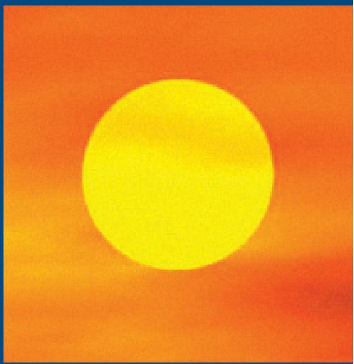
Energy for Sustainable Development

in Asia and the Pacific Region:

Challenges and Lessons from UNDP Projects



United Nations Development Programme

The cover photographs of the sun, water and biomass symbolize sources of renewable energy that are fundamental to supporting the life systems of our planet. The picture of a family enjoying electric lighting signifies the pivotal role of energy to provide better learning environments for children, which are needed to ensure sustainable development and to meet MDG's.

The orange colour of the text represents the colour of the sun, which is a primary source of renewable energy.

Cover photograph courtesy of Manit Sriwanichpoom for United Nations agencies in Bhutan.

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Energy Working Group in Asia and The Pacific

The initation of the *Energy Working Group (EWG)* in Asia and the Pacific was based on the concept of bringing together staff from regional UNDP Country Offices, who were interested in energy and sustainable development, to form a working group for sharing experiences and lessons learned among energy practitioners. The EWG was launched during the Energy and Environment Regional Workshop, in November 2002, in Kuala Lumpur. The workshop identified the energy focal-point of UNDP Nepal, Tek B. Gurung, as a "Champion" to lead the EWG process, facilitated by the *Sustainable Energy Team* based at the Bangkok SURF, UNDP. As a first step, a series of electronic discussions was organized to identify key EWG activities. One of the main activities identified was the preparation of case studies based on UNDP supported energy projects implemented within the region. This publication is a good example of the EWG effort. Currently, the EWG has 44 members, of whom 21, from 14 countries, represent UNDP Country Offices; 23 are UNDP Policy Advisors and Programme Specialists.

During the Energy and Environment Practice Workshop held in Bangkok in May 2004, the need to expand the EWG into a fully-fledged "community of energy sub-practice", including practitioners from UNDP supported energy projects was agreed on. It was also suggested that UNDP project professionals/practitioners/policy advisors dealing with UNDP's core development practices (such as environment, poverty and democratic governance) need to be encouraged to join the team for cross-fertilization of cross-practice initiatives and innovations. Based on the recommendations, requests for lists of selected energy practitioners engaged in UNDP supported projects were made to UNDP Country Office energy focal points. With these additions, the EWG – expanded into *Community of Energy Sub-practice in Asia and the Pacific (CEPAP)*, – now has a total membership of 104. CEPAP is envisaged to:

- function as a vibrant community of practice around energy and cross-practice linkages, which contributes to enhancing the effectiveness of UNDP programming in the energy and non-energy sectors;
- heighten awareness of the linkages between energy and other (sub) practices, including contribution of energy to advance development objectives (including achievement of the Millenium Development Goals); and,
- make a contribution from Asia and the Pacific to the evolution of the UNDP as a practice-based organization in the field, including codification of data, information sharing and knowledge management at the global level.

For further detail or to express your interest in becoming part of the field-based practice initiative, please contact the facilitator, *Sooksiri Chamsuk,* at *cepap@undp.org*

Foreword

Poverty reduction remains a profound challenge in Asia and the Pacific Region, and, despite continued economic growth, 800 million people remain in abject poverty. As poverty is seen as a major contributor to increased pressure on the environment and natural resource base, it continues to pose a challenge for formulating sustainable development policies and practices. The availability of energy resources, the demands for energy, and its links to poverty, have thus emerged as a critical challenge in the region. In response to these challenges, UNDP's second Regional Cooperation Framework (2002-2006) places poverty reduction at the center for achieving sustainable development.

The urgency of energy efficiency, and the quest for renewable sources, is underlined by the recent rise in the price of oil. At over US$ 50 a barrel, energy imports are putting an enormous strain on the balance of payments and development possibilities of many poor countries. Energy affects practically all aspects of social and economic development, including livelihoods, water, agriculture, population, health, education, job creation, and gender-related issues. Energy is thus central across all the Millennium Development Goals. The main thrust of UNDP's approach to energy is to focus on creating equitable access to affordable, reliable and clean energy services so as to contribute significantly to economic growth and poverty reduction. UNDP has by far the largest energy portfolio among all UN agencies and the portfolio is going rapidly. During 1996-2003, its total energy programme portfolio amounted to US$ 1.96 billion, with over 370 energy projects in 159 countries. The Asia-Pacific Region represents the largest focus in UNDP's efforts in implementing energy programmes at the country and regional level through its core-funded energy activities and its role as a Global Environmental Facility (GEF) implementing agency.

As a follow-up to the 2002 Asia-Pacific Regional Energy and Environment Focal Point meeting in Kuala Lumpur, an Energy Working Group was initiated, with voluntary membership from CO energy focal points, to share experiences and lesson learned. Under the auspices of the Energy Working Group, and facilitation by the sustainable energy team based in Bangkok SURF, the paticipating CO focal points prepared case studies of selected energy projects, as documented in the form of this publication. The aim of this publication is to contribute to the transformation of UNDP as a knowledge-based organization. The results of the exercise offer key lessons for replication and strategic fine-tuning for the development and formulation of energy programmes/projects. The lessons yielded by the case studies have been many, and are invariably influenced by their country contexts, and, institutional backgrounds. Key lessons about participatory approaches, technology choices and policy options are summarized creatively. The role of energy in poverty reduction is a consistent theme through the Report.

This publication is the first of its kind and a good example of UNDP's engagement to codify, synthesize and document lessons and challenges faced during the implementation of UNDP supported energy projects in the Asia and the Pacific Region. I am confident that this publication will strenghten the knowledge base among the energy, environment and development practitioners at all levels, and that the documented case studies will provide valuable insights for our efforts in advancing the achievement of the MDGs.

Hafiz Pasha
Director
Regional Bureau for Asia and the Pacific

List of Unit Abbreviations

Table A1: Unit Abbreviations

bbl	barrel
t	tonne
m/s	metre/second
m^2	square metre
km^2	square kilometre
m^3	cubic metre
Tcf	trillion cubic feet
A	Ampere
kVA	Kilo volt-ampere
Wp	Watt peak
kW	Kilowatt
MW	Megawatt
GW	Gigawatt
kWh	Kilowatt-hour
kWh/m^2	Kilowatt-hour/square metre
kgoe	Kilograms oil equivalent
ktoe	Kilotonnes oil equivalent

Table A2: Unit prefixes

k	kilo (10^3)
M	mega (10^6)
G	giga (10^9)

Chapter 1

Energy for sustainable development: Challenges for Asia and the Pacific and lessons from UNDP projects in the region

K.V. Ramani[1]

Abstract

Energy strategies to support the Millennium Development Goals (MDGs) – especially, the goal to halve extreme poverty in the developing world by 2015 – need to address both "human poverty" (deprivation of basic social needs) and "income poverty" (lack of employment and economic opportunities). They need to overcome three critical barriers that inhibit the provision of modern energy services to the poor: physical ***access*** to modern energy services; ***affordability*** of such services; and the absence of ***choice*** to match the most cost-effective and environmentally sustainable resource/technology solutions to specific energy needs. Shifting towards such strategies is a daunting challenge given that two billion people in the world today have no electricity and the same number of people rely on traditional biomass fuels.

UNDP has focused on "energy for sustainable development" since 1996 through a series of initiatives. The Asia-Pacific region has featured prominently in UNDP's energy efforts, in terms of both resources committed and number of projects implemented. Case studies of seven UNDP projects on energy for sustainable development in the Asia-Pacific region offer valuable lessons for the future. The most important are: (a) participation is the key to successful delivery of modern energy services in rural areas; (b) technology options must remain open and be development-needs driven; and (c) policies to promote energy services for productive applications can maximize development effectiveness. The case studies also suggest that country diversities will offer different entry points for energy in the context of poverty reduction and, therefore, a "one size fits all" approach should be avoided.

1. Energy strategies to support the Millennium Development Goals

Access to energy services is indispensable for achieving the Millennium Development Goals (MDGs)[2], foremost of which is halving extreme poverty in the developing world by 2015. Although the MDGs do not explicitly refer to energy, none can be achieved without the availability of adequate and affordable energy *(Box 1-1)*. As noted by the Commission on Sustainable Development at its ninth session in 2001: "To implement the goal accepted by the international community to halve the proportion of people living on less than US$1 per day by 2015, access to affordable energy services is a prerequisite". The global community echoed this view at the World Summit on Sustainable Development (WSSD) in 2002 and agreed upon the need for policies and initiatives to accelerate the provision of modern energy services, particularly in rural areas where poverty is most concentrated.

To help reduce human and income poverty, energy strategies that support the MDGs need to focus on the issues of energy, poverty and social equity (in particular, gender equity) and how they interact. This nexus includes environmental sustainability. For instance, a focus on productive uses of energy services can help to increase incomes and create wealth to reduce the number of people living below the poverty line. In the process, it can also ensure

1 Senior Energy Consultant, UNDP.

2 Adopted by the UN Millennium Summit, September 2000.

energy security at the local level by enhancing the poor's economic self-reliance. Implementing such energy strategies requires a major shift in policy and it is a critical challenge for developing countries.

Box 1-1: Energy and the Millennium Development Goals

To halve extreme poverty: Access to energy services facilitates economic empowerment – micro-enterprises, livelihood activities beyond daylight hours, which will create employment.

To reduce hunger and improve access to safe drinking water: Energy services can improve access to pumped drinking water; 95 percent of staple food needs cooking before it is safe to be consumed.

To reduce child and maternal mortality, and to reduce diseases: Energy is a key component of a functioning health system, refrigeration of vaccines and other medicines, sterilization of equipment and transport to health clinics.

To achieve universal primary education and to promote gender equality and empowerment of women: Energy services reduce the time spent by women and children (especially girls) on basic survival activities (gathering fuelwood, fetching water, cooking, etc.); lighting also permits home study, increases security and enables the use of educational media and communication technologies.

To ensure environmental sustainability: Improved energy efficiency and use of cleaner alternatives can help to achieve the sustainable use of natural resources, and reduce emissions to protect the global environment.

To promote global partnership for development: Energy services can be an entry point for addressing development challenges through global and regional cooperation, and partnership with stakeholders to promote sustainable energy solutions.

UNDP, 2002

Globally, two billion people have no access to electricity and the same number of people rely on traditional biomass for cooking, agro-processing and heating. This means that four out of five people depend primarily on biomass fuels and exist without electricity; they live in rural areas of the developing world, mainly in South Asia and sub-Saharan Africa. That these people also happen to be poor is more than just a coincidence.

The lack of access to modern fuels and electricity symbolizes poverty and it is a barrier to improving key indicators of human development including, in particular, income. Energy deprivation critically hampers people's prospects of escape from the poverty trap, whereas its availability induces a range of benefits capable of triggering wider social and economic changes in their lives.

The role of energy in poverty reduction revolves around the issues of *access, affordability and choice*. Centrally produced electricity and modern fuels do not reach many of the poor who live in rural areas due to the remoteness of their locations and the high costs of delivery. Even in rural (and peri-urban) locations where communities as a whole have access to energy services, the poor among them may lack purchasing power in the absence of financial alternatives, such as micro-financing and consumer credit. Given this situation, poor households have to forego the benefits of energy services, which could have been employed for income-generating activities. Many people, in effect, suffer from a *vicious circle of energy poverty* whereby the inability to buy energy services results in low productivity, low quality of outputs and an inability to release labour for economic activity which, in turn, lead to low returns on investment and labour inputs, again limiting the capacity for energy investments.

Within this context, women are affected more adversely than men. They, together with their children, collect much of the traditional fuel that poor households rely upon in the absence of modern energy, and they spend long hours each day on cooking and household chores; this reflects human drudgery, perpetuated by the lack of modern energy alternatives. The impacts of energy deprivation on women range from serious health effects due to indoor pollution from the use of biomass fuels to lost opportunities for self-improvement and family well-being through the betterment of social and economic status.

Ensuring a wider *choice* of modern energy services is, therefore, critical to meet the needs of the poor. This implies providing them with access to a wider range of options in technologies, service providers and service delivery mechanisms. At the same time, distinguishing between the poor's energy needs in general and those of poor women in particular can help resolve gender inequity and poverty at large. *People-centred and pro-poor* approaches are needed if the MDGs are to be achieved in little over a decade from now.

2. UNDP's approach to energy for sustainable development

UNDP's current approach to sustainable energy originates in its 1996 Initiative for Sustainable Energy (UNISE), in which sustainable energy was defined as energy produced and used in ways that support long-term sustainable human development. UNDP has a well-defined presence in sustainable energy issues through its core-funded energy activities and its role as a Global Environmental Facility (GEF) implementing agency at national, regional and global levels. UNDP has by far the largest energy portfolio among all UN agencies and its energy portfolio is growing rapidly. From 1996 to 2003, its total energy programme portfolio amounted to US$1.96 billion, with the implementation of over 370 energy projects in 159 countries via the mobilization of local, national and global partners. The World Energy Assessment (WEA)[3], established by UNDP, UNDESA and WEC in 2000, conceptually underpins UNDP's efforts in energy. In 2001, UNDP launched the Thematic Trust Fund on Energy for Sustainable Development in order to further UNDP's efforts on energy to meet MDGs.

UNDP's initiatives to promote energy for sustainable human development are centred on the quality of energy service...

In recent years, UNDP's efforts in energy for sustainable development have supported the MDG to halve the proportion of people living in poverty by 2015. This has received further impetus from a series of global events, which included the ninth session of the Commission on Sustainable Development (CSD-9) in 2001, the World Summit on Sustainable Development (WSSD) in September 2002 and UNDP's Plan of Implementation containing specific recommendations on energy access to facilitate the achievement of MDGs and to establish a clear link between energy and poverty eradication. UNDP's initiatives to promote energy for sustainable human development are centred on the *quality* of energy service rather than the source of energy supply. This is evident in the most recent version of UNDP's Multi Year Funding Framework (MYFF) for 2004 to 2007, which clearly identifies access to energy services as a service line to meet the goal of managing energy and the environment for sustainable development. UNDP corporate energy priorities are set around four thematic areas:

- Strengthening national policy frameworks to support energy for poverty reduction and sustainable development;
- Promoting rural energy services to support growth and equity;
- Promoting clean energy technologies for sustainable development; and
- Increasing access to investment financing for sustainable energy.

A fifth and cross-cutting area concerns analysis and global advocacy. These elements enable multiple development concerns related to economic growth, environmental protection and social equity to be addressed simultaneously. Energy policy frameworks and their energy service delivery mechanisms are devised to meet the needs of the poor and marginalized groups, especially the rural poor. In the same context, they address environmental concerns, which are crucial to finding compatible solutions. Activities in these areas complement and help UNDP-GEF programmes in the fields of climate change and support to sustainable livelihoods.

In addition, UNDP is engaged in a number of global partnerships in sustainable energy, many of which were launched at the WSSD and which will also benefit countries of the Asia-Pacific region. These include UNDP's Global Village Energy Partnership (GVEP)[4], the World Bank and other partners. This initiative is aimed at ensuring access to modern energy services by the poor via support to action plans for energy in development frameworks; capacity development to expand the number and capabilities of rural enterprises; exchange of information and approaches related to improved delivery of energy services; and monitoring of progress on the impact of energy services on sustainable development. UNDP's LPG Challenge[5] and the World LP Gas Association (WLPGA) address barriers to meeting

3 Provides the best analytical thinking on the social, economic, environmental and security issues linked to energy, and the compatibility of different energy options; it is discussed at length in the World Energy Assessment (WEA): energy and the challenge of sustainability, published in 2000 by UNDP, UNDESA and the World Energy Council (WEC). An overview update was published in 2004.

4 www.gvep.org

5 www.worldlpgas.com

the thermal energy needs of rural and peri-urban populations in developing countries through the expanded use of a clean- burning, readily available fuel. The Global Network on Energy for Sustainable Development (GNESD)[6] is a network facilitated by the United Nations Environment Programme (UNEP) with UNDP as a partner to support information exchange, learning, analysis and research, policy support and capacity development.

3. Issues and challenges for the Asia–Pacific region

In 2000, 1.1 billion people were estimated to have incomes below one dollar a day and nearly two-thirds lived in the Asia-Pacific region: 432 million (39.2 percent) in South Asia and 261 million (23.4 percent) in East Asia and the Pacific. The vast majority inhabited, and continues to inhabit, rural areas with no or minimum access to electricity and can only afford a modicum of modern fuels like kerosene for essential lighting. Their livelihoods revolve around agriculture, often on small plots of low quality land that are subject to the vagaries of weather, and with few income-earning opportunities other than those related to farming.

As agricultural activities are largely dependent on human and animal labour, energy is chiefly used in rural areas for heating applications, mostly cooking (more than 85 percent of total energy consumption) based on biomass fuels. As many as 72 percent of the global population who depend on biomass fuels live in Asia. Empirical data show that the higher the level of biomass consumption, the higher the incidence of poverty *(Table 1-1)* and the lower the values of key human development indicators, such as life expectancy and infant mortality.

Poverty in the Asia-Pacific region is also closely associated with low levels of access to electricity. Nearly one-third of the population, more than a billion, in the region's developing countries had no access to electricity in 2000, with the average electrification rate in South Asia (41 percent) being less than half of the average for East Asia, including China and the Pacific (86 percent) *(Table 1-1)*. On a country basis, approximately 15 percent of the populations of Nepal and Cambodia had access to electricity. Again, global evidence indicates that lack of electricity coincides with poverty conditions.

Table 1-1: Poor people's reliance on traditional fuels and lack of access to electricity

Countries/region	Population below income poverty line (%)	Traditional fuel consumption 2001 (as % of total energy use)	Electrification rate (%)
Nepal	37.7	88.0	15.4
Bangladesh	36.0	63.6	20.4
India	34.7	24.3	43.0
Viet Nam	17.7	32.5	75.8
China	16.6	7.8	98.6
Philippines	14.6	33.4	87.4
Pakistan	13.4	26.6	52.9
Indonesia	7.5	24.8	53.4
Sri Lanka	6.6	34.8	62.0
Malaysia	2.0	2.3	96.9
Thailand	2.0	15.9	82.1
Cambodia	34.1	95.1	15.8
East Asia and the Pacific [7]	23.7	10.9	86.2
South Asia	39.2	23.4	40.8

Sources: UNDP, 2004; OECD/IEA, 2002

6 www.gnesd.org

7 This also includes China.

Table 1-2: Energy consumption and carbon dioxide emissions - regional comparisons

Region	Traditional Fuel Consumption (% of total energy requirements) (2001)	Electricity consumption per capita (kilowatt-hours) (2001)	Carbon dioxide emissions per capita (tonnes) (2000)
Sub-Saharan Africa	62.6	495	0.8
South Asia	23.4	554	1.1
East Asia and the Pacific	10.9	1,194	2.3
OECD	4.5	8,503	10.9

Sources: UNDP, 2004

Data on traditional fuel consumption (as percentage of total energy requirements), electricity consumption, and carbon dioxide emissions per capita reveal sub-regional variations within the Asia-Pacific area as well as similarities with other regions *(Table 1-2)*. While there is still a big gulf between the Asia-Pacific region and the OECD[8] on these three parameters, the East Asia region is closer to the OECD figures than South Asia. Regionally, traditional fuel consumption varies from 10.9 percent of total energy requirements for East Asia and the Pacific but is more than twice as high in South Asia. Electricity consumption and CO_2 emissions per capita are twice as high in East Asia and the Pacific as compared to the South Asia region. On these two parameters, South Asia shows stronger similarities with Sub-Saharan Africa, with both regions exhibiting closely comparable figures.

High dependence on biomass fuels and low electricity and overall energy consumption characterize poverty in developing Asia-Pacific countries. Yet, satisfying the basic needs of the poor requires relatively small amounts of modern energy in absolute terms. It is estimated that the quantity of electricity to meet minimum needs is only about 300 kWh per capita, per year[9]. This means that the total amount of electricity needed to meet the basic needs for two billion will be 600 TWh per year, which is less than one percent of the overall global energy consumption.

Increasing populations and mounting pressures upon regional governments to reduce rural-urban disparities will mean increased demands for modern energy. It is anticipated that by 2010 energy consumption in the region will account for one-fifth of global consumption levels. The primary challenge for developing countries in the region is to ensure "universal access" to cleaner, affordable and reliable energy services for countries that remain unserved, while accelerating transitions to more sustainable energy systems in rapidly growing economies in the region.

4. Lessons from UNDP country projects in the Asia–Pacific region

The Asia-Pacific region represents the largest focus in UNDP's efforts in energy (including TRAC[10] resources), accounting for approximately one-third of programming endeavours in the 1990s. Also, UNDP is in the process of implementing a three-year Regional Energy Programme for Poverty Reduction *(Box 1-2)* at the request of regional governments based on the lessons drawn from energy projects supported by UNDP, bilateral donors and multilateral institutions in partnership with various stakeholders at the local and regional levels.

From the scores of UNDP-supported "energy for sustainable development" projects that are being implemented or are ongoing in the region, seven case studies have been compiled to examine their conceptualization, design, delivery and outcomes *(Annex 1-1[11])*. The impacts of these diverse projects vary according to their country setting, aims and adopted implementation approaches/mechanisms. However, they have been largely positive in improving access to modern energy services promoting efficient use of energy and increasing access to financing.

The results of the exercise offer valuable insights into key lessons for replication and strategic fine-tuning for the development and formulation of

8 The Organisation for Economic Co-operation and Development.

9 WEC, 2000.

10 Target for Resources Assignment from the Core

11 Refer to the case studies for more detailed information.

Box 1-2: Regional Energy Programme for Poverty Reduction (REP–PoR)

This programme focuses on enhancing equitable access to appropriate, reliable and affordable energy services to reduce human and income poverty and to contribute towards the achievement of MDG targets through broad-based interventions in three thematic areas of priority: (i) improving access to energy services; (ii) promoting efficient use of energy; and (iii) increasing access to financing for sustainable energy. Three strategic services (policy advocacy, capacity development and knowledge management) are pivotal for translating the proposed thematic interventions to ensure that poverty reduction is mainstreamed into the energy development agenda. Partnership among various stakeholders at the national/local and regional levels is identified as a tool to sustain and continue the impact of the proposed interventions.

energy programmes/projects in the countries of the region to guide future courses of action. The lessons yielded by the case studies have been prolific and they are invariably influenced by their country contexts, institutional backgrounds and resonance or otherwise with prevailing national policy climates. The following lessons stand out in importance:

Participation is the key to successful delivery of modern energy services in rural areas

There is a need to adopt a participatory "people-centred" approach to programme/project identification, design, implementation and delivery mechnisms in energy programmes/projects. This is necessary to ensure the empowerment of local communities, with a particular focus on the poor, and can be achieved by engaging relevant stakeholders across all key stages of decision-making. The issue of empowerment is as much an issue of project implementation as it is a matter of broader national policies on governance and participation. It is also important to recognize that the introduction of modern energy technologies into a rural setting is an intrusion into a community's way of life. Therefore, helping rural communities, in particular women, to cope with the change – in terms of social, economic and environmental impacts – is critical to ensure the success of energy delivery in rural areas. Nepal's Rural Energy Development Programme (REDP) is a good example of how the extensive participation of local communities can lead to the smooth introduction of modern energy technologies. Women and women's groups are capable of a high degree of commitment and endurance to ensure project sustainability, as witnessed in Nepal. Therefore, energy policies and strategies should view women as preferred rather than concomitant participants for taking the lead in community energy initiatives that lead to their social and economic empowerment.

Technology options must remain open and be development-needs driven

There is a need to increase awareness of various technological options for the provision of energy services and their potential to enhance household incomes; it is also necessary to address communities' perceived needs for sustainable livelihoods. The process must begin with identification of the needs of poor and rural communities in general and matching of these needs with required energy services. This should be followed by identification, by the communities themselves, of suitable energy technology options based on their social, economic and environmental backgrounds. Such an approach is distinct from one that merely "identifies" a set of needs that best fits a particular energy technology of a particular scale. Since the approach essentially revolves around the end-users, it is necessary to "empower" local institutions and community groups, which are unfamiliar with the range of energy choices available, with the necessary knowledge and information. The Biomass Energy Project in India has proved successful in empowering local communities by engaging them to plan, implement and operate energy systems by themselves. In addition, it focused on sustainable livelihood issues of the community, which influenced the sustainability of the project as a whole.

Policies to promote energy services for productive applications can maximize development effectiveness

The central theme of poverty reduction through energy interventions must be to reduce unemployment and create new livelihood opportunities. Rural people are usually ready to work together and are willing to pay for energy services that cater to their multiple needs. At the same time, rural communities also need safe drinking water, health care facilities, schools, roads, communication and other infrastructure and social services. Rural energy projects should seek simultaneous gains on as many of these fronts as possible. A judicious mix of appropriate energy technologies and the blending of energy with other aspects of rural infrastructure and services are essential for sustainable rural development. The success of the REDP in Nepal has brought about positive changes in rural energy policies that ensured upscaling/replication of the project approaches in other parts of the country. Policies to ensure external financing through innovative mechanisms – such as microcredit, public-private partnerships and rural energy service companies operated by communities – are necessary, as exemplified by the cases of Bangladesh and Indonesia.

The review provides sufficient evidence of the potential economic, social and environmental benefits of decentralized rural energy options, their mutually reinforcing linkages with many other aspects of rural development and their ability – when combined with enabling government policies and good governance – to trigger social and economic empowerment.

5. Conclusions

The role of energy in poverty reduction has become more critical than ever for developing countries. This is especially the case in Asia-Pacific countries that are handicapped by the largest concentration of global poverty, and is associated with large gender differences. The experiences from UNDP energy projects in the region, and from others elsewhere across the developing world, show that while sustainable human development is a shared goal among Asia-Pacific countries, the energy paths to it are neither uniform, nor necessarily prompted by the same reasons.

Differences in country situations and priorities indicate that while sustainable energy is a common goal for the region at large, the entry points to it will vary from one country to another.

Asia-Pacific countries like Bangladesh, India and Indonesia have a substantial rural population base, high levels of poverty and large proportions of their people still exist without access to electricity or modern fuels. While they all have policies supportive of rural electrification, their people are equally in need of solutions to overcome biomass fuel scarcity and inefficient end-use technologies. The relatively low income levels of the poor prompt them to pay greater attention to productive uses of modern energy services as a means to reduce poverty and gender differences.

In other countries like Bhutan and Nepal, there are powerful arguments in favour of decentralized energy options, particularly for electricity. Given their rugged mountainous terrains, the feasibility of extending grid supplies to remote rural communities is unlikely to improve in the foreseeable future. Remoteness, thus, plays a far more compelling role in these countries than in others. At the same time, in spite of their relatively abundant forest resources, both countries suffer from localized fuelwood scarcities, so fuel issues remain equally important for them.

The Philippines, in contrast, has a high rate of rural electrification, with 80 percent of its villages and townships having adequate access. Its motivation for decentralized electrification lies more in its desire to reduce fossil fuel imports (which form nearly 58 percent of the national primary energy supply) rather than poverty concerns *sensu stricto*, although the two issues do coincide. Samoa, which has an even higher rural electrification rate of 95 percent, is motivated by equity and social justice considerations to ensure energy to the population that remains without access on small outlying islands for which the cost of grid connection is prohibitive.

These differences in country situations and priorities indicate that while sustainable energy is a common goal for the region at large, the entry points to it will vary from one country to another. While the lessons gained so far offer valuable guidelines for the future, it is necessary to avoid a "one size fits all" approach to devising energy strategies. This has special relevance to the ongoing drive towards marketization/privatization of the rural energy service provision process. If rural poverty reduction is the overarching development goal, then energy equipment manufacturers and service providers need to be far more flexible than they are in urban markets. Their marketing strategies should recognize the unique conditions of rural communities in general – and those of the poor and women in particular – and be willing to test new ideas to gain policy support where it is most readily available. Policy-makers, in turn, should provide those enabling conditions that can effectively introduce the benefits of efficient new technologies in competitive rural markets for energy while ensuring sufficient safeguards to protect the interests of the poor, women and marginalized groups.

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Annex 1-1: Overview of UNDP country project case studies in the Asia-Pacific region

Sustainable rural energy project in Bangladesh [12]
Several renewable energy systems – mostly solar photovoltaic systems, but also wind power, biogas and micro hydro systems – have been installed under this project since 1999; the energy is for illumination (in households, health clinics, schools and community facilities) and water purification and generates income (lighting for rural markets and refrigeration for fishing), with a focus on poor communities. In addition, a Renewable Energy Information Network has been developed to help planners, project developers, researchers and other interested parties; and a number of capacity-building and technology transfer activities have been undertaken for end-users, technicians and energy/energy-related institutions. Users' contributions to operation and maintenance costs of installed systems have been a key feature of the project.

Wood energy conservation projects using improved cooking stoves in Bhutan [13]
Two projects were implemented in Bhutan to reduce fuelwood consumption and collection time, and to promote forest conservation practices among rural communities and religious institutions. The projects stressed community participation and project implementation was led by the Bhutan Youth Development Association and the Tsirang Women Group. This has resulted in a substantial reduction in fuelwood consumption in households and community centres, reduced smoke and smoke-related health risks to kitchen users, and promoted wider administrative and public interest in the technology.

Biomass energy for rural India project [14]
This ongoing project is aimed at demonstrating the technical and financial viability of biomass gasification for power generation, and biogas for cooking, drinking water and lighting using participatory processes and public-private partnerships to devise financial, institutional and marketing strategies for commercial replication. The project has been structured along the WEHAB framework to generate multisectoral and multistakeholder impacts, including improvements to agricultural practices for water conservation; fuelwood resource management; enhanced local institutional capacities, and improved economic capacity of the poor to enable them to afford energy services.

Microhydro projects in Indonesia [15]
Two microhydro systems were commissioned in 2002 in East and West Java to develop local technical capacity to install and operate micro hydro systems for home lighting, to stimulate income generation and to increase the economic value of local natural resources through electrification based on community cooperatives. Water and forest resource conservation were components of project objectives, which were implemented through local village cooperatives. The projects have been economically viable and one of them has been able to enhance revenues through sale of excess power to the grid under a negotiated power purchase agreement.

Financing energy services for small-scale end-users (FINESSE) project in the Philippines [16]
This project, which was undertaken from 1998 to 2001, intended to strengthen the capacity of the Development Bank of the Philippines to develop and manage a portfolio of renewable energy projects to be implemented primarily by private sector investors. While it had limited success in creating a pipeline of renewable energy projects, it contributed to capacity-building within a national financing institution with the potential for replication among other public and commercial financing institutions.

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12 Islam, 2004.

13 UNDP, 2004a.

14 Rao, 2004.

15 Siagian, 2004.

16 Bussink and Donaire-Pamintuan, 2001.

The Rural Energy Development Programme in Nepal [17]

This comprehensive multisectoral and multistakeholder initiative has been pursued since 1996 to mobilize communities for implementing "energy embedded" rural development projects to improve rural livelihoods, enhance environmental conservation, develop local human resource capabilities (including those of women) and strengthen community and local organizations. By 2003, the programme had significantly raised rural incomes, improved health, contributed to children's education, enabled rural communities to acquire knowledge of the outside world and mobilized community savings and credit for energy and other rural infrastructure facilities, including micro-enterprises for income generation. It had also made substantial progress with institutionalizing rural energy development at the national, district and local community levels through the participation of diverse stakeholders.

Sustainable power supply project for Apolima Island in Samoa [18]

Although this project is still in its planning stages, it has generated several insights as a consequence of its preparatory studies and participatory consultative processes into balancing multistakeholder priorities against feasible technological options through a holistic cross-sectoral approach. A key finding of the project has been the social, economic and environmental cost-effectiveness of solar photovoltaic systems as a sustainable source of island power supply consistent with the needs of the local community.

