cooperation (including multilateral and bilateral ODA) [12% of total expenditures].

Each of these sources has, and will continue to have, an important and distinct role to play in ensuring a sustainable and secure water future for the world. These totals tell only part of the story, since different water use sectors (e.g., agriculture, urban and rural water supply and sanitation, industry, energy, and environmental services) require unique combinations of funding that can depend more heavily on some of these sources than on others. In all sectors, however, it is clear that the majority of future investments must increasingly come from an appropriate balance of self-regenerating domestic public sources of capital as well as domestic and international private sources.

The Water Governance-Finance Connection

The themes of governance and financing for water resources management intersect at many levels. Good governance is a central precondition for the successful generation of the financial and human resources necessary for the sustainable development and management of water resources. Unfortunately, some of the countries that are most in need of additional resources lack the governance conditions that will either attract new sources of financing or ensure that public and private resources are managed in an equitable or sustainable way.

Sound governance practices create “enabling environments” that encourage good both public- and private-sector investment. Beyond providing general support to achieve good governance conditions, specific attention should be directed to efforts that reduce risk and facilitate healthy capital markets, especially domestically. Some additional guidelines on using good governance to mobilize financial resources include these:

- Water should be recognized as an economic, social, and environmental good; the full costs of water management and water services should be acknowledged; and the costs should be allocated transparently, equitably, and sufficiently throughout society (through tariffs, subsidies, taxes, etc.).
- Conditions and mechanisms of access to capital should be available at all levels (e.g., microcredit, revolving loan programs, local bond issues).
- Stable systems that provide access to water and allocate water should be available (e.g., water rights frameworks, formal and informal water markets, common property management).
- Accountable and transparent systems, the full accounting of costs and benefits, a progressive policy and legal environment, and a constructive relationship between civil society and government should be promoted to

ensure that flows of resources from all sources are generated and allocated in a way that protects the public interest, considers the needs of the full spectrum of social participants, and adequately protects ecosystems.

The responsibility for forging better water governance throughout the world, including creating the enabling environment necessary for sustainable financing, is ultimately the responsibility of local participants. However, these processes are unlikely to take hold in many places unless there are increasingly coordinated partnerships among external donors, domestic public bodies, the private sector, and civil society. In this mix, ODA serves an essential catalytic role. Targeted and strategic expenditures of development assistance funds can help advance the sustainable management of water resources through good governance. Such assistance can include supporting basin-level management structures, fostering appropriate technologies and nonstructural measures to reduce consumption and improve quality, and strengthening enabling conditions to mobilize financial resources. Such support is most effective when it is applied to local strategies that encourage innovative processes and approaches, broaden the menu of tools and options available, leverage internal and external support and investments, and build capacity in civil society and the public and private sectors.



SUSTAINABLE ENERGY AND WATER SUCCESS STORIES

India Zero Emissions Transportation Program (IZET)

Location: Delhi, Agra, and Pune

Type: Design, test, assemble, and demonstrate electric vehicles

Size: 1,000 electric three-wheelers

Funding: Total: US\$9,360,000

Private: US\$5,460,000

Public: US\$3,900,000

Objective: To reduce health impacts from vehicular emissions.

Duration: 1999–2003

Scale: Urban

Summary

Under the IZET Program, seven three-wheelers are being field-tested in the city of Agra for one year. With the initial success of the prototype three-wheeler demonstration phase, Bajaj Auto Limited (BAL) of India and New Generation Motors (NGM) of the United States (US) have signed a Memorandum of Agreement (MOA) to enter into a joint venture to produce 1,000 electric three-wheelers in India. Soon the people of India, and perhaps those throughout the region, will have options for replacing pollutant-emitting conventional vehicles with zero-emission vehicles.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Partners in the IZET Program recognized that a sustainable economy requires a market-based approach. In pursuit



of this strategy, the program collaborated and cost-shared with US and host-country private sectors to leverage resources and encourage private-sector participation.

Sound principles that have helped instill commercial standards and attract private financing included the formation of a management team independent of the government, and hiring and developing staff with appropriate skills matched to the job. Educational workshops for decision makers, stakeholder partnerships and exchanges, dissemination of best practices, and participation in international forums and workshops have enabled informed decision making. Such activities have also increased the awareness, knowledge, and skills of sector professionals in such technical areas as commercial business practices and management of private-sector involvement.

Increased public support for sustainable development has been enhanced through programs in public education and communication; implementation of state-of-the-art systems for collecting, demonstrating, and exchanging information; and innovations in the use of education, communication, outreach strategies, methods, and tools. Papers were presented and prototype vehicles were displayed for show-and-ride at various transport-related seminars to emphasize the importance of zero-emission vehicles in mitigating tailpipe emissions and improving human health.

The federal and state governments have issued a series of stringent directives and regulations against conventional vehicles and encouraged alternative transport options in urban areas.

Financing

Total project investment from all sources is roughly US\$9,360,000, which covers activities through prototype testing and some redesign. Estimated private financing contributions include US\$3,900,000 from NGM, US\$1,500,000 from BAL, \$30,000 from Sheraton, and \$30,000 from Pizza Hut. The United States Agency for International Development (USAID) contributed US\$3,900,000.

NGM has secured US\$700,000 in funding from the Industrial Credit and Investment Corporation of India (ICICI), a leading private equity investor in India, to analyze vehicle design to improve production techniques for commercial production of the first 200 electric three-wheelers.

Initial USAID funds were leveraged 1:1.3, and, should full-scale production ensue as expected, the private-sector funding will dwarf USAID's funds.

The Project

Indian urban centers are among the most polluted in the world, resulting in respiratory disease and the expenditure of billions of dollars a year. Emissions from two- and three-wheeler two-stroke vehicles are the major source of urban air pollution. The IZET Program seeks to replace pollutant-emitting conventional two-stroke engines in two- and three-wheeler vehicles with electric motors. Electric vehicles have zero tailpipe emissions, thus reducing the impact on human health.

IZET is collaborating with motivated private firms that have the technological, financial, and commercial resources to move electric-vehicle technology from demonstration to commercialization. BAL has entered into a MOA with NGM to produce 1,000 state-of-the-art electric two- and three-wheelers in India. Each partner to the agreement has agreed to produce 200 electric three-wheelers by early 2003. BAL and NGM are also considering a similar MOA for production of electric two-wheelers.

Technical Data

The key technologies used are direct current brushless electric motors and microcontrollers. The equipment is designed to meet Indian driving and environmental conditions. Range, for example, is well within the majority of consumers' needs, and the vehicles can operate without degradation during the rainy season.

Performance Data

The IZET Program serves two cities. On the basis of the projected penetration scenario, electric vehicles are expected to reduce significant amounts of vehicular pollutant emissions, including greenhouse gases.

Participants and Roles

BAL screened electric-drive systems for the Indian marketplace, which led to NGM of the US becoming a technology provider. BAL has also provided substantial resources in design, testing, certification, operation, maintenance, oversight of data acquisition, and product evaluation of electric vehicles. NGM provides state-of-the-art motors and controllers for electric vehicles and cost-shares their design and production activities in the program. Welcomgroup's Mughal Sheraton Hotel in Agra uses prototype electric three-wheelers to transport guests to local attractions. Tricon Restaurants



International (Pizza Hut) in New Delhi will use electric two-wheelers as part of its normal operations. USAID identified various partners in India and in the US to increase interest in electric-vehicle technology. With nominal financing, USAID brokered partnerships with organizations in the host country while maintaining the overall schedule and providing technical assistance to partners.

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Hidroeléctrica Papeles Elaborados S.A. (HPE)

Location: Pueblo Nuevo Vinas, Department of Santa Rosa

Type: Hydroelectric plant

Size: 8.2 MW installed capacity

Funding: Total: US\$12,400,000

Private: US\$12,400,000

Objective: To provide constant, inexpensive energy for a manufacturing facility, and subsequently to provide electricity to distribution companies.

Duration: 1999–2000

Scale: Rural

Summary

A small, commercial paper company, HPE, brought energy to its facility by constructing a hydroelectric power plant nearby. Realizing a significant business opportunity, HPE brought 8.2 MW of additional capacity to the grid connection, providing approximately 42 GWh of electricity per year. Given the demands of the power system in Guatemala, if such renewable energy had not been provided, energy needs would likely have been met through thermal energy production. In addition, HPE completed one of the first international green certificate transactions involving a developing country, whereby a Dutch utility (Nuon) has committed to purchase 100% of its environmental benefits for a period of 10 years.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development



A key principle that helped attract the private financing was the effective coordination among sectors, between public and private actors, and across multiple geographic and institutional scales.

A management team independent of the government, the hiring and developing of staff with appropriate skills matched to the job, and stakeholder partnerships and exchanges also were important to attracting private-sector participants.

Important institution-building principles included privatization of the energy structure, and a comprehensive energy law that meets global norms and standards characterized by basic policies and priorities, and separate policy-making, ownership, and regulatory functions.

Financing

Total project investment was US\$12,400,000. All funds came from private sources and included US\$5,400,000 from shareholders, US\$6,000,000 from the Central American Bank of Economic Integration (CABEI) and local banks, and US\$750,000 from the Corporación Financiera Ambiental (CFA), an environmental venture fund, and US\$250,000 from E+Co.

Capital costs included US\$6,800,000 for infrastructure and construction and US\$3,700,000 for power plant and equipment. Costs for studies, administration, legal, and engineering totaled US\$800,000.

Financing was 44% equity (from the shareholders) and 56% debt (from the other sources).

The Project

The project consists of a small commercial hydroelectric power plant connected to the grid in Guatemala. Initially, the primary goal of the project was to supply energy to the nearby paper plant using a constant and inexpensive power source. As the company realized that there was a significant business opportunity associated with generating this power, it expanded the capacity and became a mainstream electricity supplier to Guatemalan distribution companies, which are privatized. The project transmitted lessons to traditional lending institutions, thereby facilitating access by new renewable energy ventures to bank financing.

Technical Data

The project consists of two 5-MW “Francis” turbines and maximizes the hydroelectric generation of the Aguacapa River.

The HPE is generating approximately 42 GWh of electricity per year and is operating at 58% of installed capacity.

Performance Data

The project has generated 400 jobs during the construction phase and 30 additional permanent jobs for operating and maintaining the facility in the town of Pueblo Nuevo Vinas.

Roughly 20 employees have been trained in turbine maintenance and related subjects.

The plant has reduced annual carbon dioxide (CO₂) emissions by 10,000 tons, and a carbon emission transaction was made with the Dutch utility Nuon. The utility has committed to purchase 100% of the environmental benefits from HPE. This transaction represents one of the first international green certificate transactions involving assets in a developing country.

Participants and Roles

Shareholders of HPE provided US\$5,400,000 in equity financing for the project. The CABEI, local banks, and the environmental venture fund CFA provided US\$6,750,000. E+Co provided enterprise development services and a US\$250,000 loan, which leveraged US\$750,000 from CFA.



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Renewable Energy for Agriculture

Location: Rural Mexico
Type: Rural agricultural development
Size: 1,152 photovoltaic (PV) water pumping projects;
 55 demonstration wind-water pumping systems
Funding: Total: US\$31,000,000
 Private: US\$7,750,000
 Public: US\$23,250,000
Objective: To increase the capacity of small ranchers and farmers to operate in an environmentally friendly manner.
Duration: 2000–2004
Scale: Rural

Summary

Through the program, more than 1,000 engineers, technicians, and agricultural extensionists throughout Mexico are receiving training in the appropriate use of renewable energy technologies for ranching and farming. More than 1,000 demonstration projects are scheduled for installation, and more than 10,000 rural producers are expected to benefit from the program, which will result in a strong and growing private market for renewable energy technologies in the agricultural sector.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws



The Government of Mexico has demonstrated the capabilities and the institutional arrangements, including appropriate independent evaluation and oversight, necessary to implement and manage this project.

The program is highly decentralized, with activities underway in each of Mexico's 32 states. Thus outreach and education of the local participants are key to its success and long-term sustainability. Such outreach and education, although focused on empowering local people to make decisions related to their own energy and water use, also provide a structure for increased democratization in rural areas, which is often reinforced by the need to make decisions at a community level.

Capacity-building activities that have helped foster the implementation of commercial standards, thereby helping to attract private financing, include the formation of a management team independent of the government, hiring or developing staff with appropriate skills matched to the job, installing management information systems, and keeping financial records in line with international accounting standards.

Strengthened institutional structures resulting from the creation and definition of competitive markets and the management of private-sector involvement also have helped attract private investment.

Financing

Total project investment from all sources is about US\$31,000,000. Roughly 25% (US\$7,750,000) will come from the Mexican private sector. The Government of Mexico, through World Bank financing, contributed half of the funding (US\$15,500,000).

The Global Environment Facility (GEF) contributed US\$7,750,000. United States (US) investment in the pilot phase of the project, which eventually led to the GEF funding, included roughly US\$5,000,000 from the US Department of Energy (USDOE) and US\$6,000,000 from the US Agency for International Development (USAID). The Mexican private sector contributed US\$2,500,000 to the pilot phase.

The Project

In 1994, USAID and the USDOE began collaborating with Fideicomiso de Riesgo Compartido (FIRCO), the Mexican implementing agency, and local suppliers to introduce renewable energy technologies. Under the "Mexico Renewable Energy Program" (MREP), more than 200 PV water pumping projects were installed in 12 Mexican states,

principally for livestock watering on ranches. FIRCO and the Secretariat of Agriculture are now implementing a nationwide program with a World Bank loan and a GEF grant to facilitate the use of renewable energy technologies to power water-pumping and other agriculture systems.

Benefits for ranchers and farmers and their families range from improved nutrition to more sustainable irrigation.

Over the long term, renewable energy systems are typically less expensive than conventional systems. They result in fewer pollutants than the diesel and gas-powered pumps they replace, and they reduce emissions of greenhouse gases. Operations and maintenance requirements of renewable systems consume less time, thus allowing ranchers and farmers to engage in more productive activities. This shift can lead to the development of new industries in various sectors, serving numerous end uses.

Technical Data

Solar PV and wind electric systems for water pumping for small irrigation and livestock include appropriately sized, renewable energy technologies and systems that utilize groundwater in a sustainable fashion.

Performance Data

More than 450 engineers and technicians have been trained in project implementation, including private- and public-sector implementers.

The program has produced more than 28,000 direct and indirect beneficiaries, including ranchers and farmers, other community members, and system suppliers.

Participants and Roles

USAID and the USDOE provided funding during the pilot phase through premarket investment in demonstrating the feasibility of the technologies. Sandia National Laboratories has managed the program, and the USDOE's National Renewable Energy Laboratory (NREL) has helped implement the program.

Other partners include FIRCO, Secretariat of Agriculture, Mexico, World Bank, GEF, Winrock International, New Mexico State University, Enersol Associates, and Ecoturismo y Nuevas Tecnologías.



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Krasnogorsk Water-Efficiency Program

Location: Krasnogorsk, in the Moscow Region
Type: Water utility reform and water efficiency
Size: 13 pumping plants
Funding: Total: US\$158,000
 (All from the joint stock water utility)
Objective: To reduce water utility energy consumption.
Duration: 1997–2000
Scale: Urban

Summary

The municipal water utility in Krasnogorsk, a municipal utility turned joint-stock company, implemented several innovative water efficiency measures – all completely funded by the “vodokanal” itself. Automating remote control systems and introducing variable speed drives (VSDs) reduced electricity consumption per unit of pumped water by an average of 17%. Despite a 20% increase in pumped water in 2000 compared with 1997, electricity use remained the same, and actual costs of municipal water supply dropped by 3.4%.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making

A basic principle for enabling effective, sustainable, and integrated water management was the effective coordination among sectors, between public and private actors, and across multiple geographic and institutional scales.

An important guideline that helped create an enabling environment and mobilize financial resources was the consid-



eration of water as an economic, social, and environmental good, including acknowledgement of the full costs of water management and water services, and transparent, equitable, and sufficient allocation of those costs throughout society.

Financing

The Krasnogorsk Vodokanal was, as were all water utilities in Russia, a municipal enterprise. Subsequently it became a rented company, and ultimately, a joint-stock company. With this change of status, a new generation of leaders emerged, who focused on finding ways to analyze and reduce production costs.

All funding (US\$158,000) for the improvements came from the joint-stock utility.

The Project

Water supply and distribution in the vodokanal includes 13 pumping plants supplying water from water wells to the municipal network. Water pumping stations differ in capacity and vertical rise (head), so each station had a different impact on the network. In the past, there was little if any monitoring information or data for individual stations, making optimal functioning of the entire system difficult to ensure.

Reliability decreased from year to year, and maintenance costs grew. In 1996, vodokanal management decided to replace this remote control system with a more up-to-date one. The new system allows for permanent control over all pumping plants by monitoring water pressure, water consumption, and water store in the city. At any minute, the dispatcher has complete control over all pumping plants and can change their operating parameters by switching on/off relevant equipment.

Technical Data

The obsolete remote control system was replaced with a modern one that uses computerized tools, controllers, and software that allow for retrospective information control. Information for up to 400 days in the form of curves, charts, etc., allows for equipment operation analysis and projections for various scenarios.

On the basis of water level in storage tanks, the updated system regulates the work of pumps. Frequency converters or VSDs have been incorporated in the rotary pumps control layout. By changing parameters of frequency converters, daytime

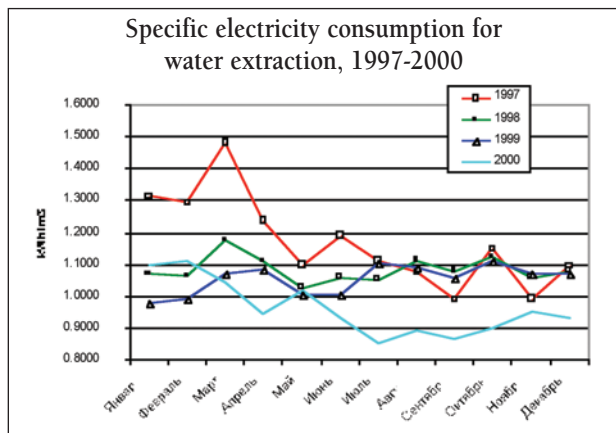
and nighttime pressure in the network is ensured — so the system can adjust for changes in demand, thus saving energy when demand is lower.

Performance Data

The remote control automation system, by stabilizing water pressure and removing water hammers, has reduced the number of emergencies in water pipe operations. Water pipe breaks were 33% lower in 1999 to 2000 as compared with 1998 because of the installation of frequency converters. The system also reduces electricity consumption by lowering nighttime pressure from 5.5 to 3.6 atm. Installation of frequency converters also reduced electricity consumption by 30%.

Participants and Roles

The project improvements were conceived of and financed by the joint-stock utility. Outside contractors provided technical guidance, equipment, and software.



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Renewable Energy for Protected Areas in Mexico

Location: Southern Mexico (Chiapas, Oaxaca, Quintana Roo)

Type: Distributed photovoltaic (PV) and wind applications

Size: 75 independent stand-alone systems, ranging from 50 to 11.2 kW

Funding: Total: US\$900,000

Private (in-kind): US\$300,000

Public sources: US\$600,000

Objective: To use renewable energy technology in remote, protected areas.

Duration: 1994–2000

Scale: Rural

Summary

This program successfully demonstrated the role that renewable energy technologies can play in managing protected areas and developing buffer zone communities throughout southern Mexico. As a result, international and local non-governmental organization (NGO) partners are now including energy considerations in their planning activities, and they have the capability to decide when clean energy technologies can help to meet these needs. The approach has stimulated improvements in field research capabilities, improved quality of life for reserve rangers and guards, and enhanced environmentally friendly economic development throughout Mexico.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws



Capacity-building activities that helped enable the success of the partnerships included awareness and educational workshops for decision makers, skills-oriented training for decision makers and staff, study tours, stakeholder partnerships and exchanges, dissemination of best practices, and participation in international forums and workshops.

Programs in professional training, public education and communication, and outreach have helped increase public knowledge of, and participation in, energy decision making.

The definition and creation of competitive and captive markets also helped to improve institutions.

The Mexican Environment Secretariat has maintained a strong mandate to manage activities related to the protection of the environment. The success of this project comes largely from the strength of this government office and the high value that it places on partnerships with NGOs and the private sector.

Financing

Total capital costs were approximately US\$600,000. In-kind contributions from conservation organizations are estimated at roughly US\$300,000. These nongovernmental contributions, which were used to conduct the procurements, manage the installations, and assure their viability, were essential to the success of the project.

The Project

Protected areas are national parks, biosphere reserves, and other designated conservation areas where a governing body has officially declared protection of nature to be a priority.

Effective and efficient management of these areas include the sustainable use of available energy resources. Since 1994, international conservation organizations, together with their respective local NGOs, have integrated energy planning into remote conservation and sustainable development activities.

Since 1997, program partners have installed 74 systems, totaling more than 25 kW, which provide critical electricity services for operations, infrastructure, and community development activities in protected areas. Renewable energy projects include PV electrification, PV communication, PV water pumping, and wind electrification.

For example, a PV-powered radio network enables more than 200 coffee producers to mobilize coffee more efficiently. The resulting higher incomes not only benefit these producers and their families, but also draw other producers to more sustainable cultivation practices.

Such projects have generated substantial private- and public-sector replication. For instance, in Chiapas, where a PV system was installed in a reserve, surrounding community residents elected to invest their municipal funds in PV electrification of several hundred rural homes.

Technical Data

PV and wind electrification systems range from 50 to 11,200 W. They power water-pumping and purification activities, communications, scientific and audiovisual equipment, refrigerators, fans, computers, and basic lighting. Most systems are less than 300 W. Three examples follow:

- Three 300-W wind turbines provide lighting and power, and an independent PV system provides water pumping for a ranger station and visitor center on Isla Contoy, an island designated as a bird sanctuary off the shores of Cancun.
- A 1.9-kW PV system pumps stream water over a kilometer to provide 38 families with potable water.
- Four PV systems totaling 1.9 kW provide electricity for a central lodge/research station and three remote cabins in the El Eden Ecological Reserve, where biologists demonstrate the profitability of conservation.

Performance Data

Implementation of the PV and wind systems has given more than 4,000 people dispersed across remote communities access to clean and quiet electricity.

Although the true test of sustainability is time, the high performance of the systems and favorable operator response indicate that the services will continue to satisfy local needs well into the future.

Continual feedback, routine inspections, and word-of-mouth transfer of basic concepts on the installation and maintenance of solar systems and the benefits of renewable energy enhance the likelihood of long-term satisfaction.

Participants and Roles

The partner NGOs, which implemented the systems, are The Nature Conservancy, Conservation International, World Wildlife Fund, Linea Biosfera, Amigos de Sian Ka'an, El Eden



Private Reserve, Campesinos Ecológicos de la Sierra Madre de Chiapas (CESMACH) coffee growers cooperative, Instituto de Historia Natural, and Pronatura Península Yucatán. US and Mexican Implementing Partners were Sandia National Laboratories, New Mexico State University, Winrock International, Enersol Associates, and Ecoturismo y Nuevas Tecnologías. Project sponsors included the United States Agency for International Development (USAID) and the United States Department of Energy (USDOE), and the Mexican Secretariat of Environment, Natural Resources, and Fisheries (implementing partner).

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Sale and Distribution of Household Biogas Systems

Location: Rural areas in Vietnam

Type: Household biogas systems

Size: 3,000 systems

Funding: Total: US\$89,590

Private: US\$89,590

Objective: To commercialize the sale of household biodigesters to improve water quality and meet energy needs.

Duration: 2001

Scale: Rural

Summary

Vacvina, Vietnam's national horticultural training association, has successfully installed roughly 3,000 household biogas systems in rural, agricultural areas of Vietnam. The systems provide an inexpensive source of cooking fuel, displace the need to collect and use fuel wood, remove wastes that often flow into local streams, and improve living conditions through improved sanitation and cleaner air.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making

The most important in-country principle that attracted the private financing was the ability to hire and develop a staff with appropriate skills matched to the job. This activity was necessary to bring the project in line with commercial standards, which, in turn, enabled energy product and service transactions to be economically sustainable.



Financing

Total project financing was US\$89,500, all of which was provided by E+Co. (E+Co. is a United States [US] corporation that provides business development services and financing to establish enterprises that provide sustainable energy.) The US\$89,500 is catalytic seed capital that allows entrepreneurs to move from initial stage ideas to investment, implementation, and growth. With this support, Vacvina has moved from an organization that had no commercial basis to one that shows a positive cash flow on a month-to-month basis.

The Project

Vacvina provided planning and financial assistance to commercialize the sale and distribution of household biogas systems. These systems use the waste from the one to two pigs typically owned by a farmer to produce sufficient methane to meet daily cooking requirements. As such, they displace the need for collecting and using fuel wood, remove the waste stream that often flows into local streams, and can provide a supplementary water source for fish farming.

Eighty percent of Vietnam's population lives in rural areas and practices agriculture. Family plots are extremely small, and farming techniques must be adapted to provide sufficient food for household needs. The most important animal husbandry activity is pig farming. The development of environmentally friendly, renewable energy sources is important for maintaining agricultural production while meeting energy requirements.

The use of the biodigesters eliminates the flow of animal waste into surface water and provides a decontaminated water supply suitable for fish farming and small-scale irrigation. It also improves sanitation and the drinking water supply, the latter of which is enhanced by the ready availability of a fuel source to ensure that water is boiled prior to consumption.

To date, roughly 3,000 household biogas systems have been installed.

The widespread use of biogas plants brings financial, environmental, and health-related benefits to the farmers, the environment, and the community.

The methane produced displaces the use of firewood (estimated at 2,500 kg per family per year, for which families spend between \$5 and \$10 per month) and provides a supply of boiled water for drinking. Women reap most of the benefits of household biogas plants, as these plants give them additional

time for productive activities. The plants also improve sanitation and promote cleaner air.

Technical Data

The initial biogas plants used a simple, tubular plastic holding tank and readily available fittings to use household cattle, pig, or poultry waste to produce sufficient methane to meet the daily cooking requirements of the family.

These systems initially had low profit margins, but continuing development produced a more efficient, sustainable, and profitable biogas plant structure.

Vacvina's new hybrid-technology biogas plant with automatic scum control (HTASC) represents a significant improvement over the currently used biogas plants. The design uses a small reinforced concrete unit that is more compact and can be placed below the area used by the piggery to reduce the land area needed by the more basic plastic unit.

Performance Data

Vacvina has sold and successfully installed nearly 3,000 units, representing the equivalent of US\$418,000.

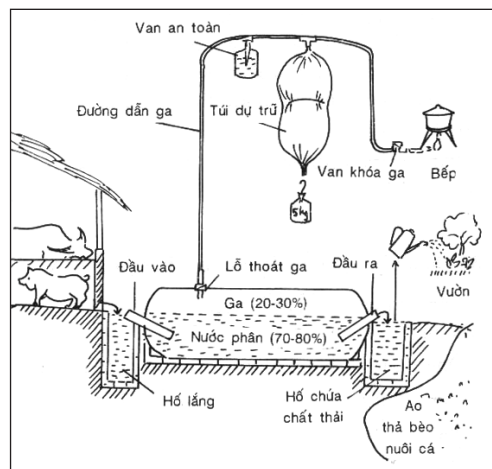
Forty-four technicians have been trained in 11 provinces.

Living conditions have improved through increased sanitation and clean air.

Vacvina has maintained the position it has built in the biogas market, improved the quality of its products, and offered a more permanent system that is simple in design but still modestly priced. The biogas activities that Vacvina has promoted to date have caught the attention of a number of bilateral agencies.

Participants and Roles

Vacvina, with development and financial assistance from E+Co., has moved from an organization that had no commercial basis to one that shows a positive cash flow on a month-to-month basis.



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Alternative Bagasse Cogeneration (Greenhouse Gas Pollution Prevention [GEP] Project)

Location: Countrywide
Type: Bagasse cogeneration
Size: 9 cogeneration units expected to total about 200 MW capacity
Funding: Total: US\$128,000,000
 Private: US\$120,000,000
 Public: US\$8,000,000
Objective: To reduce the emissions of greenhouse gases (GHGs) per unit of electricity generated by encouraging increased and efficient use of biomass fuels at sugar mill cogeneration facilities.
Duration: 1995–2003
Scale: Rural and urban

Summary

Six sugar mills installed with high-efficiency cogeneration units and using biomass/bagasse fuels generate 500 million kWh annually and offset 550,000 tons of carbon dioxide (CO₂) emissions. The bagasse-based cogeneration potential in India is estimated at 5,000 MW, with only 300 MW commissioned so far. The proven success of bagasse cogeneration will help ensure sustainability and help India achieve the 5,000 MW potential.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Activities that support capacity-building and informed decision-making principles, which in turn can help attract



private financing have included study tours, demonstration activities, seminars, and participation in international forums and workshops, which help increase awareness of commercial business practices, competitive energy market operation, and managing private sector involvement.

A central element of energy-sector reform efforts is increased public knowledge of and participation in energy decision making, which have been enhanced by professional training and outreach programs.

Government policies that supported private investment in sugar mill cogeneration for exporting electricity to the grid (for additional revenues) also contributed to private-sector participation.

