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AUGMENTING GROSS NATIONAL HAPPINESS IN A REMOTE BHUTAN COMMUNITY: COMMUNITY-BASED MICRO-HYDRO FOR LIVELIHOODS ENHANCEMENT

Towards an 'Energy Plus' approach for the poor: A review of good practices and lessons learned from Asia and the Pacific

Case Study 13

ENVIRONMENT AND ENERGY

We would like to take this opportunity to recognize the partners who have made financial and other contributions to the energy sector project described in this report. These include the Department of Energy and the Gross National Happiness Commission of Bhutan, the Sengor Micro-hydropower Management Committee and the Global Environment Facility (GEF). In addition, the project would not have been possible without the co-operation and the contribution of the Government of Bhutan and the Sengor community.

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Cover photo courtesy of UNDP/Energy Access for Poverty Reduction

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Acronyms

APRC	Asia-Pacific Regional Centre
BDFCL	Bhutan Development Finance Corporation Limited
BPC	Bhutan Power Corporation
BTN	Bhutanese ngultrum (currency)
CCF	Community Collateral Fund
CDM	Clean Development Mechanism
CO_2	carbon dioxide
DoE	Department of Energy
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GNH	Gross National Happiness
km^2	square kilometre
kW	kilowatt
kWh	kilowatt hour
LPG	liquefied petroleum gas
MDG	Millennium Development Goal
MHP	micro-hydro plant
MoEA	Ministry of Economic Affairs
MW	megawatt
O&M	operations and maintenance
RGoB	Royal Government of Bhutan
SCMHDO	Sengor Community Micro-hydro Demonstration Organization
SME	small and medium enterprises
SPV	solar photovoltaic
UNDP	United Nations Development Programme
USD	United States dollar (currency)

Synopsis

Project title: Community Micro-Hydro for Sustainable Livelihoods

Country and region of implementation: Village of Sengor, located 370 km from the capital city of Thimphu, the Kingdom of Bhutan

Focus area (technology/energy service): Piloting improved cookstoves, biogas plants and solar photovoltaic panels in rural areas

Contact details:
Mewang Gyeltshen
Chief Engineer
Department of Renewable Energy
Ministry of Economic Affairs
Thimphu, Bhutan
Tel: +975 233 4741
Fax: +975 232 4676
Email: m.gyeltshen@gmail.com

Karma Rapten
Assistant Resident Representative
Energy, Environment and Disaster Management, UNDP Bhutan
Thimphu, Bhutan
Tel. + 975 232 2424
Fax: +975 232 8526/2657

Duration: August 2005–June 2009

Cost: USD 1,090,000

Project brief: The micro-hydro project in Sengor village (Bhutan) has provided electricity to 57 remote community households. The success of the project can be attributed to the following components:

- community capacity-building;
- a focus on productive uses of energy;
- coordinated efforts by various local-level agencies; and
- the development of guidelines and manuals, which were subsequently used in the design of a national micro-hydro policy.

Lessons learned and best practices from the project are informing Bhutan's efforts to electrify remote communities not connected to the national grid. The project was in line with Bhutan's 2020 Vision of environmentally sustainable and equitable socio-economic development, which is promoted by the Royal Government of Bhutan through the Gross National Happiness philosophy. The project's model has proven effective, and consequently the Government is embarking on two similar projects in other remote areas.

Acknowledgements

Augmenting Gross National Happiness in a remote Bhutan community: Community-based micro-hydro for livelihoods enhancement is one of 17 case studies which, together with a report titled 'Towards an 'Energy Plus' approach for the poor: A review of good practices and lessons learned from Asia and the Pacific' and an Action Agenda Note, comprise a review of good practices and lessons learned in energy service delivery to the poor. Commissioned and facilitated by the United Nations Development Programme Asia-Pacific Regional Centre (UNDP APRC), this case study identifies key characteristics that have helped poor households and communities gain access to modern energy services, and to derive valuable lessons for future energy access activities. This case study is the product of an intensive collaborative process and we wish to acknowledge the many contributors, without whose generous support this work would have been impossible.

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Martin Krause
Team Leader
Environment & Energy
UNDP Asia-Pacific

Preface

Asia-Pacific has achieved remarkable economic growth and socio-political progress in the past two decades, with almost every country in the region experiencing a concomitant decline in poverty.

Despite this progress, 800 million people in the region remain without access to electricity and almost 2 billion rely on the traditional use of biomass for cooking. In Bhutan, only 57.1 percent of households have access to electricity. The high cost of extending the national grid to mountainous terrain has denied access to a large percentage of the rural population. However, the Royal Government of Bhutan is committed to finding solutions for universal electricity access by 2013. Fuel wood remains the main source of energy for cooking and heating in rural areas, where majority of the population lives.

The poor often live in subsistence economies that do not generate cash surpluses, limiting their purchasing power and opportunities to shift to modern energy services. As a result, they have to invest more of their income and time in obtaining energy, and tend to use traditional energy services and fuels. Women and children are particularly affected, spending many hours a day collecting fuelwood and preparing meals in the kitchen. Smoke from inefficient stoves in poorly ventilated homes kills 1.6 million people worldwide every year; the majority of victims are women and children younger than five years. Indoor air pollution is the fourth-biggest killer in the developing world.

Asia-Pacific countries have applied many cutting-edge practices in providing energy access to the poor, including innovative financing mechanisms. Apart from satisfying basic needs, energy services can act as an instrument to empower women and disadvantaged communities; as an entry point to mobilize communities to take charge of their own development; and, most importantly, as a means to livelihood enhancement and poverty reduction. However, the scale of expansion of energy access projects has been far from sufficient.