17 Gurung, 2004.

18 UNDP, 2004b.

Chapter 2

Sustainable rural energy in Bangladesh: A multistakeholder and multidimensional approach towards mainstreaming renewable energy technologies

M. Aminul Islam[19]

Abstract

Bangladesh has a wide variety of renewable energy resources. While 55 percent of energy supply is based on traditional fuels, currently about 88 percent of power generation is based on natural gas. However, 70 percent of the population does not have access to electricity. Since 65 percent of the population lives in rural areas, sustainable rural energy (SRE) development is vital. The SRE project framework is owned by the Ministry of Environment and Forest (MoEF), with financial assistance from UNDP, while projects are implemented through the Local Government Engineering Department (LGED). To achieve a community-based model of development, there are three categories of activities performed under SRE projects: demonstration of renewable energy technologies (RETs); capacity building and the development of renewable energy information. At the end of the project's implemen-tation programme, widespread demonstration and dissemination of the RETs in the off-grid areas are expected. In the longer term, the technologies will also provide support as sustainable commercial activities. The SRE activities promote pro-poor, self-sustaining projects and community empowerment. The government is also taking parallel steps to ensure the replication of RETs, through the offices of the LGED located nationwide. However, since activities carried out under the SRE framework are merely for demonstration purposes, it is difficult to assess the cost effectiveness of the project.

Keywords: Sustainable rural energy, renewable energy technologies, solar electrification, community empowerment.

1. Context and background

About 55 percent of the energy supply in Bangladesh is based on traditional fuels (crop residues, animal dung and fuelwood); 24 percent on natural gas; 19 percent on imported oil and coal and the remaining two percent on hydroelectricity. Currently about 88 percent of power generation is based on natural gas. Presently, 70 percent of the population does not have access to electricity and it is unlikely that they will have access to electricity in the foreseeable future. Annual per capita energy consumption is approximately 100 kgoe (kilograms oil equivalent), which is among the lowest in the world. Using the rule of thumb that each percentage of GDP growth will require 1.5 percent growth in energy use, the 7–9 percent growth that Bangladesh aspires to would presuppose 10–15 percent annual growth in energy use. This situation calls for adoption of sustainable energy strategies that permeate at all levels of the economy and provide the people with the services that they want.

Bangladesh is endowed with a wide variety of renewable energy resources and possesses the potential to cater to the unmet demand for energy for socio-economic development. Meeting the challenge of poverty alleviation requires attention to ensure access to energy with a focus on the inter-relationship with energy;

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energy interacts with all aspects of social and economic development, including livelihoods, water, agriculture, population, health, education, job creation and gender-related issues.

The development of rural energy resources provides an opportunity to widen the productive sphere of the rural economy, thus contributing to the national efforts of improving the living standards of the rural poor, as 65 percent of the population lives in rural areas. At present, rural people lack access to energy services even for meeting their cooking needs. The burden of managing household energy is increasing day-by-day, and falls disproportionately on women and girls. Biomass fuel accounts for 76.3 percent of the total fuel consumption in rural industries such as paddy parboiling, smithies and potteries and is the common fuel in rural households. Only ten percent of the rural population is connected to the electric grid network. Moreover electricity is too expensive to be used as a cooking fuel. It is mainly used for lighting, listening to the radio and watching television. Villagers who do not have electricity use kerosene lamps, which provide poor illumination; thus time for study at night is inadequate. This seriously limits educational improvement, besides causing respiratory and eye ailments.

Institutional, policy, market and technical barriers have impeded the adoption of RETs.

Concerns have been raised about the current patterns of energy production and consumption that significantly contribute to environmental degradation at the local, regional and global levels. Since access to modern energy services is viewed as an essential prerequisite for increasing productivity and improving people's livelihoods, UNDP has had significant involvement in developing the energy sector through capacity development, technology access, policy innovation, properly designed market mechanisms, integrated energy and development solutions and new partnerships with energy investors.

2. Genesis of the Sustainable Rural Energy (SRE) project

Apart from conventional energy sources, there has been a move towards finding a cleaner and more efficient energy source, especially in the rural sector.

The renewable energy sources that are available include solar, wind, biomass and microhydro. The average solar radiation in Bangladesh ranges from 4.0 kWh/m^2 in winter to 6.5 kWh/m^2 in summer. The average monthly wind speed in the coastal regions ranges from 2 to 5 m/s at 25-metre height. There is considerable potential for RET applications in Bangladesh. For example, there is the potential for four million household-based biogas plants as the country is primarily dependent on the agriculture sector, according to the Institute of Fuel Research and Development (IFRD). A survey carried out by the World Bank has found that there is an existing market potential of 0.5 million households for Solar Home Systems (SHS) on a free-for-service basis in the off-grid areas. Currently, the national grid only covers 50 percent of the approximate 100,000 rural markets and rural centres – the remaining sites are excellent candidates for the centralized solar photovoltaic plants. The World Bank study has further found that 82 percent of the diesel operators serving most of the off-grid rural markets are interested in marketing SHS in the surrounding areas.

Despite the natural endowment of such resources, Bangladesh is at the very early stage of utilization of non-conventional and renewable energy resources. Various institutional, policy, market and technical barriers have impeded the adoption of RETs. Technical barriers such as the limited in-country capacity for resource assessment, system design, installation, operation and maintenance (O&M) have impeded the application of the renewable energy resources. Modern RETs are still in the research, development and demonstration phase *(see Annex 2-1)*. Bangladesh Atomic Energy has undertaken RET projects since 1985, however these projects were not targeted towards the communities in the remote areas. Grameen Shakti is currently implementing various renewable energy projects but their activities are based on credit systems. The users have to buy the system either on a cash or credit system.

In contrast to the projects carried out earlier, the SRE project promotes pro-poor, self-sustaining projects. Several renewable energy options are being considered for implementation under the SRE project, with a focus on demonstration of the sustainability of the technologies. This will provide poor and marginalized groups with increased access to energy services.

3. Design of the SRE project

The SRE project has been conceived within the overall framework of the Sustainable Environment Management Program (SEMP) being implemented by the MoEF with financial assistance from UNDP. The component is being implemented by the LGED. The objective of this component is the development of community-based models for sustainable practices of renewable energy as an alternative source of clean rural energy in off-grid areas. The specific objectives are the demonstration of RETs and capacity building for technology transfer as well as wide dissemination of these technologies to mainstream them as sustainable long-term commercial activities.

The focus of the SRE is multidimensional and involves four potential renewable energy sources: solar, biomass, wind and microhydro. The activities under SRE projects can be grouped into three main categories:

Figure 2-1: RET demonstration under Sustainable Rural Energy (SRE)

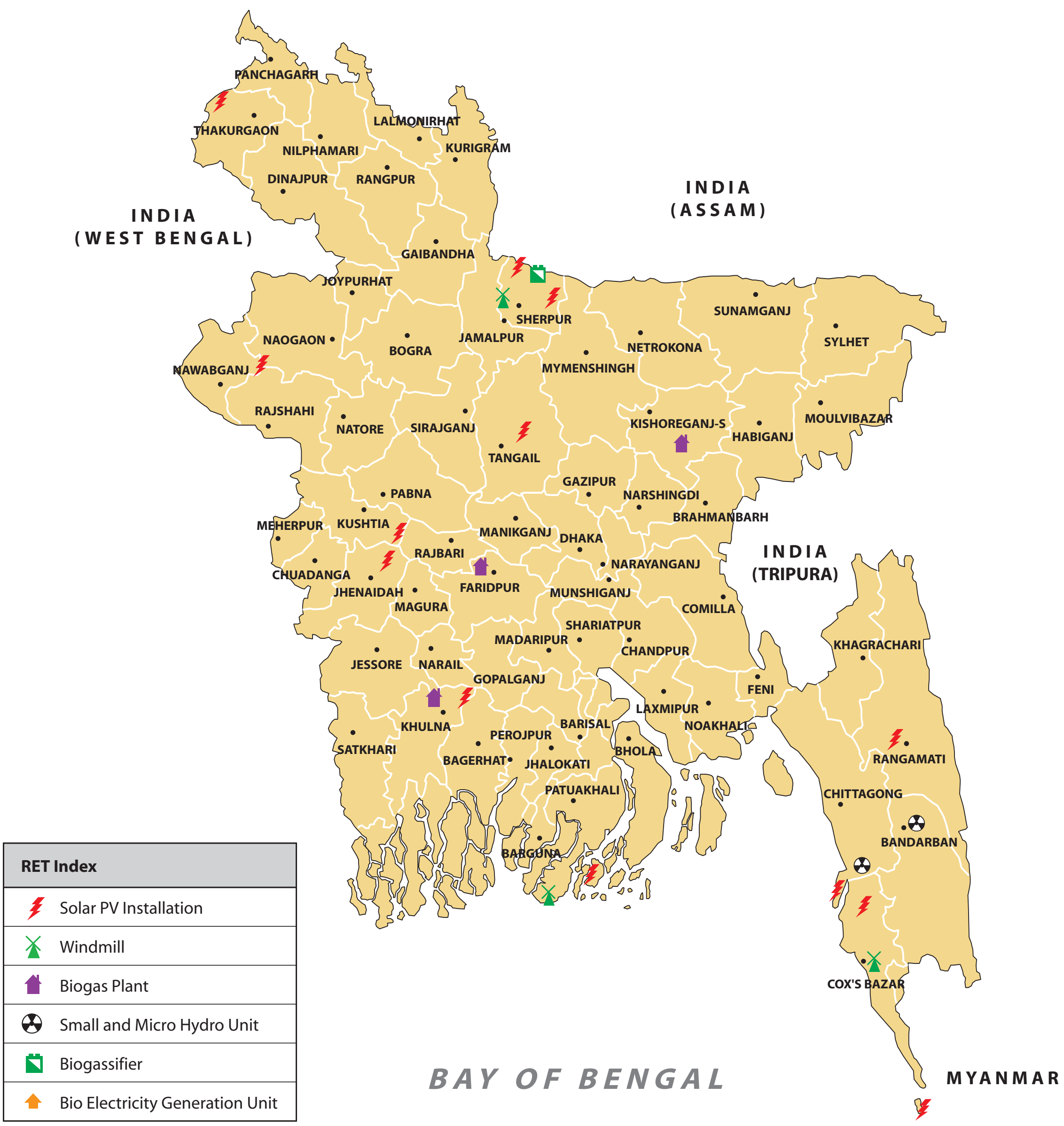

Table 2-1: Renewable Energy Technologies (RETs) in Bangladesh and their salient features under the UNDP-supported SEMP SRE component

Type of RET	Project name	Year of installation	System capacity	Beneficiary	Total cost (US$)
Solar Energy System	Solar Home Lighting System	1999	2,625 Wp	35 households	1,980
	Centralized Solar Electrification (AC) for Growth Centre	1999	1,800 Wp	50 shops, 2 small industries and a mosque	34,000
	Cluster Village Solar Electrification	1999	1,725 Wp	60 families (homeless people)	24,200
	Solar PV System for Goznee Tourist Spot	1999	225 Wp	Tourists	3,500
	Solar Water Purifier in LGED HQ	1999	150 Wp	LGED officials	
	Solar Electrification in Rural Clinics	2001	1,500 Wp	Rural people at Kamarul, Khulna (30 000 people)	15,850
	Solar Electrification at Ambaria UP Complex Bhaban	2001	600 Wp	Chairperson of UP (local governance), members	10,275
	Solar Home Lighting System for Tribal Community and Buddha Temple	2001	1,080 Wp	15 tribal families and a Buddhist temple	14,160
	Solar electrification for IT development	2001	375 Wp	Upazilla Engineer's Office	6,200
	Centralized Solar AC System for Fisherfolk Communities	2002	5,000 Wp	Coastal fisherfolk communities	90,000
Wind Energy Development	Low Speed High Torque Windmill	1999	15,000 litres/day at 4m/s wind with starting speed 1.8m/s	Irrigation, gardening, freshwater for coastal tourist resorts	2,650
	Solar-wind Hybrid System	2000	400 Wp	Tourists	2,950
	Wind Energy Resource Mapping				
Bio-energy Development	Community- based Biogas Plant	1999		Community members (around 150 families)	8,425
	Biogas plant for educational institute	2002 (ongoing)		Students, teachers and local people	8,425
	Bio-electricity Generation from Poultry Waste	2002		Students, teachers	10,000
Microhydro Energy Development	Proposed microhydro power unit	2003	10 kW	Agricultural farms	
	Development of an in digenous microhydro unit and harnessing small/micro potentials	2002 (ongoing)			

- Demonstration of RETs;
- Capacity building through training on RETs ;
- Development of the Renewable Energy Information Network (REIN).

The O&M for the various projects is case-specific and is carried out by the beneficiary. In most cases however, the community, being the beneficiary, is responsible for the smooth operation of the system. Beneficiary training is also being provided for assisting in the operation of the various systems. Funds for periodic maintenance will be mostly borne from the money contributed by the beneficiaries. For example in the case of the solar home systems for household application, the maintenance expenditure will come from the contributed initial down payment and monthly payments received from each household.

3.1 Solar energy-based technologies

The introduction of solar photo-voltaic systems and their increasing use worldwide is a major step towards an ecological and sustainable energy system. It is a more environmentally friendly technology than any other means of generating electricity, making power available anywhere; thus the current prohibitively expensive process of extending electrical grids everywhere is avoided. Their modular nature, low maintenance and availability make this new and emerging power source an attractive alternative for its large-scale usage in rural areas.

> *Community-based biogas plants not only provide an alternative source of energy but also improve the health and sanitation of the community.*

3.2 Bio-energy-based technology

Apart from the LGED's own initiatives on the construction of biogas plants, two Upazillas[20] (subdistricts) have been selected as project areas on a pilot basis under the SRE component. The community-based biogas plants not only provide an alternative source of energy but also improve the health and sanitation of the community. All families are provided with improved sanitary latrines connected with a central digester. The demonstration plant benefits the community in many ways: providing energy for cooking and thereby saving fuelwood, ensuring better health and sanitation for the community and also providing good quality pathogen-free fertilizer for agricultural use. From the community, a beneficiary committee has been formed and this committee is entrusted with the proper O&M of the system.

In Faridpur, the poultry project of the Mission constructed a poultry house of about one thousand square feet involving 5,000 birds. An electricity generation unit from poultry waste has also been set up at Faridpur. Currently, installed power generation is 4 kW, but it is hoped that this will increase to 10 kW. The children of the Mission are provided with hands-on training. The eggs and owls supply nutrition to the residents. After completion of the project the system will be handed over to the management committee, who will be responsible for the O&M of the power unit. If successful, this project could be replicated throughout the country and contribute significantly to the energy sector.

3.3 Wind energy technology

Wind energy is in the early stage of application. Several locations have already been assessed to evaluate the wind energy potential of the coastal region. The scope of utilization of wind energy resources can become effective in certain cases of exclusive applications during wind water pumping and power generation through wind-diesel hybrid systems at suitable locations. The installation of two water-pumping windmills and one wind-solar hybrid system has already taken place.

Under the SRE project, in collaboration with BUET (Bangladesh University of Engineering and Technology) and BIT (Bangladesh Institute of Technology), Chittagong has also started a study on wind resource mapping. The study has been designed in a comprehensive manner, aiming at systematic observation on wind regimes at 20 suitable locations including the Chittagong Hill Tracts over a longer period of time.

20 Upazilla means sub-district. It is a government administrative centre at the local level. An upazilla comprises several unions and a union comprised of several villages.

3.4 Microhydro plant

Bangladesh is a riverine country with three main rivers: the Ganges, the Brahmaputra and the Jamuna. About 1.4 trillion m^3 of water flows through the country in an average water year. Numerous rivers flow across the country, which are mostly tributaries of these main rivers leading to immense hydropower potential. At present only 230 MW of hydropower is utilized in Karnafuli Hydro Station, which is the only hydro-electric power plant operated by Bangladesh Power Development Board (BPDB). Several attempts have been made in the past to find out the potential of small and microhydro power units, which are believed to be more environmentally or ecologically friendly in comparison to large hydros with dams.

Through the SRE project, assistance has been provided for the development of indigenous microhydro power units. Moreover, the installation of a 15kW microhydro unit at Bamerchara under Banskhali thana in Chittagong District is under consideration.

3.5 Renewable Energy Information Network (REIN)

The development of an information network for a renewable energy database and its maintenance is the key activity of REIN. This network has been designed and developed to facilitate the energy planners, project developers, researchers and all relevant organizations. REIN is designed to work as an information platform for compilation of data in the following four categories:

- Resource Database: The database is a compilation of information on the national resources relevant to RETs. The major categories of the resource database available include not only renewable energy resources but also human resources, and logistical resources;
- Renewable Energy Projects: Assistance provided for the development of renewable energy projects;
- Research and Development: Information about completed and ongoing research and development projects will be put online;
- Information Media: Periodic newsletters on renewable energy are posted online by the SRE summarizing the impact and status of renewable energy project activities in Bangladesh.

The development of an information network for a renewable energy database and its maintenance is the key activity of REIN.

3.6 Training for capacity building and technology transfer

Required training programmes for capacity building and technology transfer are provided through the project's activities. The novelty of the technologies demonstrated in this project demands a sound plan for training and capacity building. Activities have been undertaken to ensure user-training, technician-training, training-of-the-trainers as well as institutional capacity building. Systematic maintenance and proper use of the systems on a daily basis ensures minimum repair and maintenance work. The users of the systems are provided with written and illustrated guidelines safe usage. The local technicians are responsible for the day-to-day troubleshooting and other maintenance-related work. For the long-term sustainability of the programme, trainers have been trained to meet future training needs and are prepared to offer training to the users in the community on the operation of the community-based systems.

3.7 Expected end result according to the project document

At the end of the project implementation programme, it is expected that there will be widespread demonstration and dissemination of the RETs in the off-grid areas. The impact of such activities will be the mainstreaming of such technologies as sustainable long-term commercial activities.

4. Implementation of project activities

Some of the pioneering efforts carried out by the project are described below:

4.1 Solar electrification in cluster villages

The SRE project built on the ongoing government priority programme Asrayan (shelter for the homeless) through solar electrification in cluster villages for the landless poor. The objectives are twofold: first to assess the potential of the technology in improving the quality of life of the landless poor and second to verify whether the landless groups can organize themselves to support O&M of the system. The installation has been successfully completed in Nalitabari *Upazilla*[21] in Sherpur District providing solar electricity to 60 houses of the landless poor; this has been operating smoothly for the last one-and-a-half years. It also demonstrates the capacity of the landless poor to maintain the technology, which contributes to improving their quality of life.

4.2 Centralized solar market electrification

For the first time in Bangladesh, the SRE project has successfully completed solar market electrification in a rural market at Gangutia under the *Shoilkupa Upazilla* in Jhenaidah District. The objective of this scheme is to install a demonstration plant of a centralized solar photovoltaic system for electrification of a rural market in the off-grid area and to assess its technical and economic viability in the context of rural Bangladesh.

4.3 Gangutia growth

This site has been selected for solar electrification because of its remote location (the nearest grid extension is around seven kilometres away). The system has the capacity to produce 1.8 kW of power with a daily consumption of 2,000 watt-hours, providing lighting to 45 shops, three food-processing small industries, one health centre and one bazaar mosque. O&M have been entrusted to a local NGO, Shuboshoti. Each consumer is paying Tk.[22] 4.00/day, which is adequate enough to support major maintenance requirements like replacement of CFL lamps and batteries at regular intervals. The total cost of market electrification is around Tk.11 *lakhs*[23]. The successful installation of solar market electrification has created great enthusiasm among the local villagers and it will be a milestone for the green energy movement in the country.

The installation of solar electricity system in the village also demonstrates the capacity of the landless poor to maintain the technology, which contributes to improving their quality of life.

5. Lessons from implementation of the SRE under the LGED

5.1 Reaching the poorest of the poor

The project has been designed to have a pro-poor focus in the off-grid areas, which are often the least developed. It is unlikely that in the foreseeable future the majority of this population will have access to electricity, especially in the far-flung areas. Thus the lack of energy sources has a negative impact on the development of these regions. The project has therefore provided new and inventive methods for the provision of non-traditional energy sources in such areas.

5.2 Ownership to the community

In almost all cases, the stakeholders of the project are the members of the community. Community building has been emphasized since the beginning of the project through the participatory approach. The project is designed to eventually hand over the plants to the beneficiaries. The beneficiaries will therefore take greater care in their maintenance and increase the lifespan of the RETs.

Community ownership thus promotes community empowerment; it allows greater integration among the members of the community to achieve a common goal. For example, the solar electrification of the bazaar in Jhenaidah provided a means for building community spirit. It allowed the beneficiaries to gain the benefits of the electrification collectively.

5.3 Sustainability of the operation

All initiatives are designed in a manner that allows UNDP to exit without hampering their effective operation. The activities are designed to be self-sustaining; the community, which is often the stakeholder, is able to continue with the operation of the plants after the project ends.

21 An average upazilla population is approximately 200,000.

22 US$1.00 = Taka (Tk.) 58 (approx).

23 1 lakh = 100,000.

Since technical training is provided to members of the community, smooth operation of the systems is thereby ensured. A system has been set up for regularly collecting funds contributed by the beneficiaries. The necessary funds for the O&M of the systems are therefore borne by this contributed money and do not pose an extra burden.

5.4 Economic empowerment as a result

Economic empowerment is being gained by the poorest of the poor due to the activities of this project. For example, the demonstration of a microhydro unit in Chittagong will improve the quality of life and provide income-generating activities. Women are also being empowered as the light is providing them with the opportunity to earn a livelihood. Earlier, the extent of their activities was determined by the presence of sunlight; with sunset, their day was more or less over. But now they can continue with their daily activities, as well as pursue income-generating activities in the evenings and at night. Also centralized solar electrification of the market at Jhenaidah has led to an increase in the daily market activities and boosted rural economic activities.

5.5 Social change brought about in the communities

A social change is being brought about due to the availability of an alternative energy source. People are gaining greater knowledge about the subject and are also showing interest in the renewable energy sources. There is a mushrooming of the RETs in the areas surrounding the demonstration sites, indicating the demand for such technologies. Replication by the NGOs can lead to greater dissemination of the ideas.

The government-run evening adult education classes have benefited greatly from the project due to the extension of active hours as a result of electrification. There is improvement in the healthcare provided in rural areas through the presence of an alternative energy source. Solar-powered refrigerators can preserve vaccines, blood etc, while solar-powered lights can be used in operating theatres.

5.6 Provision of a cleaner energy source

Usage of a cleaner technology is reducing the pressure on the environment. Especially in the rural households, the pressure on the biomass was high due to traditional energy sources such as the burning of wood for fuel. The provision of an alternative energy source therefore benefits the environment by reducing the need for burning wood to provide energy. A decrease in the use of diesel for electrification in the project areas also has a positive impact on the environment.

5.7 Removal of the information barriers through the establishment of REIN

The information barriers that were present arlier due to the lack of availability and access to information sources have been diminished considerably because of the establishment of REIN. The publication of a newsletter/brochure on RETs provides greater information sharing on this subject both among the producers as well as the consumers of these technologies.

There is improvement in the healthcare provided in rural areas through the presence of an alternative energy source.

Through REIN's multistakeholder approach, the interaction of the providers as well as the consumers of the RETs has been facilitated. Up-to-date information is being provided not only about the inputs but also about the organizations that are involved in the renewable energy practices. There is now greater awareness regarding the costs and benefits of the range of technologies available for providing renewable energy-based modern energy services.

5.8 Training on non-renewable technologies allows more effective maintenance

Technical barriers for the implementation of sustainable rural energy practices have been broken down. Personnel who design, install, operate, manage and maintain renewable energy-based services are available owing to the training provided under the SRE project. While the training has been provided to a limited number, in the current country context this is still a major step leading to greater national capacity development.

5.9 Drawbacks to the project

Since the activities carried out under this component were merely for demonstration purposes, it is very hard to assess the cost effectiveness of the project.

The activities were also conceptualized under ideal conditions therefore more demonstrations need to be carried out in order to find out the institutional constraints of the activities.

Although the demonstrations have taken place in off-grid areas, their applicability in grid areas also needs to be noted.

5.10 Replication initiatives

Interest in sustainable renewable energy practices is high as can be seen by their replication in the areas surrounding the demonstration sites. There is considerable scope for the government to tap into this alternative energy source. NGOs specializing in renewable energy, which are already involved in this sector, could be instrumental in the replication process and thereby aid the development of the energy sector. Due to the overwhelming dependence on biomass-based energy consumption in rural areas and the depletion of bio-diversity, the situation is becoming critical. The only alternative to prevent catastrophe is to opt for renewable energy.

As a result of the activities of this component, which focuses on decentralized community-based renewable energy in multipurpose applications, the government is also taking parallel steps to ensure the replication of RETs. Through the numerous offices of the LGED located throughout the country, there is greater opportunity for the RET applications to be duplicated.

5.11 Existing barriers to the widespread adoption of the RETs

Policy barriers: There is a lack of financial incentive policies to encourage renewable energy development. Legal, regulatory and policy framework mechanisms for the market-oriented energy programmes are missing.

Institutional barriers: Most of the renewable energy programmes are primarily technology driven and the focus is on R&D rather than promotion and encouragement of commercial and private sector involvement in RETs. The lack of coordination between the different ministries, agencies and institutions that deal with the RET sector makes the widespread dissemination of RETs problematic.

Market barriers: The high initial cost at the user level is a considerable market barrier to the increased use of renewable energy sources.

Financial barriers: No dedicated financing is presently available in financial institutions for renewable energy activities. The financial institutions also lack the capacity to appraise renewable energy proposals and loan requests and judge their viability.

5.12 Future scenario – case study follow up

As part of the exit strategy of this component, emphasis has been put on noting the successes of the various demonstration projects and aiming future endeavours at mainstreaming these activities. It has been suggested that the Solar Home Systems that have proved to be so successful should be mainstreamed in the future. Similar mainstreaming programmes are also being envisaged for Biomass Gasifiers, Solar Thermal Systems and SPV pumping systems. Detailed programming for such mainstreaming is currently being worked out. The programme would include some aspects of financial support to alleviate the initial high cost of installation.

The financial institutions lack the capacity to appraise renewable energy proposals and loan requests and judge their viability.

As a follow up to the activities of this component, UNDP Bangladesh is in the process of formulating a pro-poor environmentally friendly energy programme aimed at achieving energy efficiency, energy conservation and promotion of RETs. There is a need to focus on poor people's energy needs, and frame energy in the development process.

While Bangladesh has traditionally focused on sectorally-based mega projects, a shift is needed from the sectoral- and technology-driven approaches to one which embodies energy as a basic need for the poor. The programme will thus focus on improving access to energy services that meet people's needs and priorities, focusing on the "un-served" and poor through public-private partnership and involving local governments and NGOs.

Emphasis will also be put on promoting a decentralized energy system as well as examining in greater detail the different relationships involving energy such as the poverty-environment-energy nexus.

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Annex 2-1: Status of R&D activities in Bangladesh

Technology	Organization	Remarks
Solar Photovoltaic/ Balance of System	Grameen Shakti, CMES, IFRD, BUET	Possible to manufacture all the balance of system components (like charge controller, cable, inverter, converter etc.) locally.
Solar Water Heaters	RERC, Dhaka University, IFRD, CMES	Possible to manufacture with local design and fabrication facilities.
Improved Stoves	IFRD	A number of designs have been developed at IFRD with three basic categories: (I) improved stove without chimney; (II) improved stove with chimney; and (III) improved stove with waste heat utilization.
Solar Cooker-Parabolic	IFRD, ANANDO	IFRD has successfully field-tested its design which can quickly raise water to boiling point under clear sunny days. ANANDO is also manufacturing and marketing its products with imported materials and design.
Solar Cooker-Box Type	IFRD, CMES	IFRD's design is made of locally available raw materials. The manufacturing cost of such a cooker is about Tk.800 excluding the cost of utensils. The cookers are now being sold at IFRD.
Solar Dryer	IFRD, BRRI, BAU	Different types have been designed and tested with locally available materials.
Solar Wood Seasoning Plant	BFRI	A simple, inexpensive and effective solar kiln has been developed for seasoning timber using solar radiation. The kiln can be constructed conveniently with locally available materials. Timbers of different species and dimensions can be seasoned throughout the year in the solar kiln.
Solar Passive Architecture	BCSIR	A solar house has been designed and built in the BCSIR campus; the purpose is to keep the house warm in winter and cool in summer.
Briquette Machine	BIT Khulna, BRRI	Under the RET in Asia Program, BIT Khulna is developing better machines with longer screw life.
Biogas	IFRD, LGED, BAU	Fixed-Dome type plants are indigenously designed and constructed.
Water Current Turbine	Department of Mechanical Engineering (DME), BUET	DME, BUET are studying a model water current turbine for harnessing energy from river current and is in the process of developing a prototype.
Wind Turbines	BUET	Computational models are developed for simulation of horizontal and vertical axis wind turbines.

Source: Islam, Mazharul, August 2002. Utilization of Renewable Energies in Bangladesh. Shakti: Energy Website of Bangladesh. Accessed February 12, 2004. http://shakti.hypermart.net/publications/ebook2.pdf

Annex 2-2: Abbreviations

ANANDO	NGO for national development organization
BAU	Bangladesh Agricultural University
BCSIR	Bangladesh Council of Scientific and Industrial Research
BFRI	Bangladesh Forest Research Institute
BIT	Bangladesh Institute of Technology
BPDB	Bangladesh Power Development Board
BRRI	Bangladesh Rice Research Institute
BUET	Bangladesh University of Engineering and Technology
CHT	Chittagong Hill Tracts
CMES	Center for Mass Education in Science
GoB	Government of Bangladesh
IFRD	Institute of Fuel Research and Development
LGED	Local Governance Engineering Department
PV	Photovoltaics
REIN	Renewable Energy Information Network
RERC	Renewable Energy Research Center
RETs	Renewable Energy Technologies
SEMP	Sustainable Environment Management Programme
SME	Small and Medium Enterprises
SHS	Solar Home System
SRE	Sustainable Rural Energy
UNDP	United Nations Development Programme
UP	Union Parishad

Chapter 3

Working with rural communities to conserve wood energy:

A case study from Bhutan

Ugyen P. Norbu and Seeta Giri[24]

Abstract

Bhutan has a population of 685,000, growing at an annual rate of 2.5 percent. Seventy-nine percent of the population lives in rural areas. While the country is known for its well-preserved natural environment, it is also known to have some of the highest per capita domestic fuelwood consumption in the world. According to the 1991 FAO wood energy analysis, it was estimated that a Bhutanese citizen consumed 1.27 tonnes of fuelwood annually. Due to no suitable alternatives and socio-economic constraints, fuelwood is the most important source of energy in rural Bhutan. UNDP's activities in energy and the environment comprise working with the government at the national level, working with local communities and GEF-funded small grant programmes. This case study covers two small wood energy conservation projects. The first project is Improved Community Cooking Stove: an Alternative to Mitigate Fuelwood Pressure in Trashigang. The second is the Biomass Fuel Efficiency Project in Tsirang. The first project has demonstrated a significant reduction in fuelwood consumption as a result of the installation of shielded, metal stoves. The smokeless stoves also contribute to the cleanliness of the community kitchens, shorter cooking time and less smoke-related health risks to kitchen users. Tsirang, in the second project, is a district severely affected by fuelwood shortage. The district is also one of the most densely populated in the country. The project significantly reduces fuelwood consumption, with a good focus on local capacity building. The key lessons learned from the two projects suggest that interventions that demonstrate tangible benefits within a short term would be more appealing to local people. Energy conservation projects have more impact on local people when the intervention is connected to their daily lives.

Keywords: Fuelwood, wood energy conservation, cooking stoves, capacity building, rural communities, poverty, gender.

1. Background and context

1.1 The wood energy situation in Bhutan

Wedged between two giant nations, China and India, the Himalayan kingdom of Bhutan is a small country both in terms of population and size. Some 685,000 people – growing at a rate of 2.5 percent *per annum* – live in the 38,394 km^2 country. Seventy-nine percent of the population lives in rural areas subsisting on a farming system, which integrates crop agriculture, livestock rearing and the use of natural resources for a wide range of products and services. Most of the population lives in the mountains and valleys of the central belt and in the foothills along the southern frontier. The population in the northern part is very sparse and scattered.