Financing

Total cost is US\$128,000,000. Private-sector sugar mills invested US\$120,000,000. The United States Agency for International Development (USAID) contributed US\$8,000,000 in grants and technical assistance.

The Project

The project is designed to reduce the emissions of GHG by encouraging increased and efficient use of biomass fuels at sugar-mill cogeneration facilities. (Cogeneration is the joint production of process steam, and bagasse is a waste product of sugar-cane processing.)

Under the project, nine sugar mills will set up high-efficiency cogeneration units using biomass and bagasse fuels. Six of these plants have already installed cogeneration units and are generating about 500 million kWh of electricity annually. Cogeneration units at the three remaining sugar mills are being commissioned in 2002.

Net CO₂ emissions from bagasse/biomass usage for energy are considered zero, because these fuels absorb CO₂ during their growth, and the corresponding CO₂ generation by fossil fuels is eliminated. Thus, the use of biomass/bagasse fuels in the six plants eliminates approximately 550,000 tons of CO₂ emissions per year.

The utility sector is the primary beneficiary of the project, but all sectors benefit from the increased provision of electricity using nonpolluting energy sources.

The project is also extending the merits of bagasse cogeneration to other biomass fuels year round, as many cogeneration developers use coal or lignite in the off season.

Implementing high-efficiency cogeneration at sugar mills and supplying the excess electricity to the grid is akin to distributed generation, and therefore minimizes transmission and distribution losses because of the local end use.

Technical Data

The sugar mills are switching to high-pressure/high-temperature-based cogeneration units and multifuel boilers with electrostatic precipitators.

Performance Data

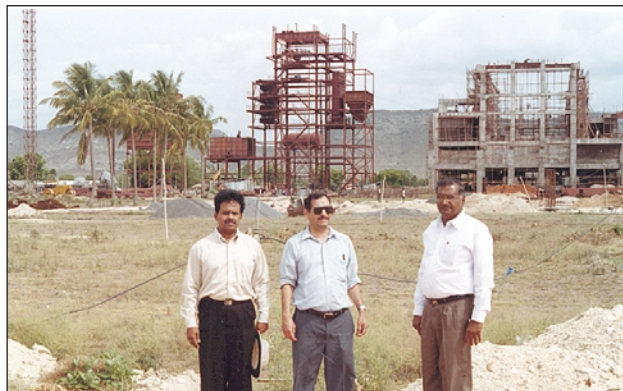
The six sugar mills with completed installations are generating about 500 million kWh electricity annually and reducing CO₂ emissions by about 550,000 tons per year.

Participants and Roles

The Industrial Development Bank of India implements the project's investment-related activities, and the sugar mills provide the vast majority of funding. The US Department of Energy (USDOE) National Energy Technology Laboratory (NETL) provides technical assistance and training to Indian counterparts through Science Applications International Corporation (SAIC) and Winrock International India.

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Collaborative Labeling and Appliance Standards Program (CLASP)

Location: Multiple countries with an emphasis on China, Mexico, India, Brazil, Ghana, and Poland

Type: Energy-efficiency standards and label development

Size: Nationwide impacts for several countries

Funding: Total: US\$4,760,000

Private: US\$2,640,000

Public: US\$2,120,000

Objective: To lower energy costs and pollutant emissions through energy-efficiency standards for appliances, equipment, and lighting products.

Duration: 1996–present

Scale: Urban and rural

Summary

Worldwide residential energy consumption can be reduced cost-effectively by over 5% through energy-efficiency standards and labels. By 2010, CLASP will have assembled a global network of experts and provided in-depth and tailored technical assistance and training in the development of energy-efficiency standards and labels to more than 15 priority coun-

tries, while simultaneously supporting as many as 50 others through information dissemination.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws
- Public participation in, and support of, sustainable development

Capacity-building and informed decision-making principles help government officials, lawyers and judges, manufacturers, product distributors, retailers, consumer groups, and the public become more capable bureaucrats, businessmen, and citizens, thereby attracting private-sector financing. Activities that have enabled the realization of these principles for CLASP include formation of a management team independent of the government, hiring staff with skills matched to the job, providing training for decision makers and staff through study tours, stakeholder partnerships and exchanges, participation in international forums and workshops, and dissemination of best business practices.

Institution-building principles and activities that have helped attract private financing included comprehensive energy laws that accord with global norms and standards.

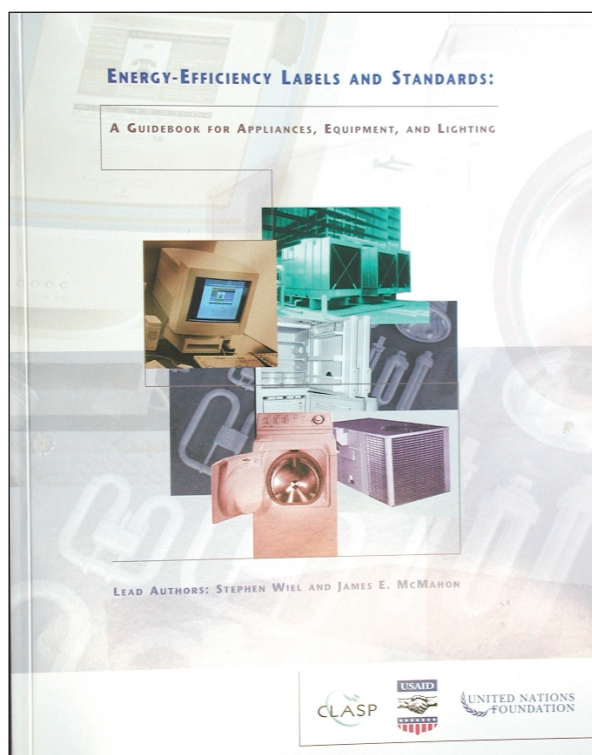
Financing

Total project investment from all sources is US\$4,760,000. Private sources have contributed more than half of the total investment and include the Energy Foundation (US\$330,000), the International Copper Association (US\$700,000), and the United Nations Foundation (UNF) (US\$1,610,000).

Public funding has come from the United States Agency for International Development (USAID) (US\$1,150,000), the US Department of Energy (USDOE) (US\$260,000), the US Environmental Protection Agency (USEPA), and others.

The Project

CLASP originated from the realization that energy-efficiency standards for appliances, equipment, and lighting products, which potentially affect the manufacture and sale of



all energy-consuming products, may be the most cost-effective energy saving policy a government can adopt.

Every country has opportunities for more energy-efficient appliances, equipment, and lighting products, the use of which can lower energy costs, lower demand on constrained electric utility systems, and reduce greenhouse gas (GHG) and local pollutant emissions.

All sectors benefit through improved lighting, refrigeration, and cooking systems, and more stringent requirements placed on manufacturers through energy-efficiency standards and labels can stimulate a healthier and more competitive appliance industry.

By 2010, CLASP will have provided in-depth and tailored technical assistance and training in the development of energy-efficiency standards and labels to over 15 priority countries and will have simultaneously supported roughly 50 others through information dissemination via the Internet and other training forums.

Technical Data

The CLASP Web site (www.CLASPOnline.org) contains information on standards and labeling programs worldwide and has received nearly 500,000 hits from more than 100 countries.

Technical assistance for developing standards for room air conditioners, clothes washing machines, fluorescent lamp ballasts, lamps, and motors is being provided to governmental institutions.

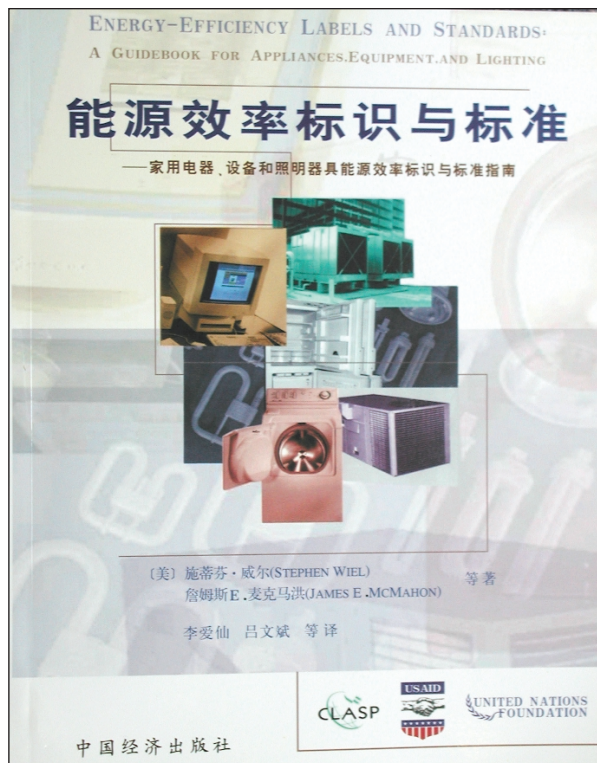
Performance Data

More than 20 developing countries have introduced energy-efficiency standards or labels for a total of 43 energy-consuming products.

To date, 20 Chinese and 6 Mexicans spent 100 person-weeks at Lawrence Berkeley National Laboratory learning about energy efficiency, testing, standard setting, and labeling.

Over the next 10 years, dozens of countries are expected to initiate energy-efficiency standard-setting and labeling programs. Performance targets include a 1 to 2% reduction in the ratio of energy consumption to gross domestic product, a 5% reduction in national residential energy consumption, and a 5% reduction in urban pollutants and GHG emissions.

Benefits from a standards and labeling program can start to accrue in as little as 3 years, but 6 to 10 years are generally needed to build institutional capability, conduct rulemakings for each product, and modify production lines to produce the products that will meet the new standards. Benefits will continue to accrue over the following 10 to 30 years, depending



on the particular product as the existing stock wears out and is replaced.

Participants and Roles

In 1999, the International Institute for Energy Conservation, Lawrence Berkeley National Laboratory, and the Alliance to Save Energy formed CLASP to establish regional standards. The USAID, the USDOE, the UNF, the Energy Foundation, and the International Copper Association are major partners and sponsors. In addition, numerous US agencies, other funding organizations, project consultants, volunteers, host-country government agencies, manufacturers, and nongovernmental organizations are participating.

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Water Efficiency Team (WET)

Location: Countrywide
Type: Water system efficiency
Size: 55 water enterprises
Funding: Total: US\$400,000
 Private: US\$8,000
 Public: US\$392,000
Objective: To improve water system service.
Duration: 1998–1999
Scale: Urban

Summary

Water service to the urban poor was greatly expanded through implementing the principle that the most efficient way to increase service delivery and coverage is through more commercially oriented and professional water enterprise management. The WET project made financial, management, and technical recommendations that helped more than 50 water enterprises reduce costs, increase revenues, and install 20,000 new water connections to the urban poor.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws

A key principle that helped attract private investment in more efficient water delivery systems was the consideration of water as an economic, social, and environmental good, including acknowledgment of the full costs of water management and water services, and transparent, equitable, and sufficient allocation of those costs throughout society.



Also important were an emphasis on decision making and assignment of authority at the lowest appropriate level, broad stakeholder participation and empowerment in water resources decision making, and stable systems of access to and allocation of water.

Indonesia's reformation and decentralization initiatives have created a supportive atmosphere for professional, commercially viable, consumer-oriented piped water service. Local governments are now fully accountable to their constituents for their water enterprises, thus creating an incentive to provide affordable and convenient service.

Financing

Total project investment was US\$400,000. The United States-Asia Environmental Project (US-AEP) provided the bulk of the funding, and the Water Environment Foundation (WEF) contributed about US\$8,000 for general project support.

The Project

Less than 40% of Indonesia's urban population is served by piped water. Over the past 20 years, the Government of Indonesia has spent the equivalent of more than US\$2,000,000,000 on water-related projects. However, these efforts have not significantly improved service or increased coverage.

The primary goal of the WET project was to work directly with local water enterprises to identify areas for reducing costs and improving revenues and to improve the efficiency and effectiveness of water delivery services, especially during the 1989-1999 Asian monetary crisis.

Most of the water system enterprises assessed by WET suffered from high debt, idle excess production capacity, and a waiting list of potential consumers. Income for the water enterprises was low, because tariffs covered only about 70% of the average water enterprise's total costs.

Indonesia's 300 municipal water enterprises were so squeezed by soaring costs that some put untreated water through the mains, threatening large-scale epidemics, and others planned complete shutdowns. By implementing WET financial, management, and technical recommendations to address these problems, more than 50 water system enterprises were able to reduce their costs, improve their services, and increase their revenues.

Previous well-intended but misdirected policies required cash-strapped water enterprises to sell water to the poor at a loss, thus draining funds that would have been used to

expand and maintain the distribution system. As a result, the urban poor purchased from vendors who charged up to 12 times the price they would have paid for piped water, were it available. The new connections gave thousands of poor people access to clean water.

Technical Data

The project made recommendations addressing financial, management, and technical aspects of water delivery; it did not recommend, use, or install specific technologies.

Performance Data

Because of the WET recommendations, 55 individual water enterprises were trained in ways to improve service delivery. Approximately 20,000 new connections servicing 250,000 people were installed. At least 150,000 person-days of employment were generated.

WET helped small water enterprises create recovery plans and explained those plans to skeptical local governments. The local governments approved long-overdue tariff increases that were tied to improvements in service. WET assistance led to tariff increases valued at 12 times the start-up investment.

New connections were extended to customers on the backlog list, thus expanding service, increasing revenue, and moving water enterprises back to financial health.

WET's emphasis on transparency and self-help rather than capital infusion has helped move the Government of Indonesia's priorities for the development of the water sector toward full commercialization. WET has demonstrated that even small water enterprises can become financially self-sufficient with the institution of proper systems and procedures.

Participants and Roles

US-AEP partnered with the Government of Indonesia, the Asian Development Bank, and the World Bank to help fund the outreach effort. The WEF provided support with budgeting, travel, and selection and orientation of technical assistance teams.



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South Asia Transboundary Water Quality Monitoring (SATWQM) Project

Location: South Asia
Type: Water quality monitoring
Size: 6 partner organizations; 40 supporting organizations
Funding: Total: US\$350,000 (annually)
 Private (in-kind): US\$50,000
 Public: US\$300,000
Objective: To sample, monitor, and create a shared database on transboundary river water quality.
Duration: 1999–present
Scale: Rural and urban

Summary

The purpose of the SATWQM project is to assess river water quality and identify potential problems that can lead to serious adverse health effects. By focusing on the less sensitive subject of water quality (as compared to quantity) and using non-governmental partners, the SATWQM project is progressing despite continuing, strained relations between India and Pakistan. The SATWQM network is poised to expand its membership, increase the number of sampling sites and parameters, and begin the transition from a United States (US)-hosted initiative to one managed by a regional organization.

In-Country Principles That Attracted Non-Donor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws



Principles that have helped attract private-sector support for SATWQM include integrated, intersectoral, and multiobjective decision making about water resources at the watershed or basin scale; informed and science-based decision making; broad stakeholder participation and empowerment in water resources decision making; and strong, objective and culturally appropriate institutional, policy, and legal frameworks.

Other principles that have attracted private-sector interest include effective coordination among sectors and across multiple geographic and institutional scales; consideration of water as an economic, social, and environmental commodity, including acknowledgement of the full costs of water management and water services; an emphasis on decision making and assignment of authority at the lowest appropriate level; the commitment to create and strengthen human and organizational capacity for sustainable water management; systems of accountability and transparency; and a progressive policy and legal environment.

Financing

Total approximate annual funding for this ongoing project is US\$350,000. The estimated dollar value of in-kind services provided by regional partners is US\$50,000. On average, the United States Department of Energy (USDOE) provides US\$200,000, and the US Department of State contributes US\$100,000 annually.

The Project

The project has created a network of South Asian organizations that monitors water quality in transboundary tributaries of the Ganges and Indus River basins and shares the data over the Internet.

Issues of concern to SATWQM include impacts of untreated sewage, industrial effluents, and agricultural runoff; river siltation and channel shifting; salinity increases in fresh waters; and the environmental degradation of critical habitats.

The principal idea underlying the project is that cooperation to ensure a sustainable environment can improve relations among countries. The network includes research institutions, universities, and nongovernmental organizations that collect water quality data in the border regions of Pakistan-India (on the Ravi River), Nepal-India (on the Bagmati and Narayani Rivers), and Bangladesh-India (on the Ganges River).

Comprehensive water quality monitoring across national boundaries enhances assessment of water resources across an entire watershed and helps identify potential problems.

Environmental cooperation among countries also has several indirect security-related benefits. It increases dialogue between policy makers and scientists that can be maintained even when talks on other more sensitive subjects are suspended. It also creates an information-sharing infrastructure that can be expanded to include sensitive security and arms control subjects.

Technical Data

Technologies include the Hydrolab minisonde with electronic sensors to measure water quality, Jal-Tara field-testing kits for chemical analyses of water samples, global positioning system units, Secchi disks to measure turbidity, and digital cameras.

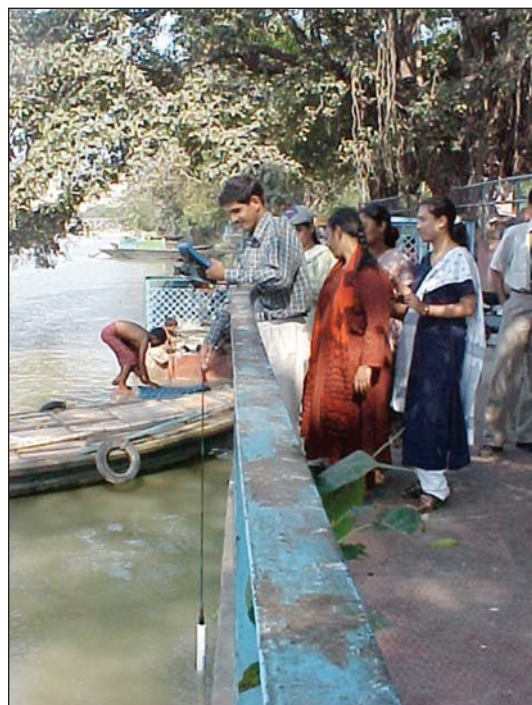
Temperature, pH, conductivity, salinity, and dissolved oxygen are monitored using the Hydrolab minisonde, and 14 other physiochemical water quality parameters are monitored using the Jal-Tara semiquantitative field-testing kits.

Performance Data

The network of participating organizations has doubled in 2 years and now totals 40. The sophistication of the sampling equipment has improved, and the number of parameters monitored and the amount of data shared has increased significantly. Approximately 40 people have been trained in water quality monitoring to date.

Participants and Roles

The six transboundary data collection partner organizations (in alphabetical order) are Bangladesh Unnayan Parishad, Dhaka, Bangladesh; Center for Environment and Development, Kolkata, India; Department of Biology, Guru Nanak Dev University, Amritsar, India; Environment and Public Health Organization, Kathmandu, Nepal; Environmental Biology Laboratory, Patna University, Patna, India; and the World Wide Fund for Nature, Lahore, Pakistan. Data collection partners provide in-kind services needed to collect the SATWQM project data and share data using the project Web site. Other supporting partners share relevant archival data from other water quality monitoring projects on transbound-



ary rivers using the SATWQM project Web site, disseminate project data and information, and provide insight and guidance to ensure project success and sustainability.

The Cooperative Monitoring Center at USDOE Sandia National Laboratories acts as the catalyst for the SATWQM project through the sponsorship and guidance of the US Department of State's Regional Environmental Affairs Office, Kathmandu, and the USDOE. It also supplies equipment to SATWQM partners and creates mechanisms to access and use the data via the project Web site.

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Geothermal Heat Pump Demonstration Project

Location: Beijing, Ningbo, and Guangzhou
Type: Geothermal heat pump (GHP)
Size: 5,825 tons cooling/heating capacity
Funding: Total: US\$5,460,000
 Private: US\$5,300,000
 Public: US\$160,000
Objective: To provide cost-effective heating and cooling using renewable energy.
Duration: 1987–2001
Scale: Urban

Summary

This project, a part of the United States (US)/China Bilateral Protocol on Energy Efficiency and Renewable Energy, resulted in the completion of three major residential GHP demonstration projects. These projects, which were facilitated with training, information, study tours, and prefeasibility studies, were ultimately financed on a purely commercial basis, with a total investment of US\$5,300,000 by private-sector Chinese companies.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Key to attracting private-sector financing was the ability for the energy sector to operate under standard commercial practices. Related to this were the increased awareness,

knowledge, and skills of sector professionals in commercial business practices, which resulted from study tours, stakeholder partnerships, exchanges, and participation in international forums and workshops.

Another important principle that helped attract private-sector interest was increased public knowledge of, and participation in, energy decision making. Programs in professional training, public education and communication, and outreach helped increase public access. A particularly important activity in this area was developing and implementing monitoring and evaluation strategies and tools for measuring the impact of education, communication, and outreach programs.

Financing

Total capital costs for equipment purchases were approximately US\$5,300,000. All of these funds came from private-sector Chinese developers.

Prior to the capital investment, the US Department of Energy (USDOE) provided training, linkages to US industry, information exchanges, and prefeasibility funds, totaling about US\$160,000 over several years.

The Project

As China moves toward sustainable economic and energy development, a key challenge is how to reduce its reliance on coal combustion, with its associated adverse environmental impacts. China has rich geothermal resources and a long history of geothermal resource use for direct applications. More than 1,600 sites in China use geothermal energy, and these sites have produced energy equivalent to 5,000,000 tons of coal.

GHP technology, which uses soil or water temperature as a heat exchanger to heat and cool buildings, is a cost-effective, energy-efficient, and environmentally friendly way to cool and heat buildings in China.

China and the USDOE have identified eight pilot GHP projects. Three have been demonstrated successfully. They include separate apartment projects in Beijing, Ningbo, and Guangzhou. These projects are to be replicated on a larger scale, with the goal of commercialization.

The GHP technology saves end users energy and money. Reduced power demand reduces utilities' needs to build more plants, and offsetting the electricity consumption for cooling in buildings reduces peak power loads for utilities.



Technical Data

GHP technology uses the earth's relatively constant soil temperature to provide efficient year-round heating and cooling, by exchanging heat with the earth through a system of buried plastic pipes, or ground heat exchangers.

The three demonstration projects provide a combined heating and cooling capacity of 5,525 tons.

Performance Data

Performance monitoring is underway, and preliminary results indicate that the GHPs are resulting in reduced operating and maintenance costs. Monitoring and evaluation of the project and dissemination of this information will help to further develop the market for GHP technology.

Participants and Roles

Chinese developers implemented the demonstration projects, the USDOE provided training and outreach, and the USDOE's National Renewable Energy Laboratory (NREL) provided technical assistance.

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Solar Systems for Schools in the Province of Jujuy

Location: Province of Jujuy
Type: Rural electrification
Size: 1,500 110-W photovoltaic (PV) systems
Funding: Total: US\$1,400,000
 Private: US\$700,000
 Public: US\$700,000
Objective: To provide electricity to off-grid rural areas.
Duration: 2001–2002
Scale: Rural

Summary

One thousand five hundred rural schools now have electricity provided by PV systems. The rural electrification project stems from an aggressive utility privatization plan. It represents the first actual implementation project in Latin America where international funding, local government policies, the private sector, and community representatives have joined in the common goal of applying renewable energy systems to a rural electrification sustainable business model.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws
- Public participation in, and support of, sustainable development

A key factor in attracting private-sector investment has been allowing utilities to operate under standard commercial



practices, which include financial recordkeeping systems consistent with international accounting standards and a management team independent of the government. Participation in international forums and workshops helped energy-sector professionals increase their knowledge and skills in commercial business practices, cost-based pricing, international accounting standards, competitive energy market operations, independent energy regulation, and management of private-sector involvement.

Institution-building principles that attracted private financing included the creation of competitive markets and a successful energy restructuring. Also important was a comprehensive energy law consistent with global norms and standards characterized by basic policies and priorities; separate policy making, ownership, and regulatory functions; an independent regulator; and a framework for private investment and ultimate privatization. A legal and regulatory framework covering tariffs, social and security issues, and the privatization process was key. Technical assistance, in which development partners worked with Argentine nationals to allow corporate restructuring of energy enterprises to support commercial operations, also helped attract private financing.

Also important were increased knowledge of, and participation in, energy decision making, facilitated through citizen education and an institutionalized sustainable education, communication, and outreach program.

Financing

Total costs were US\$1,400,000. BP Solar (United States [US]) was involved in the amount of US\$700,000; the Government of Argentina and the World Bank/Global Environment Facility (GEF) each contributed US\$350,000.

Empresa Jujeña de Sistemas Energéticos Dispersos Sociedad Anónima (EJEDSA), the utility company for Jujuy, is a private company. As part of its concession contract with the government, it is required to provide electricity through renewable energy sources for dispersed public and private users. BP Solar was awarded the contract to provide 1,500 PV systems. Special financial terms (LIBOR [London Interbank Offered Rate] plus 1.5%) for a five-year US Export-Import Bank (Eximbank) loan were arranged between the utility and BP Solar for equipment purchase.

The debt/equity ratio for the project was 50:50. A key factor for sustainability is that maintenance and operation of the installed systems comes from monthly user fees.

The Project

One thousand five hundred schools that were never part of the power grid now have access to reliable and economical electricity through PV systems.

An aggressive privatization and concession plan for the utilities was the main engine for success. Utilities joining the program are obligated to use PV systems to supply electricity to the dispersed areas of the province, where there is no conventional grid. Community buildings (schools, health centers, police stations) and home users in those rural areas apply to the utility to install the PV systems where the conventional grid is not available. A fee-for-service rate approved by the federal government is applied for those users. The collected fees are reinvested for maintenance and operation services as a sustainable business model.

Residential sectors benefit through improved health, lighting, and education. The utility sector benefits by extending its coverage and adding new customers beyond the schools.

The project is 75% complete (three of four scheduled deliveries have been made). The final delivery is on hold pending resolution of recent social and economic problems in Argentina.

Technical Data

Each of the 1,500 PV systems includes a 110-Wp solar panel, a solar controller, a 150 Ah/12-V battery, an 11W/12V lamp, and a wiring kit. Local components are used where possible.

Performance Data

With the addition of the 1,500 rural schools, the electrification index in the province increased by 10%.

The market value of services achieved because of the project is US\$1,400,000. More than 50% of the total investment came from local suppliers of batteries, lamps, wiring kits, and battery containers, and local installation services.

Energy demand has been reduced by 10%.



Participants and Roles

EJEDSA (the private utility company) provides electricity from PV systems to rural schools off the power grid. BP Solar (US) supplied the PV systems; the equipment purchase was supported by a US Eximbank loan. The Secretaria de Energia of the Federal Government of Argentina was responsible for program and policy development with assistance and funding from the World Bank/GEF. Allfirst Bank was the US intermediary bank.

The World Bank, Organization of American States, Renewable Energies in the Americas (REIA), and US Solar Energy Industry Association (SEIA) conducted regional seminars that helped attract project interest and financing.

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Ngong Cookstove Project

Location: Ngong, Kenya

Type: Improved cookstoves

Size: 800 systems

Funding: Total: US\$10,000

Private: US\$2,000

Public: US\$8,000

Objective: To save money and improve health through the use of safer, more efficient cookstoves.

Duration: 1999–2001

Scale: Urban

Summary

Women who had no alternative but to burn plastic bottles and other trash as a cooking fuel were trained to build and construct more efficient stoves to save money and improve health. The women have now gone into business building these stoves and selling them to communities across Kenya. Strong community participation and capacity building have helped to ensure economic viability and continued investment in the project by community members.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public access to, and support of, sustainable development and public participation, coordination, and partnerships

Capacity-building principles that helped attract private funding included hiring and developing staff with appropriate skills matched to the job, incorporation of popular input, and study tours. Also important were skills-oriented training for decision makers and staff and stakeholder partnerships and exchanges.



Public understanding of the changes made to the energy sector was facilitated through increased knowledge of, and participation in, energy decision making. Activities that helped increase public access and participation, which, in turn, helped generate private-sector support, included defining appropriate applications of education, communication, and outreach methods, and institutionalizing sustainable education and outreach programs.

Financing

Total project investment was US\$10,000. The capital costs of the project were approximately US\$4,000; operations and maintenance costs were US\$6,000.

The Ngong Women's Group, an informal community-based organization of women, contributed US\$2,000, and the United States (US) Department of Agriculture contributed US\$8,000.

Two aspects of this financing arrangement are noteworthy. The first is the relatively small amount of total financing for a project that has already brought financial and health improvements to over 800 families and that led to the development of a small business. The second is the size of the contributions relative to the resources of the funding organizations. Proportionally, the contribution by the Ngong Women's Group far exceeded the contribution of the government group.

The Project

Fuel cost savings and health benefits for poor women and their families were achieved through reducing wood fuel use and avoiding toxic cooking fuels. The women of Ngong, an impoverished area outside of Nairobi, were increasingly unable to afford the wood needed to fuel their stoves and were using toxic materials such as plastic bottles and other trash as fuel.

To eliminate the harmful effects of using such cooking fuel, the women constructed energy-efficient household-scale ceramic cookstoves and insulated cookers that allowed them to return to using wood as a fuel source.

The project is operational and has benefited the residential sector through increased health through improved cooking methods. Not only have the women enriched their families' health, but also they have developed a business that builds the stoves and sells them throughout Kenya.