The country has a good environmental track record, major indices being a forest cover of 72.5 percent and a protected area system covering more than 26 percent of the country linked by biological corridors that make up another 9 percent. While the country is known for its well-preserved natural environment and large, contiguous forests, it is also known to have some of the highest per capita domestic fuelwood consumption in the world. A wood energy sectoral analysis published by the Food and Agriculture Organization of the

24 Seeta Giri is Head of the Environment Unit, UNDP Bhutan, managing the Energy and Environment portfolio; Ugyen P. Norbu is a consultant with expertise in the Environment sector.

United Nations (FAO) in 1991 estimated that each Bhutanese on average consumed 1.27 tonnes of fuelwood a year[25]. While the scenario in urban areas has changed since then with the availability of modern cooking and heating appliances (e.g. gas stoves, oil radiator heaters) and growing affluence and changing lifestyles, fuelwood consumption in the rural areas is much the same due to lack of suitable alternatives and socio-economic constraints.

Fuelwood is by far the most important source of energy in rural Bhutan and is expected to remain so for many more years – rather decades – to come. Currently, fuelwood accounts for 70 percent of the national energy consumption (RGOB 2002). Although rural hydropower electrification is gaining ground and many rural homes are now installing solar power systems, these are likely to be largely limited to lighting purpose whereas rural energy use is most intensive for cooking (and space heating in high altitude areas). Besides domestic consumption, fuelwood is also used by industries such as Bhutan Carbide and Chemicals Limited, Bhutan Ferro Alloys, and Bhutan Board Products, and during the blacktopping of the roads.

Fuelwood is by far the most important source of energy in rural Bhutan and is expected to remain so for many more years – rather decades – to come.

All fossil fuels such as diesel, petrol, kerosene, liquid petroleum gas (LPG), and aviation turbine fuel are imported. While LPG is the main cooking fuel in urban areas, kerosene is used for lighting in remote villages without access to electricity. The import of fossil fuel in 1999-2000 included 26,844 kilolitres of diesel; and 6,520 kilolitres of petrol (RGOB 2002)".

Fuelwood is in short supply in many areas because of high population density and localized deforestation caused by intensive forest use. The *dzongkhags* (districts) affected by fuelwood shortages include Trashigang, Pema Gatshel, Trashi Yangtse (southeastern part), Mongar (eastern part), Wangduephodrang (central part), Thimphu (areas around Thimphu township), Paro (southeastern part) and all the southern dzongkhags – Samtse, Chukha, Daga, Tsirang, Sarpang and Samdrup Jongkhar (FAO 1991).

1.2 United Nations Development Programme in Bhutan

The involvement of UNDP Bhutan in the area of energy and environment is threefold. One, it is helping the government at the national level through advocacy, policy advice and support for national conservation strategies. Two, it works with local communities through pilot initiatives that show people how to escape from the poverty cycle while conserving the environment on which they rely. Three, the UNDP-implemented/Global Environmental Facility (GEF)-funded Small Grants Programme (SGP) is boosting local community actions to address global environmental concerns, namely biodiversity loss and climate change.

The SGP was launched in Bhutan in October 1998. The SGP supports projects of up to US$50,000 by community-based and non-governmental organizations, focusing on local problems and community actions related to global environmental concerns such as biodiversity loss and climate change. It recognizes the crucial role that households and communities, applying locally appropriate solutions, can play in conserving bio-diversity and reducing the likelihood of adverse climate change and operates on the premise that people will be empowered to protect their environment when they are organized to take action, have a measure of control over access to the natural resource base, have the necessary information and knowledge, and believe that their social and economic well-being is dependent on a sound environment. Since its inception in the country, the SGP has supported 16 projects with grants totalling nearly US$400,000. Of these, four were related to climate change and dealt with wood energy conservation.

2. Introduction to the case study

This case study covers two wood energy conservation projects, both supported through the SGP during the programme's nascent phase. The first project was called Improved Community Cooking Stove:

25 The analysis was a part of the Master Plan for Forestry Development in Bhutan Project. This is the only comprehensive wood energy study carried out to date in Bhutan.

An Alternative to Mitigate Fuelwood Pressure in Trashigang and was located in Trashigang District. The other was Biomass Fuel Efficiency Project and was located in Tsirang District. The map shows the location of the districts.

The case study is based on an analysis of the project documents, progress reports, evaluation reports and the SGP Biennial Programme Review (October 1998 to June 2002). It seeks to outline the positive features and limitations of the projects and highlight the lessons learnt with the view that such knowledge management will be useful in planning and implementation of similar projects in the future, both within and outside the country. The principal reasons for selecting the two projects for the case study were:

- The projects were initiated at the beginning of the SGP and, therefore, there is enough experience to reflect upon;
- The commonality in the key objective (i.e. reduction in wood energy consumption) notwithstanding, the two projects applied different strategies. One was implemented by an NGO and focused on religious community institutions while the other was implemented by a local women's group and focused on rural households based specifically on women's participation.

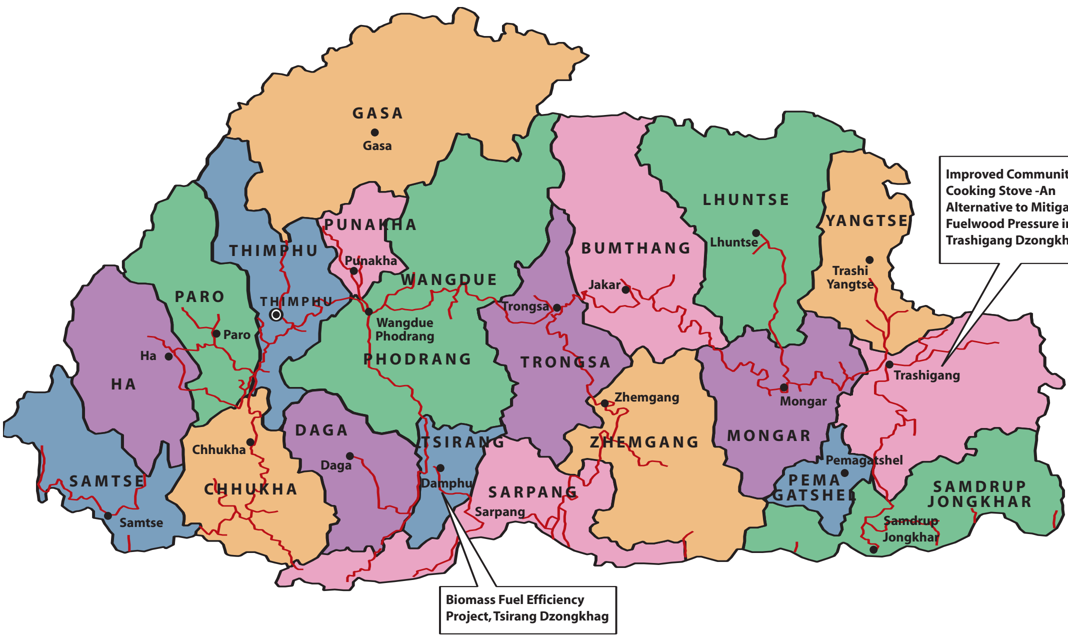
3. Overview of the Improved Cooking Stove project, its positive aspects and limitations

3.1 Improved Community Cooking Stove: An Alternative to Mitigate Fuelwood Pressure in Trashigang

3.1.1 Context

The per capita domestic fuelwood consumption of Trashigang District is higher than the national average – the 1991 FAO wood energy sectoral analysis puts the figure at 1.47 tonnes a year[26]. In addition the district has a relatively high population density of about 30 people/km^2, far exceeding the national average of about 17 people/km^2, and the forest resources in many accessible areas have long disappeared. The end product is unmistakably a district with the most severe fuelwood shortage in the country. It is therefore no surprise that local people in many villages place fuelwood collection (due to increased collection distances) among the most arduous tasks. Some villagers claim having to walk as far as six kilometres to fetch fuelwood.

Figure 3-1: Map of Bhutan showing the locations of the two case studies



26 At the time of the analysis, Trashigang also included what is now Trashi Yangtse District. For this case study it is assumed that the fuelwood consumption figure would not have been affected by the bifurcation of the district given that the bulk of the population live in Trashigang and the socio-economic activities of the two districts are more or less similar.

The people of the district' are *Sharchhopa*[27]. They are perhaps the most devout Buddhists among all the Bhutanese. This is evident from the numerous *lhakhangs* (monasteries) and *dratshangs* (monastic institutions) that are scattered throughout the district. Apart from the rural households, these institutions constitute the largest consumer of fuelwood. Every year on average, it has been estimated that each institution organizes religious festivals and rites for 50 to 60 days and burns up about eight to ten truckloads of fuelwood to prepare food and beverages for the monks, devotees and lay people who congregate for the events.

Box 3-1: Religious institutions where the stoves were installed

- Galing Lhakhang, Shongphu geog
- Namdruchholing Lhakhang, Radhi geog
- Chador Lhakhang, Bartsham geog
- Kakani lhakhang, Bidung geog
- Phongmey Lhakhang, Phongmey geog
- Bikhar Lhakhang, Samkhar geog
- Yonphula Lhakhang, Kanglung geog
- Khaling Lhakhang, Khaling geog
- Brekha Anim Dratshang (nunnery), Thrimshing geog
- Khardung Anim Dratshang (nunnery)

3.1.2 Project description

The project was started in October 1999 and ended in December 2000 at a total cost of US$33,069, of which SGP funding was US$25,670. The Bhutan Youth Development Association (BYDA), an NGO, was the main project proponent and actor, with the Trashigang District administration providing logistical support. The project was aimed at working with religious institutions and local communities to:

- Reduce fuelwood consumption by half in selected religious community kitchens;
- Significantly reduce the time spent by local people in collecting fuelwood for religious community kitchens so that they can channel the time and energy saved to other viable economic activities;
- Raise community awareness about the consequences of deforestation and the need to use natural resources judiciously; and
- Demonstrate the manifold benefits of improved cooking stoves to promote widespread adoption of the technology in the district.

The main project intervention was the installation of shielded, cylindrical metal stoves with hot water jackets. The project installed two stoves each in ten religious institutions *(see Box 3-1 for the names of the institutions)*. The installation of the stoves was abetted by community workshops to demonstrate the use and maintenance of the stoves and raise awareness for forest conservation. School/college-going rural youths were mobilized during their holidays to assist in the implementation of activities.

3.2 Positive features

3.2.1 Significant wood energy conservation

As envisaged during project planning, there has been a significant reduction in fuelwood consumption as a result of the installation of the shielded metal stoves. All the community kitchens reported fuelwood consumption dropping to at least half. Statistically, this would translate to about four to five truckloads of fuelwood saved each year by each institution or 40 to 50 truckloads of fuelwood a year by all the religious institutions where the stoves were installed. The given lifespan of the stove is seven to ten years. Assuming that each truckload is equivalent to 5.7 tonnes of fuelwood, the stoves would be saving roughly 220 to 280 tonnes each year or 1,500 to 2,800 tonnes of fuelwood in their lifetime.

3.2.2 Spin-off benefits related to the daily lives of the beneficiaries

Apart from reducing fuelwood consumption, the improved stoves contributed to cleanliness of the community kitchens, reduced cooking time considerably and lowered smoke-related health risks to the kitchen users. While the primary aim of the intervention was to reduce fuelwood consumption and improve forest conditions, what appealed more to the beneficiaries were these spin-off benefits that affect their daily lives.

3.2.3 Good demonstration value and multiplier effect

In selecting religious institutions where many people congregated and where religious festivals and ceremonies were conducted more often, the project not only targeted religious institutions with higher fuelwood consumption but also achieved high public visibility and demonstration value. As a result, the project had a multiplier effect – the Trashigang District administration, based on widespread positive public response to the intervention, has embarked on a project to install similar stoves in some 14 additional religious institutions with funding from UNDP.

27 People from eastern Bhutan and of Indo-Burmese or Tibetan origin are generally known as *Sharchhopa*.

3.2.4 Enhancement of BYDA's profile
The project gave BYDA the first-ever experience of dealing with environmental conservation on the ground. Besides, the involvement of school/ college-going rural youths contributed to the organization's core mission and the concept of wholesome youth development. In so doing, the project has set a precedent for the youth development/environmental conservation linkage.

3.2.5 Linking energy and gender
While the project was not gender specific, it did ensure that both men and women participated and benefited from the project. Two nunneries, namely Khardung Anim Dratshang and Brekha Anim Dratshang, were among the ten religious institutions that received the stoves and back-up training.

3.3 Limitations

3.3.1 Weakening of project impact as a result of change in project design
Originally, the plan was to cover seven religious institutions with three stoves for each of them. Subsequently, on the insistence of the Trashigang District administration to cover more institutions, the project was modified to cover three more religious institutions but without altering the budget and total number of stoves. So, each religious institution received two stoves instead of three. Consequently, several institutions still used traditional open hearths alongside the improved stoves. The kitchen users explained that they are required to usually prepare rice, one or two items of curry and tea concurrently whereas the two stoves were only sufficient for rice and a curry. So, they have to use the traditional hearth for preparing tea and additional curry.

3.3.2 Centralized project implementation
BYDA had no local presence. As a result, project implementation was centralized with BYDA volunteers travelling all the way from Thimphu to supervise and carry out project activities. Trashigang District administration's role was limited to providing some basic logistical assistance. This affected the continuity and quality of project implementation, with some activities such as community workshops being organized in an *ad hoc* manner.

3.3.3 Nullification of experience
After the completion of the project, the key people who spearheaded the implementation of the activities pulled out of BYDA. Their exit has nullified the experience gained from the project.

4. Overview of the Biomass Fuel Efficiency project, its positive aspects and limitations

4.1 Context

Tsirang is also one of the districts severely affected by fuelwood shortage. It is in southern Bhutan and most of the inhabitants are Lhotshampa. Most of the people follow Hinduism but there are also several communities (e.g. Sherpa, Tamang and Lama) who are Buddhists. High agricultural productiveness, a healthy climate and its proximity to the bordering towns have made the district one of the most populous in the country, with a population density of roughly 32 people km^2 – nearly twice the national average. All rural households depend on fuelwood for cooking (meals and cattle feed). Recurrent harvesting without replenishment has shrunk the forests significantly and increased fuelwood collection distances over the years. The local people most commonly use open fire mud stoves with raised lumps around the pot seats.

Khardung Anim Dratshang, one of the religious institutions that received a pair of improved stoves (right)

4.2 Project description

The project was started in October 1999 initially at a cost of US$62,985 with a funding of US$29,400 from the SGP. The SGP extended additional funding of US$15,000 to cover more households. The Tsirang Women Group executed the project with logistical support from the Tsirang District Administration and technical assistance from the Improved Stove and Biogas Support Programme, Ministry of Trade and Industry. The project was conceived with the following objectives:

- To reduce household fuelwood consumption by at least 50 percent;
- To build the technical capacity of the local women to construct, repair and maintain the smokeless stoves; and
- To promote the use of smokeless stoves among the local public in general.

The project installed improved stoves in 2,000 households. The improved stove is basically a mud kiln (like a traditional oven) with a metal sheet chimney pipe and iron grate. The pot seats are left flat to prevent heat from escaping. The installation of the improved stoves was supported by training of a local woman from each of the 12 *geogs* (blocks), who are also members of the Tsirang Women Group. These women have become stove technicians who can construct the improved stoves and carry out repairs and maintenance, and have organized public demonstrations to display the construction, functioning, maintenance and the manifold advantages of the improved stove.

4.3 Positive features

4.3.1 Significant reduction in fuelwood consumption

The majority of the rural households that have installed improved stoves claim reduction in fuelwood consumption by at least 50 percent, with a few even reporting reduction as high as 75 percent. If Tsirang's average per capita fuelwood consumption is assumed to be 1.25 tonnes per annum and rural household size (conservatively) six people, then individual household consumption works out to 7.5 tonnes per annum. Half this amount – 3.75 tonnes – is what is saved per household. Extrapolate this figure to 2,000 households and the result is 7,500 tonnes of fuelwood saved each year, which is a significant amount by any standard.

QUOTE	UNQUOTE

"This (smokeless stove) is my TV, radio, fridge... it's my proudest household possession. Life has never been so comfortable."

KAMALA BHANDARI
40 years old and mother of seven, lower Tshokhana, Tsirang

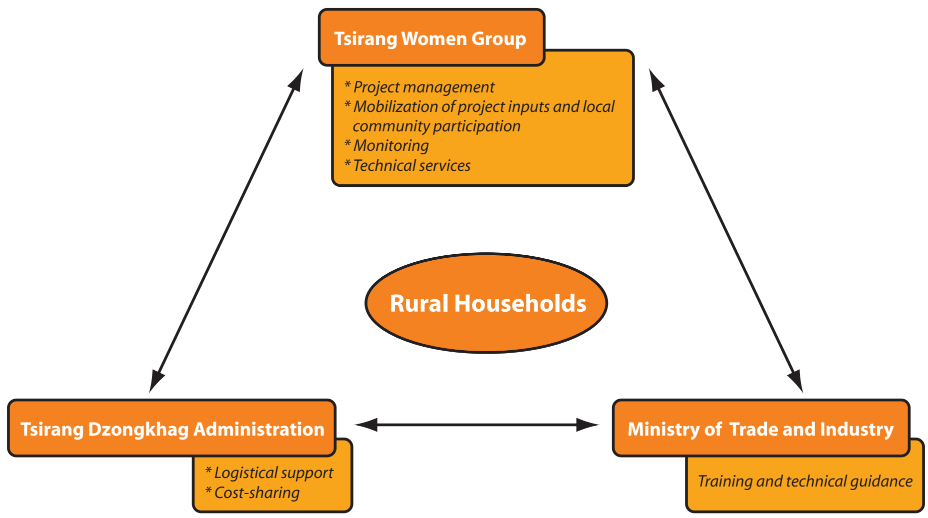
4.3.2 Spin-off benefits that relate to daily rural life

Local people reported cleaner kitchens and utensils, considerably reduced time spent on cooking, washing utensils and collecting fuelwood, the ability to keep food warm longer and reduced risks of smoke-related illness as the foremost social benefits. As in the case of the community cooking stove project in Trashigang, the spin-off benefits connected very well with the daily lives of the beneficiaries. Although women were the primary beneficiaries, the benefits spill over to the whole family. Children, particularly infants, who cling to their mothers most of the time, are at greater risk due to constant exposure to smoke and they are likely to suffer from respiratory problems. Men, who are usually required to fetch fuelwood, especially when long distances are involved, also benefit by having to collect less fuelwood.

4.3.3 Partnership and collaboration

The project provides a fine example of partnership and collaboration. The Tsirang Women Group was very well supported by the Tsirang District administration and the Ministry of Trade and Industry, each playing a distinct but complementary role. The Tsirang Women Group managed the project, mobilized local participation and monitored the activities, the Tsirang District administration provided logistical support particularly for organizing training and demonstrations and procurement of materials, and the Ministry of Trade and Industry assigned a full-time stove technical supervisor to provide training and technical guidance for 18 months. The partnership with the Tsirang District administration also involved the sharing of project costs. The Administration covered the salary and travel expenses of the technical supervisor during the period he was assigned to the project.

Figure 3-2: Collaborative linkages with rural households as the focus of intervention



4.3.4 Good focus on local capacity building

The technical supervisor trained a woman from each of the 12 geogs in the construction and maintenance of the smokeless stoves. These trained women – fondly called *chullah tshogpas* by the villagers – have in turn conducted demonstrations on the construction, functioning and maintenance of the stoves in their respective geogs. They also serve as local stove technicians to whom people can turn to for technical assistance, if necessary. The demonstrations on improved stoves were packaged with messages from the district health and forestry officials on the benefits of the improved stoves to their health and the local environment. The training and demonstrations also facilitated interaction between the local women representing the different geogs and helped to develop camaraderie among them.

Moreover, the project, being the first undertaking of the Tsirang Women Group, provided the members with hands-on experience and skills to manage similar projects in the future and to work as a team. It also gave them new insights into rural development and working with local communities.

4.3.5 Low cost and simple technology

The low cost and technical simplicity of the improved mud stove have made it easier for the local people to adopt it and enhanced the sustainability and replicability of the intervention. The metal chimney pipes and iron grates can be procured without much difficulty from the neighbouring Indian town of Bongaigaon (three-to-four-hour drive from Damphu, Tsirang's headquarters).

4.3.6 Cost-sharing as a tool to establish local stakeholders and ownership

Each beneficiary was required to contribute about US$3.00 and local materials such as wood and mud. This cost-sharing, without being a burden to the beneficiaries, has helped to establish local ownership of the intervention.

4.4 Limitations

4.4.1 Project planning not community driven

The project planning was not community driven but community enthusiasm and response to the intervention grew immensely as local people realized the many benefits of the improved stoves.

4.4.2 Technological limitations

The improved stoves had two negative aspects: (1) the stoves do not radiate heat to keep space and people warm during winters; (2) they produce very few coals to roast food over, e.g. corn. A few households reported not being able to use the smokeless stoves to prepare cattle feed.

5. Key lessons

- ***Interventions that demonstrate tangible benefits*** within a short term are likely to be more appealing to the local people than those with long gestation periods. Both projects were quick in showing benefits, contributing to widespread positive public opinion.

- ***Energy conservation projects have far more meaning for the local people when the intervention is connected well to their daily lives.*** While reduction of fuelwood consumption was the principal objective, both the projects also generated several spin-off social benefits: cleaner kitchens and utensils, reduced risk of smoke-related illnesses, considerable reduction in time spent on cooking, washing utensils and fuelwood collection; these benefits affect the daily lives of local people profoundly. This further demonstrates how energy projects can add value to the broader rural development objectives.

- ***Low-cost and simple interventions are easier to promote and possess greater potential for success.*** This is particularly evident in the case of the Biomass Fuel Efficiency Project, where public response has been extremely positive as the improved stoves are affordable and very easy to construct and maintain. Based on the positive public response, the SGP extended additional funding to the Tsirang Women Group to cover more households. As mentioned earlier, affordability and simplicity also enhance the sustainability and replicability of the technology.

- ***Systematic integration of local capacity development into the project has greater potential for long-term success and sustainability.*** Both the shielded, cylindrical metal stove and the improved mud stove are not new interventions in Bhutan. However, in the past, in most cases the installation of improved stoves was not backed up with proper training of the users in the use and maintenance of the stoves. Consequently, most stoves became defunct and users reverted to traditional ovens. In contrast to this, the Biomass Fuel Efficiency Project was able to systematically integrate local capacity building activities during the implementation of the project which ensured its success beyond project duration. Whereas, in the case of the Improved Community Cooking Stove Project in Trashigang, capacity building activities were not well targeted.

- ***Effective partnership and collaboration between stakeholders is the key for successful project implementation.*** The interinstitutional partnership in the case of the Biomass Fuel Efficiency Project shows how three distinct agencies – one a local women's group, the other a local government authority and the third a line ministry – can complement each other by working together. On the other hand, the Community Cooking Stove Project was unable to develop any effective partnership and, consequently, the quality of project implementation suffered with some activities, such as the training workshops, being implemented in an ad hoc manner.

- ***The importance of site selection based on criteria that are most relevant to project objectives*** was reinforced by carefully choosing intervention sites for their high demonstration value and visibility; the Community Cooking Stove Project was able to generate a multiplier effect.

- ***Project design, especially when it has been derived from extensive stakeholder consultation, should not be compromised under pressure.*** This was demonstrated by the Community Cooking Stove Project. The other option – which is the easier one – would have been to increase the budget to buy additional improved stoves so that all the religious institutions would have received three stoves each as originally planned. The number of the improved stoves would then have been more compatible with actual usage and intended project impact would not have been diluted.

- ***Project planning and appraisal can benefit immensely from simple cost-benefit or input-output analysis.*** If the total budget of the project is taken as cost or input and the saving of fuelwood as the key benefit and output, then the Biomass Fuel Efficiency Project was a far more efficient project than the Community Cooking Stove Project. The former saves 7,500 tonnes of fuelwood a year at a total budget of US$77,985, which means each tonne of fuelwood saved per year costs a little more than US$10.00. In comparison, the latter saves 220 to 280 tonnes of fuelwood a year at a total budget of US$33,069, which translates to more than US$130 per tonne of fuelwood saved each year.

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Chapter 4

Participatory approaches to rural energy supply: A case study of biomass energy for rural India

K. Usha Rao[28]

Abstract

Even after five decades of planned effort through programmes and policies in the Indian energy sector, electricity has reached only one-third of all households. Access to modern fuels for cooking is primarily limited to semi-urban or urban areas. Rural households, which comprise 70 percent of the total population, continue to rely primarily on traditional energy sources such as fuelwood, agriculture residues and animal dung for their energy needs. The Government of India's Tenth Five Year Plan and Electricity Act (2003) envisage shifts in the approaches to energy programmes and policies; this makes them more demand-driven and participatory. Biomass energy technologies have tremendous potential to meet decentralized energy needs sustainably. However, there are a number of barriers and risks that have to be addressed. This paper discusses an ongoing project, Biomass Energy for Rural India, which attempts to deal with these issues. The emerging lessons from participatory approaches adopted in this case study are assessed in the context of the provision of integrated energy services in rural areas. The paper also highlights a few lessons learned from the implementation to date.

Keywords: Rural energy, participatory approaches, poverty, gender.

1. Background

Natural resources are basic assets of the poor and most of these are their primary sources of energy. Energy in rural areas is used for lighting, cooking, space heating in the domestic sector; water lifting and transportation in agriculture and for use in small and medium enterprises. The lack of modern energy sources severely constrains rural development; this affects employment and income-generation prospects and exacerbates poverty.

Centralized planning and implementation in the energy sector have had limited impacts, particularly on the poor, who mostly consume energy inefficiently (such as traditional cooking based on fuelwood). Similarly, it is estimated that 70 to 80 million Indian households are not served by grid quality electricity. Unreliable as well as erratic power supply – including for electrified homes – compels villagers to rely on kerosene lamps and other more expensive substitutes. The problem of low levels of consumption is further compounded by dependence on fossil fuels, a major source of greenhouse gas (GHG) emissions. High dependence on fuelwood has a significant and detrimental impact on the environment and forest ecosystems. Energy issues related to efficiency, security, access and the environment remain major challenges.

The Government of India's (GOI) Tenth Five Year Plan (2002–2007) places emphasis on integrated energy approaches for addressing these issues; the Electricity Act (2003) stresses the need for expansion of local energy supply options, decentralized energy generation, transmission and distribution through *panchayats*[29], cooperatives,

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29 An administrative body of elected members for a group of villages.

non-governmental organizations (NGOs) and private entrepreneurs. In order to achieve greater impacts on the poor, there is a need for a shift from the largely supply-driven approaches of the past to more demand-driven participatory approaches to energy services' planning and implementation. This approach is expected to generate a number of technological, market, financial, socio-economic and political challenges.

1.1 Analytical framework

This paper presents a case study of the ongoing project Biomass Energy for Rural India (BERI) funded primarily by the GOI, the State Government of Karnataka, the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP) and the India Canada Environment Facility (ICEF). The project complements the efforts of the GOI in promoting an integrated approach to rural energy with emphasis on community participation and women's involvement. It proposes the development of management structures for sustained use of renewable energy technologies involving communities. The lessons learnt during project formulation and implementation stages are discussed in the conceptual frameworks of barriers, risks and mitigation; Water, Energy, Health, Agriculture and Biodiversity (WEHAB) and the development-practice areas of the UNDP. Since the project is ongoing, it should be noted that lessons are still incipient.

2. Case study: Biomass Energy for Rural India

2.1 Conceptualization

Preliminary surveys were carried out to determine energy demands and options for supply in a group of villages in Karnataka. Although the pilot demonstration area *(Figure 4-1)* was electrified already, the quality of the electricity supply was very poor in terms of availability and variations in voltage and frequency. Three biomass energy technologies – leaf litter-based biogas, dung-based biogas and biomass gasifiers were identified for meeting the villagers' energy needs. It was evident that although the proposed technologies were technically feasible for large-scale deployment, they could not have been propagated without addressing a number of barriers related, *inter alia*, to capacity – both at institutional and individual levels; finance, as they are capital-intensive; markets and policies, due to the subsidized energy prices of alternatives.

The technological interventions proposed are based primarily on local resources. Biomass availability on a sustained basis requires dealing with other resources such as land, water and human contributions. Insufficient land, scarcity of water and lack of local people's participation become potential risks for the project. Participation at the local level as an integral component of the project was thus perceived as being inevitable. Consequently, the project's primary aim was promoting participatory approaches for meeting rural energy needs sustainably.

The four components of the project were:

1. **Demonstration of the technical feasibility and financial viability of bio-energy gasification technologies** on a significant scale in a cluster of about 24 villages of Tumkur District in Karnataka for meeting irrigation and other electrical energy needs: biogas systems were designed to accommodate cooking gas, drinking water and lighting requirements.

2. **Capacity building and development for appropriate mechanisms for implementation, management and monitoring of the project;** the project proposed capacity building of Bio-energy Services Enterprises (BSEs) as a Rural Energy Service Company (RESCO) to overcome institutional barriers. Active networking with existing and new enterprises through implementation arrangements identified potential BSEs. Customized training modules were then designed and developed, bearing in mind the needs and background of the project beneficiaries.

3. **Development of financial, institutional and marketing strategies** to overcome the barriers identified for large-scale replication of the bio-energy packages for decentralized applications outside Tumkur District and in parts of rural India. The project goal was to ensure that the fee-for-energy service approach would be able to recover all the operations and maintenance costs initially, and subsequently introduce schemes for recovery of the capital costs of the bio-energy systems. The project proposed to establish linkages with microcredit organizations, NGOs and other village level money-lending groups to facilitate cost recovery. One of the goals of this activity was to ensure that entrepreneurs, NGOs and community organizations, which focus on the deployment of future systems could be confident that they could recover their investments.

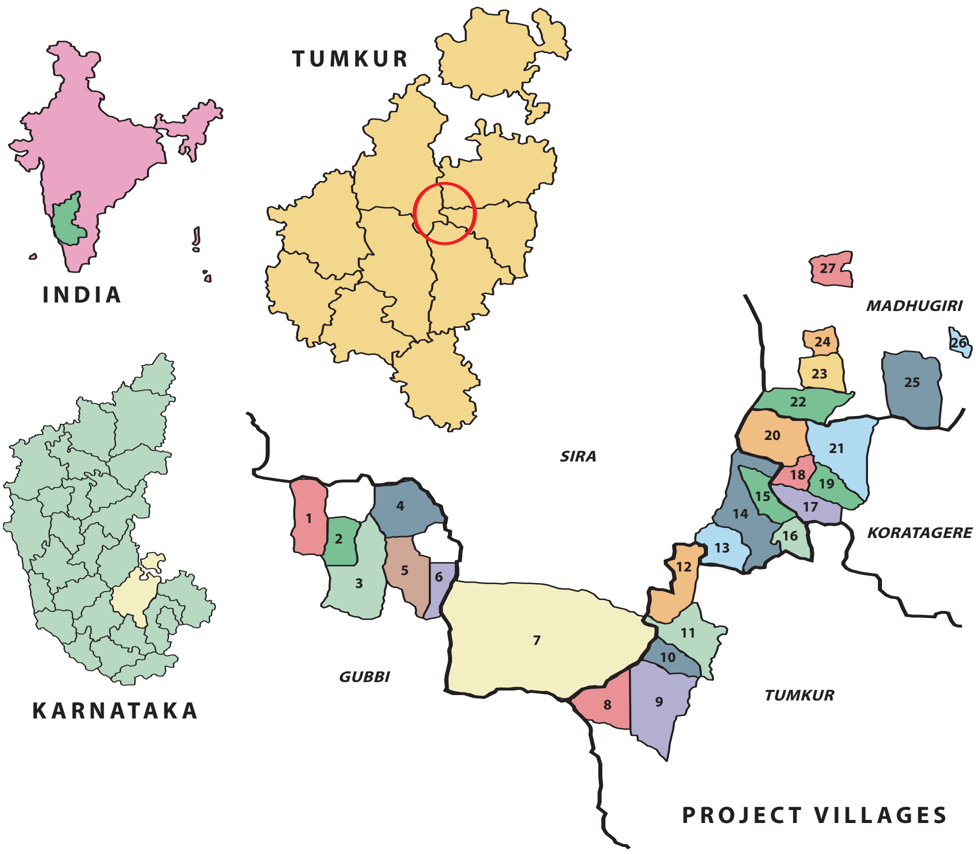
4. **Dissemination of bio-energy technology information packages** on a wide scale for their implementation to reduce GHG1 emissions.