Technical Data

An improved ceramic cookstove (“jiko”) and an insulated basket cooker were introduced to replace inefficient cooking systems. The new systems use more efficient direct combustion systems for wood. Over 800 of the new systems are in use.

Performance Data

The improved systems allow more efficient use of wood as cooking fuel. The greater efficiency of the new systems lowers the total cost of wood for cooking, thus reducing the use of plastic bottles and other toxic trash as a fuel source. The new cooking systems lead to cost savings and reduced toxic air emissions.

Participants and Roles

The Kenya Forestry Research Institute implemented the project and provided capacity-building support. The women of Ngong provided the energy, labor, and enthusiasm to not only build stoves but also build a business.

The US Department of Agriculture was the primary source of funds. Winrock International managed the project and provided technical assistance.



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Soluz Honduras

Location: North and northwestern Honduras
Type: Rural energy delivery
Size: 2,500 photovoltaic (PV) systems delivering the equivalent of 500 kW of conventional centralized power
Funding: Total: US\$1,500,000
 Private: US\$1,000,000
 Public: US\$500,000
Objective: To provide electricity to dispersed rural households and small businesses.
Duration: 1998–2002
Scale: Rural

Summary

Soluz Honduras, a private energy company with a strong market orientation and customer focus, supplies more than 2,000 rural households, micro-enterprises, churches, schools, and clinics off the power grid with electricity generated by PV systems, including over 1,500 on a monthly rental basis. Key to project success were revised private foreign investment laws, rational and transparent import tariffs, and private-sector participation in public conferences with government agencies.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws

Key to attracting private financing for the project were comprehensive and transparent energy laws and policies that defined the basic structure of the energy sector and provided



a framework for private investment and ultimate privatization. In 1994, Honduras implemented a foreign investment law. Enforcement of this law, combined with rational import tariffs on equipment, was critical to attracting investment capital. Access to and linkage with available and transparent rural electrification plans were important in attracting private investment.

Also important were principles that allowed utilities to operate under standard commercial practices and to form management teams independent of the government.

Financing

Total investment in the project was US\$1,500,000. Private-sector sources included Triodos-Solar Investment Fund (US\$250,000), Corporacion Financiera Ambiental (CFA) (US\$300,000), and SunLight Power International (US\$250,000).

The World Bank Group’s International Finance Corporation (IFC) provided US\$500,000 through the Small and Medium-Sized Enterprise (SME) Program, which is funded by the Global Environment Facility (GEF). A US\$200,000 investment from E+Co included funds that originated from the Inter-American Development Bank’s Multilateral Investment Fund. The United States Agency for International Development (USAID) provided US\$23,000 in cost-shared funds for market assessment, and Soluz funded two market surveys costing \$73,000.

Costs were allocated in two phases. Phase I, “market assessment,” was US\$500,000, and Phase II, “breakeven,” was US\$1,000,000, with three disbursements based on performance milestones.

The Project

This project provides electricity, on a private basis, to households, small businesses, schools, clinics, and churches that are not connected to the national electricity grid. It provides energy for lighting, cooking, recreation, refrigeration, entertainment, wireless communication, personal computer operation, and standard appliances to users who otherwise would have no access to electricity from the electric utility. The service displaces unsustainable kerosene and battery usage.

The company provides electricity for dispersed rural households and small businesses, mainly through a “wireless” fee-for-service (rental) approach that offers PV systems and services at affordable prices. By eliminating the up-front costs of purchasing PV systems, Soluz Honduras has achieved

significant market penetration without customer subsidies or donor programs. The company's infrastructure, developed for service to private residential and commercial customers, has expanded to serve public applications such as schools and clinics. Phase I began in 1998 and was completed with 500 customers served. Phase II is 60% complete, with service provided to 1,500 out of the 2,500 projected for this phase.

Completion of the 2,500 installations is taking 4.5 years and includes a 1-year delay due to Hurricane Mitch. Subsequent expansion phases to 5,000 units or more will occur as appropriate.

Technical Data

The distributed micropower technology is powered by PV systems ranging from 20 to 200 Wp. The systems are installed at point of use on a "wireless power" basis, thereby eliminating the need for an electrical distribution infrastructure (similar to the avoidance of telephone wires with cellular telephone technology.) A battery-recycling program helps limit pollution.

Performance Data

By early 2002, Soluz Honduras provided electricity to over 10,000 people through a rental customer base of 1,500 and a total customer base of 2,000. Monthly collection rates above 90% are attributed to customer service and client responsibility commitments.

By eliminating the need to reach remote customers through the normal electric power distribution system, about US\$2,500,000 in distribution infrastructure investment (roughly US\$1,000 per connection) has been avoided. The elimination of kerosene use reduces energy unit costs by 90% and eliminates 625 metric tons of carbon dioxide (CO₂) emissions per year.

Quality of life improvements include better in-home study habits, improved education (through access to computers), improved health (though reduced respiratory disease), and income generation (by providing energy to micro-enterprises). Participation in the democratic process is also facilitated through access to modern communications (the election process is televised).

Nearly 100 people have been trained in rural energy delivery.

Participants and Roles

Soluz Inc. developed and raised capital for the project. Triodos-Solar Investment Fund, CFA, SunLight Power International, E+Co, and International Finance Corporation



(IFC/SME-GEF) provided financing. USAID provided cost-shared funds for market assessment through Winrock International.

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Cracow Clean Fossil Fuels and Energy-Efficiency Program

Location: Cracow

Type: Emissions reductions in new and existing heating systems

Size: 300 units; combined capacity of 285 MW

Funding: Total: US\$58,400,000

Private: US\$23,300,000

Public: US\$35,100,000

Objective: To reduce sulfur dioxide (SO₂) and particulate emissions from small, solid-fuel-fired boilers and home stoves.

Duration: 1991–2000

Scale: Urban

Summary

The project reduced average annual air pollutant concentrations at more than 300 small-scale, solid-fuel-fired boilers and home stoves in Cracow by 50 to 60%. Project success is attributed to numerous joint ventures of Polish and United States (US) companies, cost-effective use of available funds, and the environmental consciousness of the people of Cracow.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws

A key factor that helped attract private financing was standard commercial operating practices for the energy sector. Such practices included maintenance of financial records con-



sistent with international accounting standards, release of redundant staff, improved cost-recovery techniques, metering systems, skills training, and cost-based pricing.

Increased public knowledge of, and participation in, energy decision making was facilitated through a survey of public opinion regarding local air quality, heating sources, personal incomes, and the willingness and ability to pay for real energy costs and environmental improvement.

Information gathered in the program was made available to the public and announced through published brochures and television and radio announcements.

Also important for attracting private-sector support was a comprehensive energy law characterized by basic policies and priorities; separate policy making, ownership, and regulatory functions; and a framework for private investment. Technical assistance allowed corporate restructuring of energy enterprises and helped energy-based nongovernmental organizations to participate in the restructuring process.

The Polish Government's action to lower permitted emission levels for many emission sources forced facilities to either lower emissions or pay fines.

Financing

Total project investment was US\$58,400,000. Private funds came from Polish local utilities (US\$22,400,000) and boiler house owners and citizens (US\$900,000). Public funding sources included Polish environmental funds (US\$15,100,000) and US Agency for International Development (USAID) (US\$20,000,000).

Local utilities and boiler house owners requested Polish environmental funds (grants or low-interest loans) for equipment installations. Eight teams of American and Polish companies were selected through an open solicitation to participate in the project. Each team provided a 50% cost share for its project task.

The Project

In 1989, the levels of SO₂ and particulates in the ambient air of Cracow exceeded the local standards by several times. The poor air quality, which resulted from emissions from small, low-stack boilers and home stoves and from upwind, high-stack sources (power plants), was harming the health of Cracow citizens and the city's historic treasures. The objective of the project was to reduce emissions from

sources within the control of the local government and Cracow citizens.

The project studied existing heating equipment and options for emissions reductions; surveyed public opinion; demonstrated energy-efficiency measures; gathered and shared data on heating equipment and emissions sources; established a clearinghouse to disseminate energy, heating, environmental, and air quality information to the general public; and prepared a regional plan to continue to improve regional air quality. US-Polish joint ventures provided technical solutions to emissions problems for industrial- and commercial-scale solid-fuel-fired boilers and home stoves.

Residential, utility, commercial, and industrial sectors benefited through upgrades to heating sources that increased efficiency and lowered emissions. Community health was improved and quality of life was improved through installation of radiator valves in apartments, allowing individuals, for the first time, to control the temperature of their apartments.

Technical Data

Technologies included commercial gas- and oil-fired boilers, automatic combustion controls, and high-efficiency particulate collection devices. District heating lines and additional heat exchangers were installed for the district heating distribution utility, and heating load was added for the electrical utility, which provided the source of district heat through cogeneration. Of the 275 boiler houses in the project, 107 were converted from coal or coke to natural gas or oil. The remaining boiler houses were eliminated and replaced by heat exchangers for the district heating system.

Performance Data

The concentration of suspended particulates dropped by nearly 60% and the concentration of SO₂ dropped by 65%. It is estimated that the program resulted in the yearly reduction of 1,771 metric tons of particulates, 1,593 metric tons of SO₂, 296 metric tons of nitrogen oxides, 2,267 metric tons of carbon monoxide, and 67,645 metric tons of carbon dioxide. Solid fuel use dropped by 70% from the 1991 level of 475,000 metric tons. The district heating utility gained more than 180 MW of new load.

Participants and Roles

Key participants included the local utilities and boiler house operators, the Polish government, and USAID. Additional participants from Poland include the Cracow Office of Environmental Protection; Polish Ministry of Environmental Protection, Natural Resources, and Forestry;



City of Cracow; and Naftokrak-Naftobudowa and the Cracow District Heating Distribution Utility (two Polish joint-venture partners.) US participants include the following joint venture partners: LSR Technologies, Honeywell, Control Techtronics, Shooshanian Engineering Associates, and Tecogen. The National Energy Technology Laboratory and Brookhaven National Laboratory of the US Department of Energy (USDOE) provided technical support.

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Bolivia Private Hydropower Project

Location: Rural Bolivia

Type: Hydropower

Size: 84 MW

Funding: Total: US\$97,400,000

Private: US\$97,319,000

Public: US\$81,000

Objective: To provide hydroelectric power and reduce carbon dioxide (CO₂) emissions.

Duration: 1999–2001

Scale: Rural

Summary

The project consists of one refurbished and two new hydroelectric plants that provide roughly 84 MW of clean energy to nearly 100,000 households in rural Bolivia. The plants will also reduce greenhouse gas emissions by 10,000,000 metric tons over the life of the project. The project was developed as a result of deregulation of the Bolivian energy market. Private electric developments are now permitted with payment based on either spot-market prices from firm capacity and energy, or negotiated power purchase agreements.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws

Sound government principles and actions that attracted private involvement in the project included investment and privatization, which followed the creation of comprehensive



legal and regulatory reform and the implementation of successful energy sector restructuring. Also important was a comprehensive energy law that meets key global norms and standards; separates the functions of policy making, ownership, and regulation; and creates a framework for private investment and ultimate privatization.

Capacity-building activities also helped attract private financing. These included the formation of management teams independent of the government; hiring and development of people with skills matched to job requirements; and increased awareness and skills of sector professionals in commercial business practices, cost-based pricing, and competitive market operation. Stakeholder partnerships, dissemination of best practices, and participation in international forums and workshops helped build these skills.

Financing

Total project costs were US\$97,400,000. Private-sector debt and equity funded more than 99% of these costs. Debt financing of roughly US\$78,000,000 came from commercial banks and bond issues. Equity sources included local industrial groups, engineering firms, and foreign groups.

The US Agency for International Development (USAID) provided \$81,000 to partially fund the feasibility study, which led to the US\$97,400,000 investment.

Capital costs were US\$68,700,000, and other costs, such as operations and maintenance, were US\$28,700,000.

The Project

The project provides roughly 84 MW of environmentally sound electricity supply to nearly 100,000 households in and near La Paz. It consists of two run-of-river plants and a refurbished facility along the Taquesi and Unduavi Rivers.

It reduces CO₂ emissions through the displacement of electrical energy produced by single-cycle combustion engines.

Increased electrical power from non-polluting hydropower benefits commercial, residential, and utility sectors in La Paz through improvements in health, education, lighting, refrigeration, irrigation, sewage, navigation, and recreation.

Construction of the project began in 1999 and was completed in 2001. The plants are currently operating.

Technical Data

A 115-kV transmission line connects the project with the Pichu substation located near Yanacachi. From the Pichu

substation, the power is transmitted on an existing 115-kV transmission line to the Kenko substation near the northern portion of La Paz, Bolivia's major load center.

The project's net electrical output is sold under the terms of Bolivia's Electricity Law, which regulates electric power production on the basis of economic dispatch and lowest marginal cost of production

Performance Data

The project serves roughly 100,000 households in and around La Paz.

It generates more than US\$2,500,000 in revenues annually from the sale of electricity production and provides power at reduced cost to the Bolivian national grid, thus allowing growth in all other economic sectors.

Construction and operations of the project have created both temporary and permanent jobs.

The project reduces CO₂ emissions by 500,000 metric tons per year, for an estimated total reduction of 10,000,000 metric tons over the projected 20-year life of the project.

Because of the small footprint of the project facilities, impacts to soil and forest resources are minimal.

Participants and Roles

Tenaska, a private US company, constructed the facility. USAID provided US\$81,000 to Tenaska to partially fund the feasibility study. Private-sector investors funded the project.

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Design, Installation, and Testing of a Cleaner Combustion Technology at a Petroleos Mexicanos (PEMEX) Refinery

Location: Tampico, on the Gulf of Mexico

Type: Boiler retrofit

Size: 385 MW

Funding: Total: US\$760,000
Private: US\$145,000
Public: US\$615,000

Objective: To increase energy efficiency and reduce greenhouse gas (GHG) and other emissions.

Duration: 1998–2003

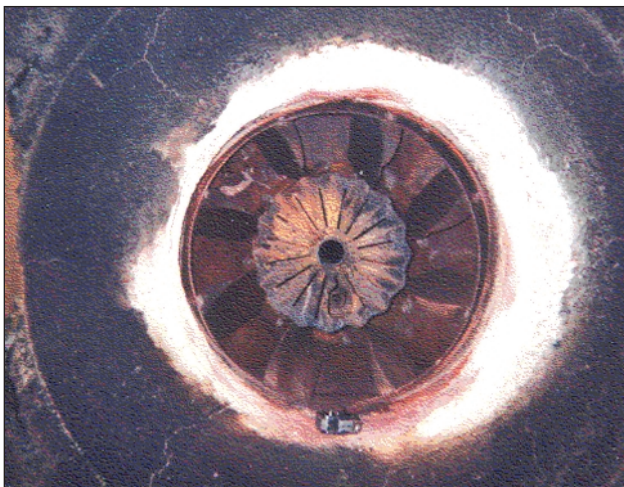
Scale: Urban

Summary

This public-private partnership project used innovative combustion technology to retrofit a steam and electric power-generating boiler at the Francisco I. Madero refinery, a large PEMEX facility near Tampico, Mexico. The project is expected to result in annual emissions reductions of 5,300 tons of carbon dioxide (CO₂) and 162 tons of nitrogen oxides (NO_x) at the facility, while simultaneously improving efficiency and reducing operating costs. Seventy percent of total project costs were leveraged from the private sector and Mexican government agencies.

In-Country Principles That Attracted Nondonor Financing

- Institution building and access to justice and enforcement of laws



The key principle that helped attract private-sector financing was a comprehensive energy law that meets global norms and standards and that created a framework for private investment and ultimate privatization.

Financing

Total project investment was US\$760,000. Electric Power Technologies (EPT) of California provided US\$145,000 in private-sector funding, PEMEX contributed US\$390,000, and the United States Agency for International Development (USAID) contributed US\$225,000.

The Project

The Madero refinery processes approximately 170,000 bbl/d of crude oil, or about 12% of Mexico's total refining capacity of 1.5 million bbl/d. The refinery has seven boilers, fired primarily by heavy fuel oil. Combined, these boilers generate about 1,400 tons per hour of steam, which is equivalent to 385 MW.

Prior to implementation, the refinery emitted about 1,800,000 tons of CO₂ and 4,000 tons of particulate matter per year.

Acting on its mandate to mitigate GHG emissions in Mexico, USAID initiated a collaborative partnership that emphasized the importance of private-sector participation. Under the partnership, USAID's Center for Environment, USAID Mexico, PEMEX, the Instituto de Investigaciones Electricas (IIE) (Mexico's research institute for the state-owned electric utility), and EPT are working together to accelerate the transfer of environmental control technologies by demonstrating them in real-world conditions.

The project is addressing environmental constraints that impede development, and it is reducing long-term threats to the global environment — particularly the loss of biodiversity — by mitigating GHG emissions while promoting sustainable economic growth.

Technical Data

The technology used in retrofitting the boilers is Reduced Emissions and Advanced Combustion Hardware (REACH). By replacing the refinery's heavy-oil burners with the new technology, combustion efficiency is improved and carbon

and atmospheric particulate emissions are reduced. The REACH burners also reduce GHGs since less oil is required to generate similar amounts of steam and electricity.

Performance Data

The project will reduce CO₂ emissions by about 5,300 tons per year. When the REACH technology is operational in all 40 PEMEX boilers, approximately 200,000 tons of CO₂ will be avoided every year, and annual savings of US\$10,000,000 are expected.

Participants and Roles

PEMEX has hosted the project and contributed financing, EPT provided the technology, USAID brokered the partnership with PEMEX and leveraged financing for GHG emissions reduction, and Nexant was responsible for project implementation.

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Pirinsko Pivo Brewery Project

Location: City of Blagoevgrad
Type: Energy efficiency and production line improvement
Size: US\$2,700,000 in annual sales
Funding: Total: US\$406,000
 Private: US\$406,000, partially guaranteed with United States Agency for International Development (USAID) mechanism
Objective: To reduce energy costs and increase market penetration.
Duration: 2000–2001
Scale: Urban

Summary

This project consisted of establishing energy-efficiency measures at a medium-sized, joint-stock company brewery, which significantly reduced annual electricity consumption and heavy oil consumption. These energy savings translated into a 6.4% average decrease in product costs, allowing the brewery to price its products more competitively and increase its market share from 4.5 to 9.5% in two years. Significant emissions reductions also resulted from more efficient operations and reduced fuel consumption.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

A key principle that attracted private financing was the ability of the firm to operate under standard commercial practices. Such practices included improved cost recovery, meter-



ing systems, and maintaining financial records consistent with international accounting standards.

Study tours and dissemination of best practices helped increase awareness, knowledge, and skills of sector professionals in technical areas such as cost-based pricing, international accounting standards, and competitive energy market operations.

Increased public knowledge of, and participation in, energy decision making — accomplished largely through outreach programs — were also important. Activities contributing to this increased knowledge and participation included institutionalizing sustainable education, communication, and outreach programs through capacity building and innovative financing.

Financing

Total project costs were US\$406,000. The Pirinsko Pivo Brewery provided US\$106,000 in equity, and the United Bulgarian Bank (UBB), a private, commercial bank, provided \$300,000 in debt financing. USAID provided a 50% Development Authority Guarantee for the loan, which allowed for risk sharing and, consequently, for the bank to make a longer-term loan under commercial rates.

The Project

In 1997, the Pirinsko Pivo Brewery was registered as a joint-stock company. At that time, its market share was 4%. To obtain a greater market share, the company realized it needed to reduce its costs, and particularly its energy costs. A comprehensive energy audit showed that the brewery's energy costs were considerably higher than those of its competitors. To reduce energy costs, the brewery developed a strategy to speed up implementation of an integrated energy-efficiency system.

The implemented energy-efficiency measures resulted in a 27% savings in electrical energy, 35% savings in heavy fuel oil, and 1% savings in production-related water consumption.

Technical Data

Several energy conservation measures and technologies were implemented. These included the following: devices enabling measurement information to be fed into a computer system for monitoring and maintaining energy consumption within prescribed standards; steam distribution improvements such as installation of reduction valves and highly effective

steam traps; refrigeration improvements, including change of the isolation and implementation of automatic control of the compressors; energy-saving lighting systems that included sectioning and automatic control; and air compressor replacement containing a new screw-type compressor that consumes 30% less power.

Performance Data

The direct energy savings helped reduce the final cost of a bottle of beer by 6.4%. This reduced product cost gave the brewery more flexibility in its pricing policy which, coupled with the increase in production capacity, led to a doubling of sales and market share in two years. Return on investment was 38%.

Carbon dioxide (CO₂) emissions due to heavy fuel oil burning were reduced by 35%. The level of production forecast for 2000 to 2004 is expected to result in the reduction of CO₂ emissions by 17,218 tons and sulfur dioxide (SO₂) emissions by 316 tons. During this period, water savings are estimated at 14,000 m³.

Participants and Roles

Participants in the project are Pirinsko Pivo Brewery, the beneficiary of the project; Energy Efficient Systems Ltd. (EES), which developed and implemented the energy-efficiency project; Electrotek Concepts, which developed the business plan and the loan application; and the UBB, which made the loan.



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Tierras Morenas Wind Farm

Location: Guanacaste region
Type: Utility-scale wind farm
Size: 24 MW
Funding: Total: US\$35,000,000, from combined private and public sources
Objective: To generate electricity without greenhouse gas (GHG) or other pollutant emissions.
Duration: 1999
Scale: Rural

Summary

The 24-MW Tierras Morenas Wind Farm is one of the largest wind projects in Latin America and has one of the best performance and output records in the hemisphere. The project provides diversity and resilience of electricity supply and generates no air pollution, water pollution, or GHG emissions. Government commitment to environmentally sustainable development helped attract investment from a private consortium.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws

A key factor that helped attract private financing was increased public knowledge of, and participation in, energy



decision making. Public access and public participation were facilitated through the institutionalizing of sustainable education, communication, and outreach programs through capacity building and innovative financing.

The Government of Costa Rica's commitment to environmentally sustainable development and resource use and reduced GHG emissions, as demonstrated by its goal to develop 60 MW of wind energy generating capacity, also helped attract private-sector investment. A long-term power purchase agreement with the local utility, as opposed to spot-market trading, was also instrumental in attracting private financing.

Financing

Total project investment was US\$35,000,000. Roughly US\$24,000,000 came from private and public loan and grant support from five Costa Rican banks and the Central American Bank for Economic Integration.

Supplemental funding for the project came from the Danish International Development Agency (DANIDA). This bilateral government support for wind power helped attract investors and reduce up-front installation costs.

The project was built under a fixed price, turnkey contract backed by service agreements and warranties.

The Project

Located near Lake Arenal in Tilarán de Guanacaste, the project consists of 32 wind turbine generators that produce about 70,000 MWh of electricity per year. The project sells this generation to the Instituto Costarricense de Electricidad (ICE), the state-owned national electric utility, under a 15-year power purchase agreement.

The Tierras Morenas project complements ICE's hydro-intensive generation mix, because its wind regime is strongest during Costa Rica's dry season.

Increased electricity production with no pollution helps improve lighting and health in the region.

Technical Data

The 24-MW wind farm consists of 32 NEG Micon 750/44-kW wind turbines, each with 44-m rotors and 40-m towers. The turbines have three blades, a 690-V generator, and are computer-controlled.

The generated electricity feeds into the ICE through the main switch house and an 11-mi overhead feeder line built over difficult terrain.

The generation of electricity produces no air emissions, and environmental impacts associated with the materials used to manufacture the wind turbines are addressed through the manufacturer's environmental policy, which calls for increasing environmental standards from its suppliers.

Performance Data

The project has reduced GHG (carbon dioxide [CO₂]) emissions by an estimated 57,200 tons due to the displacement of fossil fuels that otherwise would have been used to generate the electricity. The project causes no disruption to pre-existing land use. It allows ranching and farming to continue up to the foot of the turbines and provides more than two dozen full-time, well-paid jobs.

Despite logistical, cultural, and climatic challenges, the project was completed ahead of schedule with a perfect safety record and high degree of design and construction quality.

The annual capacity factor for the farm is about 45%.

Maintenance costs are low, and the turbines are safe enough that in Denmark, they are installed in recreational parks and public areas.

Participants and Roles

Energia Global International (EGI), developed the plant, NEG Micon manufactured the turbine generators, Zilkha Renewable Energy organized the financing partnership, and ICE purchases the electricity. The project is part of the United States Initiative on Joint Implementation (USIJI), sponsored in part by the US Department of Energy.

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Ulsan Landfill Methane Gas Project

Location: Ulsan

Type: Landfill methane gas capture and use

Size: 11,230 tons of methane per year

Funding: Total: US\$3,900,000

Public: US\$3,500,000

Private: US\$400,000

Objective: To reduce the amount of methane gas released to the atmosphere and reduce the need to import and burn natural gas.

Duration: 2000–2002 (construction)

Scale: Urban

Summary

The project captures and reuses methane gas produced from a municipal landfill. The gas is transported to a local industrial site, where it is burned in boilers without being purified. The project saves energy and prevents the exhaust of methane gas into the environment. This international, cooperative effort optimizes public-private, national, and international partnerships and funding to reduce greenhouse gas (GHG) emissions and build Korea's capabilities to install similar projects.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws



- Public participation in, and support of, sustainable development

Capacity-building principles that helped attract private-sector investment included hiring people with appropriate skills, operating utilities under standard commercial practices, creating a management team independent of the government, and providing improved cost-recovery opportunities. Stakeholder partnerships and exchanges, dissemination of best practices, and participation in international forums helped increase awareness and knowledge of commercial business practices.

Important institution-building principles that helped attract private interest included a successful energy restructuring that embodied comprehensive legal and regulatory reforms and a comprehensive energy law that meets global norms.

Also important were increased public knowledge of, and participation in, energy decision making facilitated by professional training; public education, communication, and outreach programs; and a state-of-the-art system for collecting, demonstrating, and exchanging information on outreach strategies, methods, and tools.

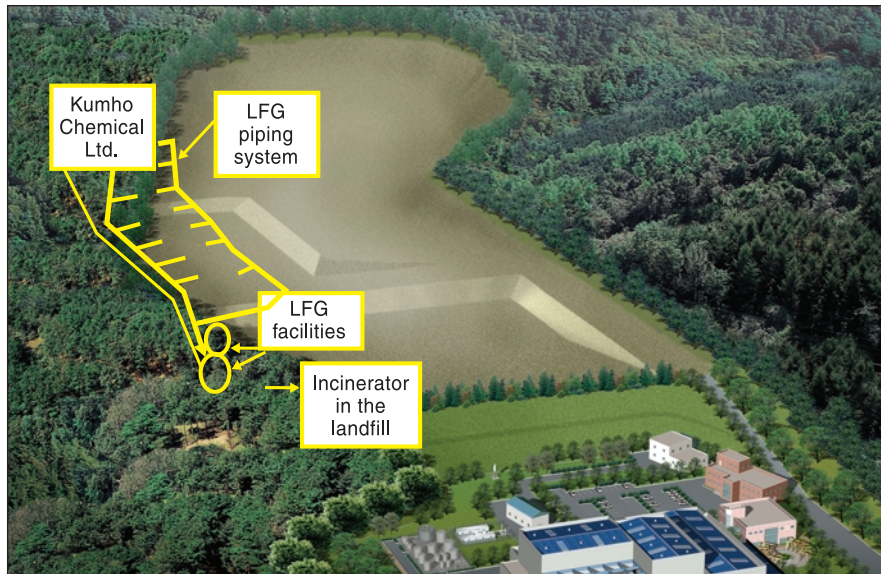
Financing

Total project investment is US\$3,900,000. Construction costs of US\$3,500,000 were funded through a commercial bank loan to the City of Ulsan using the revolving fund established by the Korean Energy Management Corporation (KEMCO). The Korean government funds and staffs KEMCO to help reduce barriers to energy efficiency. KEMCO funds energy-efficiency projects through a dedicated fund that provides low-interest loans.

Operations and maintenance costs (about US\$400,000) are funded by SK Corporation of Korea, a private company, which uses the recovered methane as fuel.

The Project

The Ulsan facility is a lined landfill, which, until recently, flared the methane gases that it generated. The project changes these GHG emissions into useful energy. Methane gas is transported to a nearby industrial site, where it fuels a boiler, thereby reducing methane emissions, decreasing the amount of natural gas that would otherwise be burned, reducing odor from the landfill, and reducing the risk of methane creep and attendant explosions in adjacent properties.



The feasibility study was started in November 2000. The municipality awarded the project in September 2001, and construction started in December 2001. Completion is expected in 2002.

Technical Data

A methane-collection mechanism, transportation pipeline, dewatering device, and connection to the boiler at an adjacent chemical company, which will use the methane as fuel, were installed. An estimated 11,230 tons of methane per year will be collected and used for fuel.

Performance Data

The market value of the methane gas supplied to the boiler over the life of the system is estimated at US\$3,400,000. Air quality is expected to improve as a result of reduced carbon dioxide (CO₂) emissions, which are estimated at 84,000 metric tons per year.

Participants and Roles

Ulsan City officials were open to installing a landfill methane project in their city, attended a workshop conducted by the United States Environmental Protection Agency (USEPA's) methane outreach program in Korea, completed the project, and funded the installation. The Republic of Korea's Ministry of Environment implemented standards that changed the way waste is disposed of in landfills, resulting in landfills that have the potential to be developed for methane recovery.

SK Corporation conducted an independent assessment of the site, installed the project, and will use the gas. LFG Consult Aps conducted a feasibility study for SK Corporation

to determine the capability of the landfill to generate gas and helped with project design.

The United States-Asia Environmental Partnership (US-AEP) provided initial funding for the US Department of Energy's (USDOE's) National Renewable Energy Laboratory (NREL) and the USEPA to pursue development of a Clean Technology Initiative in Korea.

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Environmental Audits for Sustainable Tourism (EAST)

Location: Jamaica
Type: Energy efficiency, water conservation, and waste minimization
Size: 2,147 hotel rooms
Funding: Total: US\$175,000
 Private: US\$132,000
 Public: US\$43,000
Objective: To implement effective environmental management practices for greater energy efficiency and environmental protection in the hospitality industry.
Duration: 1997 to 2002
Scale: Urban and rural

Summary

Actions put in place as a result of the implementation of environmental management systems at five Jamaican hotels have reduced energy use per guest night by 12%. These actions also reduced water consumption by 50,000,000 gal and energy use by 1,665,000 kWh. The dollar value of the efficiency gains for the five hotels was US\$616,555, or about US\$330,000 on an annual basis.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Informed decision-making principles that helped attract private sources of funding included dissemination of best



practices; participation in international forums and workshops; and increased awareness, knowledge, and skills of professionals regarding commercial business practices.

A central element of sector reform efforts that helped attract private financing was increased public knowledge of, and participation in, energy decision making. Knowledge and awareness of the conditions required for providing sustainable energy helped create the popular support necessary for political changes to enable sustainable, market-based provision of energy services. In Jamaica, such knowledge and awareness were increased via programs in professional training, public education and communication, and outreach.

Additional principles that helped attract private funding included the commitment to creating and strengthening a strong human and organizational capacity for sustainable and integrated water management and the consideration of water as an economic, social, and environmental good, including the acknowledgment of the full costs of water management and water services.

Financing

Total investment costs for the five hotels for which data were collected was US\$175,000. Of this, 75% came from private sources (Sandals Resorts International [US\$56,000] and Couples Hotels [US\$76,000]). The United States Agency for International Development (USAID) contributed US\$43,000.

The Project

For each of the hotels, an EAST project team, consisting of engineers and hotel operations specialists, assessed the hotel's infrastructure, equipment, practices, and operations to determine the environmental performance baseline and identify opportunities to improve efficiency and reduce environmental impacts. Each hotel then used this information to create an environmental management system (EMS) — a tool to help incorporate environmental care in all key aspects of a facility's operations, management, and decision-making processes.

Actions developed through the implementation of the EMS helped the hotels reduce their use of water, energy, materials, and chemicals and to realize monetary savings.

Examples of actions that led to energy efficiency and environmental benefits included monitoring electricity and water consumption to track performance and identify unusual shifts in energy use that could indicate equipment or operational problems; turning on lights and air-conditioning in

guest rooms only 30 minutes prior to guest arrival, rather than early in the morning of guest check-in; and encouraging guests to turn off lights, television sets, and air-conditioning units prior to leaving their rooms.

Actions that have contributed to reduced water use include backwashing pool filters only when recommended by the equipment manufacturer, starting a voluntary towel reuse program in guestrooms, and training staff on how they can conserve water in their daily activities.

Technical Data

Technologies used to achieve energy savings included energy-efficient compact fluorescent bulbs to replace incandescent lights, photocells and timers installed on outdoor lighting circuits to ensure that lights remain on no longer than necessary, and high-efficiency air-conditioners to replace older units.

Water conservation technologies included low-flow showerheads and faucet aerators, submeters to aid in detection and repair of water leaks, drip irrigation and low-pressure sprinkler systems, and trigger nozzles on water hoses.

Performance Data

Although the project has included 2,147 hotel rooms, the following data come from the five hotels (673 rooms) for which data were collected.

Energy use was reduced by 12% per guest night. The total savings at the five hotels resulting from the energy-efficiency improvements included 1,665,000 kWh of electricity and 160,000 L of liquid propane gas. Reduced water consumption resulting from water conservation measures totaled 50,000,000 gal.

The monetary savings from these reductions is US\$616,555, or an estimated annual savings of US\$333,000. Average annual per-room savings at each of the hotels ranged from US\$330 to US\$1,160.

In addition to the water and energy savings, carbon dioxide (CO₂) emissions were reduced by 2,140 tons per year.



Participants and Roles

PA Consulting Group conducted the environmental assessments and helped prepare the EMS in cooperation with the participating hotels. USAID contributed financial support.

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Increasing Electric Power for Development in the Southern Philippines

Location: Davao City, on the southern island of Mindanao

Type: Utility load-shedding system

Size: 190,000 household customers

Funding: Total: US\$50,000
Private: US\$50,000

Objective: To increase availability of uninterrupted electric supply.

Duration: 1999–2001

Scale: Urban

Summary

In this project, a private United States (US) electric utility (American Electric Power [AEP]) partnered with the Davao Light and Power Co., Inc. (DLPC) to implement an “under-frequency load shedding system.” As a result, DLPC can now section off portions of its power grid to increase availability of uninterrupted electric supply, thus allowing industrial and commercial enterprises to continue production operations without interruption. The project has also reduced costs to all classes of consumers because they no longer need to purchase and run backup electric generators.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and informed decision making

A key factor that helped attract private financing was the ability of the utility to operate under standard commercial



practices. Activities that helped bring the utility in line with standard commercial practices have included a management team independent of the government, and hiring/developing staff with appropriate skills matched to the job. Also important were the increased awareness, knowledge, and skills of sector professionals in technical areas such as commercial business practices, competitive energy market operation, and management of private-sector involvement. This increased awareness has been accomplished via study tours, dissemination of best practices, and stakeholder partnerships and exchanges.

Also important was a successful energy restructuring, characterized by commercialization and development of the existing dominant utilities and investment and privatization.

Financing

Total project investment was US\$50,000. All of this was for capital costs and all was provided by the privately held DLPC, the third largest electric power distribution company in the Philippines.

The Project

Systemwide power blackouts plagued 190,000 household consumers of DLPC, which does not generate its own power, but buys it from providers.

Under the United States Agency for International Development (USAID)-funded Philippines Energy Partnership Program (PEPP), AEP — a private US electric utility based in Ohio — partnered with DLPC and demonstrated how to institute an under-frequency load shedding system. At no cost to DLPC or USAID, AEP transferred its experience in sectioning off portions of its power grid to ensure power quality and reliability. Specifically, AEP showed its Philippine partner how to switch a cement plant off of its electrical system during the frequent occasions when power quality declined below acceptable levels.

This load-shedding ability enables DLPC to keep its remaining customers from experiencing total blackouts.

Technical Data

Under-frequency relays were used to limit power outages to small sections of the city, while maintaining power in the rest of the city.

Performance Data

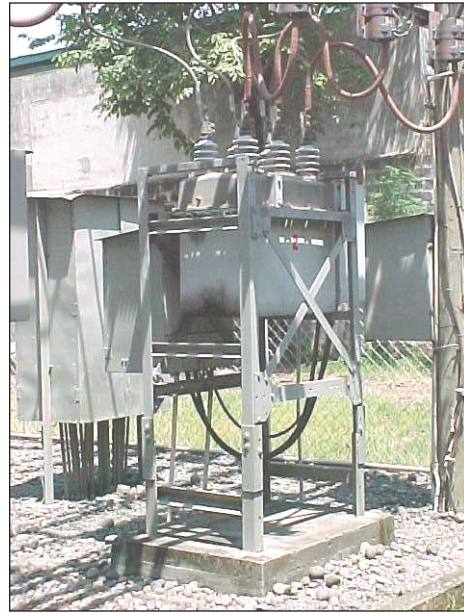
The project has limited blackouts for 190,000 households and has resulted in savings of about US\$3,000,000 per year for industrial, commercial, and residential users. The reliable supply of electricity has improved health and education in the city and has also enhanced industrial production and commercial sales.

Participants and Roles

USAID funds the PEPP, which helped link the US utility, AEP, with its Philippine Partner, DLPC. DLPC financed the capital costs of the project and AEP transferred its experience to DLPC in sectioning off portions of the power grid to ensure power quality and reliability. The US Energy Association (USAE) administers the PEPP.

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Clean Thai Biogas Plant

Location: Countrywide
Type: Biogas plant at cassava processing facility
Size: 550 tons per day of cassava starch
Funding: Total: US\$1,850,000
 Private: US\$1,585,000
 Public: US\$265,000
Objective: To convert waste into methane to reduce heavy fuel oil and electricity consumption.
Duration: 2001–2002
Scale: Rural

Summary

A Thai-based company has designed and is installing an anaerobic biodigester to convert organic-rich wastewater from a cassava processing plant into methane. The plant will save money by avoiding the costs of purchasing heavy fuel oil and electricity. The project will also reclaim dozens of acres of land that were previously used to purify the factory's wastewater. In addition, the project is expected to generate several hundred tons of carbon offsets per year.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making

The key principle in attracting private-sector financing was a successful energy restructuring, which included the creation of comprehensive legal and regulatory reform.

Another important factor was that the Thai Bureau of Investments approved the project for tax incentives and other



privileges provided to businesses willing to work in economically depressed regions of the country.

Financing

Total project investment was US\$1,850,000. Of this, the private sector contributed more than 85%. Private sources included Al Tassar Energy and the Renewable Energy and Energy Efficiency Fund (REEF).

A short-term loan from E+Co. allowed completion of the feasibility evaluation and the preparation of investment documents necessary for attracting additional investment.

Equity sources included foreign utilities, multilaterals, and insurance agencies. Local debt in Thailand is difficult to access, and it is hoped that as Clean Thai's projects build a track record, local debt availability will increase.

The Project

Clean Thai is a Thai-based company that specializes in the production of biogas from agricultural and process waste streams. It established this project to finance, construct, operate, and maintain a biodigester power plant at a cassava processing plant. The plant produces more than 500 tons per day of cassava starch, and, prior to the project, it consumed US\$2,300,000 in electricity and US\$2,200,000 in heavy fuel oil costs per year.

With this project, the waste from the plant will operate an anaerobic digestion system that will produce enough biogas to replace significant portions of the facility's heavy oil and electricity needs.

Commercial, residential, and agricultural sectors will benefit from the project. By utilizing an anaerobic digestion system, organic matter decomposes in a contained environment, thus virtually eliminating odor and pest issues caused by large-scale decomposition of organic material for residents close to the site.

As Clean Thai grows as a project developer, each additional anaerobic digestion system that it installs will provide similar environmental benefits.

Technical Data

The technology used is methane collection, powered by four gas boilers. The methane is generated through an anaerobic digestion process using cassava-rich wastewater.

Performance Data

At this writing, the project is under construction, so performance data are not available. However, it is estimated that the methane generated from the project will displace tens of thousands of barrels of heavy fuel oil per year, replacing 100% of its heavy oil needs and 75% of its electricity needs (which are currently purchased from the grid.)

Estimated carbon offsets are 315,000 tons per year.

The project is projected to save the cassava processing factory hundreds of thousands of dollars in operating expenses each year.

Four to six people have been trained in the construction and ongoing maintenance of anaerobic digestion systems.

Participants and Roles

Clean Thai developed the project, and REEF, a renewable energy equity fund, and Al Tassar Energy, a private energy investment fund based in Abu Dhabi, provided financing for the project. E+Co. provided a short-term loan at the early stage, which helped attract second-stage capital.

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Cartagena Water Supply, Sewerage, and Environmental Management

Location: Cartagena

Type: Rehabilitation and expansion of water supply and sewerage networks

Size: 240,000 m³ per day production capacity

Funding: Total: US\$117,200,000

Private: US\$4,600,000

Public: US\$112,600,000

Objective: To improve water and sewerage services, facilitate the environmental cleanup of water bodies, and enhance sustainability of water and sewerage services.

Duration: 1999–2004

Scale: Urban

Summary

The implementation of cutting-edge water treatment and production technologies by a private partner has improved the living conditions of the poor and diminished public health risks. The long-term private-sector interest in developing Cartagena's water sector has helped make the water utility of Cartagena the most advanced in Latin America.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws



The most important principles that supported reform in the water sector in Cartagena, and, in turn, helped attract private-sector financing included decentralization, enactment of a legal framework that promotes private-sector participation, and subsidies and political commitments to support private-sector participation at the local and national government levels. Also important was a clear and transparent bidding process.

Other principles that helped attract private-sector financing included the following: informed and science-based decision making; strong, effective, and culturally appropriate institutional, policy, and legal frameworks; effective coordination among sectors; an emphasis on decision making at the lowest appropriate level; and consideration of water as an economic, social, and environmental good, including acknowledgment of the full costs of water management and water services, and transparent, equitable, and sufficient allocation of those costs throughout society. Systems of accountability, including full accounting of costs and benefits, were also important.

Financing

Total project investment was US\$117,200,000. Of this, US\$103,200,000 was for capital costs, and US\$14,000,000 was for operations and maintenance.

Aguas de Cartagena (ACUACAR), the Cartagena Water Company, provided US\$4,600,000 in private funds. Public funding came from the Government of Colombia (US\$20,000,000), the District of Cartagena (US\$7,600,000), and the International Bank for Reconstruction and Development (IBRD) (US\$85,000,000).

The “mixed-capital company model,” under which the private sector provides investments as permitted by the applied tariffs and the public sector provides the balance of the funding required to achieve the performance targets set by the public sector, has achieved excellent results in Cartagena and transformed its utility to an exemplary institution.

The Project

The project had three objectives: (1) to improve the water and sewerage services of Cartagena by expanding coverage, particularly in the city's poor neighborhoods; (2) to facilitate the environmental cleanup of water bodies surrounding the city by providing adequate collection, treatment, and disposal of the entire flow of the city's wastewater; and (3) to

improve the sustainability of water and sewerage services in Cartagena by leveraging bank support to shore up the private-sector participation model pioneered by ACUACAR, the city's water and sanitation utility, against the prospect of political interference.

The project rehabilitated and increased water production capacity to 270,000 m³/d, rehabilitated and expanded water and sewerage networks to serve a population of about 1,000,000 inhabitants, and completed construction of a wastewater collection, conveyance, treatment, and disposal facility with a capacity of 4 m³/s.

Providing water and sewerage services in poor neighborhoods helped improve living conditions and diminish public health risks. Cleanup of the water bodies surrounding Cartagena (Cartagena bay, beaches, the Cienaga coastal lagoon) boosted recreational uses of these water bodies and decreased health risks to residents and tourists.

Technical Data

The following cutting-edge technologies were used to accomplish the project's objectives: sewerage networks, wastewater conveyance systems, pressure pipes, pumping stations, wastewater treatment installations, effluent disposal through a submarine outfall, centralized control and operation systems, and modern integrated financial and commercial management technologies.

Wastewater screening in fine-opening rotating screens and grit removal in vortex-type grit chambers helps control pollution.

Performance Data

The project serves 134,031 water supply users and 107,912 sewerage facility users.

The following table illustrates how the project improved water supply and sewage coverage through 2001:

	Before Project (1994)	After Project (2001)
Water coverage	68%	91%
Sewerage coverage	56%	72%
Domestic metering	30%	99%
Unaccounted water	60%	41%
Water production capacity	160,000 m ³ /day	270,000 m ³ /day
Number of clients	84,143	117,194



Participants and Roles

The Municipality of Cartagena is an associate of the water utility and provides financial support. Aguas de Barcelona, the private operator of the water utility of Barcelona, Spain, operates the water utility of Cartagena, in association with the municipality. The Government of Colombia, through the Ministry of Economic Development, provides national government subsidies and political support, and the World Bank provides financing.

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Ultraviolet (UV) Waterworks

Location: Rural villages in Guerrero, Mexico, and Manila, the Philippines

Type: Water disinfection system

Size: 57,600 gallons per day, per installation;
175 installations

Funding: Total: US\$5,690,000
Private: US\$4,605,000
Public: US\$1,085,000

Objective: To provide safe drinking water.

Duration: 1993–1999

Scale: Urban and rural

Summary

The UV Waterworks project uses an innovative ultraviolet water disinfection system to provide safe drinking water for more than 300,000 individuals in rural and urban communities in Mexico and the Philippines. Over the course of one year, 175 disinfection units were installed in Guerrero, Mexico, and in Manila, the Philippines. The community-level focus of this project and the sustainable clean drinking water management prospects helped attract almost US\$5,000,000 in private-sector investment.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Key principles that helped attract private-sector financing included training of local community members and technicians for installation and maintenance of the systems and presentation of detailed information about the project and



alternative options to the State Government of Guerrero and individual communities in Manila.

Disinfection installations in Manila resulted from a partnership between the local branch of the Rotary Club and the local communities, whereby the Rotary Club facilitated access to capital through a revolving loan program. This facilitated the establishment of a sustainable system of access to and allocation of water through a formal water market. Local community members who became entrepreneurs in the communities served by the clean water own their own kiosks.

The installations in Mexico also focus on strengthening human capacity for sustainable water management, using a public-sector approach. The state government purchased the systems, and a private local entrepreneur distributed, installed, and provided follow-up maintenance on the systems.

Broad stakeholder participation and empowerment are evidenced by an emphasis on decision making and authority at the lowest appropriate level. In Mexico, the local Health Committee, composed of village women with young children, is the primary body in charge of supervising the functioning of the units and coordinating their maintenance.

The direct involvement and ownership of the units on a community level in both Mexico and the Philippines reinforce accountable, participatory, and sustainable management and minimize opportunities for corruption, making the investment safer for funding agencies.

Financing

Total project investment was US\$5,690,000. More than 80% came from the private sector, which included the Bendix Corporation (Philippines) (US\$1,000,000), WaterHealth International (US\$3,500,000), and private foundations, such as Pew, Gilmore, and Rockefeller (US\$105,000). Public funding sources included Guerrero State in Mexico (US\$750,000) and United States (US) government agencies (US Agency for International Development [USAID] and US Department of Energy [USDOE]) (US\$335,000).

Roughly US\$440,000 went to research; US\$1,750,000 went to capital costs (175 units at US\$10,000 per unit); and US\$3,500,000 went to product development and equipment manufacturing. Operations and maintenance costs average \$100 per month, per unit.

The Project

Each UV disinfection system can meet the daily drinking water needs of a community of 2,000. The units were installed

in areas where centralized water piping is prohibitively expensive for local governments, and chlorination is not feasible because of an unstable chlorine supply and the impracticality of having a trained operator continually present.

The units, which have been tested by 11 laboratories in 5 countries, have been installed according to 3 separate approaches. In Manila, approximately 90 units were installed privately, on a for-profit basis. The Rotary Club installed another 10 in the slums in and around Manila through a revolving loan. The State Government of Guerrero purchased and installed 75 units in rural villages in Mexico.

The systems benefit both the residential and commercial sectors. Families benefit from safe drinking water without having to boil it. To boil drinking water, 3 kg of scarce fuel wood is needed per person, per day. Boiling water over a biomass cookstove creates substantial smoke inhalation for the family, thus making the process economically and environmentally unsustainable on a long-term basis.

The Manila operation generates income for local entrepreneurs and workers, and the Mexican project creates employment for local distributors and technicians.

Technical Data

The UV disinfection systems use about 60 W of electricity for disinfection and about 150 W for pumping (when needed) for about 4 hours per day. The effectiveness of the systems exceeds US Environmental Protection Agency (USEPA) and World Health Organization (WHO) disinfection standards.

Performance Data

The 175 installed units serve more than 300,000 individuals. Compared with boiling water for disinfection, the UV systems consume 6,000 times less energy (excluding the power for the pump).

Rural Mexican communities have reported a 90% decrease in gastrointestinal disorders since implementation of the new systems.

Participants and Roles

Lawrence Berkeley National Laboratory (LBNL) performed the technological research, funded by the USDOE, USAID, and private foundations, including Pew, Rockefeller, and Gilmore. The Natural Resources Defense Council helped with field-testing. WaterHealth International, Inc., developed the product and marketed it, along with Bendix Corporation in the Philippines and WaterHealth Mexico in Mexico. The State Government of Guerrero, Mexico, and the Rotary Club



and Bendix Corporation in the Philippines facilitated the purchase of the units.

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Cerveceria Cuauhtemoc Moctezuma

Location: Sonora
Type: Energy efficiency
Size: 3,700,000 kWh annual savings
Funding: Total: US\$175,000
 Private: US\$175,000
Objective: To reduce plants' energy needs by regulating electric load.
Duration: 1998–1999
Scale: Urban

Summary

This privately financed project used various energy-efficiency improvements to reduce peak demand at a large Mexican brewery. Significant savings have resulted during the summer months (roughly US\$21,000 per month) when peak electricity demand increases by six times over winter months due to product refrigeration requirements. In addition, carbon dioxide (CO₂) offsets resulting from the efficiency improvements are estimated at more than 5,000 tons during the life of the project. The performance contracting approach helped secure reasonably priced financing, and transferring carbon rights from the project to investors helped offset financing costs and mitigate the risks of new financing methods.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making

A key factor that attracted private-sector interest was the ability of the plant to operate under standard commercial practices. Activities that helped bring the plant in line with



standard commercial practices include having a management team independent of the government, improved cost recovery, and metering systems. Also important were the increased awareness, knowledge, and skills of sector professionals in technical areas such as commercial business practices, cost-based pricing, and competitive energy market operations.

Financing

Total project investment was US\$175,000. The project was structured as a shared savings, performance-type contract, with quarterly lease payments made by the brewery to an energy services company, Empresas ESM SA de CV, on the basis of actual savings measured by the brewery. The five-year contract stipulates that Empresas will receive a percentage of the savings generated by the project over a number of years, with the brewery obtaining the remaining benefits generated. At the end of the contract period, the brewery receives 100% of the benefits generated.

The contract also assigns carbon offsets generated by the project to Empresas, which in turn, shares ownership of the carbon credits with Econergy International Corporation (EIC), a private United States (US) participant, that provided subordinated debt financing, financial advisory services, and technical services related to greenhouse gas (GHG) emissions. The additional potential value of carbon offsets derived from the project enables the brewery owner to obtain the services of EIC as an "in-kind" contribution to the project. In addition, in anticipation of the future value of the carbon credits, EIC carried many of the transaction costs, accelerating financial closure, which otherwise would have been difficult to complete.

Performance contracting allowed the brewery to budget for regular lease payments as part of its operations and maintenance budgets, without an up-front outlay of capital. The approach also allows the project developers (in this case EIC and Empresas) to "own" the carbon credits generated by the project as a concession for the reasonably priced financing. The carbon credits will be aggregated into a larger package attractive to potential buyers interested in bulk carbon credit purchases.

The Project

An energy services company, Empresas ESM SA de CV, in association with a private US firm, EIC, implemented an energy-efficiency performance contract with one of Mexico's largest beer companies, Cerveceria Cuauhtemoc Moctezuma (CCM). The project includes energy-efficiency measures to

improve electricity load management during peak hours. Total peak demand is reduced by using electrical equipment for process cooling on a sequential or staggered schedule rather than simultaneously and continuously. Brewing process efficiency measures were also installed.

Technical Data

Technologies included controls on motors, fans, pumps, and other electric devices, as well as improving the efficiency of backup cooling systems.

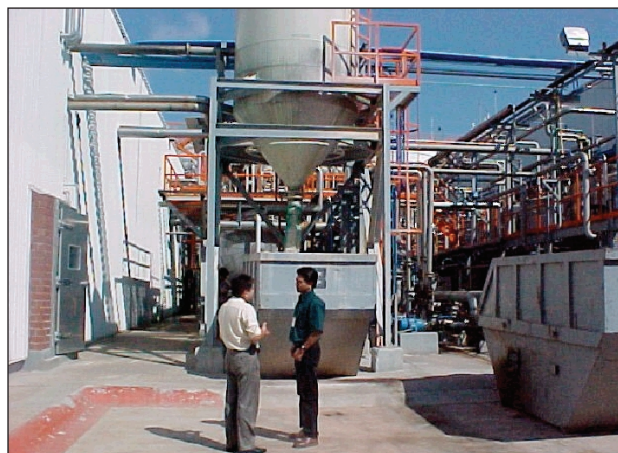
Performance Data

The energy-efficiency improvements have produced energy, emissions, and economic savings that include the following: annual energy savings of 3,775,752 kWh (or 7% of the brewery's annual energy consumption), annual carbon savings of nearly 1,000 tons, and annual economic savings of US\$126,100.

These savings have exceeded the projected savings by more than 20% on an annual basis and by more than 100% in some months. The brewery has been making quarterly payments of US\$26,340 in accordance with the terms of the performance contract.

Participants and Roles

Empresas ESM SA de CV was the project developer; EIC provided subordinated debt financing, financial advisory services, and technical services related to GHG emissions; and CCM was the "host" facility that benefited from the energy-efficiency improvements.



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Environmental Center for Livestock Waste Management (ECLWM)

Location: Neipu, Southern Pingtung County
Type: State-of-the-art research facility for waste handling and processing
Size: 48,000 L/d
Funding: Total: US\$3,150,000
 Private: US\$800,000
 Public: US\$2,350,000
Objective: To advance the state of the art of swine production/waste management to, among other things, protect drinking water.
Duration: 1997–1999
Scale: Rural

Summary

After researchers identified pig-farm waste as one of Southeast Asia's major environmental problems, faculty from the National Pingtung University of Science and Technology (NPUST) and several United States (US) universities, equipment manufacturers, and federal agencies cooperated to establish the ECLWM. At the ECLWM, team members have designed and built a prototype swine manure-management system that provides training and demonstrations for innovative, cost-effective waste management technologies that include recycling of discharge water for irrigation. Currently



focused on swine waste, the prototype will eventually include poultry and bovine waste management.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws

Specific principles that aided in attracting private funding contributions for the ECLWM included the following: multi-objective decision making about water resources at the basin scale; strong, effective, and culturally appropriate institutional, policy, and legal frameworks; effective coordination among sectors and across multiple geographic and institutional scales; an emphasis on decision making and assignment of authority at the lowest appropriate level; and a commitment to creating and strengthening strong human and organizational capacity for sustainable and integrated water management in both the public and private sectors.

An additional in-place guideline that helped reduce risk and mobilize financial resources was the consideration of water as an economic, social, and environmental good, including the transparent, equitable, and sufficient allocation of the full costs of water management throughout society.

Financing

Total investment costs were US\$3,150,000. Taiwan invested US\$2,000,000 in the construction and operation of the ECLWM. Five American universities donated engineering services (an in-kind contribution of US\$300,000) to design the waste treatment system, and several US manufacturers contributed their equipment (valued at US\$500,000) to the center. The US-Asian Environmental Partnership (US-AEP) contributed US\$350,000 to the project.

The Project

Over the past several years, countries worldwide have witnessed a shift from small pig farms to large-scale operations. While production has increased, the supply of land for proper treatment of swine waste has decreased. Plans for the

ECLWM began in 1996 after pig-farm waste was identified as a major environmental problem. Construction began in 1999, and the center is now housed on the 285-ha campus at NPUST, Taiwan.

The ECLWM is a first-of-its-kind, international training and demonstration center for the Asian region. It develops and demonstrates innovative, cost-effective technologies that impact livestock waste policies, comply with regulatory requirements, and provide technology transfer to producers in the US and Asia.

Because of the project, various waste management techniques, ranging from simple composting to cutting-edge treatment, have been shared, making the ECLWM an excellent example in the transfer of environmental protection technology and cost-effective solutions for the future of sustainable agriculture.

The ECLWM is not only a partnership between the US and NPUST, but also a regional center that engages leading livestock-raising countries in Asia such as Korea, the Philippines, Thailand, Malaysia, and Hong Kong.

Technical Data

Technologies used at the center include anaerobic digesters and batch reactors for aerobic processing. Such technologies yield a range of useful end products, including discharge water that meets regulatory standards, fertilizer, compost, and energy. The ECLWM integrates various livestock waste management systems and technologies to address different situations and conditions.

Performance Data

The ECLWM treats waste (48,000 L/d and 2.2% solids) from a 240-sow (female pig), farrow-to-finish operation.

By sharing waste management information, the ECLWM effectively transfers environmental protection technology and cost-effective solutions for the future of sustainable agriculture. The ECLWM hosts observers from around Asia, showing them new ways to address similar problems at home. It also provides for collaborative research and training activities.

Participants and Roles

The ECLWM is a product of a unique public-private consortium of leading US and Asian government agencies, companies, and universities in the field of waste management. Taiwan has contributed the bulk of funding for building and operating the ECLWM. US partners include five universities (Illinois Institute of Technology, Iowa State University, North Carolina State University, Oregon State University, and Purdue



University), which donated engineering services; the Equipment Manufacturers Institute, whose members contributed equipment; the US Environmental Protection Agency (USEPA), which led the program and provided a major financial contribution; the US Department of Agriculture, which provided extension and engineering services; and the US Department of Commerce. The Environmental Exchange Program, administered by the Institute of International Education, provided funding for travel and training, and the Environmental Technology Network for Asia Program provided technical support, including identifying and notifying US companies of the project and inviting them to participate in the endeavor.