Financial and bio-energy system management for the post project period (i.e. after 2007) will evolve as the project progresses. Two potential options indicated at the time of project conception are expected to be validated based on the project's experience:

- *Commercial Bank – Entrepreneur System:* All project assets and components will be transferred to a commercial bank. The bank will identify the entrepreneurs and provide working capital; the entrepreneurs will, in turn, repay the bank from the revenue collected from the beneficiaries. The profits or surplus income earned could be set aside in a *Special Fund,* after providing for returns to the entrepreneur to provide seed money to entrepreneurs to establish bio-energy systems in new villages;

- *Panchayat – Entrepreneurs/NGOs:* all project assets will be transferred to the panchayats, in consultation with the *Zilla Parishad* (District Administration). Zilla Parishad will provide the financial guarantee to the panchayats, who will take responsibility for the project. The panchayats will, in turn, identify NGOs or entrepreneurs and contract out the operation, maintenance and management of the bio-energy system for an agreed technical fee, but will own the assets. The surplus income will be set aside in a Special Fund to provide seed money for initiating bio-energy projects in other villages.

Figure 4-1: Pilot projects' location



Index	Village name
1	Veerannana halli
2	Sheebaiana palya
3	K.T Halli
4	Bore gunte
5	Gidadagala Ranganahalli
6	Gidadagala halli
7	Obenahalli
8	Chikkannana halli
9	Kabbigere
10	Ajjena halli
11	Haldodderi
12	Dasara halli
13	Chikkarasana halli
14	Venkatapura
15	Salapurahalli
16	Chikkaseebi
17	Nelahal
18	Gowdana halli
19	Sore kunte
20	Mallena halli
21	Hunjanalu
22	Sirivalli Halli
23	Revanalu
24	Anka sandra
25	Thogari kunte
26	Chikka hedigehalli
27	Dodda hedigehalli

2.2 Project inception

A series of village level exploratory and open-ended meetings were held to assess the needs of villagers on energy-related issues, and this provided a forum where villagers could propose possible solutions, which could be locally sustainable (i.e. without major dependence on the GOI or external sources). Through this process, the conceptual basis for the project was re-affirmed and it was further learned that:

- People are ready to unite to find indigenous solutions to local problems;
- People are willing to pay more for better and uninterrupted energy services;
- Poverty and unemployment are major issues in rural areas and any project intervention that tackles these two issues is welcome;
- Energy issues are connected intimately to other livelihood issues and therefore cannot be tackled in isolation or in exclusion of other issues;
- There is vast scope and demand for irrigation, which can enhance farm income thereby permitting farmers to pay for electricity;
- Safe drinking water is still a problem area, particularly in summer (April to June), due to power shortages.

After analysis of the baseline data and the stated preferences of the local population, the following decisions were made:

- Set up gasifier units to generate electricity that will be sufficient to provide illumination for all households; to run drinking water supply systems for the villages; to pump water to provide irrigation at the rate of at least half an acre per household; and to run flour mills and other existing or proposed village industries;
- Grow trees on (forested) common lands by involving the whole community and encourage the growing of trees on private land to avoid fuelwood supply shortages;
- Install small community biogas plants, each catering to three to ten adjacent households to manage cooking gas requirements;
- Provide irrigation facilities to individual farmers from community bore wells;
- Develop an agricultural strategy for each block of land to encourage the sustainable cultivation of crops, perhaps only light irrigation crops, and ban major water-consuming crops such as paddy and sugarcane.
- Support income-generating activities to ensure cost recovery through increased capacity to pay.


Light irrigation crop in Karnataka, India

The project originally planned to deploy biogas systems to be used for electricity generation in the provision of drinking water and lighting and for cooking based on the premise that it would not be economically viable to operate the gasifier at very low loads and capacity factors.

During the detailed consultations held with various stakeholders, particularly communities, it was realized that it would not be practical to de-link from the local grid in the context of promoting a technology, but the project could supplement the supply. The electricity distribution company, Bangalore Electricity Supply Company (BESCOM), was losing money due to high transmission and distribution losses. As the emphasis is on improving the quality of energy services, a memorandum of understanding between BESCOM and the project was developed to allow the project to supply electricity to the villages in the target area. For BESCOM, this would minimize losses due to default or non-payment of electricity bills by consumers. BESCOM was further willing to hand over the entire area for distribution of the energy services through the project. Such a decision depends on the success of the pilot villages.

2.3 Implementation framework

To implement the project, a number of participatory community organizations have either been set up or strengthened and these have been facilitated by a dedicated project team:

- *Village Bio-energy Management Committee (VBEMC):* The VBEMC is responsible for the bio-energy services' package and the biomass gasifier system. The general body of the VBEMC consists of all the adult members of the village, and comprises a 15-member committee, elected by the general body. Eventually, at least 30 percent of the members in the committee are expected to be women.

- *Village Forest Committee (VFC):* The VFC establishes and manages plantations on institutional vacant land and also private land on lease (where owners have been keeping the land fallow either due to low productivity of agricultural crops or absence of landowners in the village). It is expected that most of the produce will go to the gasifier system. It is envisaged that approximately half of the requirements of the gasifier will be met by the VFCs, with the remainder being derived from private sources.

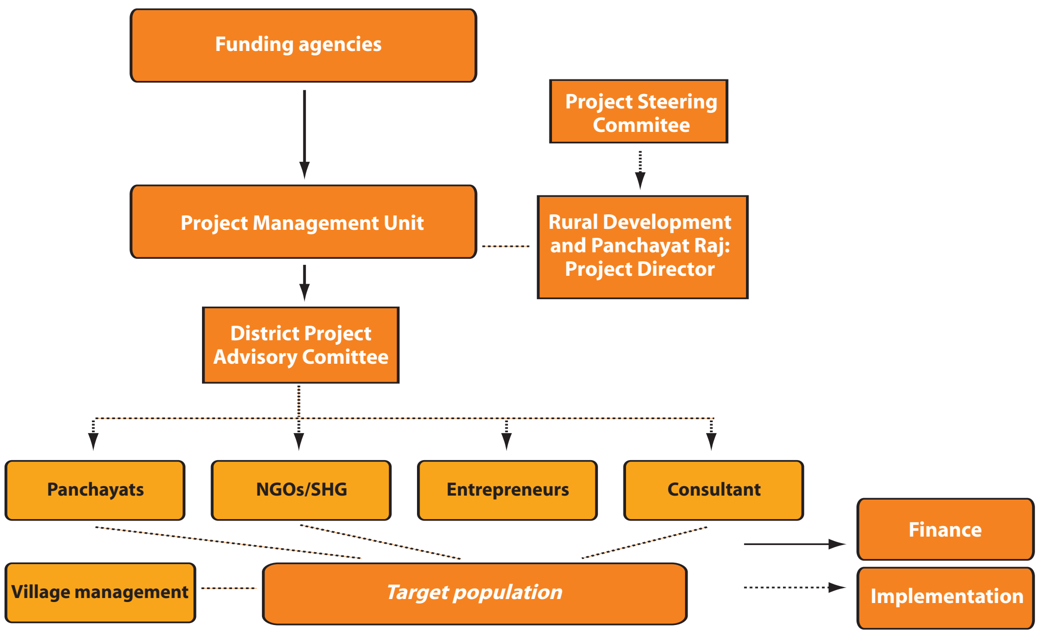
- *Water Users' Association (WUA):* Each community bore well is expected to cater to ten to 20 farmers and is managed by a WUA. The association will evolve an agricultural development strategy for each cropping season and after consulting the members fix a cropping plan that has to be followed strictly by each member. Much sprinkler and drip irrigation will be adopted for efficient use of scarce water. Each WUA will be responsible for buying electricity from the VBEMC, and will charge individual farmers for water supplied on a volumetric basis, thereby encouraging water conservation. The group will also take up ground-water recharging structures in the area. Whereas part of the initial capital cost for pipelines is expected to be contributed by the members, the remainder will be raised from other sources. All operation and maintenance (O&M) costs are proposed to be recovered by the WUA so that the entire operation is sustainable in the long term.

- *Biogas Users' Group (BUG):* The project proposes to install small community plants involving three to ten households, each plant being run by a BUG comprising the households. Initially the groups will look after the plants themselves, but in the long run, one or two operators can be appointed to operate all the plants in a village for a fee.

- *Self-help Groups (SHG):* Several women's self-help, thrift and credit groups have already been formed in the project area under the World Bank-assisted Swashakti and the state government-sponsored Stree Shakti programmes. The project is strengthening these groups to take up income-generating activities that will enhance family incomes in order to facilitate cost recovery for energy services. These groups will be trained in various skills and also on how to use energy-driven devices for better productivity.

In addition, linkages with other partners such as NGOs, entrepreneurs, research and financial institution and local bodies are being established at appropriate levels.

Figure 4-2: Current implementation arrangement



2.4 Management and coordination arrangements

Initially it was proposed to house the team with the Karnataka State Council for Science and Technology (KSCST), the implementing agency of the project. To provide for increased autonomy, it was decided to set up the Project Management Unit (PMU) as an autonomous registered society of the Karnataka Government to serve the energy needs of the rural areas in a sustainable fashion. *Figure 4-2* shows the present implementation framework for the project.

All the funding agencies route their funds directly to the PMU, which maintains a separate project account. An operations' manual was developed to help the PMU follow transparent rules and regulations in managing the project activities.

3. Emerging lessons

Although the project is in early stages of implementation, the lessons that can be learned are significant.

3.1 Analyses of barriers and risks

The present focus of the project is only on the pilot demonstration in Tumkur and largely reflects the barriers at that level. Further barrier removal strategies could be implemented subsequently for large-scale replication of bio-energy technologies for rural energy services.

Use of participatory groups, linkages with local bodies and synergizing with government programmes could be effective for provision of energy services.

- *Technical barriers:* Barring a few technology suppliers, who supply models to designers to produce gasifier systems, there is very little information openly or commercially available to facilitate decisions on performance specifications, size and costs. Based on consultations with different stakeholders who are experienced with gasifiers, and as recognized in the project development phase, the technology of the Indian Institute of Science (IISc) is at the most advanced stage. Thus, it was decided to deploy IISc gasifiers for the first cluster. For subsequent clusters, approaches would be evolved to address issues related to the technology transfer and third party certification on standards and performance of gasifier systems.

- *Institutional barriers:* There are few institutions at the local level that deal with energy issues. Efforts are being made to develop capacity at the local level by drawing appropriate linkages with village-level institutions. The experience in the first cluster of villages for implementation of bio-energy services' packages in rural areas shows that the extent of participation of village groups – self-help groups, village level institutions and NGOs has been satisfactory. From the institutional barriers' perspective, use of participatory groups, linkages with local bodies and synergizing with government programmes could be effective for provision of energy services. Also, community involvement in baseline determination, monitoring and evaluation yields better results and lower costs.

- *Information barriers:* There is a lack of awareness and information on viable technological configurations, which impedes promotion of these technologies. Villagers were not aware of the full range of bio-energy technologies and were taken to a nearby village to observe the gasifiers in operation; this subsequently led to better appreciation and greater involvement of the people. "Seeing is believing" is valid for promoting the adoption of bio-energy technologies. Cohesiveness and the confidence level of the villagers were realized and raised through visits to existing small gasifier plants, tree-based farming systems, nurseries raised by women's groups and a community biogas plant run by village women. This also illustrated that village communities are ready to accept a new technology if its benefits are perceived directly by them. Primary sources of information are vital for communities to adopt a new technology. However, this requires awareness-raising and guided demonstration.

- *Financial barriers:* It was evident from the initial consultations, participatory rural appraisals (PRAs) and baseline surveys that the high level of initial investments would be a barrier. However, if the proposed services are provided, there is considerable scope for developing innovative mechanisms for recovery of the costs of providing services. Low-income levels of the villagers, the challenges of successive droughts and the availability of subsidized low cost alternatives have limited financial access. The villagers in the first cluster have shown willingness to contribute towards the full recovery of operation and maintenance (O&M), and there is an understanding about the need to recover the capital costs.

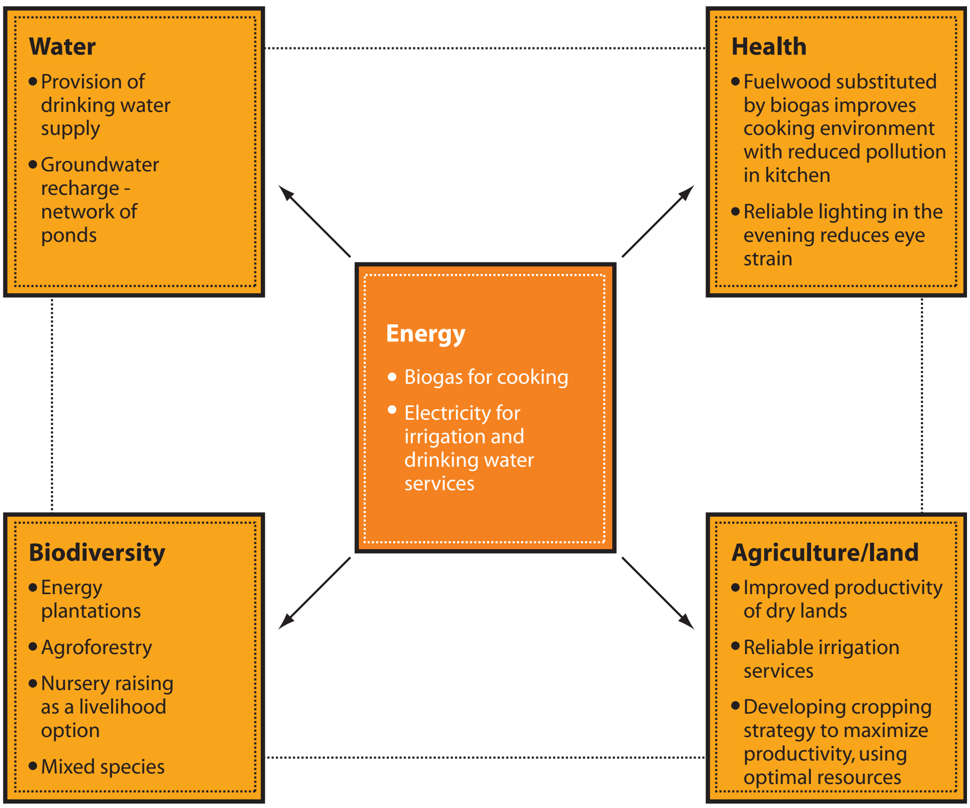
- *Market barriers:* Bio-energy technologies often have to compete with conventional sources of energy either with subsidized electricity and fossil fuel (kerosene) options or freely accessible fuelwood and biomass residues. In such situations, absence of a "level playing field" acts as a key barrier to market penetration.

Some anticipated risks did not manifest themselves and proposed mitigation measures were adopted successfully. So far, the project has managed successfully the risk of non-participation through effective implementation strategies. The risk of limited government involvement turned out to be higher than the initial perception. Availability of adequate land for raising plantations was a problem. However community involvement in selection of species and providing livelihood opportunities to women through the nursery helped to mobilize private land resources.

Increased autonomy for the PMU was seen as a key driver for the success of the project, and hence the necessity to institutionalize it as an independent entity. Another key risk not visualized at the time of project development was the potential of limited interface between the implementing agencies of the project at its development phase and the full project. Additionally, there were some misconceptions on the roles of different stakeholders.

Finally, technology risks are much higher than expected at the time of project conception. There are only a limited number of biomass gasifier installations that continuously generate electricity for distribution in a cluster of villages of this scale.

Figure 4-3: WEHAB framework of the project



Note: There are concrete links between energy and environmental sustainability that are evident in this project and this can be considered in using the WEHAB framework as a tool for analysis.

a group of women visiting a pilot nursery farm

3.2 WEHAB context for energy and environmental sustainability

The project's influence on WEHAB was analysed; it had a positive effect on each of the five elements. This is illustrated in *Figure 4-3*.

Water: The project required the drilling of additional community bore wells for providing irrigation water. Since the area had already exploited groundwater resources, the district has been classified as a grey area, which indicates that there may be low groundwater levels. Thus efforts were made to link with the ongoing initiatives of the World Bank and the state government to facilitate construction of water-harvesting structures to ensure adequate recharge. Biomass-based energy interventions enable a watershed approach that leads to groundwater recharge on a sustained basis to ensure additional water requirements for biomass production and dry land irrigation.

Deploying biomass energy technologies could minimize the impacts of climate change on sea levels, ecosystems, water, agriculture, food and health.

Agriculture/land: Biomass-based energy interventions offer solutions through effective use of the land. Biomass crops as perennials can reduce soil erosion and restore fertility through avoidance of agrochemical application. Compared with food crops like cereals, application rates of agrochemicals per hectare are one-fifth to one-twentieth for perennial energy crops. Appropriate selection of species ensures biodiversity and improves the landscape when degraded lands and other wastelands are used for biomass production. Improved land cover through vegetation leads to water retention and improved microclimatic conditions with potential positive hydrological situations at the local level. The project ensures effective management of land resources. *Ergo*, plantations for gasifiers have all these advantages.

Biodiversity: Long-term sustainability of biomass supply in the project prevents exclusive dependence on fast growing monoculture plantations, which could have supplied the fuelwood for biomass gasifiers. The need to consider biodiversity issues was essential for agroforestry, and supplying farm forestry with multiple species further helped the villagers to improve their livelihoods. Thus there is greater acceptance by the communities as well as the provision of fuelwood for the gasifiers. Additional income is generated too.

Health: Biogas replaces fuelwood cooking stoves and consequently reduces air pollution. Women and children, in particular, benefit as carbon monoxide levels and particulate levels inside homes using fuelwood in traditional stoves are reduced; currently these levels far exceed the permissible levels. They cause respiratory problems, damage to eyes and interfere with the blood's ability to absorb oxygen; other health-related problems occur as well.

Energy/environment: Renewable energy technologies, which include biomass, are considered as potential GHG mitigation options. Deploying biomass energy technologies could minimize the impacts of climate change on sea levels, ecosystems, water, agriculture, food and health.

3.3 Inherent linkages to UNDP development practices

The project has direct linkage to **poverty reduction** through energy-service support such as assured irrigation for particularly poor communities, and mechanisms to provide water rights for the landless to address equity issues; community income generation is subsequently enhanced.

Governance elements can also be gleaned from the project, which is exploring different mechanisms for the distribution of energy services to rural populations during and after the project phase. Consultations are held at the village level, with panchayats and other community groups, for future transfer of assets and their management.

The involvement of local bodies has enhanced the quality of implementation and provided a forum to address sustainability issues. Therefore, all the community groups involved in the project are proposed to be declared as subcommittees of the local bodies. All the elected members of the local bodies have been given ex-officio member status in these local level organizations. This has enhanced synergy between the local bodies and the project.

In terms of **crisis prevention and recovery,** the project could be a classical approach to deal with drought and dry lands. The environmentally friendly technologies arrest GHG emissions and thus contribute to mitigating climate risk-associated disasters in the short term and climate change impacts over the long term. The project is deploying **information communication technologies** to address a number of barriers that relate to technology, information, institutions and markets.

The HIV/AIDS linkage is less direct. However, participatory approaches adopted in the project entail sensitivity to overall developmental issues and interventions and in this context, the project has supported health camps.

Community involvement and participation are essential for tackling energy-related issues.

While the project itself falls mainly under the **energy and environment practice,** gender perspectives have been integrated fully in project activities. Energy issues are core livelihood issues for women in rural areas. The project has ensured the participation of women and men in managing the supply as well as the use of energy services. Modern energy options reduce the drudgery of household work as they reduce time taken for cooking, collection of fuelwood, collection of drinking water and save time that potentially enhances household income from other activities.

4. Interim conclusions

There is a growing realization for linking energy sources and uses. Energy sources are explicitly linked to other natural resources. In rural areas, energy is sourced primarily from biomass. However, the current practices restrict its use in different forms. Modern biomass energy conversion technologies, such as those proposed by the project, provide energy services for enhancing the quality of life of people in rural areas. These technologies also ensure environmental sustainability, the seventh Millennium Development Goal, which is part of the UN Millennium Declaration. The analysis of the project within the context of analytical frameworks (e.g. WEHAB and UNDP practice areas) indicates its continued relevance not only at the conceptual level but also at practical or field levels.

Access to modern energy services in rural areas faces a number of challenges. Community involvement and participation are essential for tackling energy-related issues in the rural areas. Suitability and availability of technologies do not guarantee their diffusion, as this depends on various factors. While technology-related barriers remain, for reasons that have been discussed in this case study, there are other socio-economic and political reasons for limited energy access in rural areas. This necessitates developing innovative institutions and extensive capacity building for decentralized generation and distribution of energy services. The project particularly attempts to address this gap by adopting participatory approaches to meet rural energy needs sustainably.

The impacts of participatory approaches adopted so far also raise important issues. These processes are intensive and sensitive, and could be time-consuming. The institutional mechanisms may become complex due to the different priorities of the stakeholders involved at the local level. As noted earlier, water is a priority, but ensuring water supply without degrading the groundwater table may not be high on the agenda. On the other hand, local needs are clearly spelt out. If these needs are met, then the long-term sustainability of the development interventions is ensured. Participation would thus be a critical factor for sustainability. This further ensures convergence and the cost effectiveness of development interventions.

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Chapter 5

Microhydro case study:
The Garung and Seloliman projects in Indonesia

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Abstract

Microhydro resources in Indonesia, which constitute approximately 450 MW, have great potential to cater to the electricity demand of rural communities. However, microhydro development has been very slow due to several barriers, including, inter alia, high initial investment in the microhydro system, lack of familiarity with the system (especially in rural areas) and lack of government policy to support the development of microhydro schemes (the oil price has been kept low, lack of incentives for microhydro projects). In addition to these barriers, past experiences suggest that insufficient preparation of the recipient community usually leads to difficulties in maintaining the sustainability of the installed microhydro system. This paper presents a case study concerning microhydro development projects, namely, Garung project in West Java Province and Seloliman project in East Java Province of Indonesia; it deals with the removal of barriers related to initial investment and weak project preparation. The paper highlights the interlinkage among environmental benefits, benefits from income-generating activities at the community level, project impacts, the potential for project duplication under the country's current economic reform and liberalization of the ower sector. In these microhydro projects, aside from installing microhydro units, the project activities also include efforts to improve the welfare of the recipient community by stimulating income-generating activities at the community level. To date, the two projects can be considered successful in terms of their ability to deliver electricity to rural communities and to improve the local community's organizational skills. The lessons learned from the two projects include: (i) a successful project is the outcome of thorough preparatory work including bottom-up initiatives, coordination of mutual interests at the earliest stage of the programme and appropriate and sufficient programme supervision; (ii) an income-generating advocacy component embedded as part of the microhydro deployment programme is insufficient to improve the income of the local community; (iii) a soft loan combined with a grant to remove the high initial investment barrier appears to be a good model for promoting the wider use of a small-scale microhydro system.

Keywords: Microhydro, rural electrification, community, participatory approach, investment barrier, income-generating activities.

1. Background and context

This paper presents the results of a case study on the performance of two microhydro development projects in Indonesia, the funding of which was partly provided by the GEF/SGP. Where linkage to the Water, Energy, Health, Agriculture, Biodiversity (WEHAB) initiative is concerned, the projects are relevant in the sense that they deal with Energy and to some extent Water. In addition to addressing the overall performance of these projects, the study highlights the interlinkage among environmental benefits, benefits of income-generating activities at the community level and the potential of project duplication under the country's current economic reform and liberalization of the power sector.

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The materials used in this study were collected from site visits, interviews with local communities and the project's executing agency and from a desktop study concerning the country's general socio-economic environment and the energy policy and priority settings that are relevant to a small-scale renewable energy system.

The rationale that motivates this work is that by conducting an in-depth probe into project implementation, the various factors affecting the success or failure of renewable energy technology application projects can be identified and necessary improvement in the approach and design of future projects can be suggested. By sharing the lessons learned from project implementation, successes can be duplicated and failure avoided. *Table 5-1* provides important statistics related to Indonesia as a whole.

Table 5-1: Indonesia's country profile

Geography	Archipelago (17,000 islands, 6,000 inhabited)
Location	Between 94o45' and 141o 05' E. Lat., 6o 08' N. Lat. and 11o 15' S. Lat.
Main islands	Java, Sumatra, Kalimantan, Sulawesi and Papua
Population (2002)	212 million (60% live in Java and Madura), around 65% live in rural areas
GDP growth	Prior to 1997: 5–7% p.a., after 1997: 3–4% p.a.
Major economic sectors (in decreasing importance)	Manufacturing, agriculture and forestry, mining and energy, services
Energy resources	Oil (5 million bbl), natural gas (92 Tcf), coal (5.9 billion tonnes), large hydropower (75 GW), microhydro (450 MW), geothermal (19 GW)
Energy consumption growth	9.3% p.a. (4,400 x 109 MJ in 2001)
Type of energy consumed	Primarily oil, followed by natural gas, coal, hydropower and geothermal, biomass for cooking in rural areas
Electricity installed capacity	21.4 GW (utility) and 15 GW (industrial captive power)
Electricity consumption growth	Before 1997: 14% p.a., after 1997: 7% p.a.
Household electrification	52% of households are electrified

1.1 Latest developments in Indonesia's energy policy

Energy prices are regulated by the government; the prices of some fuels and electricity tariffs for some segments of electricity consumers are subsidized. To reduce the financial burden of energy subsidies, steps have been taken recently to remove energy subsidies gradually. Energy subsidies are planned for complete removal by 2005.

Through power sector reform, as represented by the Electricity Law (2002), the state utility (PLN) is expected to become a more efficient and competitive commercial entity. One of the implications of this reform is that the PLN's social burden such as the rural electrification programme has been lessened significantly. It is expected that local government will take up the PLN's duty in the rural electrification programme. In order to increase renewable energy resource utilization in 2001 the government issued a ministerial decree stating that the PLN is obliged to purchase renewable-based electricity offered by small/medium enterprises (SMEs), namely the PSK Tersebar Scheme.[31]

The Regional Autonomy Law of 1999 regulates the system of regional government; it also has implications in the development of energy in rural areas. Under this law, authority and responsibility in the country's regional development have shifted from the national government to the hands of

31 A ministerial decree concerning small-scale renewable-based electricity generated by SMEs. The decree states that as long as it is technically feasible, the PLN (the state utility) is obliged to purchase renewable-based electricity offered by SMEs. The electricity price is to be determined according to the PLN's local delivery cost (abbreviated to HPP) and the electricity voltage at the connection point. If the electricity is sold to the PLN's medium voltage grid then the price is set at 80 percent of the PLN's low voltage HPP. If the electricity is sold to the PLN's low voltage grid then the price is 60 percent of the corresponding PLN's HPP.

a regency level government (*Kabupaten*). It is expected that regional governments will become active and creative in utilizing local resources, including renewable energy resources, for developing their region.

2. Project descriptions

GEF/SGP Indonesia: The Small Grant Program (SGP) is a GEF corporate programme launched in 1992 to provide support for community-level initiatives in developing countries that contribute to conserving global biodiversity, mitigating global climate change and protecting international waters. The programme focuses on participation and democracy, synergy through partnerships, empowerment of women and indigenous people, replicability and sustainability. The SGP has also sought to have an impact on national environmental policies and donor agendas by increasing public awareness of global environmental issues and communicating lessons learned, including best practices from its community-based experiences.

In Indonesia the implementation of the GEF/SGP started in 1996, and was hosted by a foundation working in the environmental area called the *Yayasan Bina Usaha Lingkungan* (YBUL). One staff member of the YBUL is appointed National Coordinator and a forum consisting of a number of NGOs, personnel from the Ministry of Environment, industry and the media serves as the National Steering Committee. To date, there are approximately 100 GEF/SGP projects in Indonesia. Two of these projects form the basis of this case study: (i) Community Empowerment through Development of Pikohydro, located in Garung, West Java Province; and (ii) Upgrading the Capacity of Microhydro Facility to Enhance Economic Activities Development of Local Community, located in Seloliman, East Java Province. For the sake of simplicity, the former will be referred to as the Garung Project and the latter as the Seloliman Project. To avoid confusion relating to the terms "pikohydro" and "microhydro", the hydropower plants in the two projects will be termed microhydro because their generating capacity falls within the same class.

The Garung Project started in July 2001 and the microhydro power plant was commissioned in April 2002 (project proposal: March 2001 to February 2002). The Seloliman Project began in August 2000 and was completed in July 2001. Therefore, as far as the SGP is concerned, the two projects have finished. A short description of the two projects is given in *Table 5-2*.

3. Project objectives and expected outputs

According to the project document, the Garung Project objectives include: (i) to develop the capacity of local technicians to install and operate a microhydro unit; (ii) to stimulate income improvement by using electricity and (iii) to increase the value of local natural resources for improving rural economy through electricity generation.

Table 5-2: Project characteristics

Key features	Project location	
	Garung, West Java	Seloliman, East Java
Plant capacity	15 kW	23 kW
Water head	19 metres, 140 litres/second	11 metres, 300 litres/second
Grid connected	No	Yes
Operating hours	Daily, 1800 to 0600	24 hours
Electricity uses	Lighting for 78 houses	Lighting for 39 houses, an office complex, 2 productive users, sold to state grid
Current load	8 kW	21 kW
Financing	Loan and GEF/SGP grant	GEF/SGP grant
Project executing agency	POKLAN (NGO)	Konsorsium Seloliman (NGO)

Note: Both the Garung and Seloliman plants use a cross-flow turbine manufactured by PT Heksa Prakarsa Teknik (an Indonesian company located in Bandung, West Java Province).

The expected outputs of the Garung Project are: (i) five microhydro installations (total 50.7 kW) serving 330 houses; (ii) three community organizations to operate the installed microhydro; (iii) three business units to provide additional income to 200 family heads; (iv) reserve funds for operation and maintenance of the installed microhydro units for the first three months; (v) a community with improved awareness in maintaining the water catchment in upstream rivers.

The objectives of the Seloliman Project are: (i) to provide environmentally friendly energy alternatives; (ii) to provide education media and to raise the community's awareness on energy alternatives; (iii) to build community knowledge on sound utilization of natural resources; (iv) to increase the community standard of living via the development of economic activities using electricity; (v) to increase community awareness and community involvement in conserving the water catchment area in Seloliman protected forest; (vi) to establish a strong local cooperative, which will maintain the facility and its related activities (such as a revolving fund for productive activities) and (vii) to establish the community's shared ownership (managed through a cooperative) of the microhydro facility.

The expected outputs of the Seloliman Project are: (i) optimized use of water resources; (ii) microhydro installation as an electricity generator as well as an educational medium (demonstration unit); (iii) emergence of productive electricity usage; (iv) increased community welfare and educational support activities; (v) a professional local cooperative managing the microhydro installation; and (vi) a clear ownership scheme of the microhydro facility.

4. Project inputs

For ***Garung,*** there are two external funding sources: a grant under the SGP/GEF programme and a soft loan from YBUL. The GEF/SGP grant (US$25,000) was used to finance the preparation of the local community in the adoption of microhydro technology including programmes for stimulating income-generating activities at the community level. The loan from YBUL was used to finance the construction of the microhydro plant. According to its initial plan, five microhydro units were to be installed in three villages in West Java (one unit in Cipangramatan, two units in Dewata tea plantation and three units in Batu Ireng).

Figure 5-1: Projects' Location

The Cipangramatan plan was cancelled because the PLN (state utility) was extending its grid to the village. The Dewata plan was cancelled because POKLAN (an NGO which implements the Garung Project) could not obtain the necessary permit from the plantation company. The programme was then modified to include three villages namely: Gunung Halu, Batu Ireng and Garung. Community development programmes and necessary preparation for microhydro installation had been carried out at these sites by POKLAN. During the project's implementation, however, POKLAN has not been successful in obtaining the necessary funding for the microhydro units that was expected from other donor agencies.

In response to the high community expectancy for a microhydro running in their villages, YBUL then took the initiative to finance the micro-hydro construction. However, due to limited funding capacity, YBUL could finance the Garung Project only. This site was selected because it was considered the cheapest and the most ready compared to the other two sites. The financing scheme is a soft loan (zero interest). The Garung microhydro construction was completed and commissioned in April 2002. In June 2002 Garung community representatives, POKLAN, GEF/SGP and YBUL agreed that subsequent supervision activities for the Garung Project were to be undertaken by YBUL. Since then, one field officer working for YBUL has been stationed at this site.

In addition to the funding sources, the local community also provides inputs to the project in the form of workforces and materials for the civil work of the plant.

In addition to the funding sources, the local community also provides inputs to the project in the form of workforces and materials for the civil work of the plant (equivalent to approximately US$2,500). The installation cost to connect 75 houses to the microhydro grid (US$2,650) was borne by the connected house. The loan for microhydro construction (US$10,500) is to be repaid by the community from profits generated from operating the microhydro (electricity sales minus operation and maintenance costs).

The capacity upgrading of **Seloliman** microhydro was financed using a GEF/SGP grant (US$27,388). The grant package also included financing for community development activities including initiatives for strengthening income-generating activities at the community level and productive usage of electricity. The grant was proposed by the Seloliman Consortium. The consortium, which was established for the GEF/SGP project, consists of two local NGOs namely: the Center for Environmental Education (abbreviated to PPLH) and LEM21 (an NGOs in Seloliman). The focal agency of the consortium is the PPLH. Similar to the Garung case, the Seloliman community also provided inputs to the project in the form of workforces during the microhydro installation.

5. Community background

Garung community is located in a remote and mountainous area and can be reached via a semi-hard road using a motorcycle or a sport utility vehicle (SUV). The community comprises mostly subsistence farmers working with fixed land in and around the village. The educational level of the people is low; around 77 percent of the adults have only elementary school education and therefore their reading and writing are poor. The community has a strong spirit of collaboration and an open culture. They are experienced in organizing themselves to work in occasional community activities such as simple road improvement and mosque construction. The community, however, has no experience in managing activities/endeavours that are more regular in nature such as the management and operation of a microhydro power plant.

Prior to the microhydro project implementation, the Garung community was already familiar with the concept of generating electricity by harnessing water resources because they had observed one of the community members own and run a small hydropower plant in the village. Due to technical problems, this plant was eventually abandoned by the owner. Concerning household lighting, prior to the microhydro installation the community used kerosene lamps. Besides illumination, there are practically no economic activities that require electric power or that could be improved by the existence of an electricity supply. The farthest houses that are electrified are around two kilometres from the microhydro power plant.

In fact, the community could access electricity from the PLN's 220 V grid. Several houses in the community are connected to the grid but they are relatively distant from it and the quality of the electricity is low (the voltage at the houses is only around 170 V). Also, this distance makes the connection cost to the grid very high and unaffordable for most of the community.

Seloliman is the name of a subdistrict in Mojokerto District, East Java Province. The project site houses three subvillages in Seloliman namely: Biting, Sempur and Janjing. The power plant utilizes water resources from Maron River. The water intake is in Sempur, the power house is in Biting and the consumer is located in Janjing. The PPLH (the project grantee) is close to the project site. Except for Janjing (the electricity consumer), the project site can be reached by car. Janjing is located in a remote area. It can be reached by foot or motorcycle.

The community consists mostly of farmers working with fixed land around the village. Prior to the GEF/SGP project implementation, a microhydro installation (12 kW) was already in place. The installation was built in 1994 by the Mandiri Foundation under a GTZ[32]-funded project and was operated under the management of the PPLH. The original plan of the GTZ project was to use the microhydro to electrify the PPLH office complex and the previously mentioned three subvillages. However, in the same year the PLN grid reached this site. Sempur and Biting were connected to the PLN's grid while the PPLH complex and Janjing community were connected to the microhydro installation. The PPLH maximum consumption was around 5 kW while the connected 30 houses in Janjing had a power limit of 200 watts/house. The power plant management considered that the capacity of the existing plant needed to be upgraded since the plant experienced overload periodically. In 2000, the PPLH together with LEM21 requested a GEF/SGP grant for capacity upgrade to 32 kW. The GEF/SGP project proposal also included a plan to undertake community development activities.

When the programme offered a microhydro electricity system with much lower connection costs compared to the PLN, the community supported the programme eagerly.

The microhydro upgrading work was completed in 2000 and the plant has been operational since then. The turbine, generator and related control systems were all replaced with higher capacity components. The system uses the previously existing water supply system and powerhouse.

6. Project experience

Project preparations for Garung and Seloliman were performed carefully including resource surveys, community participatory approaches and advocacy activities. Community responses were very good. They have been participating actively since the planning stage of the programme including the negotiation of a loan repayment scheme and the amount of monthly installment. This participation is due in part to the fact that the community needs electricity for lighting. They had witnessed the comfort of electric lighting demonstrated by their neighbours who were already connected to the PLN's grid. As mentioned previously the majority of the community cannot afford the PLN's electricity, especially the high initial connection cost. So, when the programme offered a microhydro electricity system with much lower connection costs compared to the PLN, the community supported the programme eagerly. The connection cost to the PLN's grid at this site ranges between US$180 and 240 (depending on the distance of the house to the grid) while the connection cost to the microhydro unit is only US$40.

As part of community preparation, both the Garung and Seloliman programmes established local community organizations (LCOs). In Garung the LCO is called the LPKM while in Seloliman it is called the PKM. This was done before the programme began microhydro construction activities. In Garung, the LCO officials comprised a chairperson, a secretary, a treasurer and two microhydro operators. They were elected democratically by the community for a four-year service term. Inspection of the LCO operation is performed by the official community head

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and one prominent member of the community. The latter was also determined through election by the community. In Seloliman, the LCO has two groups of officials namely: the daily working group, which is responsible for the daily operation of the microhydro installation, and an advisory group. The PKM daily working group consists of a chairperson, a treasurer and operators. The advisory body consists of individuals representing the microhydro stakeholders, i.e. two persons from the PPLH (one of them chairs the LCO), two persons representing customers from Janjing Village and one person representing Sempur Village. Both in Garung and Seloliman, LCO management is carried out according to written rules drafted and agreed by the community.

Under the supervision of the implementing agency, the LCO organized meetings to prepare a microhydro construction plan, negotiation of electricity tariffs among the community, some environmental advocacy activities and administration of the rural economic development programme. Bottom-up initiatives, the participatory approach, coordination of mutual interests at the earliest stage of the programme, commitment, clear definition of roles and responsibilities for all parties and appropriate and sufficient programme supervision are probably the reasons why, within the context of renewable-based rural electrification, this project is considered successful.

6.1. Garung Project

To date, the ***Garung micro hydropower project*** has been operating for around 18 months without major problems. Since the unit is still in its infancy, its sustainability still needs to be proven. There are two aspects of sustainability that need to be addressed: technical sustainability of the microhydro unit and loan repayment sustainability.

As far as technical sustainability is concerned, microhydro is considered a simple and established technology with a simple maintenance requirement; thus no major technical problems from the unit itself are expected. Local microhydro operators, who have received technical training through the programme, appear to be able to handle the system's operation and maintenance. For handling major technical problems, they continue to need outside help. If this occurs, the closest location for assistance (metal work, spare parts, an electrician) is around 40 km from the site

Micro hydropower house in Garung

and therefore it is not expected that a long system breakdown will take place. The same situation applies to Seloliman.

The availability of sufficient water resources is a problem in Garung micro hydropower project as it uses water from a river collected through a previously existing channel used to irrigate the farm land of the community. Currently, some of the water flowing through the channel (upstream of the microhydro) is also used to irrigate the land. During a relatively long dry season, as experienced in 2002, the water resource could not serve both the microhydro and the farm land. Owing to this problem, and based on the results of a community meeting, the water was prioritized for the farm land and the microhydro was shut down for 13 days. Another problem was the blocking of water channels due to landslides during heavy rainfall, causing a system shutdown. The channel was repaired by the community at practically no cost since they worked on a voluntary basis using material available on site. It is important that the members of community need to be taught and made aware of the importance of water catchment maintenance for irrigation water and the micro hydropower project.

So far, no water problem has been experienced by the Seloliman microhydro. However, the Seloliman LCO is concerned about recent deforestation activities (converted to farm land) within the catchment areas of the micro hydropower project, which may decrease the availability of water. Since the catchment area is beyond the management of the LCO, the Seloliman LCO has been requesting the local authority (the water conservation board) to help stop the ongoing deforestation activities.

Concerning the loan repayment of the Garung microhydro, which under current repayment rates would take 12 years to complete, its sustainability depends on the technical sustainability of the plant and the livelihood of the community. As described later, the programme appears to have an impact on the community's income. Therefore, it is expected that as long as the microhydro functions satisfactorily, the loan repayment will be sustained. It is assumed that there will be no sustainability problems with the community's compliance in paying off the loan because the community was well-informed in advance that the microhydro financing was a loan instead of a grant and had to be repaid via their monthly electricity bills. The electricity tariff, which is around US$1.76 per month for roughly 100 watts power limit, resulted from community consensus. Currently, the community's discipline in paying their electricity bills has been good.

Power purchase agreement was signed in November 2003 and the plant has been selling excess electricity to the PLN.

With regard to the power system performance, while most of Garung's customers are satisfied with the quality of electricity supply there is an important technical issue that needs to be addressed by the LCO. A number of customers complained that the circuit breakers in their houses tripped when they used 60 watts (nominal) load while the circuit breaker is specified for 0.5 amperes (roughly equivalent to around 100 watts). Meanwhile, other houses with the same power limit could install 80-watt bulbs without any problem. As the electricity bill is determined based on the installed power limit, regardless of the wattage used, the customers who get less power for the same bill feel they are being unfairly treated by the LCO. If this equity issue is not addressed and resolved properly, payment delinquency by dissatisfied customers, jealousy among the community members and subsequent local conflicts could arise, which in the long run could jeopardize the sustainability of the power plant. No such problem is experienced in Seloliman since the electricity bill is based on energy consumed and recorded by the kWh meters installed in each house.

6.2. Seloliman Project

The **Seloliman micro hydropower project** has been operating for around two years without major problems. The plant sells electricity to 39 residential consumers, the PPLH office complex, two productive users and the PLN (since 5 December, 2003). The average installed capacity of the residential consumers is 450 VA. The two productive users have installed capacity of 3.2 kVA (total) while the PPLH complex has total installed capacity of 5 kVA. Each consumer is equipped with a kWh meter. Residential consumers use the electricity mostly for lighting. Only some of the consumers have TV sets, radios and electrical kitchen-ware. The plant is operated 23 hours a day (one hour off in the morning for maintenance). Realizing that the local consumption is still low and the fact that the site is located close to the PLN grid (around 50 metres), the PKM applied for excess power sales to the PLN, utilizing the PSK Tersebar Scheme. After much paperwork among different agencies, a power purchase agreement was signed in November 2003 and the plant has been selling excess electricity to the PLN since 5 December, 2003. The grid interconnection cost was financed by GTZ through a loan (US$12,700) and a grant (US$6,000).

According to a recent load test conducted by the PLN the maximum power of the plant is 21 kW. This is probably attributable to an insufficient water rate since the plant uses a previously existing water supply system (piped) that was designed for smaller unit (12 kW). During the day, the plant sells 16 kW to the PLN and the remaining 5 kW to local consumers (the local community and the PPLH complex). Between 1800 and 2100, local consumption uses 12 kW and 9 kW is sold to the PLN. After 2100 the power sale is the same as during the day.

Since the unit is considered to be still in its early stages, the system's sustainability still needs to be proven. However, since the PPLH already has good experience in micro hydropower management, as far as technical sustainability is concerned, sustainability seems to be promising. The main consideration is the funding for major repairs/ overhaul in the future. The funds have to be accumulated from the monthly electricity bill paid by local customers and also from power sales to the PLN. The community's electricity tariff is divided into two components namely: fixed cost (varies between US$0.35 and 1.75/month depending on the power limit) and variable cost (ranges from US$1.00 to 1.4/kWh – the higher the consumption the higher the tariff). This tariff is lower than that of the PLN's for the same power limit (fixed cost: US60 cents to US$4.7/month, variable cost: US2.00 to 4.8 cents/kWh). Without power sales to the PLN (prior to December 2003), the electricity bill income collected from local consumers was only sufficient for paying operators and simple maintenance costs. Any increase in electricity tariffs is difficult because the consumers recall the past when they paid only US23.5 cents/month for a 200-watt power limit; there is also the issue of the low purchasing power of the community. Power sales to the PLN, which are around US5.3 cents/kWh, help to improve the economics of the plant. Now management should be able to save some money as a reserve for future system overhaul/major repairs. Power sales to the PLN help to improve the sustainability of the power plant and therefore could help to encourage others to duplicate the scheme.

Seloliman is the first microhydro unit that was interconnected to the PLN utilizing the newly introduced PSK Tersebar Scheme. Officials from the Seloliman microhydro management (PKM) suggest that the mechanisms for implementing PSK Tersebar are discouraging because the paperwork for obtaining the power sales' agreement is too excessive and complicated. To help promote and encourage wider implementation of the PSK Tersebar Scheme, the relevant electricity regulating agency needs to devise implementation mechanisms that are less bureaucratic.

7. Project impact

7.1 Impact on the local economy

While a portion of the SGP/GEF fund in both the Garung and Seloliman projects was intended to stimulate new income-generating activities at the community level, at the current stage it can be concluded that the projects did not have any economic impact on the local community.

In Garung, the GEF/SGP grant was used to encourage several families to enter small businesses such as production of banana crisps, banana chips, coconut oil and fish farming. The grant is channelled to the community as a revolving loan fund administered by LCOs. The programmes aimed to improve family income by transforming family activity into family business. However, the results so far have been poor. The primary reasons are probably because the members of the community are farmers working on an individual basis. They have no experience of working on a collective basis. The LCO may need to try to encourage a business setting on a collective basis. At the moment, the communities perceive that the activities offered to improve their income are not closely linked to their own immediate concerns; they tend to be satisfied if they can feed their families and there seems to be no sufficient motivation to enter into new endeavours other than farming. Another factor is the daily routine on the farm and other daily activities that already consume much of their physical energy. This shows that it is difficult to transform a farmer into an entrepreneur.

Communities perceive that the activities offered to improve their income are not closely linked to their own immediate concerns.

The only new economic activities generated by the microhydro installation are small service businesses run by the LCO; i.e. battery charging, milling for coconut, flour and coffee. The customers for battery charging come from other villages that have no access to electricity. The income from this business is considered as LCO income. Compared to the income collected from electricity sales, the milling and battery-charging income is insignificant.

Payment of electricity bills by the community does not seem to cause an additional expenditure burden on the community since the tariff is only slightly higher than that previously spent for buying kerosene for their lighting needs. Also, the community perceives that this slight increase is equal to the comfort and service they now enjoy from having their houses connected to the electric power supply.

To improve the economics of the project, the LCO may need to consider selling electricity from Garung Project to the PLN grid utilizing the PSK Tersebar Scheme. Although this site is relatively far from the PLN grid (around three kilometres), interconnection with the PLN grid is technically possible. The LCO needs to assess the economic feasibility of power sales to the PLN including possible financing of the interconnection cost. An increase in local power demand in coming years has to be anticipated and considered in the economic assessment.

In Seloliman a grant for upgrading the equipment of a cotton-cleaning business has been provided to encourage productive use of electricity.

However, the upgrading apparently has had no effect on the economics of the business. Four out of seven personnel who formerly worked at this plant have left, indicating that the business is probably unattractive. It is therefore not surprising that no one in the community tried to emulate the cotton-cleaning business. The only beneficiary of the economic programme at this site is the cotton business owner (acquiring an upgraded blower and a cheaper electricity tariff compared to the PLN). Another productive use of electricity in this area is using recycled paper-slurry and small handicraft-making activities. Prior to the micro hydropower installation, existing businesses used power from the PLN. The only effect that could be attributed to the microhydro plant is the availability of cheaper electricity from it.

With regard to the current electricity tariff, the Seloliman community considers it to be too expensive. For the community, the new microhydro installation has a negative economic impact. Prior to the microhydro capacity upgrade, the community paid IDR2,000/month for a 200-watt power limit. This tariff, however, was in fact too low because it was determined in 1994 and based on kerosene consumption that has been replaced by electricity. Since the kerosene price in 2002 was already two times higher than that of the 1994 price, expecting the electricity tariff to remain at the 1994 level was unrealistic. The PPLH, the former operator of the old microhydro system did not increase the electricity tariff during the six-year microhydro operation because the community had low purchasing power and therefore the power supply to the community was more out of charity than a commercial venture. With the new microhydro unit, the Seloliman LCO may need to start educating the community concerning the value of energy by slowly increasing the electricity tariff to a realistic but affordable level. By doing so, the microhydro operation would become more profitable, and therefore enhance its sustainability; at the same time the community would be encouraged to work harder and generate more income. Part of the accumulated fund can also be used to help finance initiatives for improving the income of the community.

Power supply to the community was more out of charity than a commercial venture.

7.2 Impact on the environment

The Garung and Seloliman microhydro projects fall within the climate change focal area of the SGP/GEF programme. Direct links between the project and climate change mitigation are limited to the removal of emissions from kerosene for lighting, which has been replaced by electric lighting. The microhydro uses the existing water channel that is used for irrigating the community's farm land. The community had awareness on maintaining water resources prior to the project's implementation. Now, because the water resources serve two purposes, it is expected that the community will be more aware of the importance of water channel maintenance.

Awareness-raising in Garung and Seloliman on the importance of preserving the environment was conducted during the project's implementation. However, the impact of this effort cannot be judged at the current stage of the project because such impact is long term in nature. The community consists of farmers working with fixed land around the village. One of the possible environmental problems associated with this community is illegal logging of the surrounding natural forest as a source of income. As long as their livelihoods from farming are deemed sufficient, illegal logging is not likely to occur in the community. The impact of the environmental awareness effort may only be evaluated by observing the community's response when it is confronted with difficult times, such as crop failure.

7.3 Social impacts

The formation of the LCOs in Garung and Seloliman is one positive impact of the project in terms of improving the organizational skills of the local community. The improved organizational skills of the community are probably due to the presence of on-site staff of the implementing agencies (YBUL in Garung and PPLH in Seloliman) that monitor and supervise the day-to-day operation of the organization.

Another indirect impact of the project may also be linked to the community's better access to outside information via TV, which is now accessible through the provision of electricity. However, this has to be considered with care since TV may also have a negative impact on the community by boosting consumptive lifestyles (due to advertising). For both Garung and Seloliman, the long-term impacts of the programme cannot be observed yet as the project duration is still less than three years.

Financing via a soft loan combined with a grant to remove the barriers of high initial investment in a micro hydropower scheme seems to be a good model.

8. Lessons learned

8.1. Thorough preparation for rural electrification projects

As demonstrated in Garung and Seloliman, a successful project is the outcome of thorough preparation. Bottom-up initiatives, participatory approaches, coordination of mutual interests at the earliest stage of the programme, commitment, clear definition of the roles and responsibility of all parties and appropriate and sufficient programme supervision have proved to be key elements for successful projects.

8.2 Creating income-generating impacts is difficult

The experience of the Garung and Seloliman projects suggests that income-generating activities as part of microhydro project development may not be sufficient to stimulate or catalyse local communities to supplement their incomes; other factors such as access to market, quality of products, etc. need to be considered. This is particularly true where efforts to increase productivity have been limited and hampered by the absence of electrical energy; for example: grain milling and pottery-making home industries, which still use human or animal power. In such a community, the availability of electricity may help to increase the community's productivity (income) either by the use of more powerful electric motors or by expanding working hours. Increased income may also result from improved product quality from the use of electrical appliances that generate better precision than manual work.

8.3 Grants and soft loans appear to work

As demonstrated in Garung, financing via a soft loan combined with a grant to remove the barriers of high initial investment in a micro hydropower scheme seems to be a good model. However, the YBUL soft loan (zero interest) scheme is a special case. Other NGOs or foundations that are no involved or related to the development probably will not provide soft loan financing as YBUL did. Besides, an NGO or foundation in Indonesia generally, by design, is not a financial (lending) institution. Therefore, for the dissemination of micro hydropower in the country, the involvement of formal financial institutions, such as regional banks, is necessary. Soft loan financing schemes (not necessarily zero interest) that are suitable and dedicated to small-scale renewable energy development should be made available by banks at the district level. When the grant component is concerned, it is logical to expect that regional government should be the provider.

8.4 The PSK Tersebar Scheme

The success story of the Seloliman microhydro in converting off-grid units to on-grid units (interconnected with the PLN) shows that the policy for promoting a small-scale renewable energy system (PSK Tersebar Scheme) becomes viable operationally. However, attention should be given to the suggestion from the microhydro officials in Seloliman (PKM) who consider the paperwork for obtaining the power sales' agreement to be excessive and complicated. To help promote and encourage wider implementation of the PSK Tersebar Scheme, the relevant electricity regulating agency needs to devise implementation mechanisms that are less bureaucratic.

9. Potential for replications

The Garung and Seloliman projects both have demonstrated that with proper and appropriate project preparation, a microhydro system can be implemented for rural electrification. This success story could be potentially duplicated in other areas of the country as long as the characteristics of the targeted areas are similar to Garung and/or Seloliman. Some of the characteristics that need to be considered for a successful project include water resources, community needs and community background. It is well understood that each site has its own characteristics. But with the country's microhydro potential of around 450 MW (more than 1,000 locations), it is generally acknowledged that it is highly likely that at least 100 sites that have similar characteristics to Garung and/or Seloliman could be found.

As previously reported, the country's policy climate is good and conducive towards wider development of small-scale renewable energy systems. As an outcome of the Regional Autonomy Law and reform in the power sector where the PLN is no longer fully responsible in the rural electrification programme, regional governments are expected to be more active and creative in searching for funding partners needed for their rural electrification projects. When Seloliman power sales to the PLN are successful – technically as well as financially – many parties are expected to be interested in duplicating the Seloliman success story; this will allow a change in the "mind-set" of policy-makers to encourage the purchase of electricity produced from small-scale generators employing renewable energy resources.

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Annex 5-1: Abbreviations

EL	East latitude
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German international development agency)
HPP	*Harga Pokok Penjualan* (local electricity delivery cost of PLN)
LCO	Local community organization
LEM21	GEF/SGP implementing agency in Seloliman, East Java Province
LPKM	Local community organization in Garung
NL	North latitude
Pembangkit Sekala Kecil-PSK Tersebar	Small Private Renewable Energy Power (a decree requiring PLN to - purchase renewable-based electricity offered by SMEs)
PKM	*Paguyuban Kali Maron* (local community organization in Seloliman)
PLN	*Perusahaan Listrik Negar* (the state utility)
POKLAN	GEF/SGP implementing agency in Garung, West Java Province
PPHL	*Pusat Pendidikan Lingkungan Hidup* (GEF/SGP implementing agency in Seloliman, East Java Province)
SME	Small and medium enterprises
SL	South latitude
YBUL	*Yayasan Bina Usaha Lingkungan* (an NGO hosting the Indonesia GEF/SGP programme)

Chapter 6

The Rural Energy Development Programme as a model of holistic rural development in Nepal

Tek B. Gurung[33]

Abstract

Nepal is one of the poorest countries in the world. The vast majority of its population is rural who primarily depend on biomass-based energy resources. The level of energy consumption as well as access to modern energy services is extremely low despite the huge hydropower potential. Due to the difficult geographical setting and scattered settlements in the hills and mountains, the costs of large-scale power generation and transmission are exorbitant. The Rural Energy Development Programme (REDP) supported by the United Nations Development Programme (UNDP) has shown a workable example for extending sustainable energy services into the remote and isolated areas of Nepal through the promotion of microhydro, biogas, solar energy and improved cooking stoves. This paper provides an account of the country situation under which the REDP began its operation, the modalities and mechanisms that were adopted and the results and impacts that may be attributed for the REDP to be a model for rural development. It also includes some important lessons, including key challenges, leading to a conclusion on how the REDP should be seen in the context of sustainable rural development. The holistic development approach comprises community participation and empowerment, socio-economic inclusion, ownership building, promotion of energy technology packages and capacity building at different levels; these are the key elements for validating it as a good rural development model.

Keywords: Rural energy, biomass energy, modern energy, energy mix, holistic approach, community mobilization, capacity building and rural development model.

1. Introduction

The Rural Energy Development Programme (REDP) is one of the programmes of His Majesty's Government of Nepal (HMG/N); it has been perating since 1996 under the assistance of the United Nations Development Programme (UNDP). The successful implementation of the REDP in making a difference to the lives of rural and poor people has been well recognized both nationally and internationally. This case study attempts to analyse and capture lessons learned based on the author's involvement with the programme over the last four years both as an insider (i.e. playing a supporting role in the programme implementation) and an external observer (i.e. working in UNDP but maintaining a certain level of distance).[34]

2. Context

Nepal is one of the poorest countries in the world and is mostly mountainous, which can constrain development work. Most people live in rural areas where poverty is greater compared to urban centres, valleys and the southern plains. Social and economic inequalities, low growth rates, unbalanced development approaches, discrimi-nation, exclusion, environmental deterioration and inappropriate policies lead to a vicious circle of poverty, which can be perceived as one of the key contributing factors of the current conflict in the country.

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34 The analysis of this experience is extremely challenging for the author, as he is fully aware of the sentiments and sensitivities that prevail among the progamme, government and other actors in the sector. At the same time, one has to justify issues in a professional and independent manner and to learn from past experiences.

Energy consumption in Nepal is extremely low. There is a significant gap between per capita energy requirements and actual consumption. Biomass-based and conventional energy resources are predominant in the energy mix, and are primarily used for cooking and lighting purposes. Rural communities mostly lack access to modern energy resources such as electricity, a major determining factor of living standards in the modern world. The negative implications on people's health, environmental sustainability and labour force productivity cannot be overexaggerated. This situation is ongoing in Nepal despite the country's rich endowment of renewable energy resources.

Box 6-1: Basic facts about Nepal and its energy consumption

- 82% of the land area is mountainous
- Per capita annual income of US$220
- Human Development Index (as per HDR 2002) is 0.49
- 80% of the total population of 23.2 million is rural.
- Per capita energy consumption is 44 kgoe (kilograms oil equivalent) or 2 Gigajoules (1998)
- Per capita energy requirement: 12 Gigajoules
- 90% of the population relies on traditional fuels for energy use

Nepal's aspiration in realizing its huge potential of renewable energy is reflected in the government's high priority for energy sector development. However, past efforts were predominantly focused on the development of large and centralized hydropower grid systems. Due to topographical difficulties and the highly capital-intensive nature of large projects, Nepal has been unable to realize substantially or to improve significantly access to affordable electricity for the vast majority of rural and poor people.[35] Even after substantial realization of hydropower potential, the likelihood of providing sustainable energy services to the poor appears to remain extremely low with the existing centralized mode of handling energy resources.

Commercial energy production, trade and consumption trends in the last 20 years have been distorting the foreign exchange balance[36] of the country and can be impediments to a country's achievement of its sustainable development goals. Additionally, Nepal faces the challenge of promoting renewable and cleaner energy technologies due to heavy subsidization of imported petroleum products.

3. Rural development in Nepal and the inception of the REDP

Nepal's planned development has its origins in the late 1950s and underwent various trials. In the middle of 1980, the failure of Integrated Rural Development Programmes (IRDPs) to achieve expected results forced a paradigm shift in rural development thinking in Nepal. IRDPs were criticized for being unfocused and having a top-down approach, suffering from coordination problems and lacking an effective presence of line agencies at the local level. Shortly after, the potential of the community participatory planning process began to gain recognition as it could take advantage of the government-supported pluralism in the existing market place. In a predominantly agrarian-based economy, it was also realized that the community approach could hold promise in engaging the vast majority of poor people in the development process to modernize their subsistence agriculture. This, coupled with the promotion of cottage and small-scale industries, could form the essential elements of the strategy for the transformation of the hill and mountain economy towards a more sustainable state, one in which energy inputs would be crucial.

While there is an energy crisis in Nepalese rural areas, particularly in the hills, it appears to have been neglected for the past several years in the government's development prioritization. As a result, there are serious negative impacts on natural resources and rural development such as deforestation, low productivity agriculture, the inability to pump water for irrigation and drinking purposes, the inability to introduce technologies that reduce drudgery (especially for women) and poor livelihood opportunities.

35 Nepal has realized only approximately one percent of its huge techno-economic potential of 42,000 MW of hydro-electricity and its people pay some of the highest electricity prices in the world (approximately 12 cents per kilowatt hour).

36 The production of commercial energy (mostly electricity and solid fuels) in 1982 was 26 ktoe (kilotonnes oil equivalent) that increased to 101 ktoe in 1998 - nearly a fourfold increase. However, the consumption increased from 166 ktoe in 1982 to 1,011 ktoe in 1998, more than a sixfold increase. This major gap in the change in the production and consumption of commercial energy over the years gave rise to a substantial increase in the import of energy/fuel from 141 ktoe in 1982 to 916 ktoe in 1998, almost six and half times more. Data were taken from the Energy Statistics Year Books of the United Nations from 1982 to 1998.

The high potential for promoting sustainable rural livelihoods through better utilization of local water resources cannot be over exaggerated. The role of rural electrification could be dramatic if institutional and technological hurdles are overcome. This was also seen in the light of the liberal sociopolitical environment that emerged after the restoration of democracy in the country in 1990. The Eighth Five Year Plan (1992–1997) of the government made it possible for the involvement of non-government organizations (NGOs) in the delivery of services to the local people. Further, the Electricity Act (1992) created an environment conducive to community and private-sector participation in hydropower development through de-licensing of up to 1,000 kW capacity. This policy, along with tax exemption for 15 years, provided a strong incentive mechanism for the development of the small- and microhydro sector by encouraging investment from the private sector and communities.

The REDP intervention emerged; it took advantage of this enabling environment for rural development through provision of rural energy in which microhydro was the central element. The new and distinct feature in the REDP concept, compared to past initiatives, is that it combines hydropower and other forms of energy such as biogas, solar energy and improved cooking stoves. The integration of different forms of energy could be instrumental in inducing agricultural diversification, leading to rural industrialization, and promoting rural employment, as well as reducing pressure on the natural resources.

In addition to other renewable energy initiatives (e.g. biogas and solar energy), over 1,000 microhydro plants were established in rural Nepal, utilizing the incentive mechanism and benefiting from an enabling environment prior to REDP intervention. While many institutions supported those initiatives, there was a lack of appropriate institutions at the central as well as local levels to take up energy initiatives in their multifaceted form as a cross-sectoral issue. Rather, the major thrust was on the promotion of privately-operated microhydro plants without due consideration of other factors. Although some successes were achieved, studies (ICIMOD, 1993a; Junejo, 1994 and 1995) pointed out that they tended to suffer from technical and operational problems, such as frequent breakdown of machinery and a lack of repair and maintenance services within convenient reach. In addition, due to poor people's difficulty in paying tariffs, a number of schemes were unable to generate enough revenue, operate at a financially viable level or to repay the loan. The REDP, with its twin goals of improving rural livelihoods and preserving the environment, was designed to address these issues. Key elements crystallized in the objectives of the programme are summarized below:

Traditional way of delivering and grinding grains including wood collection and use of kerosene lamp

- institutional arrangements and development to promote rural energy development in its cross-sectoral dimensions, at the central and local levels;
- environmental preservation through social mobilization and the promotion of alternative energy primarily in the form of microhydro;
- promotion of local economies and livelihoods;
- utilization and development of research and dissemination of technologies; and
- human resource development for the development as well as operation and maintenance (O&M) of rural energy systems.