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Increased Use of Renewable Resources Program for Central America

Location: Guatemala, El Salvador, Honduras, Nicaragua, and Panama

Type: New power generation using renewable energy sources

Size: 1,200 photovoltaic (PV) home systems in use; 5 MW of biomass potential power; 2 MW of hydropower

Funding: Total: US\$4,295,000

Private: US\$625,000

Public: US\$3,670,000

Objective: To develop renewable energy enterprises and projects.

Duration: 2000–2003

Scale: Urban and rural

- Institution building and access to justice and enforcement of laws

A key principle that helped attract private-sector financing was allowing energy facilities to operate under standard commercial practices. In El Salvador and Honduras, activities that helped accomplish this included forming a management team independent of the government and hiring and developing staff with appropriate skills matched to the job. Corporate restructuring of energy enterprises to support commercial operations was also important. Other principles that helped attract private-sector support included broad stakeholder participation in decision making and effective coordination among sectors, between public and private sectors, and across multiple geographic and institutional scales.

Summary

Under the Financiamiento de Empresas de Energia en Centroamerica (FENERCA) Program, five Latin American countries have integrated environmental and economic sustainability into their energy agendas. Numerous rural communities without access to conventional power grids and urban communities with unreliable power systems now have access to clean, renewable, and reliable electricity through the establishment of PV home systems and power generating facilities using hydro and biomass fuel. Entrepreneurs structured and, in some instances, initiated operations to produce clean energy for the region.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development



Financing

Total project investment was US\$4,295,000. E+Co contributed US\$625,000 in catalytic seed capital. Public funding sources included the United States Agency for International Development (USAID) (US\$2,850,000), United Nations Foundation/United Nations Environment Program (UNF/UNEP) (US\$70,000), and United Nations Development Program/Global Environment Facility (UNDP/GEF) (US\$750,000).

Local Central American financial institutions are considering investing US\$2,000,000 in renewable energy projects and initiatives.

The Project

FENERCA, a USAID initiative, seeks to promote the development of renewable energy enterprises and projects, while increasing the capacity of financial institutions and non-governmental organizations (NGOs) in the region. The program provides enterprise development services, assists in securing financing, and provides regulatory and policy alternatives to local governments.

The project has enabled entrepreneurs to structure and, in some cases, initiate clean-energy-producing projects. As a result, several rural communities have gained access to clean energy services. In addition, urban areas have benefited from increased grid capacity.

Residential, industrial, and commercial sectors are benefiting through improved health, education, lighting, refrigeration, drinking water, cooking, and recreation.

Technical Data

Technologies include biomass (sugar cane bagasse) for increased grid capacity, geothermal, hydro (turbines), solar PV (home energy systems), and wind. To date, 1,200 solar home systems have been installed, providing 375 kWh/d. Five megawatts of biomass power potential have been developed, and approximately 2 MW of electricity will be generated through three hydro projects under construction.

Performance Data

Of the approximately 120 proposals identified under the FENERCA program, 24 received enterprise development services and 15 have business plans under review. Two enterprises are delivering new clean energy, and three are under construction.

In Honduras, 18 proposals for renewable energy projects have been approved by the electric utility, and a local Honduran financial institution has provided a loan of US\$550,000 to finance the construction of a hydroplant.

Several direct and indirect jobs have been created, road conditions that facilitate commuting between regions have improved, indoor use of kerosene has been displaced, and access to clean energy in rural communities has been provided.

Greenhouse gas emissions have been reduced by the displacement of fossil fuels used to generate electricity.

Comprehensive training sessions on business plan development and renewable energy finance were held to strengthen the capacity building of entrepreneurs, NGOs, and financial institutions. As a result, local financial institutions are considering US\$2,000,000 in active investments, and funds totaling US\$525,000 have been committed and/or invested by E+Co in three specific project proposals.

Participants and Roles

FENERCA is an initiative of the USAID being implemented by E+Co, in close partnership with BUN-CA (Biomass Users Network-Central America).



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Cherepovets Water-Efficiency/Tariff Reform Program

Location: City of Cherepovets
Type: Tariff reform and water efficiency
Size: 1,100 water meters, 24 km of pipes, three pumping stations, new treatment facility
Funding: Total: US\$1,600,000 — all from increased water tariffs
Objective: To improve the financial situation of the utility, enabling it to invest in system improvements.
Duration: 1998–2000
Scale: Urban

Summary

Cherepovets, a city with a typical Russian income profile, has shown how tariff reform can help rehabilitate a city's infrastructure, and in so doing, build its economy and enhance the quality of life for its citizens. The city's program demonstrated that prices could be raised to the point of full-cost recovery (plus profits needed to make investments). The city was able to accomplish this while increasing the overall level of payments and without significant political opposition. The Cherepovets example has demonstrated that the public will support and pay for increased tariffs, despite opinions to the contrary.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

The tariff redesign was accomplished in a manner that built consensus within the city government and educated the population on the need to increase prices (thus reducing pub-



lic opposition). Part of this effort was a public awareness campaign, including educating children on water conservation through games in schools.

A key factor that made the reform possible was educating the general public about the need for raising prices and assuring people that the tariffs would be used to improve the quality of heating and water services. Creating a working group that included members of different city departments and the general public was critical for successful reform. The process for increasing prices was transparent and based on consensus.

The following principles also contributed to the ability to finance system improvements with no outside funding: (1) a sound and rational tariff policy, which included the introduction of a dual tariff (network charge plus actual consumption payments) that improved and stabilized the financial situation of municipal utilities; (2) a tariff restructuring that substituted subsidies for all citizens with subsidies only for the truly needy; (3) gradual improvement of the market environment in the municipal housing and public utility services sector through tenders for renovation of public buildings and for technical maintenance of residential buildings; and (4) development of private contractors, who, incidentally, are expanding their activities to include reducing the amount of heat wasted in area schools.

Financing

Total investment costs were about US\$1,600,000. With no outside money, the City of Cherepovets raised water tariffs not only enough to cover costs, which would have been a success in itself, but also enough to generate revenues for investment. Investments funded by the increased tariffs include:

- A new water treatment facility (investment of 40.5 million rubles)
- Three new, modern pumping stations (1.5 million rubles)
- Twenty-four kilometers of old, leaking pipes replaced with new pipes (1.6 million rubles)
- More than 1,100 water meters installed in buildings city-wide, enabling consumption-based billing (investment of 6.4 million rubles)..

The Project

The City of Cherepovets, in Northwest Russia, has implemented a wide-ranging tariff reform and water-efficiency

program that has proven to be a model for Russia. The city took two very innovative steps. First, it rationalized subsidies on the basis of income. As a result, the poorest people pay no more than 10% of their income to utility payments, and those who can afford to pay 100% receive no subsidies from the municipality. Second, the city used the additional revenue to implement a major water-efficiency investment program, which invests in both the water supply system and in end user buildings. The results of these efforts include the following.

The city raised water tariffs enough to cover costs and to invest in water-efficiency projects. These projects included a new water treatment facility, 3 new pumping stations, the replacement of 24 km of old, leaking pipes with new pipes, and the installation of more than 1,100 water meters in buildings all over the city so that water can be billed on the basis of consumption.

The city reduced leaks in the supply network from 25 to 10% in four years. It also reduced the amount of electricity required to pump 1 m³ of water through the system by 12%.

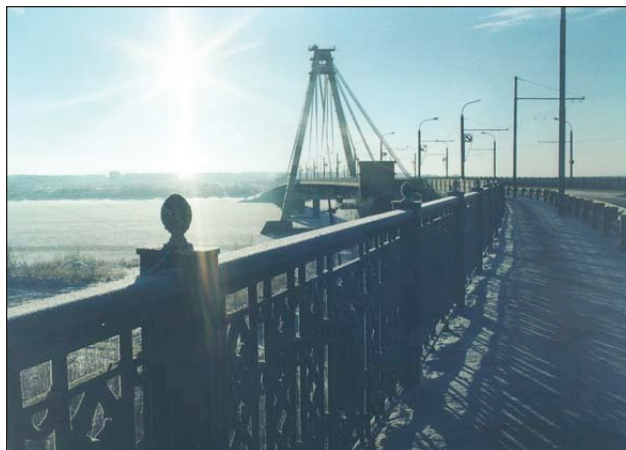
Before the initiative, 75% of the network's pipes were more than 25 years old (intended lifetime is 20 years). Today, only 25% of the pipes are more than 25 years old.

Technical Data

The technologies used included water meters, new water pipes, and new water treatment technologies.

Performance Data

The project has produced revenues that the city has invested to provide 3 new pumping stations, a water treatment station, and 1,110 water meters in buildings across the city.



The tariff reform and subsequent investment have reduced the amount of electricity required for water pumping by 12% per cubic meter pumped.

Participants and Roles

The Cherepovets Tariff Design Group, which consisted of managers from several key city departments, relevant committees of the city council, and members from the general public, was responsible for the tariff program and water-efficiency investments.

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US/China High-Efficiency Motors Demonstration Project

Location: Oil fields in China
Type: Efficient industrial motors
Size: 10 motor retrofits
Funding: Total: US\$75,000
 Private: US\$75,000
Objective: To increase efficiency of industrial motors.
Duration: 2000–2002
Scale: Rural

Summary

Under this project, Shengli Oil Company, the second largest oil company in China, was identified as a potential project host for energy-efficient industrial motors. Ten oil field motor retrofits were demonstrated, and savings were greater than expected. As a result, Shengli Oil recently decided to expand the energy-efficient motors program and has set aside US\$60,000 to add more energy-efficient motors in its system. On the basis of this success, other oil companies are now evaluating their systems for use of energy-efficient motors.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws

Chinese research institutes helped create the standards that were integral to the design of national energy-efficient motors certification programs and efficiency standards. Such standards allowed motor manufacturers to differentiate their motors as efficient, able to produce real savings, and perform as expected.

Capacity-building activities that helped attract private financing included dissemination of best practices and participation in international forums and workshops to increase the awareness, knowledge, and skills of sector professionals.



Increased public knowledge and participation in energy decision making through professional training and outreach programs also helped attract private-sector interest.

Financing

Project investment for the first phase (retrofitting of 10 motors) was US\$15,000 and was privately financed by Shengli Oil Company. On the basis of the success of phase one, Shengli has committed an additional US\$60,000 to implement more energy-efficient motors in its system.

The Project

Shengli Oil Company has been interested in implementing technologies and policies that improve cost efficiency. It had already implemented demand-side management in many technologies, but not in motors. The company has more than 14,000 motors installed, consuming 14.2% of total production cost. Retrofitting 10 motors was so cost-effective that Shengli's parent company, China Petroleum and Chemical Corporation (SINOPEC Corp.), requested that all 7 of its subsidiary companies assess their potential for similar energy-efficient retrofits and report back with proposals to implement these retrofits.

Industrial, commercial, and utility sectors are benefiting from the project.

Technical Data

The high-efficiency motors pump oil from the ground and are fueled by conventional power generation through the utility grid. (About 70% of China's power is generated using coal.) After retrofit, the motors are still fueled from the power grid but are more efficient and use less power.

Performance Data

The new motors use about 9.6% less energy than the older motors.

If high-efficiency motors replaced all of Shengli Oil Company's broken motors, expected savings would be US\$4,600,000 per year.

The estimated payback period for the retrofit is about seven months.

Participants and Roles

Shengli Oil Company's Demand-Side Management Office identified and implemented the project. The United States Environmental Protection Agency (USEPA) and the China State Development Planning Commission manage the US/China Technology Cooperation Agreement Pilot Project, which sponsored the demonstration project. The US Department of Energy's (USDOE's) National Renewable Energy Laboratory (NREL) and China's Tsinghua University coordinate technology activities. The International Institute for Energy Conservation led technical assistance and evaluation efforts. The USDOE helped provide technical assistance in monitoring, evaluating, and demonstrating the energy and cost savings.

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Improving Manufacturability and Reliability of Solar Water Distillers

Location: Juarez, Columbus, and Palomas
Type: Water technology development and deployment
Size: 1 to 2 gallon-per-day distillation units
Funding: Total: US\$182,000
 Private: US\$10,000
 Public: US\$172,000
Objective: To address water quality problems and create business opportunities.
Duration: 2001–2002
Scale: Urban and rural

Summary

By using solar water distillers, sunlight (an abundant resource in Mexico) is used to produce drinking water (a scarce resource). The solar water distillation technology for the project was designed to be manufactured locally, thereby expanding the industrial capacity of the private sector. Local, private-sector participation supports the sustainability of this energy technology, which simultaneously gives households access to clean drinking water and creates wealth and well-being.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public access in support of sustainable development and public participation, coordination, and partnerships



Principles that attracted financial support for the project included hiring people with the appropriate skills to match job requirements and developing those skills as needed. Partnerships, exchanges, and outreach programs also have helped enhance communication and education on water use issues.

Another principle that has attracted private-sector financial support has been broad stakeholder participation and empowerment in water resources decision making across sectors and social/cultural groupings.

Financing

Total project investment is US\$182,000. The Border Pact provided US\$10,000 of private funds. The United States Environmental Protection Agency (USEPA) contributed US\$100,000, and the US Department of Energy (USDOE) National Border Technology Partnership Program and the Sandia/New Mexico Small Business Assistance Program provided US\$52,000 and US\$20,000, respectively.

The Project

The installation of household-sized solar distillation units capable of providing 1 to 2 gallons of drinking water per day helps eliminate or reduce reliance on expensive bottled water.

The project benefits industrial and commercial sectors by capitalizing on the existing capacity in the regions. The distillation units come from local suppliers and manufacturers.

The residential sector gains financial savings and improved health through safe and readily available drinking water.

Technical Data

The technology consists of family-sized, solar thermal distillation units that are capable of generating 1 to 2 gallons of drinking water per day.

Performance Data

Forty households are using the units and saving money, because they no longer need to buy bottled drinking water.

Four people have been trained to manufacture the solar distillation units.

Participants and Roles

Sandia National Laboratories, the University of Texas – El Paso, New Mexico State University, SolAqua, Inc., and El Paso Solar Energy Association were all involved in the project. The US-Mexico Bi-National Laboratory Initiative connected the key players to develop and implement the solar water distillation project.

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Leak Abatement in Romania

Location: City of Iasi
Type: Water delivery efficiency
Size: 60,000 m³ of water saved per year
Funding: Total: US\$118,074
 Private: US\$71,250
 Public: US\$46,820
Objective: To develop, implement, and evaluate a water pipe leak-detection system.
Duration: 1999–2000
Scale: Urban

Summary

A water utility that was losing 30% of its daily production to leaking pipes teamed with a private environmental technology provider to pilot a pipeline leak-detection system. Three of the leaks detected with the new system accounted for losses of 60,000 m³ per year, or US\$24,000. The pilot project demonstrated the value of private- and public-sector teaming for identifying cost-effective responses to energy inefficiencies. The success of the pilot project has paved the way for a systemwide US\$40,000,000 leak-abatement program.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making

A key principle that helped attract private-sector financing was the commitment to creating and strengthening strong human and organizational capacity for sustainable and integrated water management, in both the public and private sectors.



Another important principle was the consideration of water as an economic, social, and environmental good, including acknowledgment of the full costs of water management and water services, and transparent, equitable, and sufficient allocation of those costs throughout society (through such means as tariffs, subsidies, and taxes).

Financing

Total project investment was US\$118,074. A small United States (US) civil and engineering firm provided US\$71,254 in private funds, and the remaining US\$46,820 came from a United States Agency for International Development (USAID) EcoLinks grant.

Capital costs were US\$20,000; technical assistance costs were US\$98,074.

The Project

Regia Autonoma Judeteana de Apa-Canal Iasi (RAJAC), a local water utility company established by the Iasi City Council in 1991, is responsible for providing water to the city and for operating the municipal sewage system. It serves more than 550,000 inhabitants and 2,100 institutions with a 600-km distribution network. RAJAC loses about 16,000,000 m³, or 30%, of its water production annually, wasting potable water, treatment capacity, energy, and money.

As a first step in a proposed program to cut those water losses by at least half, RAJAC teamed with an American technology provider, Cavanaugh & Associates, using a USAID-sponsored EcoLinks grant, to develop, implement, and evaluate a pilot leak-detection and abatement program. RAJAC provided water-system maps, and Cavanaugh trained RAJAC personnel in the use of leak-detection equipment. The project team prepared a list of conservation measures to raise consumer awareness. Other utility companies were informed of project successes, paving the way for establishing a US\$40,000,000 systemwide leak-abatement program.

The project increases the operating efficiency of the utility, and residential, commercial, and industrial sectors benefit from reduced water costs.

Technical Data

Technologies included Doppler leak-detection equipment, data loggers, and computer software. Local utility personnel are easily trained to operate the equipment, which is useful not

only for water utility companies, but also for district-heating enterprises and other large water-transportation networks.

Performance Data

Roughly US\$24,000 and 60,000 m³ of water are saved annually because of this pilot project. The payback period for the equipment during the pilot project was less than one year.

Potential savings of 8,000,000 m³ and US\$3,000,000 per year are expected once the US\$40,000,000 infrastructure project is in place.

Consumer water conservation measures are promoted through media campaigns.

Discussions are underway to develop an autonomous company providing leak-detection systems to other water companies in Romania.

The project has generated interest in applying the leak-detection technology to the Iasi District Heating Company, and requests to demonstrate the technology in Bucharest, Poland, and Moldova have been received.

Participants and Roles

Cavanaugh & Associates teamed with RAJAC to conduct the pilot. Fluid Conservation Systems, the manufacturer of the leak-detection equipment, provided supplementary equipment training.



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Renewable Energy Systems in the Peruvian Amazon Region (RESPAR)

Location: Indiana and Padre Cocha in Loreto, Peru

Type: Rural community electrification

Size: Indiana, 600 kW/d; Padre Cocha, 300 kW/d

Funding: Total: US\$2,740,500

Private: US\$1,503,000

Public: US\$1,237,500

Objective: To provide 24-hour electricity to rural communities.

Duration: 2002–2004

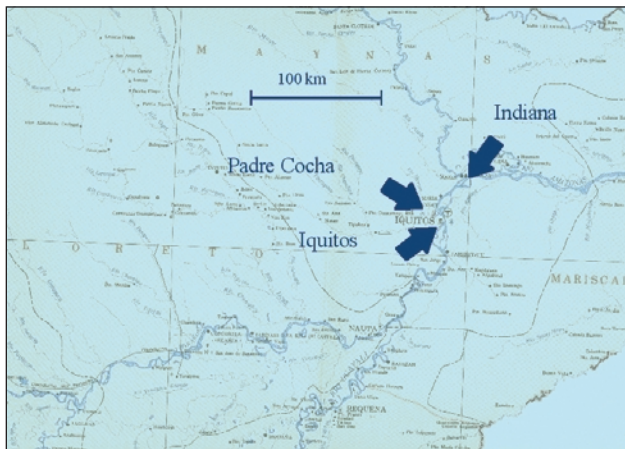
Scale: Rural

Summary

Integrating solar renewable energy, advanced batteries, and high-quality electronic control systems with existing diesel generators in remote villages will provide 24-hour-per-day electricity and significantly reduce diesel fuel usage, costs, and noxious air emissions. Rural communities that are not connected to a power grid will no longer have to depend on diesel generators, which require frequent maintenance, use expensive fuel, and release noxious emissions, to produce only a few hours of electricity per day. Remote Area Power Supply (RAPS) systems will help alleviate poverty, improve lifestyles, and improve environmental conditions.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development



- Institution building and access to justice and enforcement of laws

The Peruvian Rural Electrification Program and the Peruvian tariff treatment in the Loreto region helped attract private financing by allowing utilities to operate under standard commercial practices. Thus, management teams can function independently of the government, and staff with skills matched to the job can be hired and trained.

Also attracting private investment were activities to increase public participation in energy decision making. These included stakeholder partnerships and exchanges and participation in international forums to increase energy-sector professional knowledge of energy practices. Public input on pricing and payment issues was solicited, and the results were incorporated into energy policies.

Financing

Total project investment was US\$2,740,500. Private funding sources included Common Fund for Commodities (US\$600,000), Australian International Greenhouse Partnership (US\$105,000), Solar Energy Industries Association (SEIA) (US\$18,000), Ferreyros (Peru) (US\$80,000), and International Lead Zinc Research Organization (ILZRO) (US\$700,000). Electro Oriente (Peru) provided an in-kind loan of US\$713,000.

Public funding sources included Regional Government of Loreto (US\$385,000), Global Environment Facility (GEF) (US\$747,500); United States Department of Energy (USDOE) (US\$80,000), and National Association of State Development Agencies (NASDA) (US\$25,000).

The Project

The objective of the project is to help ensure sustainable development of communities by providing electricity to increase income-generating activities. By incorporating solar renewable energy, advanced batteries, and high-quality electrical control systems with existing diesel generation, RAPS systems will provide 24-hour-per-day electricity and greatly reduce diesel fuel use. Diesel fuel reductions mean lower fuel costs and reduced environmental damage.

Sustainability of the RAPS system is based on identifying and promoting income-generating activities for community members that are compatible with the ancestral habits of the

inhabitants, rational use of natural resources, and minimal energy consumption. Local utilities will benefit with the increased business from the communities.

The project development period is July 2002 to July 2004. Currently, equipment is being transferred to and installed in the village sites.

Technical Data

The RAPS technology consists of two to four modules, each capable of 150 kWh per day (rps-150), designed to operate in parallel, with the capacity to provide electric energy of 300 to 600 kWh per day. The systems consist of a battery bank of 750 Ah to 240 VDC, a power conversion system of 40 kW, and an assembly of photovoltaic (PV) panels with a maximum capacity of 50 kWp.

Also included is a control system to monitor the voltages, currents, and temperatures of the battery bank; current and voltage of the solar panel assemblies; ambient temperature; and other system parameters to determine operating conditions and the need for modification. Indiana will have four modules and Padre Cocha will have two. A generator will be included as an additional power source for each of the two systems.

The RAPS system includes recycling plans. The battery installer will remove and send the old, lead-containing batteries to a recycling center. All batteries will be replaced at the same time and will be removed from the community in an environmentally appropriate manner. The financial incentive for recycling is the significant salvage value of the used batteries. Disposal of used lubrication oil from remote diesel generators has traditionally been a problem. However, the reduction in hours of RAPS generator operations means that only 4 oil changes are required a year as opposed to the usual 35. Smaller amounts of used oil production mean that disposal can occur once a year during fuel delivery or maintenance visits.

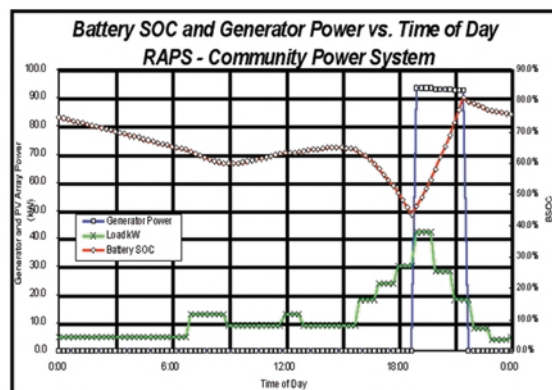
Performance Data

Diesel fuel savings of 466,000 L/yr are expected. Actual performance data are not yet available.

Participants and Roles

In July 1997, ILZRO, the SEIA, the Direccion Ejecutiva de Proyectos (DEP) of the Ministry of Energy and Mining (MEM) of Peru, and, later the Regional Government of Loreto, signed a Memorandum of Understanding to collaborate on reducing diesel fuel dependence by using a PV-battery-diesel hybrid system.

Typical System Operation - Padre Cocha



Key participants include the following: GEF focal point in Peru (Consejo Nacional del Ambiente [CONAM]); United Nations Development Program (UNDP)-Peru; MEM and DEP in charge of the National Electrification Plan; Solar Energy Industries Association (Solar Energy Research and Education Foundation [SEREF]/SEIA); the Regional Administration of Loreto (Consejo Transitorio de Administración [CTAR]-Loreto); the National Fund for Social Programs (Foncodes); Solarex/Ferreyros; Doe Run Peru; Indiana and Padre Cocha communities; and local nongovernmental organizations.

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Modernized Biomass Utilization

Location: Jilin Province, Hechengli Village
Type: New construction of a biomass gasification combined heat and power project
Size: 14,000 m³ of gas per day for cooking and heating and 200 kW of electricity
Funding: Total: US\$1,994,000
 Private: US\$254,000
 Public: US\$1,740,000
Objective: To provide cooking gas, heat, and electricity to village communities in China.
Duration: 2000–2004
Scale: Rural

Summary

This combined heat and power project in Northeast China will show that existing agricultural residues can be converted into a clean, modern energy carrier that improves the lives of local villagers. The production of gas for winter heating and the generation of electricity for sale to the local grid makes the project economically attractive and is expected to lead to project replication.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Activities that have increased awareness, knowledge, and skills of sector professionals in commercial business practices, which, in turn have helped attract private financing, include awareness and educational workshops for decision makers, skills-oriented training for decision makers and staff, study



tours, stakeholder partnerships and exchanges, dissemination of best practices, and participation in international forums and workshops.

Increased public knowledge of, and participation in, energy decision making — a central element of energy-sector reform efforts — has been facilitated through programs in professional training.

Financing

Total project investment from all sources is US\$1,994,000, of which US\$734,000 is for capital costs.

Private equity, in the amount of US\$254,000 comes from Hechengli Village Enterprise, a local community group. Other funding comes from the United Nations Development Program (UNDP), via a US\$480,000 equipment grant, and US\$760,000 in UNDP technical, business plan, and impact assessment support. The Jilin Environmental Protection Bureau is providing \$500,000 for design, training, evaluation, and dissemination.

The Project

The project will demonstrate the technical, economic, and market viability of a modern biomass gasification system to provide cooking gas, heat, and electricity to village communities in China.

Jilin Province is an ideal location for the project, because it has abundant biomass resources, the need for rural development, an emerging industrial base, and the government commitment needed to ensure sustained growth of such a new industry. The project was designed to be consistent with UNDP's corporate policy on sustainable energy, which promotes the provision of sustainable energy services as a means of addressing multiple social, economic, and environmental bottlenecks to human development.

The residents of Hechengli Village will receive clean gas for heating and cooking, which will reduce indoor air pollution and its associated adverse health impacts. The gas will be two-thirds the price of liquefied petroleum gas (LPG) and will compete with coal. Outdoor air pollution will be improved because less surplus agricultural residues will be burned in the fields. The village standard of living will be improved, and women and children will have more time available for productive activities. The project will create jobs, and the sale of biomass residues to the project will generate revenue for the poorer villagers. The electric company will benefit from this distributed electricity generation from a renewable resource.



Construction is nearing completion, and following a trial production period, full operation is scheduled for December 2002.

Technical Data

The project will use thermochemical gasification of crop residues (corn stalks and leaves) to provide a clean-burning gas for cooking, heating, and electricity generation. The plant will consist of biomass preparation and feeding equipment, three gas generation systems rated at 600 m³ of gas per hour, a 500-m³ gas storage tank, a piping distribution network to the households, and a 200-kW gas-engine generator interconnected to the electricity grid. All systems will use commercially proven equipment.

Performance Data

The project will meet the entire cooking and heating demand for the village, which consists of 224 households. The net electric output, after plant loads are met (about 140 kW), will be sold to the local electricity grid.

The project will generate about US\$140,000 of revenue from the sale of gas, electricity, and ash fertilizer. It will employ about 15 villagers, who will be trained in the operation and maintenance of the system, and it will pay about US\$25,000 to local farmers for the biomass residues.

A reduction of about 2,400 tons of carbon dioxide (CO₂) equivalent warming potential is expected due to reduced coal-based electricity generation and the elimination of traditional biomass combustion for cooking and heating.

Participants and Roles

The project sponsors are the Jilin Environmental Protection Bureau and Hechengli Village Enterprise. The UNDP, with funds from the UN Foundation, is providing a

grant to the project. Clean Energy Commercialization is providing technical and business planning support, and Princeton Environmental Institute is supporting the assessment of the project benefits.

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Clean Cities Santiago Program

Location: Santiago
Type: Alternative fuel vehicles (AFVs)
Size: 500 taxis, 12 buses, 6 refueling stations
Funding: Total: US\$1,587,800
 Private: US\$210,000
 Public: US\$1,378,000
Objective: To reduce vehicular emissions through the use of alternative fuels.
Duration: 1995–present
Scale: Urban

Summary

The Clean Cities Santiago Program is a public-private partnership in cooperation with the United States Department of Energy (USDOE) for the deployment of AFVs. Establishing a dialogue between fuel suppliers, equipment manufacturers, and regulators led to the conversion of 500 taxis to natural gas, the deployment of 12 natural gas buses, the construction of 6 natural gas refueling stations, and the potential for building a natural gas refueling station at the Arturo Merino Benitez International Airport.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws



A key principle that helped attract private financing was the convening of fuel providers, natural gas equipment manufacturers, fleet operators, policy makers, and legislators to deploy natural gas vehicles in Santiago. Activities such as awareness and educational workshops, skills-oriented training for decision makers and staff, study tours, dissemination of best practices, incorporation of public input, and participation in international forums and workshops helped increase the awareness, knowledge, and skills of sector professionals in commercial business practices.

Also important were legal and regulatory frameworks covering tariffs and the willingness of the public sector to establish subsidies and incentives promoting natural gas vehicles. A comprehensive energy law that meets global norms and standards characterized by basic policies and priorities and a framework for private investment also helped attract financing.

Government mandates, policies, and strategies combined with local private-public partnerships created a demand for vehicles using alternative fuels and infrastructure. Public support for sustainable development was facilitated by educating citizens so that they could help shape the policies, markets, and institutions that affect their lives; and by implementing state-of-the-art systems for collecting, demonstrating, and exchanging information to increase the impact of education, communication, and outreach strategies.

Financing

Total project investment was US\$1,587,800. Of this, US\$210,000 was privately funded via a METROGAS subsidy for light-duty conversion kits. (METROGAS is the monopoly distributor of natural gas in Santiago.) In addition, several private companies funded portions of training visits. Public-sector contributions included a US\$1,250,000 subsidy from the Chilean National Development Corporation (CORFO) for compressed natural gas (CNG) buses, and US\$127,800 from the USDOE's Clean Cities International Program.

The Project

Santiago had reached critical levels for carbon monoxide (CO) and particulate matter. In 1995, the Clean Cities International Program began sharing information on reducing emissions through the use of natural-gas-fueled vehicles with the City of Santiago. It helped develop the Clean Cities Santiago Coalition, a group comprised of national and local

governments, natural gas utilities, manufacturers, and fleet managers with the local goal of reducing emissions from mobile sources. The coalition sought to develop and use natural gas-fueled vehicles, which would emit less reactive hydrocarbons, CO, nitrogen oxides (NO_x), and particulate matter than diesel and gasoline vehicles.

The Chilean National Environment Commission for the Region of Santiago (CONAMA RM) took over and now administers the Clean Cities model; to date, 500 taxis have been converted from gasoline to natural gas, 9 diesel buses have been retired and replaced with CNG, and 3 diesel buses have been converted to CNG. In addition, 6 refueling stations now provide natural gas for vehicles.

All sectors reap health benefits associated with switching from diesel or gasoline fuel to cleaner-burning natural gas. Local reservoir water quality has improved due to reduced pollution from the converted vehicles affecting the river running through Santiago (el Rio Mapocho). The new transportation market also benefits the natural gas distribution system in Chile.



International Corporation (SAIC) coordinated reverse trade missions.

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Technical Data

Technologies used in the project include CNG buses and conversion kits, and a refueling structure for natural gas.

Performance Data

Although not quantified, the project is helping to decrease CO, NO_x, ozone, particulate matter, and greenhouse gas emissions in the Santiago area.

Roughly 500 drivers/mechanics and several airport officials have been trained on the safety, maintenance, and environmental benefits of natural gas vehicles.

Participants and Roles

CONAMA RM administers the project. METROGAS and CORFO provided subsidies. The USDOE provided technical experts to ensure an effective and safe natural gas vehicle program, conducted public outreach, and organized reverse trade missions. It also provided technical assistance to the Arturo Merino Benitez International Airport on the potential siting of a natural gas refueling station. Blue Energy provided technical assistance, the Gas Technology Institute (GTI) helped with logistics for technical visits, and Science Applications

Greening the Supply Chain (GSC)

Location: Indonesia, Malaysia, Vietnam, India, Philippines, Thailand

Type: Technical support for increased energy and water conservation

Size: 3,000 suppliers

Funding: Total: US\$1,300,000
Private (in-kind estimated): US\$1,000,000
Public: US\$300,000
(for 1997-2001)

Objective: To achieve energy and water conservation in small- and medium-sized enterprises.

Duration: 1994–present

Scale: Urban

Summary

GSC is a tool and a process that allows corporations to reach out to small- and medium-sized enterprise suppliers to improve environmental practices and to identify energy and water conservation opportunities. The GSC has led to improved environmental conditions and more efficient use of scant natural resources. Improved product quality, increased productivity, and involvement and participation of top management in environmental matters have also resulted from the program.

In-Country Principles That Attracted Nondonor Financing

- Capacity-building and informed decision making
- Public participation in, and support of, sustainable development

Capacity-building activities that helped promote commercialization and attract private financing included the formation of a management team independent of the govern-



ment, improved cost recovery, and installation of management information systems. Informed decision-making activities that helped increase the awareness, knowledge, and skills of sector professionals included awareness and educational workshops for decision makers, skills-oriented training for decision makers and staff, stakeholder partnerships and exchanges, dissemination of best practices, and increased knowledge in the management of private-sector involvement. Increased public access in support of sustainable development included programs in professional training and citizen education, institutionalizing sustainable education and communication programs, and monitoring strategies to measure the impacts of these programs.

Financing

From 1997 to 2001, total project investment is estimated at US\$1,300,000. During that time, the United States-Asia Environmental Partnership (US-AEP) awarded approximately US\$300,000 in grants, which leveraged matching resources amounting to roughly US\$1,000,000. Although the contributions of private-sector companies were not shared with the project sponsors (US-AEP and US Agency for International Development [USAID]), the following companies are illustrative GSC champions: United Technologies Corporation, Ford Motor Company Philippines, Nestle, Philippines Shell, Unilab, and the Philippine National Oil Company.

Implementing environmental controls and environmental management systems (EMSs) can be prohibitively expensive for small enterprises. Several companies and corporations are helping reduce those barriers by providing subsidized loans or other financial support. A continuing benefit of the project is its ability to leverage extensive partner resources from much smaller amounts of project funds.

The Project

Supply-chain management refers to the process by which buyer companies require a certain level of environmental performance from their manufacturing partners and vendors. When a company imposes environmental conditions on the products and processes of its suppliers, it is called GSC.

Companies participating in GSC leverage scant resources to reach small- and medium-sized enterprises in developing countries to increase energy and water conservation and improve environmental practices. Through various environmental and cost-saving initiatives, including “green” procurement, enhancing regulatory environmental compliance, and

implementing an EMS, private-sector companies are starting to work on environmental initiatives with their suppliers to “green their supply chain.” In the process, many of these companies have found that GSC not only generates significant environmental benefits, but also offers opportunities for cost containment, enhanced quality, and strategic and competitive advantage.

The project identifies corporations who champion the values of GSC, collaborates with US and Asian companies to create environmental outreach programs with suppliers, and delivers technical assistance and training to Asian industry associations that provide expertise to small- and medium-sized enterprise supplier companies on environmental protection and energy and water conservation.

Increases in efficiency, competitive advantages through innovation, improved product quality, and improved public images resulting from the program have benefited industrial, commercial, and utility sectors.

Technical Data

The International Organization for Standardization (ISO) 14001 EMS and various supplier environmental management activity protocols have been used extensively in this project. These include outreach, education, and training to identify water and energy conservation opportunities.

Performance Data

To date, more than 3,000 suppliers (mostly small- and medium-sized enterprises) were reached that could not have been reached without the program. A typical example is a case in which one GSC company visited six industrial supplier sites ranging in size from tiny enterprises with four employees to enterprises with several hundred employees. The visits helped identify energy and water conservation measures that provided opportunities to save money and improve industrial environmental performance.

Dollar savings that result from energy audits at sites vary, but generally average 5 to 10%.

Improved environmental protection, resource efficiency, and water and energy conservation have had positive though unquantified impacts on surrounding communities.

Participants and Roles

US-AEP and USAID have sponsored the program, completing several discrete GSC activities in India, Malaysia, the Philippines, Indonesia, Thailand, and Vietnam. Many private-



sector companies have provided financial and in-kind support to improve the environmental standards of small- and medium-sized enterprises.

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Efficient Power Generation (Greenhouse Gas Pollution Prevention [GEP] Project)

Location: Countrywide

Type: Energy-efficiency improvements in electricity generation

Size: Coal-fired stations totaling 20,000 MW capacity

Funding: US\$12,000,000, plus unquantified in-country partner contribution

Objective: To improve power-sector management, increase operating efficiencies, and enhance environmental protection.

Duration: 1995–2005

Scale: Rural and urban

Summary

Increased operating efficiencies through the use of advanced technologies at coal-fired power plants generating 20,000 MW are reducing greenhouse gas (GHG) emissions and narrowing the gap between power supply and demand. The project identified the potential for a 2% improvement in heat-rate efficiency. Technologies are being implemented to reduce fuel costs and, consequently, the price of electricity. Efficiency improvements have reduced carbon dioxide (CO₂) emissions by 1,840,000 tons per year.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public access in support of sustainable development and public participation, coordination, and partnerships

Activities that support capacity building and informed decision-making principles, which in turn help attract private



financing, have included study tours, demonstration activities, seminars, and participation in international forums and workshops, which help to increase awareness of commercial business practices, competitive energy market operations, and managing private-sector involvement.

A central element of energy-sector reform efforts is increased public knowledge of, and participation in, energy decision making, which has been enhanced by professional training and outreach programs.

Government policies are being modified to support the introduction of clean-coal technologies in electric-power generation to mitigate climate change.

Financing

Total project investment includes US\$12,000,000 from United States Agency for International Development (USAID) technical assistance, plus an unspecified amount of in-kind contributions from the Centre for Power Efficiency and Environmental Protection (CENPEEP), established by India's National Thermal Power Corporation Ltd. (NTPC), with assistance from USAID-India.

The Project

The project is designed to reduce the emissions of GHG per unit of electricity generated by improving the efficiency of existing coal-fired power plants and by implementing advanced technologies for future coal-based power plants.

The CENPEEP was established to implement the Efficient Power Generation (EPG) component of the GEP project, which was set up by the Government of India and USAID. CENPEEP is a national resource for assimilating, disseminating, and demonstrating technical know-how in support of improved power-sector management, increased operating efficiencies, and strengthened environmental protection in India.

Advanced technologies have improved power generation efficiency and environmental controls at coal-fired power stations. NTPC and some state electricity boards have been implementing heat-rate improvements in power plants with a combined generating capacity of about 20,000 MW. Increased operating efficiencies reduce the gap between the demand and supply of power, reduce GHG emissions, and improve the reliability of electricity supply to end users.

Long-term sustainability through cost recovery, global climate change mitigation through implementation of the heat-rate

guidelines, and information dissemination are the guiding principles of CENPEEP and its regional centers.

Technical Data

Technologies include boilers, turbines, electrostatic precipitators, high-pressure/intermediate-pressure turbines, condensers, and high-pressure heaters.

New technical initiatives include (1) a mine-mouth coal washery to demonstrate the benefits of using washed coals in pit-head power generation; (2) mine backfilling of coal-derived ash to demonstrate the benefits of large-volume ash utilization and abandoned mine land reclamation for afforestation; (3) evaluation of integrated gasification combined cycle (IGCC) technology for significant thermal efficiency improvements in new coal-based power generation; (4) and regional centers for CENPEEP to expedite heat-rate improvements in additional power plants.

Performance Data

Power plant performance optimization studies are showing significant improvements in efficiency and reductions in CO₂ and particulate emissions. For example, for a 210-MW unit, heat-rate improvement potential identified by optimizing high-pressure/intermediate pressure turbine efficiencies, condenser vacuum, high-pressure heaters, and relative humidity spray is about 100 kcal/kWh. This optimization corresponds to the following annual reductions: 46,000 tons of coal, 60,000 tons of CO₂, and approximately US\$135,000 in fuel costs.

The cumulative CO₂ reduction achieved due to all efficiency improvements is about 1,840,000 tons/yr.

Participants and Roles

The CENPEEP provides a self-sustaining mechanism for long-term support of coal-fired power plants for testing and demonstrating efficiency improvements. India's NTPC and USAID-India helped to establish CENPEEP. The US Department of Energy's National Energy Technology Laboratory provides technical assistance and training to CENPEEP.



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Kanata Hydroelectric Plant

Location: City of Cochabamba
Type: Hydroelectric plant
Size: 7.4 MW; 8,000,000 m³ of potable water
Funding: Total: US\$6,131,000
 Private: US\$6,131,000
Objective: To increase the city's water supply and generate electricity.
Duration: 1995–1999
Scale: Rural

Summary

The 7.4-MW capacity Kanata hydroelectric project is generating 22.3 GWh of electricity and 8,000,000 m³ of potable water per year for the City of Cochabamba. Kanata's power began to feed the Bolivian grid in May 1999, making it the first independent power production project of its kind in the country.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making

Sound principles that helped attract private financing included integrated, informed, and science-based decision making about water resources at the basin scale; broad stakeholder participation and empowerment; effective coordination between public and private sectors and across multiple geographic and institutional scales; a commitment to strengthening human and organizational capacity for sustainable water management; and consideration of water as an economic, social, and environmental good (including acknowledgment



of the full costs of water management and water services) and transparent, equitable, and sufficient allocation of those costs throughout society.

Specific capacity-building activities that helped attract financing by bringing the enterprise in line with standard commercial practices included the formation of a management team independent of the government, hiring and developing staff with appropriate skills matched to the job, installing management information systems, and keeping financial records in line with international accounting standards.

Activities that helped increase knowledge of sector professionals in commercial business practices and competitive energy market operations included awareness and educational workshops for decision makers, skills-oriented training for decision makers and staff, stakeholder partnerships and exchanges, dissemination of best practices, and participation in international forums and workshops.

Financing

Total project investment was US\$6,131,000. All of the funding (70% debt and 30% equity) came from private sources. Equity sources included Strycon GmbH (US\$821,000), Continental Vissions Ltd. (US\$525,000), and Austrian and Bolivian individuals (US\$693,000). Debt sources included Giro Credit (Bank) (US\$1,668,500), Cidre (local development credit fund) (US\$500,000), Continental Vissions Ltd. (US\$804,000), and Austrian and Bolivian individuals (US\$1,051,000).

Although the Bolivian developers had assembled a financing mix of debt and equity from European and local investors, a US\$1,000,000-financing gap existed in 1996.

E+Co provided a US\$250,000 loan, which allowed the developers to leverage the balance of debt and equity necessary to complete the project financing.

The Project

The Kanata hydroelectric project is a joint venture of Bolivian and Austrian companies. It was developed to increase the water supply to the City of Cochabamba (which suffers continuous drought conditions), generate electricity, and position the project as the first independent power producer in Bolivia.

The plant's annual generation of 22.3 GWh of electricity and 8,000,000 m³ of potable water benefits approximately 50,000 people in the City of Cochabamba.

Prior to the project, water from this dam passed through an open canal that lost a significant amount of water to spillage.

The project has provided a 4-km grid line, which has enabled the expansion of the electricity distribution network to unelectrified rural communities in the surrounding areas, thus benefiting industrial, commercial, and residential users.

End uses improved by the project include health, education, lighting, drinking water, nutrition, cooking, and recreation.

Technical Data

The plant uses high-efficiency Pelton turbines, which are well suited to partial load conditions and to conditions of severe fluctuations in the water supply.

Performance Data

Kanata's power began to feed the Bolivian power grid in May 1999, making it the first independent power production project of its kind in the country. The Kanata facility results in the avoidance of 2,000,000 m³ of water losses per year. Water pollution has also decreased, reducing water treatment costs.

During the construction of the project, new jobs were created. The project provided clean energy to previously unelectrified rural communities, and it increased the availability of potable water by 30%.

Participants and Roles

Bolivian developers, in conjunction with Austrian partners, designed and implemented the project. They also assembled a financing mix of debt and equity from European and local investors.

E+Co provided a \$250,000 loan, allowing the developers to leverage the balance of debt and equity necessary to complete the project financing.



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Sustainable Cities Initiative

Location: Indore and Pune

Type: Water and energy efficiency

Size: Varies with pumping station

Funding: Total: US\$393,000

Private: US\$15,000

Public: US\$378,000

Objective: To reduce energy use and improve efficiencies of water utilities.

Duration: 1997–2005

Scale: Urban

Summary

Sixty people were trained to identify and implement energy-efficiency opportunities in municipal water systems. A municipal energy management team established by the mayor of Indore identified energy-efficiency savings measures that resulted in savings of more than US\$100,000. In Pune, a similar team identified energy-efficiency measures that saved the city more than 300,000 kWh.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building and access to justice and enforcement of laws

Capacity-building principles that helped attract private funding included a governmental structure that allowed utilities to operate under standard commercial practices, which included improving cost recovery and setting up metering



systems. Training local water utility staff to better manage energy and water within their utilities was also important.

Other factors that helped attract private financing were the existence of a legal and regulatory framework that covered tariffs; increased public knowledge of, and participation in, energy decision making; an emphasis on decision making and assignment of authority at the lowest possible level; a commitment to creating and strengthening human and organizational capacity for sustainable and integrated water management; and consideration of water as an economic, social, and environmental good, including acknowledgment of the full costs of water management and water services.

Financing

Total project investment to date has been US\$393,000. Private-sector sources made in-kind contributions of US\$15,000, which provided necessary technical expertise on specific technology areas. The Indore Municipal Corporation contributed US\$80,000 (US\$30,000 in cash and US\$50,000 in-kind). The United States Agency for International Development (USAID) provided US\$200,000, and the US-Asia Environmental Partnership (US-AEP) provided US\$98,000.

A proposal is being considered that would use private money, through an energy-service contract, to retrofit all the street lighting in Indore using the energy savings to pay back the investment and profit; this would provide additional private-sector investment of about US\$800,000.

The Project

As water needs grow and supplies become scarce, water-service-related energy use and associated costs become more expensive. Energy efficiency provides a way for municipalities to reduce costs for water services while simultaneously improving the capacity and reliability of the delivery system.

Energy management teams were established in municipalities and trained to identify and implement opportunities to make energy and water use more efficient. Reduced energy and water use costs allow municipalities to redirect limited resources to other areas of need and result in improved customer service.

Industrial, commercial, and residential sectors are benefiting through improved health, nutrition, education, drinking water, sewage, and irrigation. The utility sector benefits through expanded service areas, increased number of connections, improved operating efficiency, and reduced energy demand.

The project has sought not only results that can be achieved elsewhere in India and globally, but also to institutionalize energy- and water-efficiency concepts to ensure that savings continue well beyond the end of the project.

Technical Data

Technologies used to increase efficiency included variable speed motors, high-efficiency pumps, leak-detection systems, and low-friction pipes.

Performance Data

Sixty people have received energy management training to date.

The Indore energy management team identified more than US\$100,000 worth of energy savings opportunities. The city has commissioned a municipality-wide energy monitoring protocol and developed a budgetary system to evaluate and implement energy-efficiency projects.

Energy-efficiency activities in Pune have saved a total of 4,230 MWh with an average payback of 16 months. In addition, 4,319 tons of carbon dioxide (CO₂) are avoided in Pune per year.

Participants and Roles

The municipalities of Pune and Indore provided the regulatory structure and financial support with cash or in-kind services. The W. Alton Jones Foundation and the Honeywell Foundation contributed funding to provide technical assistance and conduct seminars. USAID and US-AEP provided additional funding.



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Municipal Water-Efficiency Program

Location: City of Fortaleza, State of Ceara
Type: Water- and energy-efficiency improvements
Size: 22,000,000 m³
Funding: Total: US\$385,000
 Private: US\$115,000
 Public: US\$270,000
Objective: To increase water utility efficiency.
Duration: 2000–2003
Scale: Urban and rural

Summary

Inadequate or outdated water delivery systems create reliability problems and high energy demands. This project is helping promote energy efficiency, and thereby expanding and improving water service to end users. Energy costs are reduced and water use efficiency is increased through comprehensive energy management strategies for water utilities.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws
- Public access in support of sustainable development and public participation, coordination, and partnerships



The key to private-sector interest in this project has been political support for reform from the state government and governor. Also key has been allowing utilities to operate under standard commercial practices, for example, by hiring and developing staff with appropriate skills matched to the job, improving cost recovery, setting up metering systems, installing management information systems, and keeping financial records in line with international accounting standards.

Increased awareness, knowledge, and skills of sector professionals in technical areas, the existence of a legal and regulatory framework that includes tariffs, and increased public knowledge of, and participation in, energy decision making have also been important. The project includes a water- and energy-efficiency public outreach campaign.

Other in-place principles helping to attract private-sector interest include effective coordination among sectors, between public and private sectors, and across multiple geographic and institutional scales; an emphasis on decision making and assignment of authority at the lowest appropriate level; consideration of water as an economic, social, and environmental good, including acknowledgment of the full costs of water management and water services; and conditions and mechanisms of access to capital at all levels.

Financing

Total investment to date has been US\$385,000. The municipal water authority, Companhia de Água e Esgoto do Ceará (CAGECE) provided US\$100,000 of in-kind contributions (staff time and event costs). Private-sector groups contributed about US\$15,000 of training, in addition to travel expenses.

The United States Agency for International Development (USAID) contributed US\$250,000, and the US Department of Energy (USDOE) provided US\$20,000.

Additional funding of US\$1,600,000 for further efficiency investments is expected to come from a loan from the World Bank and Programa Nacional de Conservação de Energia Elétrica (PROCEL) and guaranteed by the local, privately held electric utility. PROCEL is the Brazilian national electricity conservation program, an organization that funds or cofunds private- and public-sector conservation projects.

The Project

As water needs grow and supplies become scarcer, costs for water-service-related energy use become more difficult for municipalities to afford. Problems such as inadequate or

antiquated infrastructure and limited or irregular supply impede the efficient delivery of water to end users. Water delivery is a relatively energy-intensive municipal service, and energy efficiency can help municipalities reduce the costs associated with water services while improving the capacity and reliability of the delivery system.

The city of Fortaleza, aided by the Alliance to Save Energy, is developing a comprehensive energy management strategy for its municipal water system. Specific activities include assessing the potential for energy and water savings, mobilizing community-wide resources to participate in the development and implementation process of a comprehensive water management strategy, and developing and implementing the strategy.

The project has expanded and improved water service to end users at lower costs. It has also given water utilities the ability to manage energy use in the midst of an energy crisis and rationing, and has increased management's understanding of energy use as a nonfixed cost. Commercial, industrial, and residential sectors are benefiting through access to safer, cheaper, and more reliable water services.

Technical Data

Technologies include variable-speed motors, high-efficiency pumps, and supervisory control and data acquisition (SCADA) systems.

Performance Data

Between 2000 and 2001, US\$181,000 worth of energy savings resulted from efficiency improvements. Sixty internal utility staff and 100 external staff have been trained in energy management strategies. The population served by the water utility has increased.

Participants and Roles

CAGECE provides in-kind support, and USAID and USDOE provide financial support through the Alliance to Save Energy. Other existing and potential participants include PROCEL and the World Bank.



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India Renewable Resources Development (RRD) Project

Location: Nationwide
Type: Commercialization of renewable energy technologies
Size: 3,000 MW from renewable resources
Funding: Total: US\$216,000,000
 Private: (in-kind support): Amount not provided
 Public: US\$216,000,000
Objective: To increase private-sector involvement in renewable energy.
Duration: 1993–2001
Scale: Urban and rural

Summary

The renewable energy share of power generation capacity in India grew from 0.1 to 3% in eight years as the approach to renewable energy development shifted from largely state administration to a demand and market-driven commercialization approach with active private-sector involvement. Nearly 3,000 MW of wind, small hydro, biomass, and solar photovoltaic (PV) power systems were in operation by March 2001, compared with about 100 MW in 1992. The increase is attributable to a pricing policy that more closely represents the economic costs of energy supply, trade, and industrial policy reforms, and the entry of the private sector to augment power generation capacity.

In-Country Principles That Attracted Nondonor Financing

- Institution building and access to justice and enforcement of laws



The project attracted private-sector investment because of successful energy-sector restructuring that established a framework for private investment and ultimate privatization.

Fiscal incentives and policies that helped encourage private-sector participation included low-interest loans with soft repayment terms, a five-year tax holiday for independent power producers, 100% accelerated depreciation in the first year, reduced customs duties on renewable resources energy equipment, sales-tax exemptions (in select states), and facilities for banking, wheeling, and third-party power sales.

Financing

Total project investment was US\$216,000,000. The Indian Renewable Energy Development Agency Limited (IREDA), an autonomous financial institution within the Government of India's Ministry of Nonconventional Energy Sources (MNES), has financed about half of the capacity additions through direct and loan support. Private-sector equity (amounts not reported), MNES support, and loans from other lenders financed the balance. Public financing sources included the Swiss Development Corporation (SDC), the Danish International Development Agency, and the Global Environment Facility (GEF).

The Project

India's renewable energy resource use increased substantially through the expansion of the role of the private sector in technology commercialization.

Commercial, industrial, and residential sectors benefit because of increased access to reliable and reasonably priced electricity. Other benefits include land price increases, improved quality and availability of power in the vicinity of wind farms, and infrastructure development, such as improved roads.

The development of a commercial solar PV market has created a large, private-sector-led manufacturing base (60 firms in 2002 compared with 10 in 1992), a competitive marketplace where product costs are now among the lowest in the world, and increased participation by financial intermediaries.

Technical Data

Technologies include 5-Wp solar lanterns, 900-Wp PV irrigation pumps, 500- to 2,500-Wp solar power packs, 25-kWp village power systems, and a 200-kWp-grid tied system.



Performance Data

Small Hydro

Over 113 MW of small hydro capacity (33 projects) was commissioned and financed, compared with a target of 100 MW. Installed capacity has risen to more than 1,340 MW. Construction of 17 more small hydro systems (over 34 MW) has begun. An additional 155 MW has been financed in part with domestic market borrowings. The vast majority of new installations are owned and operated by private-sector companies.

Installations produce an aggregate annual energy output of 465,000,000 kWh at an average plant factor of 47%. Unit costs average US\$1,150 in real (year 2000) terms. Average estimated cost was US\$1,000/kW (year 2000 dollars) in comparison to US\$3,000/kW when installations were developed by the public sector. As the time from groundbreaking to commissioning has decreased from 20 to 54 months in 1997 to 11 to 20 months today, project cash flows have improved.

Wind Power

Installed capacity is now 1,340 MW as compared to 40 MW in 1992; more than 92% of capacity was implemented by the private sector. Unit costs are about US\$1,070/kW (year 2000). Rural employment amounting to 7,000 to 9,000 jobs in Tamil Nadu resulted from the 800-MW wind farms installed in the state.

Solar Photovoltaics

Seventy-eight projects with a combined capacity of 2,145 MWp generate 3,000,000 kWh annually; 40% of the 20 MWp produced in 2000 was exported. Average unit cost in real terms has declined from US\$22/Wp at appraisal to US\$11/Wp. There has been a five-fold income increase among farmers using PV pumps and a 50% increase in net income by some traders using solar rather than kerosene lighting. The income of some rural households is rising by 15 to 30% due to increased home industry output.

In addition to these performance measures, the carbon emissions avoided by RRD are estimated at about 3.6 million, 0.74 million, and 87,000 tons over the lifetime of the small hydro, wind, and PV projects financed under the project, respectively.

Participants and Roles

IREDA, under MNES, Government of India, implemented the project. The GEF, the SDC, and the Danish International Development Agency provided technical assistance.

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Comision Federal de Eletricidad/Arizona Public Service Company of Phoenix (CFE/APS) Renewable Energy Mini Grid Project

Location: San Juanico, Baja California Sur (BCS) State

Type: Alternative energy generation

Size: 205 kW

Funding: Total: US\$1,040,000

Private: US\$530,600

Public: US\$509,400

Objective: To use a renewable-energy hybrid system to extend delivery service and reduce greenhouse gas (GHG) emissions.

Duration: 1998–2028 (mini grid is fully operational)

Scale: Rural

Summary

In this project, two United States (US) electric utilities worked with the Mexican national utility CFE to replace a 205-kW diesel generator in San Juanico, Mexico, a small village not connected to the power grid. The hybrid system, which uses solar, wind, and diesel capacity, extends electrical service availability from the current 3 to 4 hours per day to 24 hours per day. It has improved the economic well-being and quality of life in this rural village, using technologies that keep GHG emissions to a minimum. The BCS State government plans to use this model to electrify several coastal villages over the next several years.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws



Private-sector interest was facilitated by the ability of utilities to operate under standard commercial practices, as evidenced by the hiring and developing of staff with appropriate skills matched to the job. Also important were the increased awareness, knowledge, and skills of sector professionals in technical areas, made possible, in part, by stakeholder partnerships and exchanges and dissemination of best practices.

Technical assistance, where development partners worked with Mexican nationals to invent and design solutions for local implementation also helped attract private-sector financing. The commercialization and development of existing utilities and a legal and regulatory system that covers tariffs also helped attract private-sector interest.

Financing

Total project investment was roughly US\$1,040,000 (US\$135,000 for project development and US\$905,000 for implementation). Of the total, more than half (US\$530,600) came from two private US utility companies, APS and Niagara Mohawk Power Corporation (NMPC). The government of BCS State contributed US\$222,750, and CFE contributed US\$37,100. The US Agency for International Development (USAID) and the US Department of Energy (USDOE) contributed a total of US\$249,480.

The local community formed an electrification committee (patronato) and agreed to a tariff structure that makes the project sustainable by generating revenues sufficient to cover labor and expenses for system operation, fuel, equipment maintenance and minor repair, and replacement of consumables.