The immediate objectives of the REDP stated in the project document are: i) to support the establishment and institutionalization of a rural energy development agency to promote rural energy system development in Nepal; and ii) to enhance rural livelihoods through community- (or entrepreneur-) managed rural energy systems development and demonstration programmes through enhanced capacity at the district level to manage rural energy development.

4. An introduction to the REDP: elements, structures and processes

The critical programmatic components of the REDP are:

- **Community mobilization:** i) organizational development through group formations and capacity building; ii) capital formation through savings and credit schemes; iii) skills' enhancement through training and exposure visits; iv) women's empowerment through equal participation; v) technology promotion through demonstration and R&D; and vi) environmental management through nursery management, plantations and sanitation activities. In this regard, the REDP aimed to ensure that 99.9 percent of households in a programme village participated and became beneficiaries.

- **Promotion of microhydro demonstration schemes:** i) microhydro system installation; ii) fund mobilization through savings in the community, District Development Committee (DDC) and Village Development Committee (VDC) equities, donations and project contributions; iii) end-use promotion through appropriate technologies and enterprise promotions; and iv) and O&M of microhydro by the villagers.

- **Promotion of other rural energy technologies:** biogas, solar home systems and improved cooking stoves, as appropriate, to fulfil the needs as well as demands of the communities.

- **Human resources development:** orientation and sensitization, training/fellowships, capacity development of manufacturers, conservation education/awareness and local enterprise training.

- **Environmental and natural resources management:** sustainable natural resource utilization, conservation, planting and management of community-based forestry initiatives.

Figure 6-1: The management and coordination structure at the centre

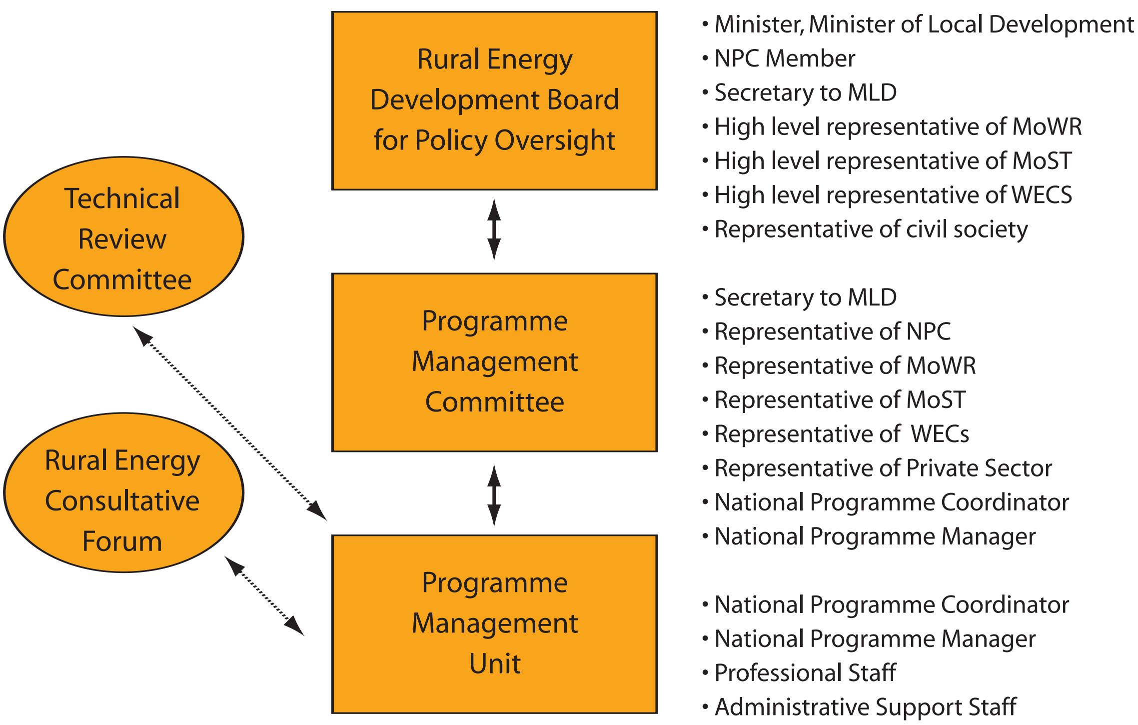
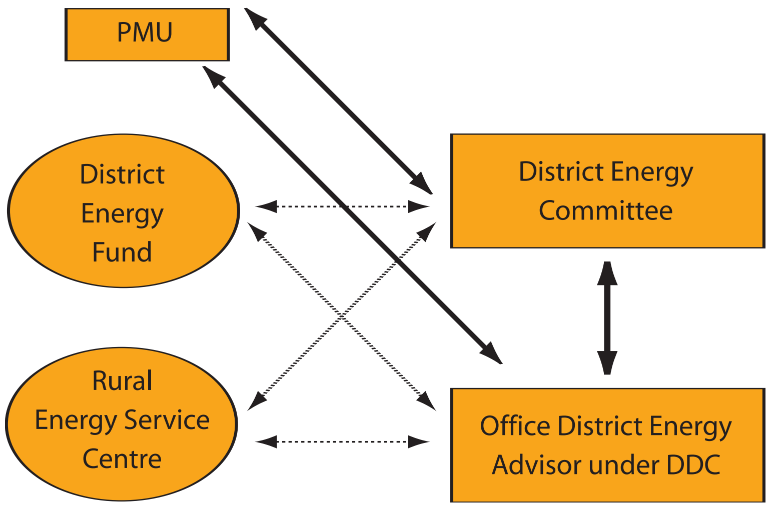
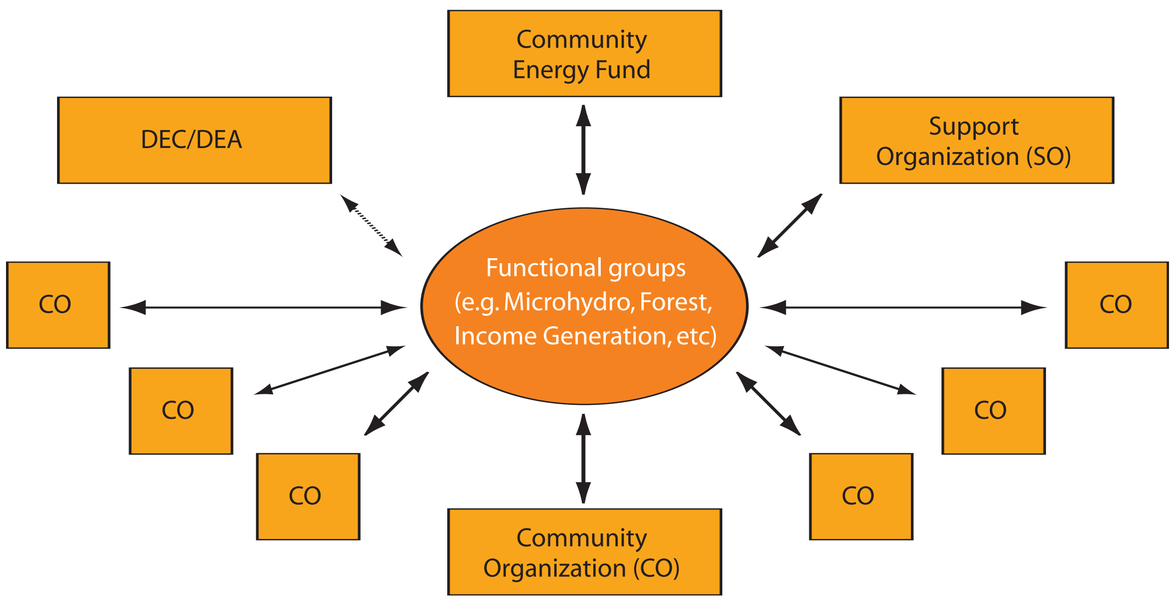


Figure 6-2: The management and coordination structure at the district level



- Chairperson, District Development Commitee
- Local Development Officer
- Representatives of Line Agencies such as District Forest Office, District Agriculture Office etc.
- Representatives of Private Sector Agencies
- District Energy Advisor
- Logistics Support Staff

Figure 6-3: The management and coordination structure at the community level



Notes:

1. PMU= Programme Management Unit, CO= Community Organizations, DEC=District Energy Committee.
2. These schematic diagrams are based on the period for the REDP from 1996 to 2001. From 2002 onwards, the REDP has been aligned with the Alternative Energy Promotion Centre (AEPC) under the Ministry of Science and Technology (MoST). Accordingly, at the central level the Alternative Energy Promotion Board (AEPB) replaces the Rural Energy Development Board chaired by the Minister for MoST. Likewise, the Management Committee has been chaired by the Executive Director of the AEPC who is also the National Programme Director instead of National Programme Coordinator. The district and community level arrangements remain the same.

- **Promotion of income-generating activities:** promotion of micro-enterprises and delivery of related training.

- **Institutional building and strengthening:** formation of community organizations (COs) and functional groups (FGs), establishment of Rural Energy Development Sections under DDCs, and the strengthening of DDCs, VDCs and private sector organizations.

- **Research and development (R&D):** review of R&D status, needs assessment, prototype development and field testing.

The management and coordination structures at various levels are depicted in *Figures 6-1 to 6-3* (extracted from other project documents).

Fund flow mechanisms and resource mobilization: The programme funds go directly to the District Energy Fund (DEF) and then to the Community Energy Fund (CEF) based on plans that evolve through a bottom-up planning process. The UNDP funds (mainly for microhydro installation) serve as a catalyst to mobilize resources from local communities, local government bodies, government subsidies and other energy-related programmes. Support includes: attaching toilets with biogas reactors; skills' training for improved cooking stove construction and installation; upgrading local electromechanical enterprises into Rural Energy Services Centres (RESCs) and training on community management and systematic operation of rural energy.

Box 6-2: Guidelines and coordination arrangements created by the REDP

Guidelines:

1. Community Mobilization Guidelines
2. District Energy Planning and Implementation Guidelines
3. Environment Management Guidelines
4. Microhydro Implementation Guidelines
5. Microhydro Operators' Manual
6. Microhydro Managers' Manual
7. Technical Guidelines for Installation of Microhydro Schemes
8. Tariff Determination Guidelines

Forums:

1. Technical Review Committee
2. Consultative Forum among all related stakeholders.
3. District Energy Network of programme DDCs
4. Microhydro Promoters' Group among donors
5. Microhydro Manufacturers Network
6. Solar PV Suppliers Network

Development of operational guidelines: Considering the issues mentioned earlier and challenges illustrated below, it was important to develop a number of operational process guidelines and strategies within the purview of the legal frameworks of the country and policy and strategy of the UNDP *(see Box 6-2)*. These guidelines help to keep track of the implementation, as well as to generate lessons in a systematic manner. A number of guidelines pertaining to community mobilization, district level operations, environmental management, including an operational manual for microhydro, were developed to help implementation of the programme.

5. Results and impacts

A summary of the key quantitative achievements is presented in *Box 6-3*. Holistic rural development is underway. Hundreds of rural energy systems have been developed comprising microhydros, biogas, solar energy and improved cooking stoves. Villagers are becoming increasingly engaged in various income generation activities, such as village tea stalls, poultry raising, piggeries, fresh vegetable production, carpentry, weaving, knitting, *Thanka* (traditional Nepalese painting depicting Buddhist culture), photography the public telephone service and computer institutes. Environmental management initiatives such as watershed management, plantations and community forestry are fostering sustainable development. The local (district) level NGOs have been developing as support organizations, which has helped in forming social capital and mobilizing latent local resources. Local electromechanical/grill workshops have been promoted as rural energy service centres (RESCs) for technical support. The local government bodies (DDCs and VDCs) have been strengthened for internalizing the decentralized rural energy planning, programming and monitoring and evaluation systems.

The outputs are gradually translating into positive changes in the capacity of all concerned stakeholders and ultimately, in the enhancement of rural livelihoods. The changes encompass: (i) increased income from off-farm and non-farm activities; (ii) improved health due to a reduction in drudgery, labour and smoke inhalation, and improved sanitation; (iii) better education of children due to the availability of brighter ligh at night to do their homework (extension of study hours); (iv) increased awareness among the rural people about global activities via telecommunications and computers (thereby helping to reduce the digital divide); and (v) an increased capital base from savings and credit operations and the establishment of infrastructures like microhydro, schooling, potable drinking water and micro-enterprises. Moreover, an impact study of the REDP shows improvement in the Human Development Index (HDI) of REDP villages compared to the average district level HDI. There is increased government commitment for the promotion of the community-based rural energy systems through policy upscaling as a vehicle for poverty alleviation. This is evident in the target of increasing 1,000 rural energy systems in the tenth rolling Five Year Plan (2002–2007) and the government's commitment to replicate the REDP in 150 VDCs in 25 districts by the middle of 2006, made possible through funding from the IDA fund of the World Bank.

Box 6-3: Key achievements of the REDP at a glance (as of Jun 2003 from 1996)

Rural energy systems		
Microhydro schemes including Peltric sets		120 (1,575 kW)
Biogas plant with toilet attached		2,953
Solar home systems		1,524
Improved cooking stove		7,200
Environment initiatives		
Nursery establishment		96
Community-managed forests		181
Plantation		2,702,622 (plants)
Toilet construction		9,803
Environment classes/campaigns		321
Human resource development		
Training on technical subjects		1,170
Environment management training		2,219
Training: income generation and micro enterprise		4,598
Institutional development training		6,446
In-country study tour		2,047
Others		3,914
Community mobilization	Male	Female
Community organization	1,366	1,371
Community members	27,307	28,126
Cumulative weekly saving (Rs)	10,576,176	9,442,977
Cumulative investments (Rs)	21,345.647	19,255,557
Institutional development		
District Energy Fund		15
Rural Energy Development Section		15
Community Energy Fund		120
Rural Energy Services Centres		13
Support organizations (NGOs)		15
Microhydro cooperatives		13

Note: 1. At the current rate US$1.00 = Rs.75
2. All figures are in number except indicated in parentheses.

6. Key challenges and lessons

Implementation of the REDP has yielded a range of challenges and lessons since its inception and throughout implementation. Key challenges are:

i. At the time of the REDP's inception, the prominent actors in the energy sectors, for the most part, believed that small and microhydro systems were less cost effective and efficient, and of poor quality.

ii The failure of many microhydros prior to REDP intervention, as well as IRDPs, created a challenging scenario for wider appreciation of the programme concept.

iii During implementation, the multiplicity of actors in the rural energy sector, largely a result of the liberal policy of the government in the 1990s, had created unnecessary competition, coordination problems as well as an environment of mistrust and latent tension among actors. This represented a serious challenge for the programme on how to effectively bring the various stakeholders on board to succeed. Therefore, it was important for the programme to conceptualize and materialize various forums to engage them *(see Box 6-2)*.

iv. Since the programme was designed to be holistic and evolving in nature, and so many issues were to be handled simultaneously, it became imperative to deal with them. It was therefore a challenge to develop appropriate guidelines *(see Box 6-2)*.

v. After the initial successes of the REDP, many staff members were given the opportunity to pursue higher studies, which created a critical challenge in terms of maintaining the spirit and speed of work. This was further compounded by the uncertainty of funding for the continuity of the programme beyond the originally stipulated duration. Further, a paradox occurs when success stories begin to crystallize, and the importance of the programme becomes heightened as does the excitement of the staff; yet, at the same time the life of the programme draws closer to conclusion. Under such a situation, it can be challenging to maintain high morale among staff, as it appears that they may exhibit symptoms of job insecurity or begin sourcing new employment opportunities.

vi. Given the fluidity of the security situation, the question of how to replicate the REDP's success (adapted where appropriate) in 25 districts has arisen as a critical challenge for the future.

A systematic study should reveal the programme's lessons and stories. Nevertheless, through the author's observations and analyses, **several critical lessons *vis-à-vis* cross-cutting issues** emerge:

i **Rural energy serves as an entry point in reaching the poorest of the poor.** The most important lesson is that, through community mobilization, rural energy has to be approached to ensure 100 percent participation of the people in a certain political or geographic unit. The "hand-to-mouth" problem of the poorest needs to be addressed by providing them direct economic benefits *(see Box 6-4)*.

ii **Community mobilization for rural energy development is instrumental in overcoming social discrimination.** Empowering disadvantaged, discriminated or marginalized groups can be done by organizing them into fairly homogenous groups, which can be segregated at the initial stage and aggregated when they have developed a certain level of confidence and capacity. The REDP experience suggests that this can be done within a period of six months *(see Box 6-4)*.

iii **Energy should not be viewed as simply a technical issue, but more importantly in the context of governance.** The experience of the REDP illustrates that good governance is most challenging at the central level and easiest at the community level. At the district level, it is in between; however, this level is particularly complex given the need for coordinating relationships strategically, particularly with higher bodies at the centre.

iv **Enhancing capacities of local people empowers, thereby contributing to the fostering of good local governance.** The aim of establishing rural energy in their locality binds local people together. It is important that the strengths of rural people should be acknowledged and encouraged. Their leadership capacity should be nurtured and built through various means including exposure to the outside world and alternative experiences *(see Box 6-5)*.

v **Provision of "energy only" is not the solution for sustainable development, and use of only one energy technology does not serve the purpose – an appropriate and dynamic "energy-mix" needs to be developed.** In the case of rural Nepal, it is important to build the capacity of people to be able to pay for the energy services they require through

Box 6-4: Poorest and socially discriminated people in Nepal and associated challenges

The poorest of the poor are generally the disadvantaged groups due to discriminatory social structures like caste, ethnicity and gender. In the hierarchical social structure, so-called Dalits (kami/blacksmiths, Sarki/leather workers, Damai/tailors, etc.) and women in all categories are the poorest and very likely to be excluded in the project implementation process. They may even remain unseen. They are always addressing basic survival issues and avoid or are systemically excluded in the development process. They can only be brought into the development process if a rule is established for 100 percent participation and their immediate hand-to-mouth problems are addressed. Once participation is ensured through careful intervention, their capacity to afford energy services is another challenge. It is possible to gain consensus among the villagers for supporting the poorest as well as addressing the equity issue which serves as a shield against insurgency (destroying microhydros). So far no single microhydro scheme has been damaged.

Although the constitution of Nepal does not allow discriminatory practices based on caste, ethnicity, colour, religion and sex, many discriminatory structures and practices are embedded in the social system and are perpetuated by the patriarchal norms. Therefore, it is pertinent to consider organizing **homogeneous** people in terms of their caste and gender in community mobilization. There should be gradual social guidance to empower them to become equal participants. Adult literacy classes, envisioning exercises about their lives and the role of energy services in their lives were some of the key tools applied in the community mobilization process. These helped to mainstream the disadvantaged into the overall development paradigm which was a key to successfully overcoming these social barriers.

The selection of community mobilizer(s) is also a critical dimension. The REDP set a policy that the mobilizers must be from within the district but not from the same village where they have to act. This gave a fair chance of employment within the district and at the same time the biases that could arise due to being resident of a particular village were avoided. This is, however, still a point for future debate.

Box 6-5: Good community governance through self-reliance

Nepal is a heavily donor-dependent country; but most of the support and services for rural people have been delivered without consideration of demand. As a consequence, this has undermined or not tapped into people's strengths and capabilities. This orientation also blocks communities from new opportunities. The conventional practice was that the outside contractor would establish microhydro without local participation and would hand it over to the community or private entrepreneur(s) after its commissioning. This seriously hindered ownership building and sustainability.

In contrast, the REDP approach involved all beneficiaries from the beginning, building and strengthening their institutions and institutional capacities, promoting their leadership abilities, enhancing transparent decision-making processes and letting them lead the process on their own. To establish their rural energy system by constructing microhydro (which forms the nucleus of the system), people demonstrated their solidarity and leadership capabilities to mobilize funds from the community, district bodies and bank loans.

Often the provision of support to hardware components such as construction or infrastructure development may be susceptible to all sorts of financial irregularities. In the case of the REDP, microhydro equipment procurement is a vulnerable component because considerable amounts of money are involved. In order to avoid all possible irregularities, a mechanism has been devised to procure microhydro equipment; the community selects their group leaders to send them to markets and when they come back to the village they organize stringent community audits in addition to the regular REDP audit process. The REDP plays a facilitator role by providing a list of qualified manufacturers and brokering appointments for these community people. This approach empowers people, building a sense of ownership and accountability and developing their leadership capabilities in the process. These village leaders do their best for the village in negotiating prices. This provides an opportunity for them to be exposed to the outside world away from their villages. A number of community organizations have succeeded in securing a reasonably good bargain price for their equipment and, at the same time, they have become familiar with people and places to contact in the event of future problems. This has also fostered "rural-urban" linkages.

economic activities such as micro-enterprises. Similarly, it is important to promote location-specific combinations of electricity (microhydro) which could be utilized for multiple purposes; biogas and improved cooking stoves for cooking family food, as well as cooking feeding materials for livestock. If microhydro is not feasible in an area, solar energy, batteries or other forms should be considered. Attaching toilets with a biogas reactor has been promoted and is an increasing trend which has a direct bearing on public health due to improved sanitation in the village and reduction of contamination of water sources.

vi **Technological concerns and issues in rural energy could be addressed through R&D for which synergistic coordination and linkages are essential.** The key concerns in the REDP pertain to the quality of rural energy technologies and the provision of technical support after the establishment of rural energy systems. For R&D, the academia and research institutions were brought on board and for technical support the local level electro-mechanical/grill workshops were promoted, which alleviated most of the concerns. This also ensured a self-running mechanism.

7. Conclusion

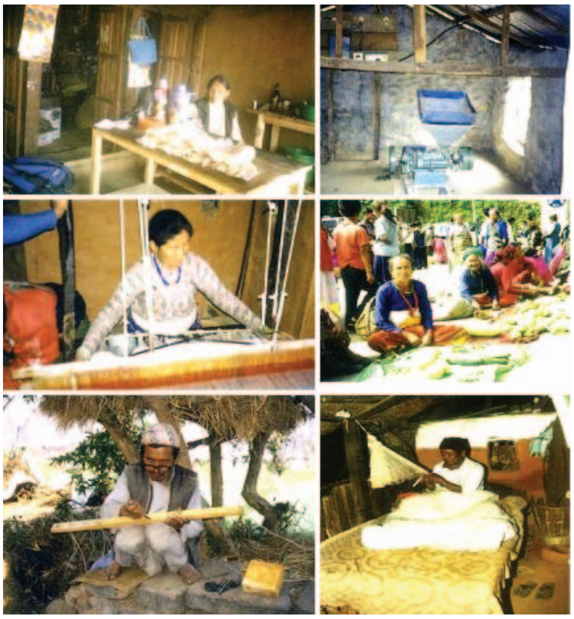
In conclusion, the REDP must be viewed in the context of sustainability. In Nepal, poor people, for the most part, do not have the capacity to invest in the establishment of rural energy systems without state or outside support. If sustainability is defined in terms of people's capacity to fund by themselves entirely as an extension from one village to another via demonstration effects, then the REDP is not a sustainable operation. However, if sustainability is viewed in the context of the community's capacity to handle the "established business" after support ceases (in this case rural energy systems), it is most important to ensure the people's capability of assuming this task, with elements contributing to this as integral parts of the project. **The salient elements of sustainability that have emerged through REDP intervention are:** a) rural energy should be viewed from the holistic perspective; b) sustainability should focus on the local level; c) capacity building should address issues of good governance; d) legitimacy aspects of local systems should be fostered; e) financial and service delivery mechanisms, such as RESCs, should be developed and f) public–private partnership issues should be considered from the outset. As a result, the

Installed in project areas: Microhydro powerplant (left)
Biogas Plan (right); Solar Home System (top)

REDP **as an approach to rural development** is also an important issue for consideration and further discussions.

Related to sustainability is the impact the REDP has had and continues to have in the policy arena. The most important policy issues emerging from the lessons learned from the REDP relate to scaling-up the lessons, by embedding them, and adoption of the approach in policy dialogues and the policies themselves. There is a growing realization among government authorities and donors that the REDP *modus operandi* has significant potential when applied to the development of other rural areas in Nepal. There are positive signs that the level of coordination is increasing among interministerial departments and donors. All development partners including government, donors and civil society are working towards the goal of poverty reduction and have realized that this has not been sufficiently addressed as of yet. This kind of favourable environment needs to be utilized in the formulation of holistic rural energy policy. The Hydro-power Development Policy (2000) envisions rural electrification, but does not fully embrace a holistic rural energy perspective which could be addressed in the ongoing policy study in the rural energy sector under the auspices of the Thematic Trust Fund for Sustainable Energy Development of the UNDP. It is expected that the lessons from the REDP will serve as a sound foundation. In addition, a study on how to proceed with rural energy sector development is under discussion among donors and the government. It is anticipated that it will be linked with the rural energy policy study mentioned above.

There are about 3,900 VDCs in Nepal and out of these, around 1,500 are situated in the plains area; the likelihood of their being connected by the national grid is very high. Some 1,000 are found in valleys of the mid-hills, which are mostly connected, and around 300 are in extremely remote areas requiring a special intervention strategy. The remainder of the 1,100 VDCs could be considered as a potential target area for programmes or other interventions similar to the REDP to make significant changes in the country's rural development paradigm. To this end, a partnership with the World Bank is being arranged, and this will permit replication of the programme in an additional 150 VDCs over the course of the next three years. This can be considered as a measure of success and as a good practice by the government and the World Bank to further the REDP initiative. Capitalizing on the strengths of the programme and **to build more partnerships is a future focus** for the REDP.



Productive uses of energy in project areas

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Chapter 7

Financing for renewable energy: Lessons from the FINESSE project in the Philippines

Minoru Takada, Sooksiri Chamsuk, Imee Manal and Jane Steel[37]

Abstract

Renewable energy in the Philippines can potentially play a significant role in expanding off-grid energy options in rural areas where many people still do not have access to adequate and affordable modern energy services. The Financing Energy Services for Small-Scale Energy-Users (FINESSE) project, which commenced in 1997, therefore attempted to address some of the key barriers to widespread diffusion of renewable energy, focusing on the provision of appropriate and accessible financing for small-scale renewable energy projects.

FINESSE's main objective was to develop the capacity of the local financier, the Development Bank of the Philippines (DBP) to handle renewable energy projects within its lending programme and to tackle some of the obstacles, which had inhibited the expansion of a renewable energy investment portfolio. This objective was successfully achieved through training sessions and the streamlining of internal lending guidelines and operating procedures for renewable energy financing; this significantly raised internal capacity for the technical evaluation and management of a renewable energy lending portfolio. However, limited policy and regulatory incentives for renewable energy development, the weak capacity of the project proponents and inflexible lending conditions inhibited the development of a significant number of renewable energy investment projects, limiting the widespread diffusion of renewable energy.

The FINESSE-Philippines project provided a best example of how to develop capacity for managing renewable energy projects. By establishing a bridgehead in the financial institutions of the Philippines, FINESSE has rendered renewable energy development in the country a valuable service, and possibly also elsewhere in the region. Yet, the DBP's experiences clearly point out that focusing on financing issues alone cannot result in desired outcomes. Concerted efforts to create an enabling atmosphere across a wider set of issues – political, institutional and financial – are essential in expanding the use of renewable energy.

Keywords: Renewable energy projects, capacity building, financiers, Development Bank of the Philippines, lending guidelines.

1. Context

A major development challenge in the Philippines is to achieve high levels of economic growth that can sustain and support its fast-growing population and, at the same time, keep abreast with the rapid pace of global development. Development requirements impose heavy demands on the country's ability to increase agricultural and industrial production, and supply appropriate technologies, facilities and infrastructure for expanding economic activities. Access to reliable and affordable energy services is not only essential to sustain economic growth, but also a prerequisite for meeting social and environmental goals. In the Philippines, the rural poor have limited access to energy services; therefore, development prospects are seriously compromised, and as a result, much potential for development remains untapped.

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Recognizing the importance of energy issues, the current Medium-Term Philippine Development Plan (MTPDP) considers modern energy services to be essential for national development. Under the MTPDP's framework, the Philippine Energy Plan (PEP) similarly promotes energy as a major element in poverty reduction and economic growth, and specifically aims to make electricity available fo all the population using both on- and off-grid options. Renewable energy can play a significant role, particularly in expanding off-grid options in rural areas, to achieve general access to adequate, affordable, reliable, high-quality, safe and environmentally benign modern energy services.

At the end of 2000, about 20 percent of the total number of *barangays*[38] (41,955) had no access to electricity. Many are rural (mainly poor) communities, which will not be connected to the grid in the foreseeable future, because of financial and technical grid extension issues. Fifty percent of the remaining unelectrified barangays have been identified as suitable for off-grid electrification using renewable energy technologies due to their distance from the grid and low population density.

There is a huge renewable energy resource potential in the Philippines. Yet, the actual use of renewable energy resources is minimal, with the exception of geothermal and large hydro energy systems.

As numerous studies show, there is a huge renewable energy resource potential in the Philippines. Yet, the actual use of renewable energy resources is minimal, with the exception of geothermal and large hydro energy systems. Currently, renewable energy contributes approximately 28 percent of the primary energy mix, most of which comes from traditional biomass. Contributions of renewable resources from solar, wind, modernized biomass and microhydro systems in terms of energy supply are virtually non-existent (less than 0.1 percent).

The diffusion of renewable energy technologies is constrained by political, technical, financial or institutional barriers. One of the foremost barriers is their initial cost, which is higher compared to conventional energy technologies. However amortized costs in the long run are much lower than conventional means. The initial cost barrier often effectively makes renewable energy technologies inaccessible for most users in the low/middle income bracket. Accessible financing, suitable for the needs of this bracket, is the key to surmounting this problem. Affordability can be dramatically increased if credit facilities are made available to entrepreneurs and consumers.

In this context, Financing Energy Services for Small-Scale Energy-Users (FINESSE) in the Philippines was launched in 1997. The main objective was to develop the capacity of local financiers to appraise, manage and monitor renewable energy projects within their lending programmes. By working with a credible national bank in the Philippines, i.e. the Development Bank of the Philippines (DBP), the FINESSE project has attempted to increase accessibility and credit availability for renewable energy project developers and end users.

This paper discusses the FINESSE project's approach to overcoming the renewable energy financing challenge as well as lessons learned, which provide insights for future endeavours.

2. The FINESSE project: Developing the capacity of financiers

2.1 Background and rationale

The FINESSE project commenced in 1997 as a three-year project[39] with funding from the Netherlands and the OPEC Fund for International Development totalling US$1.1 million through the United Nations Development Programme (UNDP). The DBP's Window III was responsible for overall project coordination and implementation, with technical support provided by UNDP. Under the overall guidance of the National Economic and Development Authority (NEDA), the DBP closely coordinated activities with other government agencies such as the Department of Energy (DOE), private groups and NGOs during implementation.

38 The smallest political unit into which cities and municipalities in the Philippines are divided. It is the basic unit of the Philippine political system. It consists of less than 1,000 inhabitants residing within the territorial limit of a city or municipality and administered by a set of elective officials, headed by a barangay chairperson or punong barangay (source: Philippine National Statistical Coordination Board website).

39 The project duration was later extended to last for six years, in order to allow sufficient time for capacity development as well as project pipeline development.

The project is an initiative aimed at promoting ways to provide technically feasible and economically viable renewable energy and energy efficiency services to residential, commercial, industrial and other productive sectors. The FINESSE concept was first applied by the World Bank[40] in South and Southeast Asia in the early 1990s, the Bank consequently produced, *inter alia*, renewable energy and energy efficiency project propositions for potential commercial lending.

One important lesson drawn from the FINESSE-Asia project was that it took a very long time (over five years) to secure investments for the resultant business propositions, partly because the project had started without prior identification of potential financiers to provide such investment capital.