The Project

The project site is a surfing destination and fishing village of 400 people in the BCS State that is 30 km from the nearest power grid. Villagers depended on a 205-kW diesel generator for their energy needs, which, because of high fuel costs, is operated for only 3 to 5 hours per day.

The APS/CFE Mini Grid Project developed solar, wind, and diesel capacity to displace the use of the diesel generator. The diesel component operates when solar and wind resources are below set levels and the battery banks are fully discharged. Under those conditions, the diesel generator provides power to the grid, with any excess power recharging the

batteries. Diesel consumption is estimated at roughly 90 L of fuel per day, compared with the previous 410 L per day.

The mini grid gives the community power 24 hours per day, allowing for the preservation of the daily fishing catch, improved food storage in residents' homes, longer school hours, and strengthened local public institutions. Economic benefits include providing power for the previously nonoperational fish processing facility and promoting tourism through the creation of a more reliable infrastructure.

Environmental benefits include reduced sulfur dioxide (SO₂), GHG, and particulate emissions from the combustion of fossil fuels. Minimal clearing of vegetation and soil movement was required, and noise and visual pollution from the wind component of the project have been minimal. The potential for spills of hazardous materials is mitigated through spill response and battery recycling procedures.

The project supports the following goals of the CFE: to apply renewable energy technologies for electrifying remote villages; to operate a hybrid power system as a sustainable business; to contribute to environmental, economic, and social development in rural villages; and to develop a project that can serve as a model for similar projects in Mexico. The project also gives CFE the opportunity to gain detailed technical knowledge of hybrid power systems and the development and implementation of projects of this type.

Technical Data

The system consists of 10 Bergey 7.5-kW turbines on 37-m guyed-lattice towers, a 17-kW photovoltaic (PV) array, a 420-kWh 240-VDC battery bank, a 90-kW inverter, and a new, more efficient, 120-kW diesel generator.

Performance Data

Project GHG emissions are expected to be reduced from 405 tons of carbon dioxide (CO₂) per year to 89 tons per year, or by 9,480 tons over the life of the project.

Participants and Roles

APS designed the plant and CFE built it. The patronato will operate the plant with support from CFE. The USDOE's National Energy Renewable Laboratory (NREL) will monitor plant performance. NMPC, USDOE, USAID, and the governments of San Jaunico, the municipality of Comondu, and the BCS State provided financing support.

The project was conducted under the auspices of the US Initiative on Joint Implementation (USIJI). Initiated in



1993 as part of the US Climate Change Action Plan, the USIJI supports the development and implementation of voluntary projects between the US and non-US partners that reduce, avoid, or sequester GHG emissions.

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Increased Access by Rural Households to Clean Water

Location: El Salvador

Type: Sustainable water resources and water supply

Size: 24 decentralized water systems serving 9 municipalities

Funding: Total: US\$21,750,000

Private: US\$9,150,000

Public: US\$12,600,000

Objective: To increase rural household access to clean water.

Duration: 1999–2002

Scale: Rural

Summary

Twenty-four decentralized water systems now serve 11,251 rural families in 9 municipalities as a result of entrepreneurial approaches to operations and management that involve active participation by local parties. These enterprises employ management models such as joint-venture companies, decentralized municipal enterprises, and nonprofit associations. In addition, 17 of 18 target municipalities now have water resources management plans in place. The project helps ensure that water resources management/regulation and water services provision are strengthened and supported at the local level.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development
- Institution building



Key principles that have helped attract private financing include strengthened local management that facilitates public participation in the local control of water systems, management of water resources at the watershed level, cooperation between and within watersheds, more equitable access to water, land use control through zoning, and regulating the use and abuse of water resources. Specific capacity-building activities that helped enable the success of the project included awareness and educational workshops and skills-oriented training for decision makers and staff, stakeholder partnerships and exchanges, and dissemination of best practices.

Programs in public education and communication and outreach have helped increase public knowledge of and participation in energy decision making. Educating citizens has helped them play improved roles in shaping the policies, markets, and institutions that affect their daily lives.

Other sound principles that have helped attract private support include integrated, intersectoral, and multiobjective decision making about water resources at the basin scale; informed and science-based decision making; broad stakeholder participation and empowerment in water resources decision making; the promotion of strong, effective, and culturally appropriate institutional, policy, and legal frameworks; effective coordination among sectors; an emphasis on decision making and assignment of authority at the lowest appropriate level; a commitment to creating and strengthening strong human and organizational capacity for sustainable and integrated water management in both the public and private sectors; consideration of water as an economic, social, and environmental good; conditions and mechanisms of access to capital at all levels; stable systems of access to and allocation of water; and systems of accountability and transparency.

Financing

Total project investment has been approximately US\$21,750,000. This includes US\$12,600,000 in United States Agency for International Development (USAID) development assistance from 1999 through 2002, US\$4,150,000 from a local nongovernmental organization (CARE), and US\$-5,000,000 from private sources. Private funds sources include grantee and local government counterpart, and community participation in both labor and material.

The Project

In Latin America and the Caribbean, responsibility for providing water and sanitation is increasingly devolving to communities. Typically, however, local/municipal governments lack the financial, technical, institutional, and social infrastructures to provide these services. This project has helped address these needs by supporting small cities and rural communities, primarily through local governance programs and direct technical assistance for water supply and sanitation.

The project increases rural household access to clean water by improving water quality sources, performance of water distribution systems, and local management of water resources. It also promotes effective citizen actions to address water issues. The focus is on local community and municipal-level interventions in 3 critical watersheds that transcend the boundaries of 18 municipalities. The project also works at the national level by assisting with the reform of national policies and by replicating successful interventions and lessons throughout the country.

The project has resulted in increased access to clean water and sanitation facilities throughout the target area. It has also implemented watershed-protection activities to improve agricultural practices such as soil conservation, organic cropping, reforestation, and integrated pest management.

Technical Data

Techniques being used to improve micro watersheds and enhance the quality of water resources include the securing of behavioral changes in micro, watershed residents, particularly small farmers, in the way that they use land. Widespread degradation of surface waters from sediment/soil runoff and municipal/domestic wastes are being reduced through the promotion of soil conservation practices and wastewater treatment, and solid waste disposal utilizing appropriate technology and recycling.

Performance Data

Rural household access to clean water increased from 30 to 53% in the target areas from 1999 to 2001. Improved soil conservation, reforestation, organic cropping, and inte-



grated pest management practices now cover more than 22,000 ha of land. Women and children in the target area benefit from new potable water systems that improve their health and increase their economic productivity and quality of life by freeing them from the need to spend time and energy carrying water.

Participants and Roles

The USAID/El Salvador Mission has supported small cities and rural communities primarily through local governance programs and direct technical assistance for water supply and sanitation. CARE has assisted with institutional implementation. The private sector has contributed through counterpart support in all areas of project implementation.

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Solar Light for the Churches of Africa (SLCA)

Location: Countrywide

Type: Alternative energy generation (solar)

Size: 5,000 facilities

Funding: Total: US\$6,000,000

Private: US\$6,000,000

Objective: To provide electric light in areas unconnected to the electric grid.

Duration: 2000–2020

Scale: Rural

Summary

This program, an ecumenical church development collaboration between primarily the Catholic and Anglican Churches for East Africa and the United States (US), is providing electric light and radio to areas of rural Uganda where electric grid extension is unlikely. The goal is to electrify 5,000 churches, schools, health clinics, community centers, and homes over two years. By replacing existing kerosene lanterns, the quality of life of residents is enhanced and carbon dioxide (CO₂) emissions are reduced. Project success is expected to lead to replication elsewhere and to reduce costs due to improved skills in design and installation of the systems.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Public participation in, and support of, sustainable development

Key principles that helped attract private-sector financing included the ability to have a management team independent of the government, and increased awareness, knowledge, and skills, facilitated through the incorporation of popular input.



A central element for energy-sector reform efforts is increased public knowledge of, and participation in, energy decision making. Activities that support such knowledge, and also helped attract private-sector interest, included programs in public education and communication, executing intervention models to increase the impact of education and outreach, and educating citizens so they can play improved roles in shaping the policies, markets, and institutions that affect their lives.

Financing

Total project investment is about US\$6,000,000, all of which comes from the private sector. About US\$3,000,000 is from the nonprofit Hathaway Foundation, US\$2,400,000 is from the Church of Uganda, and US\$600,000 is from users.

There is a 50/50 matching arrangement by which both the Catholic and Anglican Churches request solar-powered electric lighting kits by placing a 10% cash deposit with a Kampala solar equipment distributor, Solar Energy for Uganda, Ltd. SLCA, the ecumenical church development collaboration between the Catholic and Anglican Churches for both East Africa and the US, then provides 50% funding for solar lighting kits to requesting diocesan coordinators in the East African countries of Uganda, Tanzania, Congo, Rwanda, and Kenya. Solar Energy for Uganda finances the remaining 40%, which is paid back over two years by the receiving church.

The Project

Each of the 5,000 units consists of a solar lighting kit powered by a 60-W roof-mounted solar module, with a battery for nighttime use. By replacing the existing kerosene lanterns with solar lighting, each system will save approximately 526 kg of CO₂ emissions per installation per year.

The project provides numerous health, environmental, educational, and other benefits, including the following.

Eliminating kerosene lanterns removes the noxious fumes that are inhaled by the home dwellers — estimated as the equivalent of smoking two packs of cigarettes a day per person.

The successful administration of a national solar electrification program may reduce the pressure to build a third dam on the Nile River, which is home to some of the Earth's most famous natural wonders, including Murcheson Falls National Park.

The project improves education. In Uganda, competition for college education is intense, with a relatively modest number of first-year college slots available to millions of potential

students. Students raised in households or attending local schools without electric light cannot compete with their peers who can read an additional four hours per night because of available electricity. By electrifying schools with solar lights, students in rural areas now have the ability to compete with students from the electrified urban cities.

The solar electric lighting systems also afford enough power for small televisions, radios, and in some cases, for computers and Internet connections. They also extend the workday by up to four hours per evening. This allows residents to undertake micro enterprise activities and increase income opportunities. Light also increases yields from farms whose owners depend on food for livelihood. For example, solar electric light allows chickens to see their food, receive an extra feeding a day, and double egg production.

Technical Data

Each kit includes a 60-W solar module, six compact 8-W fluorescent medium base screw-in lights (with in-line electronic ballast adapter), a charge controller, a 100-amp-hour deep-cycle battery, switches, wiring, disconnect, and medium base sockets. The installation takes roughly two to three hours and once completed, provides the facility with complete hard-wired, wall-switch-controlled lights for up to six rooms. The price per kit is US\$1,200, which includes kit purchase price, international shipping, tariff, in-country shipping, and installation.

Performance Data

Estimated CO₂ emissions reductions will total approximately 52,600 metric tons over the 20-year lifetime of the project.

A May 23, 2000, letter from the Ministry of Foreign Affairs indicated that the Government of Uganda is “confident that the project ... will help promote sustainable development.”

Participants and Roles

Solar Energy for Uganda, Ltd., is responsible for system installation and maintenance; SLCA, the Hathaway Foundation, and the Church of Uganda provide financing.



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E7 Project 82 - Efficiency Improvements in Power Plants

Location: Aqaba and Amman
Type: Enhancement of efficient combustion
Size: 750 MW total
Funding: Total: US\$1,000,000
 Private: US\$1,000,000
Objective: To improve efficiency and reduce greenhouse gas (GHG) emissions.
Duration: 1997–2000
Scale: Urban

Summary

This privately financed project provided technical assistance and financing to Jordan’s Central Electricity Generating Company (CEGCO), an independent company that emerged from the privatization of the former public utility, to improve thermal power plant efficiency and reduce GHG emissions. Efficiency savings of 1.5 to 6% are expected to reduce carbon dioxide (CO₂) and sulfur dioxide (SO₂) emissions significantly. CEGCO has indicated that due to the success of the project, they hope to repeat the work on additional generating units.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws

A key factor that helped attract private-sector interest was the increased awareness, knowledge, and skills of sector



professionals made possible through such activities as dissemination of best practices and participation in international forums and workshops.

A comprehensive energy law that meets global norms and standards characterized by basic policies and priorities was also important. Jordan has adopted a national environmental strategy that prioritizes environmental issues, with sustainable energy as one of the priorities in the energy sector. The aim is to reduce GHG emissions and decrease the use of expensive fossil fuels in a sustainable manner.

Financing

Total project investment by E7 was approximately US\$1,000,000 and roughly 2 man-years of in-kind E7 effort. E7 is a group of nine of the world’s largest electricity companies, working together to promote efficient generation and use of electricity and to protect the global environment. CEGCO contributed in-kind labor in amounts equivalent to those of the E7 participants, and an unspecified amount for monitoring and testing equipment. Phase I assessment and testing cost roughly US\$195,000, and Phase II implementation costs were roughly US\$760,000.

The Project

The project was undertaken at three units at two sites operated by CEGCO — the Aqaba Thermal Power Station (TPS) in southern Jordan and the Hussein TPS in Zarqa, near Amman.

The project included two phases. The first phase consisted of boiler combustion optimization, boiler/turbine heat rate and efficiency testing, a water chemistry workshop, and training to improve plant efficiency. This phase also included the establishment of an energy-efficiency performance test team to help maintain the improvements in performance achieved with this project, and to apply the knowledge and test equipment to other units. In this phase, E7 provided CEGCO with the equipment needed for the testing of the units.

The second phase of the project consisted of improvements to air preheaters, the installation of a performance monitoring system and upgrades to instrumentation, as well as the installation of emissions measurement equipment to improve combustion instrumentation.

Technical Data

Technologies used to monitor emissions and improve efficiency included combustion performance testing equipment and software, air preheater seals, boiler tube washes, air heater upgrades, and instrumentation and emission monitoring upgrades.

Performance Data

Phase I work improved unit performance and resulted in annual emissions savings of 20,000 Mg of CO₂ and 500 Mg of SO₂. Phase I improvements in the first year of operations are expected to reduce CO₂ emissions by 30,178 Mg and SO₂ emissions by 744 Mg. Over a five-year period, it is estimated that the project will achieve savings of roughly 172,000 Mg of CO₂ and 4,100 Mg of SO₂.

Participants and Roles

E7 participants included Ontario Power Generation (OPG), which managed the project; Electricite de France (EDF), which supported training and a computer monitoring system; Ente Nazionale Energia Elettrica (ENEL) of Italy, which supported combustion testing; Hydro Quebec, which contributed additional funding; and Rheinisch-Westfälische



Elektrizitätswerke (RWE) of Germany, which supported air heater improvements. CECGO was the host utility.

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Industrial Energy Efficiency in Ukraine – Gostomel Glass Plant

Location: Kiev

Type: Industrial energy-efficiency upgrades

Size: Savings of more than 2,000,000 m³ of gas and 1,300,000 kWh per year

Funding: Total: US\$2,752,000

Private: US\$2,635,000

Public: US\$117,000

Objective: To reduce operating costs and increase production capacity by reducing energy use.

Duration: 1996–present

Scale: Urban

Summary

Using the results from an energy audit, the Gostomel Glass Plant implemented energy-efficiency measures at its Kiev factory that have produced annual energy savings of US\$220,000, including more than 2,000,000 m³ of gas and 1,300,000 kWh of electricity. Gostomel now provides all of its space heat needs with recovered waste heat. The energy-efficiency improvements have enhanced Gostomel's business position, allowing it to obtain more than US\$4,000,000 in financing for additional energy improvements.

In-Country Principles That Attracted Nondonor Financing

- Capacity building and informed decision making
- Institution building and access to justice and enforcement of laws

Capacity-building activities that helped bring the plant in line with standard commercial practices, which in turn helped



attract private financing, included improved cost recovery, metering systems, and management information systems. Stakeholder partnerships and exchanges helped increase the awareness, knowledge, and skills of sector professionals, thereby contributing to informed decision making.

Institution-building principles that helped attract private-sector financing included the creation and definition of competitive and captive markets and assistance to energy-based nongovernmental organizations in effectively participating in the restructuring process.

Also important for attracting private-sector interest were the national government's commitment to pursue energy efficiency through the State Committee of Energy Conservation and Gostomel's commitment to assume a loan to help finance the energy-efficiency improvements.

Financing

Gostomel invested about US\$800,000 of its own resources in new boilers, new insulation, and an efficient compressor. UkrESCO, a Ukrainian energy performance contracting company established by the Ukraine State Committee for Energy Conservation, provided a US\$1,835,000 loan. Gostomel has recently obtained a US\$12,000,000 loan to implement further improvements from the European Bank for Reconstruction and Development (EBRD). The United States Agency for International Development (USAID), through an interagency agreement with the US Department of Energy (USDOE), has provided US\$117,000 from fiscal year 1997 through fiscal year 1999 as part of a larger program to help Ukrainian manufacturers improve energy efficiency.

The Project

The Gostomel Glass Plant is one of the largest bottle and jar makers in Ukraine, manufacturing bottles for beverages, perfumes, and pharmaceuticals. The company's management recognized that, compared with similar plants in the West, the plant used energy inefficiently and created high operating costs. It understood that improving energy efficiency could increase production capacity and allow for market expansion and sales increases. With USDOE support, the Ukrainian Energy Efficiency Center, Agency for Rational Energy Use and Ecology (ARENA-ECO) and USDOE's Pacific Northwest National Laboratory (PNNL) conducted a detailed energy audit of the Gostomel facility. On the basis of the audit

findings, Gostomel implemented energy-efficiency measures that included installing three exhaust-heat recovery hot-water boilers, upgrading insulation of hot-water pipes, and moving the compressor air intake to a location outside the compressor building.

Technical Data

Technologies include high-efficiency air compressors, heat-recovery boilers, a backup hot-water boiler, piping insulation, and a new, energy-efficient industrial furnace.

Performance Data

Installation of three heat-recovery boilers and a backup hot water boiler produced annual savings of 1,884,000 m³ of natural gas and US\$156,395. The US\$530,900 investment was paid back in 3.4 years and provided an internal rate of return of 29.3%. Relocating the compressor air intake to outside the building cost US\$4,000 and provides annual savings of US\$2,130 and 53,250 kWh.

Upgrading piping insulation cost US\$39,000 and produces annual savings of 175,300 m³ of gas and US\$14,550, with a payback period of 2.7 years and an internal rate of return of 25.1%.

Installing a new high-efficiency air compressor produced annual savings of 670,280 kWh.

Participants and Roles

ARENA-ECO and PNNL conducted the energy audit. Gostomel participants provided technical information to ARENA-ECO, selected and implemented the measures, and secured financing to implement the measures. USAID and USDOE supported the promotion of energy efficiency in Ukraine to help provide energy alternatives to the closed Chernobyl power plant.



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APPENDIX:

Example Research and Development Technology Transfer Case Studies and Enabling Policy Environment Programs



EXAMPLE RESEARCH AND DEVELOPMENT TECHNOLOGY TRANSFER CASE STUDIES

Chevron Texaco Gulf of Mexico Gas Hydrates Joint Industry Project (JIP)

Funding: US\$3,018,000

Objective: To develop technology and data that will help in characterizing naturally occurring gas hydrates in the deepwater Gulf of Mexico.

Duration: 2001–2003

Summary

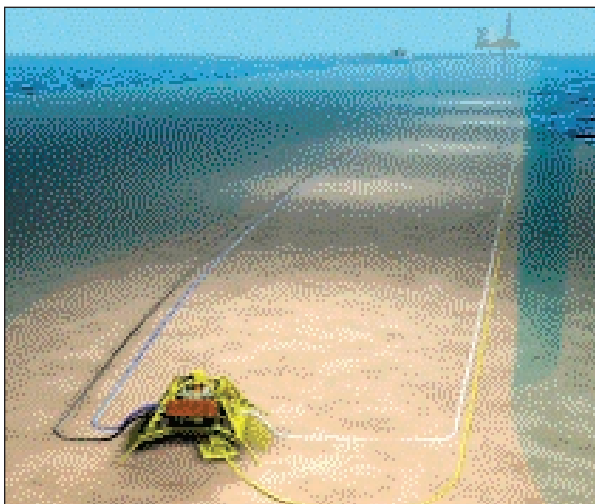
Methane hydrate is believed to be ubiquitous to the shallow marine sediments of deepwater continental shelves around the globe. Sizeable accumulations are known to exist offshore in Japan, India, Africa, and the United States (US). The project will provide information for technological solutions to seafloor failure and the uncontrolled release of large quantities of methane from hydrates during exploration and production activities.

Financing

Of the US\$3,018,000 in funding, roughly half comes from the US Department of Energy (USDOE) Strategic Center for Natural Gas (SCNG) within the National Energy Technology Laboratory (NETL). The remainder comes from the private-sector Chevron Petroleum Technology Company.

The Project

Information generated under this project will provide a better understanding of how natural gas hydrates can affect



seafloor stability, provide data that can be used by scientists in their studies of climate change, and provide data to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

The project is a two-phased study designed to drill for naturally occurring gas hydrates in the Gulf of Mexico at water depths of 1,000 ft or more. Phase I includes data collection and analysis and model development obtained through workshops. Findings will be compiled in a database. Phase II will be a drilling and sampling program. On the basis of Phase I findings, Chevron Texaco will devise a strategy to drill through and recover cores for further analysis from known hydrate accumulations.

Initial efforts focus on safety issues, characterizing natural methane hydrate, and uncovering its connections to the global environment. As pressing environmental and safety issues are resolved, the program will shift toward safely producing methane from hydrates. Work on production technologies is underway. In the near term, understanding the role of methane hydrates in seafloor and slope stability is important in developing effective safety measures in deepwater petroleum exploration and production activities. In the long term, the ability to identify unstable regions of the seafloor and take effective measures to mediate problems will result in fewer hazards and will reduce risks, costs, time, and labor.

In addition to causing slope failure on the seafloor, the large amount of gas that may be released upon disturbing the hydrate zone may have a dramatic effect on climate. The project will supply data to understand cause-and-effect relationships and to provide information for technological solutions to reduce these risks.

Sustainable Development Potential of the Project

The data and information on seafloor stability, climatic effects, and reservoirs beneath hydrate zones will guide the development of safety measures to address the risks. Avoiding unforeseen and unexpected hazards is key to a secure and affordable energy supply until such time that sustainable and renewable energy sources become feasible. The project will help support sustained economic growth by reducing risks and costs, thus adding security and additional price stability to energy supplies.

Technical Data

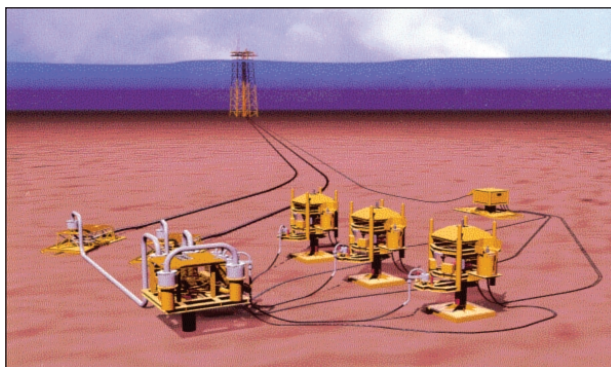
Technologies used in the project include specially tailored geophysical and geochemical techniques for hydrate appraisal. New production technologies that safely promote the in-situ dissociation of methane from hydrate are also being developed.

Technology Transfer Potential

The data and information gathered during the project can be used to mitigate hazards from seafloor instabilities in exploration and production activities in marine environments around the world. Understanding the role of hydrates in climate will help in assessing the risks for various regions if, or when, the production of methane from hydrates becomes feasible.

Participants and Roles

The USDOE's NETL is the primary funding organization. Members of the Joint Industry Project are Chevron Texaco, Conoco, Halliburton, Minerals Management Service, Phillips Petroleum Company, Schlumberger, and TotalFinaElf.



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Wabash River Coal Gasification Repowering Project/ Clean Coal Technology Demonstration Program

Funding: US\$468,000,000

Objective: To demonstrate the use of a new coal gasification process to repower a pulverized coal-fired boiler.

Duration: 1992–1995

by Global Energy in 1999) and US\$68,000,000 from PSI Energy. Of the USDOE funding, US\$168,000,000 was for capital costs, with the balance for the four-year operational demonstration phase. The Global Energy and PSI Energy contributions funded the remaining capital costs of the project.

Summary

The Wabash River Coal Gasification Repowering Demonstration Project demonstrated an environmentally superior method of generating electricity from coal. This method, integrated gasification combined-cycle (IGCC), in general, and the E-Gas Technology™, specifically, can produce a syngas stream that can be used to manufacture alternate transportation fuels such as liquid methanol, which could be beneficial in developing countries.

Financing

Of the US\$468,000,000 in funding, US\$219,000,000 was from the United States Department of Energy (USDOE). Private-sector contributions included US\$181,000,000 from Destec Energy Gasification Business Unit (which was acquired

The Project

The project is part of the Clean Coal Technology (CCT) Demonstration Program, a government-industry cooperative model established in 1985 to provide utilities and major coal-using industries with options for reducing environmental impacts of using coal and generating electricity at lower cost. The CCT Demonstration Program has helped commercialize technologies that reduce emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter, mercury, and other air toxics from coal-fired boilers.

The Wabash project demonstrated the use of the E-Gas Technology to repower a pulverized coal-fired boiler using an integrated gasification combined-cycle (IGCC) system. It provided advancements in the E-Gas Technology relevant to the use of high-sulfur bituminous coal (or petroleum coke) and data to assess the long-term reliability, availability, and maintainability of the system at the commercial scale. Industrial,



commercial, and residential sectors benefit from the improved environment and availability of cost-competitive electricity.

The project reduced SO₂ emissions by 99% (as low as 0.03 lb SO₂/million Btu) and controlled NO_x emissions to 0.10 lb/million Btu. Particulate emissions from the project are also very low (0.01 lb/million Btu). These levels meet and exceed all existing US environmental regulations. The improved efficiency of this technology relative to conventional pulverized-coal combustion techniques results in a decrease of carbon dioxide (CO₂) emissions, which could potentially impact long-term climate changes.

Even when operating on relatively high-sulfur coals, the Wabash River project is the cleanest coal-fired power plant in the world of any technology. In addition to its very low air emissions, the project produces no solid wastes and only two by-products: sulfur and slag. The sulfur produced by cleaning the syngas is sold as 99.99% pure elemental sulfur, while the slag (the coal ash component) is marketed for use in asphalt mixes and as a construction material.

Sustainable Development Potential of the Project

The project demonstrated SO₂ reductions of 99% and limited NO_x emissions to 0.10 lb/million Btu. Economic growth is assisted by allowing the use of cheap and abundant coal to generate electricity in place of more expensive alternatives. Generating reasonably priced electricity for rural areas helps provide for basic human necessities and raises the standard of living, thereby contributing to social development.

Technical Data

The E-Gas Technology is a coal gasification process that utilizes a two-stage pressurized, oxygen-blown, entrained-flow gasifier. The remainder of the system consists of a syngas cooler, hot/dry filters for particulate removal, heat exchangers for additional syngas cooling, a water scrubber to remove chlorides, a hydrolysis catalyst bed to convert carbonyl sulfide (COS) to hydrogen sulfide (H₂S), a methyl-diethanolamine-based (MDEA) absorber/stripper system for H₂S removal, a Claus unit to produce elemental sulfur, a gas turbine combined-cycle plant that incorporated an existing 1953 steam turbine, and an air separation plant.

Technology Transfer Potential

The project upgraded an existing 100-MW conventional pulverized-coal unit with a 262-MW (net) IGCC facility. Prior to repowering, this unit operated at a 30% annual capacity factor. At a 75% capacity factor, the repowered



IGCC not only makes 5.6 times more electrical power annually, but it does so while still reducing emissions: 5,500 tons per year less SO₂, 1,179 tons per year less NO_x, and 100 tons per year less particulate emissions.

The E-Gas Technology can be located on a greenfield site, or it can be used to repower an existing facility. Application of the technology results in the production of electricity, a wide range of chemical products from the gasifier-generated syngas (such as alternate transportation fuels), or both. The technology capacity range is nominally 250 to 1,000 MW(e).

Participants and Roles

USDOE cofunded the project and provided oversight. Global Energy, Inc., was a cofunder and provided the gas turbine technology. PSI Energy was a cofunder and provided the combined-cycle plant.

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Restoring Coastal Wetlands Using Drill Cuttings

Funding: US\$300,000

Objective: To assess the feasibility of using waste cuttings from oil and gas drilling for restoring wetlands.

Duration: 1998–present

Summary

Using cuttings that result from oil and gas drilling activities can provide an environmentally beneficial and cost-effective waste management strategy for drilling wastes. These large-volume wastes can be used to help restore impaired or lost wetlands. The program has applicability for wells drilled in or near environmentally sensitive wetlands environments around the world.

Financing

Of the US\$300,000 in funding, US\$250,000 was from the United States Department of Energy (USDOE). M-I Drilling Fluids, a private company, contributed in-kind support estimated at US\$50,000.