2.2 Concept and strategy

The FINESSE-Philippines project was proposed as a direct follow through to the FINESSE-Asia project. Due to the reorganization of ministries in the early 1990s, FINESSE-Philippines did not start until 1997. Reflecting on the lessons learned in the FINESSE-Asia project, at the outset the FINESSE-Philippines project identified the DBP as the main financier to work with nationally. The DBP was selected, because it was the only bank in the country that had previous experience in renewable energy issues. Of particular relevance was its special development lending programme, Window III. Window III provides concessional loans to projects with distinct development impacts. By 1995, Window III had approved the financing of five renewable energy projects.

The project sought to strengthen the DBP staff's technical knowledge and skills in evaluating and managing funds for renewable energy projects and to streamline internal lending guidelines and operating procedures for renewable energy financing.

Despite the Window III facility, the DBP faced a number of obstacles in expanding financing for renewable energy. Previous experiences uncovered weaknesses in technical evaluation and management of a renewable energy lending portfolio. For example, the DBP's lending guidelines did not consider the unique characteristics of renewable energy projects (i.e., high initial capital cost and long gestation period). Moreover, the DBP had to rely on technical input on the appraisal and implementation of projects from the DOE due to inadequate in-house technical capacity, which at times was too cumbersome.

Thus the project was designed to tackle some of these obstacles, which had inhibited the DBP from rapidly expanding its renewable energy investment portfolio. Focusing exclusively on capacity building – both at individual and institutional levels, the project sought to strengthen the DBP staff's technical knowledge and skills in evaluating and managing funds for renewable energy projects and to streamline internal lending guidelines and operating procedures for renewable energy financing. It was envisaged that the DBP would be able to marshal its own bank resources, in order to make credit more readily accessible and that this would allow it to establish itself as a credible focal point for financing renewable energy projects in the Philippines. An important indicator of the success of the FINESSE project would be the number of renewable energy investment projects the DBP would eventually develop.

Focusing solely on bankers' capacity building is rather narrow in scope, given that the barriers against diffusion of renewable energy technologies involve a far wider set of issues. Nonetheless, when project started, this was considered durable since the New and Renewable Energy Bill was expected to be approved, creating incentives for market expansion. That is, the FINESSE project in the Philippines was operationalized under an assumption that at the end of project implementation, demand for renewable energy financing would have grown substantially due to the enactment of the Bill and contingent public support. Moreover the DBP would be prepared accordingly for responding to such increased demand.

Tailored to the needs of the DBP, the project intervention strategy involved the following activities:

i) Mainstreaming renewable energy into the DBP's operational structure: Renewable energy is in fact a new commodity for most financiers and it often lacks the needed internal commitment and

40 The FINESSE concept was created in 1989 by the World Bank in collaboration with UNDP, The Netherlands Ministry for Development Cooperation (DGIS) and the US Department of Energy (USDOE).

confidence to undertake investment activities. The project aimed to provide a means for the DBP to establish and institutionalize a unit dedicated to renewable and energy efficiency issues.

ii) Building capacity – at both individual and institutional levels: Having adequate in-house technical as well as systemic capacity is a prerequisite for the sound management of the lending portfolios. The project was therefore designed to provide a series of training events specific to each renewable energy technology for DBP staff. Support was also provided for the development of lending guidelines for individual renewable energy technologies, so that the DBP could systematically evaluate and manage the proposals for renewable energy financing.

iii) Generating the renewable energy lending portfolio through "learning-by-doing": The project aggressively conducted investment promotion seminars, as well as information/ knowledge dissemination to help prospective proponents develop renewable energy proposals. In order to ensure quality business proposals and to increase access to financing, a revolving fund was established to finance feasibility studies necessary to complete the business proposals. The Project Preparation Revolving Fund (PPRF) was expected to increase the rate of project development, which, in turn, would also help to accelerate learning opportunities for the DBP and proponents.

By late 2001, the DBP had successfully developed one project beyond the pipeline; a solar-water heater project to provide water-heating facilities to commercial entities, with a total lending value of PhP 5 million.

It should be noted that while the FINESSE project financed activities to develop individual and institutional capacity as well as initial capital costs for the PPRF, it did not subsidize any lending operations, which were solely done using the DBP's internal resources.

3. Project experience: What worked, what didn't and why

To date, the FINESSE project has had a positive impact on the evolution of the DBP's renewable energy portfolio. By late 2001, the DBP had successfully developed one project beyond the pipeline; a solar-water heater project to provide water-heating facilities to commercial entities, with a total lending value of PhP 5 million[41]. There are four projects that are considered as being" in the firm pipeline"[42] and there are 19 others that are in the pre-pipeline stage ranging from "concept" to pre-feasibility levels, which are either receiving pre-loan counselling assistance from the DBP or waiting for its assistance.

While projects in the firm pipeline have increased substantially, actual lending has occurred in only one case, indicating that there are some internal and external factors that pose challenges in facilitating renewable energy financing. The analysis hereunder provides more detail – what worked, what did not and why – in relation to three issues synonymous with the project's implementation and objectives.

(1) How did the DBP manage to mainstream renewable energy into its regular operational structure?

As a first step to reinforce the DBP's capacity to manage renewable energy, a new and renewable energy core group (NRECG) with eight to ten members (number varying year to year) was formed within Window III in 1998, with the vicepresident of DBP Window III as team leader. Initially, it was viewed as a pilot unit, and did not have regular unit status. Given the uniqueness of renewable energy financing activities, the establishment of such a unit was essential. Yet, forming and running the NRECG heralded significant challenges. First, due to the new and experimental nature of the NRECG, none of the members worked (or did not opt to work) full time in the unit – on average, utilizing only 20 percent of their working time. The non-full-time assignment of members to the renewable energy project often prevented them from participating in training and other renewable energy activities in order to attend to their regular jobs at the bank. Lack of any formal terms of reference for NRECG staff and a clear work programme was a factor that contributed to uncertain benchmarks and varied commitments of its members. Second, the composition of the group changed every year due to the movement of

41 US$1.00 = 50.80 pesos (PhP).
42 Firm pipeline means those projects that are at least, past the prospecting and preliminary screening stages of the DBP's loan process flow.

the members between units, largely caused by a major DBP reorganization in 1999. Four years after the establishment of the NRECG, only four out of the original nine members remained as part of the bank's renewable energy financing programme. Changes in the composition of the group also meant that training efforts and resources spent on those who later left the group had not been fully utilized. Moreover, some training activities had to be repeated for the benefit of those who were not amongst the earlier batch of trainees.

Despite all of these challenges, the DBP's commitment did not fade. In July 2001, the DBP initiated steps to institutionalize its commitment to renewable energy by making the NRECG a regular unit of Window III. As of 2001, the unit was led (part time) by the vice-president in charge of Window III and was staffed with three full-time and four part-time DBP regular professionals, paving the way for continued and sustainable renewable energy financing after the external assistance (the FINESSE project) ended.

This successful mainstreaming of renewable energy financing into the DBP's regular structures can be attributed to two factors. One is the support and commitment of the management, which was enhanced under the project. Before the project's intervention, DBP management showed little interest and support, resulting in the limited effort by NRECG members and also in the relatively minor importance given to renewable energy activities at the time. To increase management confidence in renewable energy, training events specifically tailored for senior bank management and branch managers were conducted at the beginning of the project. Renewable energy study tours and conferences were also organized inclusive of DBP senior officers. Through these activities, they were able to understand the merits of renewable energy in relation to the bank's development goals, including economic, environmental and human resource development. This totally reversed management perceptions against renewable energy, and was pivotal in the eventual success of renewable energy mainstreaming. Another important factor was the personal dedication and commitment of several DBP staff in Window III. Despite institutional changes and limitations within the DBP, the FINESSE project was fortunate to have the continued engagement of people who drove the NRECG from the beginning. Clearly, external assistance, like the FINESSE project, would not have been possible, or made a difference, without their commitment.

(2) How was the DBP able to develop individual and institutional capacity to manage renewable energy financing projects?

As mentioned previously, lack of specific knowledge and capacity is one of the key barriers in lending for renewable energy projects. The DBP has developed both individual and institutional capacity via two components of the project, i.e. providing training for DBP staff and establishing lending guidelines to develop systemic and institutional capacity.

Training activities under FINESSE focused on providing basic understanding of the nature of renewable energy projects and the renewable energy market and adeptness with the project's development cycle (especially financial aspects); acquiring greater skill in evaluating loan applications; and managing loans for these projects. The training modules included domestic and foreign case studies in order to add a real-life dimension to the classroom instruction. Overseas training activities, in particular, provided the group with success stories of renewable energy systems for development in other countries as well as the latest information on new and renewable energy research.

These training events were organized for the NRECG members and also for senior management/ branch representatives. Between 1998 and 2000, 13 domestic courses were conducted for the NRECG. The NRECG members were also sent on a total of ten overseas training events. All training

NRECG site visit to the solar PV power plant courses for the NRECG were based on a training needs assessment conducted by a local consulting firm in conjunction with the DBP's human resources group. The courses included a series of technology-specific sessions related to areas such as biomass, wind etc, so that participants could learn about respective technologies. The training modules were prepared by a local consulting firm with support from foreign experts and were coordinated with the DOE, which provided technical experts as resource persons/ speakers, as required or available.

NRECG site visit to the Solar PV power plant

The effects of the training were immediate and positive. Firstly, the NRECG acquired the necessary technical and financial knowledge to better evaluate new and renewable energy project proposals through domestic and international training interventions and hands-on experience with the evaluation of actual proposals. The training has raised a great deal of confidence among NRECG members who started out with no knowledge on renewable energy. As training included representatives from branches and management, the knowledge has been passed on to other levels of bank personnel. Even senior management has become more knowledgeable and appreciative of the merits of renewable energy technologies, particularly in support of the bank's environment management thrust and programme.

Secondly, training and exposure enabled the NRECG to appreciate the significance of renewable energy in the overall economic development picture. This also helped them to perceive renewable energy projects as being different from standard business ventures that yield immediate returns on investment; therefore renewable energy projects need more allowance in terms of interest and repayment schedules. The NRECG was better able to balance the risks involved with renewable energy investments and realized the flexibility required in handling renewable energy loans.

Subsequently, the DBP formalized renewable energy lending by establishing guidelines and operating procedures tailored to the nature of renewable energy projects. They served as the overall appraisal system for evaluating proposed renewable energy projects for financing, and took into due consideration their financial requirements and risks. A special feature of the guidelines, not normally found in financing schemes for other types of projects, was to encourage women's participation and pay strict attention to the environmental impact of the proposed project. The guidelines are formulated inline with the DBP's lending policies and standard proce-dures, and are unique to the renewable energy projects; but they would be useful as an industry standard for renewable financing programmes in general. The guideline took into account the unique project attributes of the various renewable energy technologies, with only one major difference in the loan features – the grace period on principal repayments. Annex 7-1 provides details of the lending criteria for each technology.

Policies and lending guidelines specific to five key renewable energy technologies: solar, solar photovoltaic (PV) for telecommunications, wind, hydropower and biomass, have been adopted. Along with these guidelines, the bank's loan appraisal process flow for Window III was also formalized to include new and renewable energy. The entire process is comprehensive, comprising several activities with the corresponding number of processing days and steps involved. Annex 2 contains the loan appraisal process flow within Window III.

These lending guidelines have significantly helped the DBP to regularize renewable energy financing within its lending activities.

(3) How effective were the project interventions, such as the PPRF, in generating renewable energy lending portfolios?

Prior to the FINESSE project, the DBP had very few business proponents who were considered serious enough for lending purposes. This was chiefly attributable to the lack of serious business ventures with a definite idea of the renewable energy projects they wanted to develop and were determined to pursue by securing a bank loan. Insufficient knowledge amongst the private and public players of what a business plan for renewable energy technology projects entailed was a common problem.

To overcome these barriers, several project interventions (listed hereunder) have been identified and implemented. These include information dissemination campaigns, investment promotion seminars, establishment of a financial mechanism for feasibility studies – the PPRF – and the application of flexible lending criteria for renewable energy projects:

Raising awareness and infor-mation dissemination
This activity was pursued by various means: the FINESSE on-line website was developed; the newsletter (*FINESSE Update*), detailing project activities, was released on a monthly basis; and a project brochure was distributed to proponents, including other agencies, during business meetings, conferences, etc. as part of project promotion efforts. This strategy had some success in promoting awareness and interest among stakeholders in terms of potential investments and creation of the renewable energy-aware financial sector. Information activities heightened awareness and interest in renewable energy systems and services, not only as technologies but also as vehicles for boosting development and viable business ventures. Information linkages with other players, both international and local, have been significantly strengthened, proof of which is the growing recognition of the DBP as the strongest supporter of renewables within the country's formal lending sector.

Information activities heightened awareness and interest in renewable energy systems and services, not only as technologies but also as vehicles for boosting development and viable business ventures.

Consultation and technical support provided to project proponents
Sixteen external and two internal promotion activities were undertaken to raise awareness and build capacity among potential proponents to develop renewable energy business plans and propositions. Investment seminars were organized, followed by a number of one-on-one investment meetings between the DBP and prospective project proponents. Various linkages among potential project proponents and other key players in renewable energy were established (e.g. private developers and energy service providers, and local government units). Close consultation, counselling and provision of technical assistance to project proponents by NRECG members during loan application and project preparation helped to forge good working relationships with the proponents. In fact, most of the projects that reached the FINESSE pipeline did so after one-on-one meetings where proponents received personalized guidance on NRE project preparation and loan procedures. A list of over 20 projects in the pipeline is a clear indication of the success of such efforts. Moreover, subsequent joint activities (mainly co-financing arrangements), undertaken with other government agencies like the DOE and donor organizations like the UNDP Small Grants Programme also evidence these achievements.

Establishment of the PPRF
This mechanism provided selected project proponents with financial assistance to conduct high quality feasibility studies and business plans. The PPRF provided loans of up to PhP 1 million for feasibility studies, project design and preparatory activities for renewable energy projects, payable within three years and including a six-month grace period on the interest repayment. The proponent was expected to put up at least 50 percent of the total cost of project preparation with the fund being managed by the DBP's Trust Services Department. Collateral requirements included hard collateral and substitutes. The unpaid principal balance of the loan could also be converted into the regular loan, once the DBP approved financing of the project covered by the PPRF.

A flexible lending mechanism, developed through Window III:
Due to the unique nature of Window III, house lending rules have been applied in a noticeably more relaxed way although prudence is always maintained. For instance, as long as a project can show that an adequate return on investment is guaranteed, collateral becomes a less pressing issue. Through the renewable energy technology, specific procedures and guidelines that were developed, and training, NRECG members and management staff were able to develop the aforesaid grace period on principal repayments and were able to understand the context of the proposal they were handling. This therefore

allowed a fair amount of flexibility in dealing with each renewable energy loan that they handled.

However, despite these interventions, the actual lending portfolio grew very slowly. In fact only one project has availed a loan and is ongoing. While the number of projects in the pipeline has grown significantly, it is questionable why such proposals have been so slow to mature into loan projects. The answers are multiple, and illustrate significant structural challenges.

Firstly, one explanation for the delay in the maturity of pipeline projects is that project proponents did not have the anticipated sufficient capacity to produce "bankable" business plans. Therefore, more time than expected was invested by NRECG members in supporting proponents with the development of their business propositions. The efforts of the NRECG members are best illustrated by the way members fine-tuned, developed and nurtured basic project ideas to the stage that allowed consultants to assemble presentable business plans. This phase easily lasted a year or more and was required to ensure high quality technical inputs. The unforeseen "incubation" period of the pipeline projects assumed a dominant role because it turned out to be the only way to generate acceptable investment proposals. It is important to realize that there would have been no projects in the pipeline at all, if sufficient time with adequate resources had not been spent during this incubation period.

Delay in the maturity of pipeline projects is that project proponents did not have the anticipated sufficient capacity to produce "bankable" business plans. Therefore, more time than expected was invested by NRECG members in supporting proponents with the development of their business propositions.

Further, the incubation period that Window III allowed to be adopted was instrumental in the approval of the two PPRF loans. Without this neither of the projects was likely to reach the pipeline stage. According to the NRECG, only the two approved projects actually applied for the PPRF. Two other projects initially expressed interest, but did not complete the requirement for loan application. It appears that the PPRF may not have been as instrumental in promoting renewable energy investment as was originally expected.

A second reason is that rigid financial regulations hampered the faster development of renewable energy. Through Window III, the DBP applies the house lending rules that are more relaxed. For instance, for as long as a project can show that an adequate return on investment is guaranteed, collateral becomes a less pressing issue. However, whilst the DBP can make unsecured loans (project financing), it finds the requirement of the Bangko Sentral ng Pilipinas (BSP, i.e. the Central Bank) to set aside funds equivalent to 25 percent of such a loan unacceptably constraining in its overall funding ability. This effectively blocks very promising projects from being implemented.

Thirdly serious investment in the Philippines has been inhibited. Few, if any, domestic investors are tempted by payback periods that stretch beyond five years, no matter how sound all other aspects of the investment opportunity involved may be. Since most renewable energy investments are in this category, few renewable energy developments will be entered into immediately by the private sector. Unless, that is, financial incentives can be put in place that adequately bridge the gap with commercial expectations of rates of return on investment. Moreover, investment in renewable energy projects deals with often "non-viable" project partners such as the electricity distribution franchise holder, the electric cooperative (EC) and often, the local government unit (LGU). Technical and financial capacity is often lacking in the EC and in the LGU, (which is constrained by a low internal revenue allocation, [IRA]). Given this situation, debt servicing is severely limited. Further, legislation and regulatory functions limit the extent of cross-ownership between the generation and distribution of energy. This creates a situation whereby the possibility of accruing substantial benefits due to operational integration remains out of reach.

Fourthly, a level playing field for renewable energy has not been created yet, making it almost impossible to penetrate the market in a significant manner. Both national and local politics thus distort the energy sector both in a systemic and an *ad hoc* basis (ranging from subsidies on fuel prices, delivery costs, etc.; repeated bailouts of ECs; to "free" gifts of generating equipment/ distribution lines/fuel, etc.). This long-standing problem has yet to be addressed adequately.

Legislation *per se* cannot provide the solution. The new Electric Power Industry Reform Act (EPIRA) may mean a small step forward. As a disincentive for the use of non-renewable energy sources, fossil fuel-based generators will pay a small extra charge for grid access, which would otherwise have benefited renewable energy-based generators.

To summarize: The underdeveloped state of renewable energy with few potential and established players who understand investment proposals poses a serious limitation for the expansion of an investment market. The demand is small and the ready market of investors or borrowers for renewable energy funds does not approach the commitment level. The FINESSE approach would have been substantially useful in situations where the government had an effective renewable energy development strategy that would have generated a reasonable amount of demand for investment in the renewable energy projects.

4. Lessons learned

The FINESSE project experiences provide valuable lessons for embarking on renewable energy development endeavours in the Philippines and elsewhere. These are summarized below:

i) **Policy interventions to create a "fair ground" for renewables are a necessary precursor for expanded financing for the renewable energy sector.** The FINESSE project highlights that without appropriate national policy and regulatory frameworks, it is unlikely that demand for financing for renewable energy will increase significantly. Appropriate policy interventions, therefore, are essential to create an atmosphere conducive for the renewable energy sector to grow and sustain itself in any country.

ii) **Capacity building is needed at all levels of the financing delivery chain.** While increasing the capacity and understanding of financiers can lead to the generation of a pipeline of projects that can be evaluated for lending, the FINESSE project experience clearly points out the obvious need for a wide range of capacity-building efforts. The lack of proponents' capacity means that without incubation by financiers, there will be no pipeline projects. There is a need for strong capacity building of proponents, and indeed at all levels of the financing delivery chain.

iii) **Financiers need to be equipped with the means to manage risks.** Two important issues relating to risk emerged from the FINESSE project experience. First, local politics in several cases directly hampered the lending operations from progressing. Second, stringent mandatory equity requirements imposed by national regulations (to minimize risks) prevented promising renewable energy projects from being financed. In both cases, the DBP had basically no effective means to deal with them, as the conditions set were outside the DBP's mandate and reach. There is a strong need for a regulatory mechanism that (i) protects financiers from being exposed to political risks and (ii) provides them with the means and flexibility to take calculated risks, for example, reducing equity requirements under certain conditions.

iv) **Leadership roles to drive mainstreaming to facilitate lending of renewable energy projects are crucial.** Institutionalizing renewable energy lending in the financing sector is not an easy task, given prevailing internal and external conditions that are mostly not conducive to renewable energy development in developing countries. Under such conditions, what often makes a difference is strong leadership that drives the process. The DBP is a case in point, where the strong personal leadership and commitment of a few staff have led to securing commitment and confidence from senior management and the establishment of a unit dedicated to renewable energy development.

The DBP is a case in point, where the strong personal leadership and comminent of a few staff have led to securing commitment and confidence from senior management and the establishment of a unit dedicated to renewable energy development.

5. Conclusion

The experiences in the FINESSE-Philippines project present one good example of how in a sequential manner a financier can develop its capacity in managing renewable energy projects. The process that led to the development of a "real window" for renewable energy investments, where there was none before, offers a best practice. By establishing a bridgehead in the financial institutions of the Philippines, FINESSE has rendered renewable energy development in the country a valuable service, and possibly also elsewhere in the region.

Yet, the DBP's experiences clearly point out that focusing on financing issues alone cannot result in the desired outcomes. Concerted efforts to create an enabling atmosphere across a wider set of issues – political, institutional, and financial – are essential. For this reason, should the FINESSE- type approach be replicated, all of the critical issues raised above at all stages of the project design and implementation phase, including the project management cycle would have to be taken fully into account. The lessons of the FINESSE project have been incorporated into an ongoing renewable energy project in the Philippines funded by the UNDP-GEF, which tackles these barriers in a comprehensive manner.

With reputable bankers in its corner, renewable energy stands a much better chance of being treated fairly by politicians and achieving wider recognition of its many advantages. If the pending renewable energy bill is passed and ongoing interventions by the government and bilateral and multilateral partners can deliver on their expected outputs, the demand for financing of renewable energy projects should increase significantly, and eventually, available renewable energy resources can be harnessed. This will contribute to sustainable development in the Philippines.

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Annex 7-1: DBP new and renewable energy financing programme: lending guidelines

Description	HYDRO (Installed capacities not exceeding 50 MW)	SOLAR	PV FOR TELECOMS	WIND ENERGY	BIOMASS
Objectives	To provide financial support to hydro project developers in line with the government's rural electrification programme in areas where the generation of electric power using the hydro scheme is proven to be a viable alternative to conventional power generation systems; To improve the quality of life, particularly for the rural folk, by appropriately addressing their specific needs using renewable and environmentally friendly alternative sources.	To provide financial support to solar project developers in line with the government's rural electrification programme in areas where the generation of electric power using solar energy is proven to be a viable alternative to conventional power generation systems; To improve the quality of life, particularly for the rural folk, by appropriately addressing their specific needs using renewable and environmentally friendly alternative sources.	To support the government's telecom programme by providing financing to telecom companies using PV or PV/hybrid systems in repeater stations and other remote applications.	To provide financial support to wind project developers in line with the government's rural electrification programme in areas where the generation of electric and mechanical power using wind energy is proven to be a viable alternative; To improve the quality of life, particularly for the rural folk, by appropriately addressing their specific needs using renewable and environmentally friendly alternative sources.	To provide financial support to biomass project developers in line with the government's rural electrification programme in areas where the generation of electrical power and/or thermal energy using various sustainable biomass resources in appropriate technology applications is proven to be a viable alternative to conventional energy production systems; To improve the quality of life, particularly for the rural folk, by appropriately addressing their specific energy needs using renewable and environmentally friendly alternative sources.
Fund sources	Applicable ODA funds such as EISCP II, JEXIM IV, KFW –IPCLP, etc. DBP funds for projects/project components which cannot be accommodated under existing ODA funds				
Borrowers' eligibility requirements	Eligible borrowers include duly-registered entities authorized to undertake the project with at least 60% Filipino ownership with an exclusive or non-exclusive reconnaissance permit granted by the Department of Energy (DOE) such as but not limited to: • Single proprietor-ships (registered with the DTI) • Partnerships/ corporations/NGOs (registered with the SEC) • Cooperatives (registered with NEA/CDA) • Local Government Units (LGUs)	Eligible borrowers include duly-registered entities authorized to undertake the project with at least 60% Filipino ownership such as but not limited to: • Single proprietor-ships (registered with the DTI) • Partnerships/ corporations/ NGOs (registered with the SEC) • Cooperatives (registered with NEA/CDA) • Local Government Units (LGUs)	Eligible borrowers are corporations duly registered with the Securities and Exchange Commission with the necessary license from the National Telecommunications Commission.	Eligible borrowers include duly-registered entities authorized to undertake the project with at least 60% Filipino ownership such as but not limited to: • Single proprietor-ships (registered with the DTI) • Partnerships/ corporations/NGOs (registered with the SEC) • Cooperatives (registered with NEA/CDA) • Local Government Units (LGUs)	Eligible borrowers include duly-registered entities authorized to undertake the project with at least 60% Filipino ownership such as but not limited to: • Single proprietor-ships (registered with the DTI) • Partnerships/ corporations/NGOs (registered with the SEC) • Cooperatives (registered with NEA/CDA) Local • Government Units (LGUs)

Annex 7-1: DBP new and renewable energy financing programme: lending guidelines...(continued)

Description	HYDRO (Installed capacities not exceeding 50 MW)	SOLAR	PV FOR TELECOMS	WIND ENERGY	BIOMASS
Loan purposes	Eligible borrowers may avail a loan to: • Finance the construction of new hydro facilities, including pre-operational cost and expenses. • Finance the rehabilitation, modernization, and expansion of existing hydro facilities to enhance its present level of viability.	Eligible borrowers may avail a loan to finance the acquisition of solar systems to be installed in residential, commercial and industrial and community-based facilities for: Generation of electric power for lighting (stand alone or mini grid) and other applications, i.e. refrigeration and water pumping. Generation of thermal power for drying and water heating.	Eligible borrowers may avail a loan to: • Finance the installation of PV or PV/hybrid power systems for new repeater stations and other ancillary facilities. • Finance the rehabilitation, improvement, and expansion/retrofitting with PV or PV/hybrid power systems of existing repeater stations and other remote telecom facilities.	Eligible borrowers may avail a loan to finance the acquisition of wind generators (WTG) for power generation either on a standalone or grid-connected basis or windmills for water pumping, to be installed in sites with proven wind resource potential, backed up by at least 1 year of continuous and acceptable site monitoring data on the ground level.	Eligible borrowers may avail a loan to: Finance the construction of new biomass facilities, including pre-operating expenses. Finance the rehabilitation, modernization, and expansion of existing biomass facilities.
Loan term	Allowable repayment term of the fund source				
Grace period on principal	Maximum of 3 years for new projects and 1 year for rehabilitation/ modernization projects reckoned from the date of initial drawdown.	Maximum of 2 years reckoned from the date of initial drawdown.	Maximum of 1 year from the date of initial release of the loan for both new and retrofit projects.	Maximum of 1 year from the date of initial release of the loan.	Maximum of 3 years for new projects (depending on the technology applied and other relevant factors) and 1 year for rehabilitation/ modernization or expansion of existing facilities from the date of initial drawdown.
Interest rate DBP Funds	DBP Funds Prevailing interest rate with the gross receipt tax (GRT) for the account of the borrower. ODA funds. Applicable interest rate depending on fund source.				
Application fee	An application fee of 0.5 of 1% of loan amount (minimum PhP500) will be charged to the borrower.				
Other fees	Depends on fund source for ODAs.				
Collateral requirements	The loan shall be fully secured by assets acquired out of the loan proceeds and other applicable securities specific to the projects such as but not limited to: 1. Real estate mortgage 2. Chattel mortgage 3. Loan guarantee (e.g. from GFSME, SBGFC, and other guaranteeing institutions acceptable to DBP) 4. Internal revenue allotment (IRA) for LGUs 5. Assignment of power purchased agreement 6. Assignment of insurance cover 7. Assignment of suppliers buy-back guarantee 8. Joint and several signatures (JSS) of principal stockholders in case of corporation and key officers for cooperatives and NGOs				
Equity	DBP shall finance up to a maximum of 75% of total project cost. The remaining 25% shall be the borrowers' equity. Depending on the total project cost, syndicated loans shall be considered.				

Annex 7-2: Loan appraisal process within the DBP Window III

Activity group	Processing time (days)	Major steps involved
Client sourcing	Continuing	- Identify prospects & pre-qualification of proponent - Brief prospect re WIII guidelines/checklist - Refer prospect to Credit Appraisal Management Department for Credit Report - Site visit; environmental screening & review - Consult with DBP-Environmental Management Unit (EMU) - Initial & final interview of proponent & preliminary discussion of proposal - Formulate environmental risk & control strategies/covenants/warranties - Endorsement by DBP-EMU & Issuance of Due Diligence Report
Screening and acceptance of loan applications	1–2	- Request proponent to submit formal application - Check/accept loan application & prepare credit application document
Project evaluation	20–30	- Evaluate credit, collateral and valuation reports - Explore collateral substitutes/discuss with proponent - Evaluate market, financial, management aspects of application - Prepare draft evaluation report Review of report by immediate supervisor, Head of Window III and Loan Committee; if within credit limit, approval is authenticated; if outside credit limit, higher approving authority reviews loan application.
Documentation	10–30	- Series of authentication on the loan's approval, corre spondence with propoznent, and notarization of loan-related documents; if proponent fails to act on loan approval within prescribed period, extension is sought & papers are executed. - Registration/ratification of signed loan documents - Window III & Transactions Processing Department commences loan release procedure
Project supervision	Throughout term of loan	
Amendments/novations on loan conditions	15–30	

Source: Internal DBP document on Processing Systems of the Bank, IV 00

Chapter 8

Sustainable power supply on Apolima Island, Samoa[43]

Thomas Lynge Jensen[44]

Abstract

The Sustainable Power Supply on Apolima Island Project, which is in the design phase, is geared towards sustainable, cost-effective, reliable and environmentally sound 24-hour power supply. Samoa depends on imported petroleum for electricity generation and commercial energy supply. More than 95 percent of all households have access to electricity. Apolima Island has a total population of 93, living in nine households. The average monthly energy demand is around 350 kWh while the combined installed load of the current power system is less than 12 kW. The geographical situation, with more around 99 percent of the population living on two main islands, facilitates grid-based electrification. The possible technical options including some of their main benefits, issues and cross-practice linkages have been investigated and compared. Current fuel and lube oil handling poses an environmental concern as there is no storage compound to retain spillage or its recovery. Current operating conditions of the diesel power plant also cause both air and primarily noise pollution. As a centralized solar system needs a surface area to accommodate generation equipment, its location on a narrow volcanic crater creates a space constraint for Apolima. Meanwhile, proper disposal of batteries used in solar electrification systems should also be taken into account. Natural disasters such as cyclones are also a threat for the power supply infrastructure. For small island electrification, environmental and economic issues, and user preferences are all factors to be considered when making a technology decision. Possibly future income generation is also a potential positive impact of this project. Social-energy linkages have been investigated through a stakeholder analysis. At present, development activities in Samoa are guided by the Strategic Development Plan (SDP) Seven, covering 2002 to 2004. Two of the nine key strategic outcomes are relevant to development of the power sector and the planned project on Apolima. Currently, a National Energy Policy is being prepared. The proposed solar-energy project would have a high profile as a pilot project to help understand the technology. The case study also mentions tentative lessons learned and postcase study follow-up.

Keywords: Power supply, environmental/economic/social governance energy linkages, solar electrification systems, income generation.

1. Background and context

1.1 The topic and the cross-sector practices it addresses

The topic is power supply on a small, remote and rural island in Samoa. The study focuses on the following major cross-practice linkages (in no order of importance): a) energy-technical, b) energy-environment, c) energy-economy, d) energy-social (including gender linkages), e) energy-governance (including institutional linkages) and f) energy-replication. In reality other cross-practice linkages are involved, but they will not be mentioned in this paper.[45]

43 Please note that neither the Government of Samoa nor the Electric Power Corporation (EPC) necessarily shares the conclusions, views, recommendations, etc. expressed in this case study. UNDP Samoa has prepared this case study solely.