The Project

The USDOE has sponsored a series of projects to investigate the feasibility of using treated drilling wastes as a solid substrate for growing wetlands vegetation and restoring wetlands. The original project consisted of laboratory mesocosm studies by Southeastern Louisiana University (SLU) on freshwater wetland vegetation in a greenhouse research facility, followed by a proposed field demonstration. These studies showed that one of the two methods used to treat the drilling



wastes produced a substrate that effectively grew some species of freshwater wetland vegetation to an extent comparable to that of dredged sediments. Because of difficulties in obtaining regulatory permission to demonstrate the process in the field, the mesocosm investigations continued and incorporated the effects of increasing salinity levels and brackish and salt marsh vegetation, thereby simulating the range of conditions that may be experienced in the field. To support these studies, several improved drilling waste treatment methods are being developed by M-I, a developer, manufacturer, and marketer of drilling and completion fluids. On the basis of positive results, a second round of studies is currently underway.

The project, if successful, would benefit the oil-and-gas industry, local communities, and the environment by providing a beneficial reuse for waste materials, reducing waste management costs, and improving wetlands. Once demonstrated, the concept could be expanded to other types of non-hazardous solid waste material.

Sustainable Development Potential of the Project

The program converts a waste material into a beneficial reuse that is helping to mitigate impaired wetlands, a major environmental problem facing coastal Louisiana and other Gulf Coast states. If the concept of using drill cuttings to restore wetlands in coastal marshy locations is successful, it may be extended to restoring additional wetland acreage. The restoration program could also potentially be expanded to use other types of large-volume, low-toxicity solids.

Technical Data

The technique uses solar power to separate drilling fluids from drill cuttings. The program assumed there would be 15,000 bbl of drilling waste per well. This could restore 1.5 acres per oil or gas well. Between 10 and 100 wells are drilled annually in the Louisiana marshes. If all these drilling wastes were used for restoration, between 15 and 150 acres per year could be restored.

Technology Transfer Potential

The approach could work worldwide in areas where oil and gas drilling are occurring or near marshy areas. The resulting cuttings can be cleaned to local standards and used to restore historically damaged areas and other areas recently

disturbed by the drilling process. Before the technology can be accepted for widespread use, well-monitored field trials must show that the cuttings are a suitable growth substrate and that they do not contaminate surrounding waters. Preliminary discussions for using the wetlands restoration approach in coastal areas of Mexico and Venezuela have occurred.

Participants and Roles

The USDOE's National Petroleum Technology Office (NPTO) manages the program and provides funding. SLU conducted the mesocosm studies, and M-I's research laboratory has provided several new types of drilling fluids to increase vegetative growth. Argonne National Laboratory coordinated project efforts.

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Mallik 2002: An International Research Initiative Considering Gas Hydrates as a Potential New Energy Resource

Funding: US\$25,000,000

Objective: To assess gas hydrate properties and the stability of continental gas hydrates given predicted climatic warming trends.

Duration: 2001–2002

Summary

The Mallik 2002 methane hydrate well program will provide insight into the technical challenges facing the development of natural gas hydrates as an energy supply and will increase understanding of the role of gas hydrates in global climate change. New drilling, production, and geophysical technologies tested in this project may lead to new industrial development. Detailed studies of hydrate physical behavior will provide information to help assess the potential impacts of their release on future climate change. They will also help in developing techniques to avoid or mitigate hazardous conditions posed by gas hydrates to drilling and pipeline construction.

Financing

Of the US\$25,000,000 in funding, US\$1,000,000 is from the United States Department of Energy (USDOE) Strategic Center for Natural Gas (SCNG) within the National Energy Technology Laboratory (NETL). The remainder comes from a variety of other government and industrial partners, including the Japan National Oil Corporation (JNOC), Germany GeoForschungsZentrum Potsdam (GFZ), Geological Survey of

Canada (GSC), US Geological Survey (USGS), USDOE, India Ministry of Petroleum and Natural Gas (MOPNG), and the Canadian Petroleum Industry International Continental Drilling Program (ICDP).

The Project

A consortium with seven international partners collaborated on a research well program targeted toward producing methane from hydrates in the Mackenzie Delta of northwestern Canada. The project included the drilling of a 1,200-m-deep main production research well and two nearby scientific observation wells.

The scientific and engineering research objectives for the production research well focused on two themes: (1) assessment of the production and properties of gas hydrates, and (2) assessment of the stability of continental gas hydrates given warming trends predicted by climate change models. The researchers conducted scientific experiments to gain a better understanding of gas hydrates and to test new drilling techniques and production methods. Full-scale field experiments were conducted to monitor the physical behavior of the gas hydrate deposits in response to depressurization and thermal production stimulation. Canadian scientists are also investigating the possibility of storing carbon dioxide (CO₂) in reservoirs previously occupied by gas hydrates as an innovative way of meeting Canada's emissions-reduction objectives.

The results from the Mallik 2002 program have increased our understanding of the role of gas hydrates in global climate change and will provide insights into the technical challenges facing the development of natural gas hydrates as an energy supply. Project success may significantly augment the energy self-sufficiency of areas with extremely cold winters and those regions now dependent on others for energy supply.

Sustainable Development Potential of the Project

Natural gas is the cleanest burning conventional hydrocarbon and is likely to become a dominant energy source in the future. Well production tests in Mallik will improve understanding as to how the gas in natural hydrates can be harnessed as an energy source. The result may be increased use of clean-burning methane (relative to sulfurous coal, for example), which would help to reduce greenhouse gas



Mallik 3L, 4L, 5L

- Spud December 25

- Completion March 14

Taglu Staging Site

760 tons of equipment staged in summer,
mobilized to site in December 2001

emissions worldwide. In addition, if investigations into storing CO₂ in depleted hydrate reservoirs prove promising, there may be further reductions in emissions. The new drilling, production, and geophysical technologies tested in this project are significant and may lead to new industrial development.

A better understanding of gas hydrates will also help in assessing potential impacts of their release on future climate change and in developing techniques to avoid or mitigate hazardous conditions posed by gas hydrates to drilling and pipeline construction. This fundamental research may ultimately have a significant impact on national energy policies.

Technical Data

Technologies used in the project include Vertical Seismic Profiling (VSP), crosshole tomography, conventional two- and three-dimensional seismic surveying, newly developed logging techniques, mass spectrometry, and distributed optical fiber temperature sensing (DTS).

Technology Transfer Potential

Approximately 20% of the land area in the Northern Hemisphere is underlain by permafrost. Consortium members participating in the Mallik project from Germany, Japan, India, the United States, and Canada will be able to share with neighboring countries the information on improved technologies for drilling and production. Scientists will be

better prepared to tailor the technology and production information to regional and local conditions and will help address the energy concerns that have a direct effect on the economy and development of these regions.

Participants and Roles

Key research and funding partners include the USDOE, JNOC, GFZ, GSC, MOPNG, and ICDP.

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EXAMPLE ENABLING POLICY ENVIRONMENT PROGRAMS

South Asia Regional Initiative for Energy (SARI/Energy) Training

Project: South Asia Regional Initiative for Energy (SARI/Energy) Training

Location: Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka

Key Issues: Regional grid and energy exchange; legal, policy, and regulatory frameworks; regulation and regulatory bodies; energy efficiency

Sector: Energy industry, regulators, ministries of power and energy, independent power producers

Application: Efficient power-sector management and operation in a free-market environment

Implementer: Academy for Educational Development (AED)

Duration: 2000–2003

Background

The South Asia Regional Initiative (SARI) is a multifaceted initiative aimed at fostering regional cooperation. The United States Agency for International Development (USAID) has focused one element of SARI on energy development (SARI/Energy) and encouraged the cooperation and eventual trade in energy resources among the countries of South Asia. Achieving this objective will require firm commitments by the governments in the region, through national policies and international agreements, to support cross-border cooperation in energy and to mobilize critical private-sector capital, technology, and management expertise.

The SARI/Energy Program serves as a vehicle to bring together energy-sector players from both public and private sectors across the region to discuss and resolve issues that impede cooperation and investment in energy development. Program support helps countries develop the appropriate policy, regulatory, and investment environments to encourage private-sector investment. Program support is designed to facilitate a long-term process of rationalizing energy supply and distribution across the region, which includes the development of the cross-border infrastructure and market mechanisms that will be required for eventual trade in electricity and natural gas.

The program's first phase is improving institutional and professional capacity for making decisions in sustainable energy development; promoting private-sector participation in and encouraging civil society support for energy development; and strengthening regional forums, networks, and associations for cooperation and advocacy on energy development. By fostering cooperation that builds on mutual economic interests, the program promotes the use of clean-energy technologies, helps

stimulate economic growth in the region, and expands US investment and export opportunities.

USAID's Role

USAID provides funding to the AED to develop and provide training in South Asia.

Project Activities

The SARI/Energy Program delivers training opportunities that bring regional leaders, experts, practitioners, and citizens together to learn, teach, study, and share experiences and best practices in environments that foster relationship building and greater communication and understanding of the technical, financial, social, and structural benefits, barriers, and issues related to cross-border cooperation on sustainable energy practices. AED's program includes four of the five training components of the SARI/Energy Training Project: regional grid and energy exchange; legal, policy, and regulatory frameworks; regulation and regulatory bodies; and energy efficiency.

The AED's role in this project is to help demonstrate the benefits of regional cooperation; transfer knowledge and skills to institutions and individuals; equip participants with social marketing skills; share global experiences and best practices (what does and does not work) in technical areas; and identify opportunities and barriers to regional cooperation in sustainable energy supply and use.

Outreach to Stakeholders, Information Sharing, and Skill Building

During 2001, the AED developed and delivered 10 courses in the 4 technical areas in 4 countries. The AED training teams trained approximately 250 participants from Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka from ministries, other government agencies, power companies, the media, the private sector, and nongovernmental organizations. The AED also began the development of two distance-learning courses on Regulation and Environmental Impact Assessments and launched the training component of the project Web site. In the year 2002, 12 conventional courses and 4 distance-learning courses in all the programmatic areas are available. As of April, 89 participants have been trained in 3 courses.

Building a consensus among energy-sector professionals in the region who can initiate and influence policy changes requires the direct involvement of a variety of stakeholders from the region. The AED is reaching some stakeholders through conventional (face-to-face) training but is also reaching

out to a larger group of stakeholders with several alternative training approaches:

1. Distribution of course materials via CD-ROM so that participants can share the information with colleagues;
2. Placement of all course materials on the project Web site for remote access; and
3. Development of distance-learning courses (for the Web site and CD-ROM) to increase the audience outreach at minimal additional cost.

The basic objective of these strategies is to provide tools for multiplying the numbers of those exposed to the material and thus accelerate the process of awareness, understanding, and action. These materials also provide a way for course participants to reinforce their knowledge through easy access to the information. The philosophy underlying the AED approach is that the more people with access to information and understanding, the better the likelihood that policies will be implemented and supported.

Capacity Building in the Region

The AED is actively exploring the possibility of strengthening the linkages between SARI/Energy and energy-training institutions in the region by creating knowledge centers that will ensure continuity of the initiative in energy cooperation and development in South Asia. About 30 institutions from all the SARI/Energy countries are being evaluated on the basis of technical credibility, expertise, resources, and willingness to actively participate. Ten technical areas related to regional energy issues have been identified, and about one institution per technical area will be selected. Through this, the AED will attempt to build capacity in the regional institutions to continue the work initiated under the SARI/Energy Project.

Results

This program seeks a critical mass of participants who will return to their jobs after training and have an individual or collective impact on their colleagues and institutions regarding regional cooperation in energy. AED training activities provide opportunities for participants to interact with counterparts within the region; to increase understanding of neighboring country perspectives and options; and to strengthen networking with counterparts in other SARI/Energy countries. Training alumni are helping to spearhead policy changes by initiating dialogue and bringing regional issues in focus. More specific outcomes are listed below.

Media Outreach - In recognition of the strong influence of national and regional media on the public and opinion leaders, the AED held one training course specifically for the media about regulatory issues in South Asia. In addition, the AED encourages participation by journalists in other courses. Specific outcomes of these efforts include:

- Articles written in the Nepalese journal *Spotlight* - "There are Vast Opportunities for Regional Cooperation in Harnessing Energy"
 - "Private-Sector Participation Vital to Energy Restructuring"
 - "Nepal Should Develop Export-Oriented Power Projects."
- Articles written on energy theft by participants in the Billings and Collections course with follow-up articles subsequently prepared by two daily and weekly newspapers.

Government - Government officials are sharing information with colleagues after attending AED events. After attending a course on Marketing Energy Efficiency, the Director of the Information Technology Department at the Nepal Electricity Authority (NEA) reported that he was placing information on the NEA Intranet and the NEA Web site for the benefit of the staff and Nepalese people.

Participants from a course on Regulatory Commissions have incorporated lessons learned from the course into the development process of the Bhutanese Regulatory Commission and into Sri Lanka's pending electricity laws.

Upon completing a course on Billing and Collection Issues, a Nepalese participant has been working with his Director General at the NEA to initiate best practices learned from Bangladeshi, Sri Lankan, and Maldivian participants during the course.

Private Sector - A consultant from the Industrial Services Bureau in Sri Lanka reports that participation in the SARI/Energy course on Marketing Energy Efficiency contributed to convincing clients to invest in energy-efficiency projects. Attendance in the course taught him the tools he needed to make a convincing case to clients.

Feedback - Finally, the AED has received letters containing impressions and thanks for course materials from various participants, two examples of which are quoted below. Efforts will continue to capture the perceptual and tangible outcomes from the SARI/Energy initiative.

"The course [Standards and Labeling for Appliances] was quite relevant to India...as the GOI [Government of India] is about to establish a lead agency for implementation of the standards and labeling regime in the country. The experience of the other countries could be quite useful for framing strategies for enforcement of the regime," Deputy Secretary, Ministry of Power, GOI.

"I am entrusted with the responsibility of coordinating the restructuring process and the media...[attending the workshop] enabled me to exchange experiences and ideas...The exposure and experience I received at this workshop would...assist me in carrying out my duties..." Senior Assistant Secretary, Ministry of Power and Energy, Sri Lanka.

South Asia Regional Initiative for Energy (SARI/Energy) Rural Electrification Services (RES)

Project: South Asia Regional Initiative for Energy (SARI/Energy) Rural Electrification Services (RES)

Location: Throughout South Asia (Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka)

Key Issues: Rural energy models and best practices in rural electrification in South Asia

Sector: Energy, rural energy development, renewable energy, financing

Application: Best practices in rural electrification operations, management, planning, and financing

Implementer: CORE International, Inc.

Duration: Series of targeted training courses from September 2000 through June 2003

Background

The SARI/Energy Program was designed by the United States Agency for International Development (USAID) to assist South Asian countries in addressing the challenges of providing sufficient energy for continued economic growth. This regional initiative complements ongoing bilateral energy programs of the USAID, while coordinating the program's efforts with the multilateral banks (Asian Development Bank/World Bank), other bilateral agencies, local nongovernmental organizations (NGOs), research institutes, the private sector, and numerous other stakeholders. The SARI/Energy Program's objective is to improve South Asian country policies and agreements for cross-border cooperation for sustainable energy to facilitate the longer-term process of rationalizing the energy supply and its regional distribution. CORE International, Inc., is implementing the RES component of the program



through targeted training and institutional capacity-building activities.

USAID's Role

USAID provides funding for SARI/Energy RES under the Electricity Generating Authority of Thailand/Energy and Environment Training Program (EETP). The SARI/Energy Program coordinates its efforts with the multilateral development banks (Asian Development Bank and World Bank), other bilateral agencies of various donor countries, the private sector, local NGOs, research institutes, industry associations, and other stakeholders.

Project Activities

Through the EETP, CORE is implementing the RES component of the SARI/Energy Program. The RES Program focuses on sharing the best practices of the various rural electrification models in order to address the rural energy supply problem that exists throughout South Asia. The "keys to success" for increasing rural access to energy include building rural energy institutional capacity; involving the private sector in rural energy supply; and realizing best rural energy practices demonstrated in South Asia. Through targeted training activities, CORE is assisting political leaders, utility executives, the private sector, and other stakeholders to compare the differences between urban and rural distribution utilities and to build an understanding of the ways to best develop rural electric programs in South Asia and expand them beyond the supply of electricity only.

The five major components of the RES Program include (1) identifying a number of best practices regionally shared that will promote increased availability of commercial energy services to rural and/or lower income consumers, (2) identifying a number of new priority plans for increased rural electrification forwarded by regional governments, (3) increasing commercial energy services provided to rural and/or lower income consumers, (4) increasing the means for information exchanges for promotion of best practices, and (5) preparing trainers to transfer skills to increase the availability of commercial energy services to rural and/or lower income groups throughout the region.



CORE's Program activities include site visits and exchanges, workshops, roundtables, and in-class training. CORE has completed a workshop on Rural Energy Models and Best Practices in Bangladesh and five one-week courses for key South Asia energy officials on a variety of rural energy planning and implementation issues. These courses include tariff setting, application of renewable energy technologies to remote low-density loads, regulating rural electric utilities and off-grid supply systems, private power financing, and the roles of NGOs and village-level institutions in rural electrification program development and implementation.

Results

Because of USAID's efforts, SARI/Energy's RES Program is having an impact. Several examples worth noting include the use of the successful Bangladesh model of billing and collections by energy officials from Nepal and Sri Lanka; the use of Nepal's proven private power law by officials from Sri Lanka in developing their own private power law for rural applications; and the adaptation of successful elements of the World Bank/Global Environment Facility (GEF)-funded Energy Service Delivery Project (ESDP) implemented in Sri Lanka by energy officials from Bangladesh and Nepal. USAID will be supporting a follow-up survey of each of the more than 100 participants thus far in the program to document additional examples of how the SARI/Energy RES training activities have improved their country's approach to rural energy operations, planning, financing, renewable energy utilization, and rural energy development.

Egyptian Environmental Policy Program (EPPP)

Project: Egyptian Environmental Policy Program (EPPP)

Location: Egypt

Key Issues: Environmental policy, institutional and regulatory reforms, energy efficiency, clean energy, waste management, sustainable tourism, nature conservation

Sector: Energy industry, regulators, ministries of power and energy

Application: Training, social marketing, consensus building

Implementer: Academy for Educational Development (AED)

Duration: 2000–2001

Background

The EPPP is a multiyear activity to support policy, institutional, and regulatory reforms in the environmental sector that focus on economic and institutional constraints, cleaner and more efficient energy use, reduced air pollution, improved waste management, sustainable tourism best practices, and nature conservation. The EPPP is designed to enable the Government of Egypt to strengthen its priority environmental policies. It emphasizes improvement of the system of environmental management and related institutional capabilities, complements policy measures with related technical assistance, and is designed to maximize flexibility in addressing current and emerging issues in a dynamic policy situation. The EPPP reinforces policy development and implementation with public awareness and training to increase the participation of Egyptian partners, nongovernmental organizations (NGOs), and the general public, and to create environmental private-public partnerships.

USAID'S Role

The United States (US) Agency for International Development (USAID) funded the AED to design and implement the public awareness component of the EPPP, working in concert with Egyptian counterpart agencies and other USAID-funded contractors.

Project Activities

The AED provides public awareness, communication, and education support to the EPPP, a national program serving various stakeholder groups such as government, educators, NGOs, journalists, developers, investors, policy makers,

and the general public. Specific groups within the environmental community that the EPPP has closely supported include:

- The Egyptian Energy Service Business Association (EESBA). An industry association, EESBA addresses current market barriers facing the energy-efficiency business community and works toward solutions that expand energy-efficiency applications in Egypt. The association participates in policy development forums, communicates its message to target business groups and government leaders, and helps build the capacity of its members to meet market needs.
- The Organization for Energy Planning (OEP). An independent entity reporting to the Egyptian Ministry of Petroleum was created to undertake comprehensive and integrated energy planning within the framework of the socioeconomic development process in Egypt.
- The Energy Efficiency Council (EEC). A body of 12 organizations representing 7 ministries and 2 private-sector groups, the EEC was formed to develop a National Energy Efficiency Strategy (NEES) and foster interagency cooperation promoting and guiding energy-efficient practices in Egypt. The EEC is a voluntary consortium of organizations associated with the generation, distribution, and use of energy resources in Egypt.
- The Egyptian Syndicate of Journalists.
- The Ministries of State for Environmental Affairs, Electricity and Energy, and Petroleum.
- Egyptian preparatory and secondary teachers, educators, and educational NGOs.

Results

The EPPP operated by the AED has reached millions of people in Egypt's urban population through various national press and national public awareness efforts — from sophisticated print media for the professional sector to more accessible general population outreach methods such as road signage. Direct participants in specific educational activities such as workshops include 65 environmental journalists from around the country; 517 teachers from 56 schools in 7 governorates; 170 librarians nationwide; and 20 NGOs from 14 governorates. In every case, efforts were made to achieve gender equity. Seventy-two products and publications were produced and distributed to over 400,000 people through these efforts. The general result has been an increased awareness

and public understanding of the benefits and importance of resource conservation and the institutions that are charged with their protection. More specific outcomes are listed below.

- EESBA: Through this program, the AED provided public awareness information and materials as well as support for the establishment of EESBA's membership, including energy service companies, energy-efficiency equipment and service providers, financial institutions, relevant government agencies, and consulting firms associated with the energy service business.
- OED: As part of the EEPP, the AED worked to strengthen OEP's institutional capacity through production and dissemination of public awareness and information materials on a national energy-efficiency strategy.
- EEC: The AED has worked with and contributed to the operation of the EEC and provided pivotal assistance in the development of the NEES.
- Egyptian journalists: The AED participated with others in staging a briefing on energy efficiency in Cairo in December 2001 for more than 65 journalists involved in the Egyptian Syndicate of Journalists. The session entitled "Energy Efficiency and Future Challenges" was organized to increase the knowledge and understanding of print and broadcast media representatives about energy resources, consumption patterns, and energy pricing. The session included a video produced by the AED featuring the history of energy and current energy-efficient technologies available in Egypt, along with best practices in energy conservation and presentations by the Egyptian Environmental Affairs Agency, EESBA, and other industry groups. Products from the session included a series of 10 fact sheets on energy consumption and energy-efficient technology in Egypt, produced and disseminated by the AED. Over 65 journalists attended the workshop representing public and private newspapers, TV stations, radio, and magazines.
- Ministries: The AED and the *Al Ahram* newspaper cosponsored a policy symposium on "Energy and Sustainable Development" in June 2001, spearheaded by the Minister of State for Environmental Affairs, the

Minister of Electricity and Energy, and the Minister of Petroleum. With 130 participants representing policy makers and academics, the seminar marked an important milestone as it gave the largest press institution in Egypt the opportunity to take ownership of the energy-efficiency issue and find a visible spot for it on the Egyptian political agenda. *Al Ahram*, the largest newspaper with the heaviest circulation in Egypt, featured full-page articles on the symposium and energy efficiency in Egypt in three subsequent issues of the Friday edition of the paper, the edition with the largest circulation. As a follow-on to these activities, a workshop was held, and the proceedings were published and disseminated widely among participants and other relevant stakeholder groups.

- EEC: The AED contributed to the public awareness of the EEC through publications and media coverage, resulting in the EEC being publicly acknowledged as the body leading the preparation of energy-efficiency policy. The AED sponsored a series of workshops and retreats for the development of the NEES, which serves as a road map to increase Egypt's efficient use of its natural resources. The project further assisted the EEC in forming strategic alliances with the media, investors' associations, NGOs, policy makers, financial institutions, international organizations, educational institutions, and research organizations.
- Educational community: The AED completed the research and development of an educational learning supplement for preparatory and secondary teachers in schools and educators in NGOs in Egypt. The learning supplement allows educators to integrate energy-efficiency concepts in existing curriculum and nonformal education programs. The package includes fact sheets, background papers, classroom-tested learning activities, a 15-minute video on energy efficiency in Egypt, and a CD-ROM. The learning supplement is distributed at workshops demonstrating the best use of the materials for age-appropriate learning experiences. These workshops build on previous solid waste management and environmental education workshops, both of which included sections on energy efficiency.

Egyptian Electric Regulatory Project (EERP)

Project: Egyptian Electric Regulatory Project (EERP)
Location: Cairo, Egypt
Key Issues: Energy policy, institutional and regulatory reforms
Sector: Energy industry, regulators, ministries of electricity and energy
Application: Increased access to sustainable utility services
Implementer: Academy for Educational Development (AED)
Duration: August 1, 2001, to January 31, 2003

Background

The Government of Egypt is establishing and organizing the Electric Utility and Consumer Protection Regulatory Agency as a financially independent regulatory agency within the Ministry of Electricity and Energy. The purpose of this program is to provide technical support and training to the Electric Utility and Consumer Protection Regulatory Agency regarding personnel, resources, and capacity building to assist the Managing Director and agency staff in becoming fully operational as rapidly and efficiently as possible.

USAID'S Role

The United States Agency for International Development (USAID) mission in Egypt has had a long history of involvement in promoting change and sustainability in the Egyptian power sector. Beginning in 1994, the Government of Egypt enacted new laws and decrees that have resulted in major power-sector reforms. There is increasing recognition of the importance of private-sector participation, which requires the functioning of an independent regulator in order to be maximized. The program carried out by the AED reflects the continued commitment to power-sector restructuring and privatization by the Government of Egypt through support for improved decision making and management by host country institutions. It further reflects the long-standing commitment of USAID to meeting the challenges of economic, financial, social, and environmental sustainability of the Egyptian power sector. USAID is currently supporting four projects to reform the electricity sector, of which EERP is one. The EERP Team works closely with colleagues in other USAID energy projects.

Project Activities

The EERP Team provides a combination of training and technical assistance. The project is leading 10 tasks, designed

to provide the needed technical assistance and training to the Regulatory Agency so that the agency is fully operational and the Managing Director and his staff are skilled at meeting the responsibilities assigned to them in the enabling Presidential Decree. Activities include development of a Strategic Plan and an Information Plan for the agency, together with the software and hardware to carry out the Information Plan. The EERP is providing technical assistance and training in tariffs, licenses, contracts, procedural guidelines for tariffs and licenses, codes of conduct for participants in a reformed, competitive power market, and development of a consumer protection system for the agency. The project brings specialists in utility regulation from the US for focused training events to complement the project training.



Results

The EERP has provided significant technical assistance and training to the Egyptian Regulatory Agency since its launch in August 2001. As the agency's Managing Director, Dr. Mohammed El Sobki (pictured) continues to develop his technical team and office infrastructure. The EERP Team has served as his virtual staff and technical advisory team combined. Specific accomplishments and results of the program to date include:

- Publication of a series of more than 20 technical reports on the most pressing aspects of regulatory

practice: licensing and tariffs. Result: The agency is well-poised for licensing private entrants into the energy marketplace and for ensuring the creation of reasonable and fair tariffs as the advent of actual privatization draws near. Prompt and reasonable treatment will set an important tone for a smooth transition to the new market system.

- **Seven training presentations have been made with guest faculty from a range of areas of expertise in energy-sector regulation. Result:** Identified new regulatory staff have already secured a strong foundation of knowledge regarding their emerging roles and responsibilities. EERP's efforts are helping to ensure that the staff will be ready for the tasks ahead regardless of delays being experienced in formal staff hiring and reassignment.
- **Rules and procedures for the agency have been produced by the EERP, translated into Arabic, reviewed by legal counsel, and widely distributed. Result:** A most important tool for infrastructure development has been disseminated in a form readily accessible to all parties, helping to set an important tone of transparency that is a cornerstone of effective regulation.
- **Development of the Needs Assessment Report for the Information Management System. Result:** This document first provides the blueprint for equipment purchase, system design, and installation that will take place during this next phase of work. Second and more important, the designed system will facilitate accessibility to a complex flow of information in a manner that will underscore a philosophy of transparency. The system design effectively balances the need for confidentiality of data from market actors, while providing consumers and regulators with access to the information necessary for ensuring fair conduct and accomplishing the various regulatory oversight functions.
- **EERP senior team members and guest faculty participate in monthly meetings of the agency's Board of Directors. Result:** The initial commitment made by the Project Chief of Party to the Board of Directors when

the project was launched was to fully serve the needs of the agency and to act as an "extension of staff" until such time as the permanent staff is in place and fully functioning. This message has been consistently reinforced by the responsiveness of the EERP to the Board and Agency Director regarding inquiries on various regulatory issues, precedents, and challenges. The regular invited attendance of senior EERP staff underscores the regard in which the team and its work product is held by the Board of Directors, and is a relationship that helps to strengthen the confidence of decision makers, in general, regarding the uncharted waters of energy-sector reform.

There is a critical dimension to this list of accomplishments that must be recognized in any consideration of "results." The rapid development of technical products is helping to quickly educate all stakeholders, including the Agency Board of Directors, which approves agency expenditures and, as such, controls the speed with which the agency is deployed, thus ensuring that the reform process continues to move forward. The momentum created and sustained by the EERP Team is a strong impediment to the inertia that can sometimes plague processes of major change such as sector reform. As the project continues to maintain its steady pace and expand its audiences to the public sector and other indirect parties, the process of change may accelerate. Even so, regardless of the pace of change, a strong foothold of regulatory capacity has been built through the significant assistance of the EERP. As the next phase of work proceeds — including purchase and installation of the Regulatory Agency Information System, and two US-based Study Tours for staff, Board of Director members, and opinion leaders in the energy sector — market participants and consumers alike will expand their understanding of and faith in the independent role and functions of the emerging Egyptian Regulatory Agency.