44 The case study has been prepared by Mr Thomas Lynge Jensen, Sustainable Energy Advisor, UNDP Samoa & UNESCO Apia with input from Ms Easter Galuvao, Assistant Resident Representative (ARR), Environment, UNDP Samoa. Most of the information is from the Feasibility Study – Possible Future Power Supply Options for Apolima Tai, Samoa, prepared by Mr Gerhard Zieroth, Renewable Energy Consultant for UNDP Samoa and UNESCO Apia, March 2003.

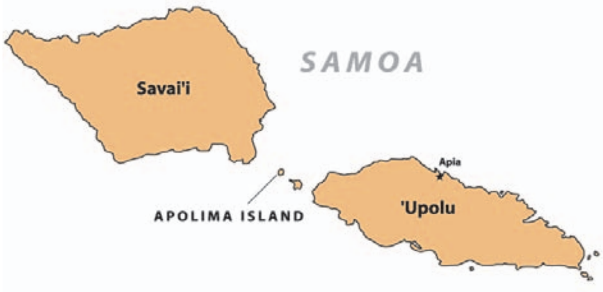
45 E.g. issues related to self-reliance and energy security also are factors that are part of the equation.

1.2 Country profile

Like most Pacific Island Countries (PICs), Samoa depends on imported petroleum for part of its electricity generation and commercial energy supply. While costs for imported petroleum once again have sharply risen, the use of energy remains vital to the economic and social development of local island communities and contributes to improving living conditions by increasing productivity, comfort, and by enhancing communication and transportation facilities. More than three-quarters of the Samoan population lives outside the capital, Apia, in rural areas and while the prospect for economic development tends to be limited in these areas, nevertheless access to energy is important for social and equity reasons. Moreover, the provision of improved infrastructure services, including basic electrification, contributes to create a more attractive environment in the rural areas thus helping to mitigate urban drift. While there is usually a broad consensus on the need to provide at least basic electrification in rural areas, the question of how to do it regularly excites the proponents of certain solutions and creates substantial controversy. Unlike other PICs Samoa has pursued a rural electrification policy that aims at complete networking of all residential areas in the country. The geographical situation with more than 95 percent of the population living on the two main islands, facilitates grid-based electrification.

1.3 Island profile

Apolima Island, Samoa lies in the Apolima Strait, outside the reef that encircles the main island of Upolu. Being the remnant of a volcano, it features high, steep cliffs that allow access at only one point. The village is located inside a crater that opens to a constricted, difficult passage from the sea. The soil of the island is poor and therefore coconuts and fish are the main sustenance for the residents. There are no roads or vehicles; all transport is by small boat. There is no piped water supply. The villagers either fetch water from a small stream or collect rainwater in buckets. There is only one large water tank. Until 1991 there was a small hospital but it was destroyed by Hurricane Val together with several residential buildings. At present, medical



Apolima Island

care is limited to visits by a doctor from the main island. There are no schooling or kindergarten facilities. A solar-powered public telephone is available. The total population is approximately 93, living in nine households; all families except two live in traditional Samoan *fales* (i.e. oval open houses) and all families occupy more than one building. It appears that there was significant out-migration in 1991; villagers quote cyclones as the main reason for this. The remnants of several buildings can still be seen in the village. Three families left the island between 1999 and 2003. The village leader considers the current demographic situation to be stable, unless a catastrophic event such as a major cyclone destroys major parts of the village again. The stated monthly household income fluctuates between WST$500 and 1,200[46]. All families receive income from more than one source. The most common sources are fishing (either selling fish caught or working on a fishing boat for a salary) and remittances. The monthly incomes do not show large variations. Current energy expenditure as a percentage of income is comparatively low for most households. There are two fishing boats in the village that are also used for transpor purposes. All families have small fields where they grow taro and vegetables. Other sources of income include revenue from the sale of agricultural produce (taro) and domestic animals, pandanus mats, transport fees (for the boat owners) and the Electric Power Corporation (EPC) salary for the operator of the generator. The village leader occasionally builds canopies for fishing boats.

46 (US1.00 = WST$2.94)

2. Project status

Inception: A feasibility study of possible 24-hour supply options was prepared by the Government of Samoa, EPC, UNESCO Apia and UNDP Samoa. UNESCO Apia and UNDP Samoa co-funded the study, which was finalized in March 2003.

Current status: The project is in the design phase. A final decision regarding the future power supply option has yet to be made by the EPC Board and the Cabinet Development Committee (CDC), Government of Samoa, but the recommended option is the utilization of solar energy.

3. Project input and profile

As mentioned, the project design is currently underway, but the expected outcome is a sustainable, cost effective, reliable and environmentally sound 24-hour power supply.

4. Project impacts

A description and discussion of some of the major linkages between energy and cross-cutting issues that UNDP Samoa will consider when determining possible (non-hardware) support to the project is given hereunder. The issues mentioned in the following sections (e.g. energy-social linkages) may also have aspects relating to another category (e.g. energy-technical linkages). Thus the categorizing is tentative and non-exclusive.

4.1 Technical–energy linkages

4.1.1 Current situation in the Apolima power system

Generation: A 20 kW diesel generator currently generates electricity. Only the evening peak demand from 1800 until 2300 is supplied. There is however, some flexibility to operate the generator on special occasions such as for funerals and major rugby matches on television. EPC technicians come to the island once a month to service the unit and bring with them the required fuel and lube oil. The village leader currently operates the generator. The operator does not carry out any maintenance. Services such as changing filters are performed by the EPC. The technical lifetime of the engine has exceeded its capacity and therefore it is in suboptimal condition. For example, the engine leaks during operation and generation records show sub-optimal conversion efficiencies for the Apolima generator. Evidence of some lube oil and fuel spills can be seen around the powerhouse.

Distribution, meter reading and billing: As all current consumers are located within one kilometre of the powerhouse, a low voltage distribution system is sufficient to supply electricity to the houses. In line with EPC standards in Upolu and Savaii, all houses have meters and are fused at 35 A. (i.e. the connections allow a total load of 8 kW). The distribution system also features three un-metered streetlights. During the monthly visits of EPC staff, the meters are read, consumption is calculated and bills are issued for the consumption of the previous month. The meter reader reports back to the EPC where the readings are entered into a billing system. Average losses in the distribution system amount to 14 percent. Taking into account that the consumption of un-metered streetlights is included in these losses, the value is considered acceptable for a low voltage single-phase distribution system.

Demand: At present the combined installed load of the Apolima system is less than 12 kW. In general, electricity is almost exclusively consumed for lighting and entertainment. Average monthly energy demand is approximately 350 kWh. There are significant differences between the consumption of individual households: average consumption in the observation period ranged from 11 to 100 kWh per month. This reflects the use of numerous appliances in one of the households but the use of electricity for lighting only in the low consumption household. Appliances such as water kettles, sandwich makers and irons exist, but residents use them infrequently because they encounter significant voltage fluctuations (flickering lights) when they are used. There has been a slightly increasing electricity demand over the last three years.

4.1.2 Possible technical options

Table 8-1 summarizes some of the possible technical options, including some of their main benefits and issues.

Apolima Island: an aerial view

Table 8-1: Possible technical options

Technical option	Benefits	Issues
Do nothing		• Generator will continue to operate in a suboptimal mode and have negative impacts on the environment • In the short term there is a risk that the diesel engine will have a breakdown
Increase supply hours and monitor load	• Energy services increased • Information on load outside the evening peak would become available	• Efficiency level of the generator would decrease • Negative impacts on the environment would increase • Financial losses would increase
Upgrade existing diesel system (i.e. new genset, new powerhouse relocated, prepaid meters, training and Demand Side Management)	• Less fuel consumption compared to existing situation • Reduced environmental impacts compared to existing situation • Lower supply cost compared to existing situation • Possibility to extend supply hours according to demand	• Vulnerable to a decline in demand triggered by loss of population • Expensive overcapacity
Undersea cable (from mainland)	• 24-hour supply • No environmental hazards	• Loads on Apolima are only 15 kW peak and the minimum capacity sea cable available is 6,000 kW, i.e. extremely expensive overcapacity • Specialized cable laying equipment required
Centralized solar system	• 24-hour supply • The existing distribution system and all consumer appliances could be retained • No pollution (including no noise) • Total independence for fuel supply • Comparatively low level of maintenance and service	• Vulnerable to a decline in demand triggered by loss of population • Expensive overcapacity • Supply limited by battery capacity • Some restrictions would have to be imposed on the use of high-powered devices (such as kettles and irons) • Power would be unavailable during occasional occurrences of extended periods of cloud • Photovoltaic (PV) technology is relatively new to the island • Expectation that external assistance will be provided to fund/co-fund this project

Table 8-1: Possible technical options (continued)

Technical option	Benefits	Issues
Solar-diesel hybrid	• Distribution system can be used • Less pollution • Supply not limited	• Technically more complex than centralized diesel or solar only systems • Expensive overcapacity • High performance batteries used in hybrid configurations are sensitive to the level of maintenance • Appears that hybrid technology would be best introduced in an environment that is more conducive to monitoring and technical back up • PV technology is relatively new to the island • Expectation that external assistance will be provided to fund/co-fund this project
Solar Home Systems (SHS)	• Would be a classic site for a basic electrification by individual solar home systems. Loads mainly consist of lighting and entertainment with some households demanding supply outside the evening hours. Superior from almost all viewpoints: • Technically simple • The SHS track record as a reliable technology for remote locations is proven in the South Pacific • No essential needs would remain unsatisfied • Reduces the risk of total loss of power significantly as compared to all central solutions (i.e. diversification of risks) • Involves the lowest economic cost under a variety of scenarios • Decentralizes power supply • No noise pollution • The elimination of the environmental impacts related to suboptimal handling of fuel and waste oil • A pilot project to test a different approach • Easy to move and the systems are a tradable commodity (i.e. individual systems are tradable units that can be relocated or sold should a user move or become unable to afford electricity)	• Would not provide the same level of service as compared with grid supply (but it will allow all users to satisfy their essential electricity needs) • Interaction between inverters and appliances such as VCRs may cause premature failure of inverters and appliances • Little institutional knowledge or commercial structure to support a project of this nature • PV technology is relatively new to the island • Power would be unavailable during occasional occurrences of extended periods of cloud • Expectation that external assistance will be provided to fund/co-fund this project

4.2 Environmental–energy linkages

4.2.1 Diesel generator

Fuel and lube oil handling: Currently diesel fuel and lube oil are transported to Apolima by small boats in drums. The supplies are stored close to the powerhouse. At present there is no storage compound to retain spillage or to enable recovery of spillage. Fuel is transferred from drums into the overhead tank supplying the diesel engine. There is no explicit procedure guiding response to any leakage or spillage. Some oil spilling has been observed around the powerhouse. It is mainly lube oil that leaks from the engine into the environment. Minor spills during fuel handling possibly add to the problem. The environmental impact of oil depends on the way in which exposure takes place. In the immediate vicinity of the oil spills, flora and fauna could be harmed or in the worst case destroyed. The adverse effects of long-term exposure of small amounts of oil are not so obvious. Oil causes severe damage to plants, the seeds and the normal micro flora in the soil. Oil-degrading bacteria also deplete oxygen and nutrients in the soil. Oil can contaminate surface water when it rains or it may penetrate through the soil into ground-water. As the residents of Apolima mainly use rainwater and water from an up-hill stream, there is probably no immediate danger for the population. It is likely that a portion of the oil spilled at the powerhouse eventually ends up in the coastal waters. Oil is toxic for animal and plant life in the water. The practice of burning waste oil-soaked rugs to dispose of the oil can contaminate both the air and the soil, since air impurities settle on vegetation and the soil. Combustion gases from burning waste oil may contain heavy metals, soot, carbon monoxide and various organic compounds. The safest disposal of waste oil produced in the electricity operations on Apolima is to collect the oil in drums and ship it to Apia for proper disposal or recycling.

Oil causes severe damage to plants, the seeds and the normal micro flora in the soil. Oil-degrading bacteria also deplete oxygen and nutrients in the soil.

***Other impacts of the diesel plant*:** Under the current operating conditions exhaust gases contain a proportion of smoke and carbon monoxide (CO) resulting from the suboptimal combustion of fuel. Other air pollutants include sulphur oxide (SOx), nitrous oxide (NOx) and carbon dioxide. Although higher than they could be, the quantities of emissions are equivalent to those of a small vehicle. Therefore they do not pose a local environmental problem (nor do they contribute in any significant way to global greenhouse gas accumulation). Due to the current location of the small powerhouse, noise pollution poses a problem for some of the residents whose houses are only 20 metres from the diesel generator. Relocation of the powerhouse and/or sound-proofing would mitigate this problem.

4.2.2 Solar electrification systems

Batteries: While recycling of lead-acid batteries is in principle a straightforward procedure, experience in solar electrification projects has shown that used batteries might be dumped on a beach, creating an eyesore and an environmental hazard. This becomes a concern particularly when low quality starter batteries (that need to be replaced frequently) are used. The undiluted waste acids (pH <2.0) pose a health hazard for people who come in direct contact with the electrolytes. Lead is a heavy metal that should not enter groundwater resources or the food chain. Assuming that high quality batteries are used that last up to eight years, this problem could be reduced substantially. The technician responsible for the project and/or the village leader should also make sure that batteries, when replaced, are sent to Apia for possible future recycling.

Space: Given that Apolima village is located in a narrow volcanic crater, the space required by a centralized solar system might be a problem. All centralized systems need a certain surface area that accommodates generation equipment, fuel and other supplies. Apart from requiring a powerhouse for the diesel generators, solar systems will use substantial space for the arrays. Per kWp power installed, a PV collector surface of approximately 7.5 m2 will be required for crystalline solar cells. The land area actually required would be approximately twice this surface given that the arrays must be well clear of vegetation. The clearance must be sufficient to avoid shading of the panels.

4.2.3 Climate change issues

Even though the current quantities of emissions are negligible, and thus contribute in no significant way to global greenhouse gas accumulation, the issue is at some level relevant for a Small Island Developing State (SIDS) like Samoa. In Samoa's First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) it is mentioned: "*The emissions of GHG in Samoa are relatively insignificant by world standards. Notwithstanding, Samoa is among the most vulnerable countries to the impacts of the greenhouse effect. It is ethical, therefore, that Samoa should recognize its obligation toward reducing GHG emissions".* It could be argued that since PICs such as Samoa have not caused the problem, they bear little responsibility for a solution under any reasonable scenario for future energy-use patterns. Global climate change will never be measurably affected by the insignificant impact of the PICs – the PIC emissions represented about 0.02 percent of total world carbon emissions in 1990. But SIDS may find it difficult to lobby effectively for global action unless they are themselves seen to take reasonable measures to progressively switch from fossil fuels to renewables (and reduce energy consumption). Therefore on the other hand, it could be argued that the PICs need to be jointly able to demonstrate that they are prepared to undertake the measures and activities that they are recommending to others (i.e. the developed countries as main emitters). This argument could be one of the reasons that the PICs in September/October 2002 agreed that they should work together to achieve a regional target of increasing the share of renewable energy to at least 15 percent of the primary energy supply by 2010.[47]

4.2.4 Natural disasters

It is possible that a cyclone might again destroy major parts of the village. Such an event would substantially damage any power supply infrastructure. For example, during cyclones the PV arrays are not only vulnerable to damage from dislodged palms and other debris, but they also provide a large surface area to be leveled by high winds. A solar array that becomes dislodged during a cyclone becomes a major hazard. Thus cyclone-proof racks and mountings have to be used.

4.3 Economic–energy linkages

4.3.1 Economic and financial issues

The financial performances of the realistic technology options (i.e. new centralized diesel, centralized solar, solar-diesel hybrid and SHS) are marginal even under the best of assumptions. None of the project configurations are "bankable" and can only be realized with considerable subsidies and/or donor contributions. A financial analysis would therefore not yield meaningful results, even if facilities such as carbon credits were taken into consideration. It is therefore more meaningful to analyse the potential for economic cost savings in the operation of Apolima electricity supply, which *inter alia* would avoid negative environmental impacts and maximize the contribution of the local community to the supply of electricity. It is not unusual that initial capital costs in rural electrification are subsidized in order to facilitate access to electricity for communities that would not otherwise be supplied under commercial terms. In such instances, economic rationale still prevails. There is always a least cost solution, i.e. a solution where a subsidy is provided in the most efficient way. Thus an approach that does not investigate the economic viability of a project but helps to find the solution that involves the lowest economic cost or the lowest subsidy required has been applied. From such a perspective distributed solar systems turn out to be the least cost option. Even if the fuel price is held constant in real terms, distributed solar power still remains the least cost solution. The second best solution is diesel including moderate DSM (30 percent savings) followed by diesel supplying the actual load. Central solar and solar hybrid are significantly more costly than diesel and distributed solar power. Thus power

It is therefore more meaningful to analyse the potential for economic cost savings in the operation of Apolima electricity supply, which inter alia would avoid negative environmental impacts and maximize the contribution of the local community to the supply of electricity.

47 Apparently the main reason was that the PICs need to work together to address some of the issues advocated by them, but not addressed adequately by the World Summit on Sustainable Development (WSSD). The WSSD discussed exactly to set "targets and timetables" for the adoption of renewable and other clean sources of energy including a proposal to ensure that renewable energy accounts for up to 15 percent of the global energy supply by 2010. This proposal was not agreed on. But a group of likeminded countries – led by the European Union – in their Joint Declaration agreed that they intend to go beyond the WSSD agreement reached in the area of renewable energy. Around 67 countries were behind this initiative. Of these countries 37 or more than 50 percent were SIDS.

supply in Apolima is a subsidized operation where the primary objective is not, it seems, to have been cost recovery *per se*, but to supply a remote community on social justice grounds (among others). This indicates that for small island electrification, factors other than capital O&M cost should form the basis for making the decision as to which technology to use. Environmental issues, economic activity issues, issues relating to reduction of economic and political dependence on fossil fuel imports and user[48] preference are all factors which need to be considered when making the technology decision.[49]

4.3.2 Income generation

With respect to the positive impacts from income generation, 24-hour supply is expected in the short term to have a small impact. Women have mentioned that the weaving of mats could be extended and potentially generate more short-term cash income. Weaving already occurs at night, often in poor kerosene light. Extended lighting will improve the conditions in which the women work, enable them to work longer hours when required with less eye strain and provide better conditions to ensure the quality of their work is maintained. In the medium and long term, the impact could be substantial via activities related to small-scale business (potentially tourism, fishing and small shops).

4.4 Social–energy linkages (including gender)

4.4.1 Stakeholder analysis

Multiple stakeholders and different points of view: Different stakeholders have different views with respect to problems encountered. Table 8-2 displays the major stakeholders together with some of their possible expectations and issues.

The EPC: In order to understand the EPC with regard to the Apolima operation, it is helpful to consider its scale relative to the entire EPC operation: while the Upolu island system supplies approx 7.5 million kWh per month, Apolima accounts for an average of 400 kWh.

The Government of Samoa: From the government's perspective the theme and focus of the current Strategic Development Plan (SDP) are opportunities for everyone, with the government intending to reduce tensions in society arising from actual and perceived inequities. To address this, the government remains convinced that strengthening family values and Samoa's social structure are key elements to achieving and maintaining social harmony, i.e. the benefits of development should be shared equitably across society.

Table 8-2: Major stakeholders and their expectations/issues

Stakeholder	Possible expectations	Possible issues
Power utility	• Reduction of technical and non-technical losses • Financially viable operation • Customer satisfaction	• Moral hazards created by defaulting customers • Subsidization of individual operations undermine viability
Government	• Environmentally sound operation • Operation in line with current legislation and policies • Social justice	• Political repercussions • Continuous subsidy for rural electrification
Villages	• Reliable 24-hour supply of electricity Low tariffs • No pollution of their environment • Support by EPC for their power supply • Being involved in the planning process for new supply	• Tariff increase • Strict implementation of disconnection policy • Loss of supply
Donors	• Economically viable projects • Environmentally sound, sustainable projects • Least cost solution	• Unexpected negative impacts (social, environmental) • Bad publicity

48 Review of the PREFACE Project – A Joint France/Australia Renewable Energy Programme, p. 7, 2002, by Mr Herbert Wade and co-workers.
49 Ibid.

Table 8-3: Ranked village development problems

Problem	Rank: Male	Rank: Female
Unreliable and inadequate sea transport to the island	1	2
No schooling for young children (classes 1+2)	3	1
Lack of medical care, infrequent visits by health workers	4	3
Lack of 24-hour electricity supply	2	5
Lack of income opportunities	5	4
Lack of hurricane shelter	6	6

Development priorities of the residents of Apolima: In order to assess the importance villagers attached to an extended electricity supply, the development priorities of Apolima were explored in consultation with the residents. Development priorities or problems mentioned by the villagers were also discussed with the village leaders in order to cross-check consistency of responses. Both male and female members of families were interviewed and women were given the opportunity to develop and discuss development priorities. Problems were identified and then ranked using a matrix ranking. The results of the ranking exercise are provided in *Table 8-3*, which shows the ranking of priorities separated by gender.

Although the ranking of development priorities seems rational, the results of qualitative surveys using participatory rural appraisal (PRA) toolss hould always be taken with some caution. What can be concluded with some degree of confidence is that a 24-hour electricity supply is probably not the first development priority. Reliable access/ transport and schooling for young children outrank it. Electricity supply also takes a different ranking across the two genders. It seems to be more important for men (who probably value entertainment by radio and TV/VCR) than women.

UNDP (Samoa): UNDP recognizes that Energy and Environment are essential for sustainable development and thus it is one of UNDP's corporate thematic focus/practice areas. With regard to energy, UNDP has four cooperate energy priority areas. These are as follows: (1) strengthening national policy frameworks to support energy for poverty reduction and sustainable development; (2) promoting rural energy services to support growth and equity; (3) promoting clean energy technologies for sustainable development; and (4) increasing access to investment financing for sustainable development. With this overall level in mind, the Apolima Project in particular should be seen in the context of priority areas (2) and (3). In the Country Programme Outline (CPO) for Samoa (2003–2007) it is stated that UNDP's interventions will concentrate on three main streams of input that support the Strategy for the Development of Samoa (2002–2004) and the United Nations Development Assistance Framework (2003–2007) with strategic areas of focus and associated goals. One of these three main streams of input is Sustainable Management of Natural Resources. Here the goal is to assist in obtaining sustainable environmental management and energy development to improve the livelihoods and security of the poor. *Inter alia*, this is to be achieved through institutional frameworks for sustainable environmental management and energy development. Regarding the results and resources framework the objective is to improve natural resource management and promote environmental sustainability. One of the outputs is that renewable energy is integrated into the national development agenda.

4.4.2 Social impacts of 24-hour power supply

It is difficult to assess social impacts from extending the service hours of electricity supply. Firstly, it is unlikely that this change would have any dramatic effects on the social structure or on the life of particular groups. It should be noted that most of Samoa's rural population does have 24-hour supply and there is no indication of this electrification having significant negative effects. An extended electricity supply using the existing diesel would of course extend socially disruptive noise into the night hours. In terms of affordability, there seems to be no problem. The incomes stated by the families are comparatively high and expenditures for energy services would require less than 10 percent of the households' incomes under the demand scenario for extended supply hours.

4.4.3 Migration

With respect to the risk of regular out-migration, any centralized power supply system would be most vulnerable to a decline in demand triggered by loss of population. Distributed solar electrification on the other hand is easy to move and the systems are a tradable commodity.

4.4.4 Payment of electricity

Some of the metered consumers are in arrears. Any intervention in the Apolima electricity supply should therefore include an effort to secure payment for electricity used. Prepaid metering could possibly be an appropriate solution. The EPC already runs a successful trial with 30 pre-paid meters on Upolu using the "cash power" system. This system is based on a numerical code that is generated by a central computer. The code is bought by the individual consumer and entered into a keypad on the meter that registers the credits bought and dispenses electricity accordingly. Introducing "cash power" meters would only require the purchase of additional meters. All other systems are already in place at the EPC and EPC staff are familiar with the system.

4.5 Governance-energy linkages

4.5.1 National development planning

Such a project should obviously be seen within the context of Samoan government development plans and programmes for the power sector. Future electrification projects should aim at consistency with the central government development plans. Highlights of plans for both the SDP and the EPC Corporate Plan are provided below. They underscore that rural electrification in general and the provision of improved infrastructure should be compatible with general development objectives. In recent years the government has taken substantial steps to tackle weaknesses in the energy sector in general and the electricity sector in particular. Currently a National Energy Policy is not available, but one is currently being prepared.

The Strategic Development Plan Seven: Development activities in Samoa are currently guided by the Strategic Development Plan (SDP) Seven that covers the period 2002 to 2004.[50] This plan lists nine key strategic outcomes. Two of these outcomes are relevant to development of the power sector and are considered relevant to the planned project on Apolima. These are:

- Access to safe, efficient and reliable infrastructure and services (water, electricity, telecommunications, transport) is important for an improved quality of life. The government will aim to provide efficient and effective infrastructure and services not only to the town areas but also to the rural and remote areas of Samoa.

- Continuation of the public sector reform programme has a high priority as a key strategic outcome. The government believes much still remains to be done in enhancing the efficiency and effectiveness of the public sector, including Public Bodies. This is an essential component for further strengthening the enabling environment and building confidence for private sector investment and development, translating into further employment creation.

Access to safe, efficient and reliable infrastructure and services (water, electricity, telecommunications, transport) is important for an improved quality of life.

The electricity sector is specifically mentioned under the infrastructure development programme. The SDP states: "Considerable investment has been directed to building the infrastructure services necessary to support the achievement of the key strategic outcomes. In the next three years, government will concentrate on improving asset management through upgrading the management efficiency of the relevant agencies. To this end, institutional strengthening efforts have commenced for the EPC, Public Works Department (PWD) and SWA." For the electricity sector the SDP specifically demands: "The Corporate Plan and Business Plan now in place will guide the work of the Corporation towards achieving its goals. It will also instill commercial discipline in its operation. Part of the plan includes the creation of a Customer Relations Section focusing on enhancing customer services. The EPC will also review its tariff structure to improve its financial viability. The plan is expected to improve the Corporation's management and operational efficiency." In addition the SDP states that the

50 The SDP was developed in close consultation with all stakeholders including village communities. This, of course, is at the core of good governance.

rural electrification programme will continue and it can be expected that full national coverage will be achieved soon. These strategy guidelines clearly set the scene for projects in the electricity sector. While improvements and expansion of infrastructure services are considered essential, the policy focus is on public sector reform, improvements in management efficiency, operational effectiveness and financial viability of the utilities.

4.5.2 The EPC Corporate Plan

The EPC's role and functions are clearly defined in the Electric Power Corporation Act of 1980 and its various Amendments. Accordingly, the EPC is the sole provider of electricity in Samoa and as such an essential part of the economy. Following the strategic guidelines of the government, the EPC developed its first corporate plan in March 2000. Although the plan nominally covers the period 2000 to 2002 it has not yet been updated and is still considered the relevant guideline for managing the EPC's operation. The plan "sets the framework for rigorous, output-oriented, customer focused performance, management and evaluation". It is based on 12 assumptions some of which can also be considered as outputs as they are under the control of the EPC. (i.e. the EPC will become financially viable, services of the EPC will improve, management will be responsible for decisions). As far as this project is concerned, the plan commits the EPC to implement cost-effective engineering solutions, to make prudent investments and to conduct safe installations. The plan also emphasizes the reduction of losses and the importance of ensuring that revenues are collected.

The policy focus is on public sector reform, improvements in management efficiency, operational effectiveness and financial viability of the utilities.

4.5.3 Institutional linkages

At present, Apolima electricity supply forms part of the EPC's rural electrification programme. As such the island is treated like any other village. Meter reading and billing follow standard EPC procedures. This also implies that customers have to pay their electricity bills in Apia.[51]

The EPC as an implementing agency: Implementing a project through the EPC would be in line with the utility's mandate. In principle there would be a continuation of the past institutional arrangement, perhaps with some minor changes. However EPC senior staff have indicated that suggestions on alternative institutional arrangements could be openly appraised. The EPC seems willing to consider outsourcing the operation as long as operational safety and EPC electrification standards are maintained. This opens up an opportunity for a community-based project as discussed below.

Implementation by the community: In recent years, community-based, decentralized rural electrification projects have become a common feature in many countries. These concepts aim at community empowerment, i.e. project management by the community is intended to contribute to greater community self-reliance, problem-solving and project management skills. It is also supposed to improve the payment of monthly fees by ensuring the accountability of beneficiaries to the community and, if designed in a sensitive manner, community management could improve the overall management of the technical systems, and relationships between participants. Such an approach requires community mobilization, i.e. a process by which communities are facilitated to unite to achieve collective goals, support the project and participate in its implementation. Participatory methodologies are generally used to facilitate the community mobilization process. While community-based projects exist in other sectors in Samoa, the concept has not yet been used in the electrification field where the EPC's grid extension policy has provided power to more than 95 percent of the population. The possibility of handing the electrification scheme over to the community has been discussed with the leaders and family heads in Apolima. While the concept was not completely discarded by the villagers, a clear preference was expressed for the EPC to remain in charge of the operation. Handing over an electricity supply to the community of Apolima is nevertheless considered as an option that would be in line with the current policy of the government to enhance self-reliance. A more realistic solution could be to hand day-to-day operation and revenue collection to the community with the EPC

51 The residents of Apolima consider this procedure cumbersome and offering the customers an easier way to pay their bills might help to reduce arrears.

providing technical back up. Again, there is a need to enhance and strengthen the capacities of the community to manage their own power supply. As such this should be an integral component of the project. Further, well-defined roles and responsibilities between the stakeholders concerned should be clearly identified.

4.6 Replication–energy linkages

The proposed solar energy project could have a high profile in Samoa, as it would depart from the conventional approach taken by the EPC in the past. It would be designed for ease of replication in other communities, mainly in Savaii. The distributed solar option has thus far, not been a mainstream solution in Samoa. As a consequence there is little institutional knowledge nor a commercial structure to support a project of this nature. On the other hand, this could be taken as an argument in favour of a renewable energy solution. As pressure increases on the EPC to become more efficient and a commercially viable provider of electricity, the utility may want to learn about feasible options to separate subsidized parts of its operation, use technologies that are better adopted to low load densities and maybe hand over remote, rural electricity supply operations to the benefiting communities. Thus a pilot project to test a different approach might be welcome. While the main island of Upolu is nearly fully electrified based on grid extension, the distributed solar systems could potentially offer an economically and financially attractive solution for significant parts of the other main island of Savaii. A pilot project might help to understand the technology.

5. Lessons learned

Listed hereunder are some of the tentative lessons the UNDP Country Office in Samoa learned during the preparation of this project and case study:

a) Even in a very small and well-defined context (e.g. like a small island community) many energy cross-sector linkages and issues are present and therefore sustainable energy interventions are complex, no matter the scale of intervention.

b) This implies further that a holistic approach to the design and formulation of the actual project of course is optimal, but at the same time it is unrealistic in most projects and programme contexts to set out to cover and address "everything". Thus at some point there must be a choice by the stakeholders involved on which cross-sector linkages and issues have priority and therefore can and/or should be addressed in a particular project.

Apolima Island: in the village

c) On the other hand the cross-sector linkage(s) and issue(s) that are given priority and thus become part of the project focus will depend on the specific project context (e.g. scale, culture), points of view (e.g. the recipients, donors, governments, utility in question, etc) and specific time period (e.g. prevailing schools of thought/paradigms).

d) For many cases of small island electrification in the Pacific, linkages other than energy-economy will form the basis for deciding on which technology to use: social-energy, technical-energy and environmental-energy are all factors, which need to be considered when making the decision regarding energy form, technology, institutional set-up, etc.

6. Post-case study follow up

Hereunder is specified tentatively how this case study is applicable to the programming and policy work in the UNDP Country Office in Samoa:

a) There is a need to apply holistic approaches to the design and formulation of actual projects to ensure cross-linkages and synergies are reflected and that relevant practices of the UNDP are formed.

b) There is a need for increased knowledge and capacity building in the area of energy cross-sector linkages.

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