UNDP has been working with its country partners to address these energy poverty issues, aiming to meet user needs, broaden energy supply options and link these efforts in achieving the Millennium Development Goals. Between 2009 and 2011, the UNDP APRC reviewed 17 energy access programmes and projects implemented by various development agencies and the private sector in the region. These projects were documented as 17 case studies (including this report), a report titled 'Towards an 'Energy Plus' approach for the poor: A review of good practices and lessons learned from Asia and the Pacific' and an Action Agenda Note. Together, these documents provide practical guidance for policymakers and development practitioners in designing and implementing future programmes and projects that ensure the delivery of low emission, affordable and reliable energy services for poverty reduction.

This case study documents a successful community-based micro-hydro project that provided electricity to households in a remote village in Bhutan. The project has had a significant impact on the livelihoods of the community members, has supported income-generating activities through a community-managed Community Collateral Fund, and has contributed to the development of the national micro-hydro policy.

Nicholas Rosellini
Deputy Assistant Administrator & Deputy Regional Director
Regional Bureau for Asia and the Pacific

1. Background

The Kingdom of Bhutan lies in the eastern Himalayas, bordered by the Republic of India and the People's Republic of China. Bhutan has a land area of 38,394 km^2 and a population of 708,427.[1] In March 2008, following successful elections to the country's first democratically elected Parliament, Bhutan became a democracy. The transition to democracy started in the early 1980s, when the Fourth King Jigme Singye Wangchuck introduced decentralization and local governance with the establishment of district and block development committees. Successive governments have since promoted decentralization with the twin goals of empowering people and ensuring balanced, equitable and sustainable socio-economic development.

In 2010, Bhutan's gross domestic product (GDP) was USD 1.412 billion, with an average annual growth rate of 6.1 percent over the 2008-2010 period. The major sectors are industry (45 percent of GDP in 2010), services (37.6 percent) and agriculture (17.4 percent).[2] Given growing investment in infrastructure (including housing and hydro power plants) and an improved service sector, the economy is expected to show steady growth in the years to come. The electricity sub-sector is also expected to grow, with a number of hydro power plants in the pipeline.

Promoting its Gross National Happiness (GNH) philosophy, the Royal Government of Bhutan (RGoB) has invested heavily in human development, focusing on improving health (through better access to quality health care) and educational facilities.[3] Despite significant progress in poverty reduction, the 2007 UNDP-assisted Bhutan Living Standard Survey reported that an estimated 23.2 percent of the population were poor. Rural poverty is prevalent (particularly in remote areas) and resulting in rapid rural-urban migration. The RGoB aims to reduce poverty to 15 percent by the end of the 10th Five-Year Plan (2013).[4]

1.1 Energy sector overview

Bhutan's energy sector is administered by the Ministry of Agriculture and the Ministry of Economic Affairs (MoEA). The former administers biomass, while the latter deals with conventional energy, alternative energy and fossil fuel imports.

Bhutan has an estimated hydro power potential of 30,000 MW, of which 23,760 MW has so far been identified and assessed as technically feasible. Most identified schemes are run-of-the-river type, with minimal environmental impact. Currently installed hydroelectrical power capacity amounts to approximately 1,488 MW, with a large portion of the generated electricity exported to India.[5] Hydro power development presents a major avenue to sustainable development, and hydroelectricity is the single largest sector of the economy (22 percent of GDP in 2010).[6]

No policy framework currently exists for the energy sector as a whole. A renewable energy policy was drafted in 2007 with support from UNDP, but is yet to be finalized. This policy focuses on accelerating the development of decentralized micro-hydro power and solar photovoltaic (SPV) home systems for rural off-grid communities. The policy aims to contribute to the attainment of Bhutan's 2020 Vision (specifically, its goals of "balanced and equitable socio-economic development" and "environmentally sustainable development").[7]

1.2 Electricity access

Electrification status and targets. Although the country generates surplus power, the high cost of extending the national grid to mountainous regions has denied energy access to a large percentage of the rural population. Currently, 57.1 percent of households in Bhutan have access to electricity. The RGoB has made 100 percent electrification a priority for the energy sector. The 2005 Rural Electrification Master Plan aimed to electrify 50 percent of rural households by 2012 and 100 percent by 2020. The 100 percent target has since been advanced to 2013 by the RGoB.

1 Central Intelligence Agency, 2011.

2 Central Intelligence Agency, 2011.

3 GNH, a concept originating with the Fourth King, attempts to provide a quantitative measurement of the well-being and happiness of a society.

4 National Statistical Bureau, 2007.

5 UNDP-DoE, 2008.

6 Asian Development Bank, 2010.

7 Planning Commission, 1999.

Challenges to electrification. The biggest challenge to energy infrastructure development is Bhutan's largely mountainous topography, with people living in scattered, remote and often inaccessible settlements. The Rural Electrification Master Plan involves extending power lines from the transmission grid to 88 percent of households and installing renewable energy systems in off-grid areas (the remaining 12 percent). The on-grid electrification programme for the 29,340 households to be connected is expected to cost USD 71.3 million.

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Construction of transmission lines.

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Construction of a penstock leading to the power house.

1.3 Micro-hydro electrification

Innovative strategies for decentralized electrification are needed to serve the 12 percent of rural households that need off-grid solutions. So far, 24 mini- and micro-hydro plants (MHPs) have been installed in off-grid areas, their sizes ranging from 8 kW to 200 kW. Installed capacity totals about 1,320 kW, serving 1,700-1,800 households. Sixteen of these plants are operational.

The primary focus of these projects has been on installation, with little consideration given to links to income generation, productive uses of electricity and community roles in operation and maintenance (O&M). Most MHPs are funded through a full capital subsidy, and inadequate tariff mechanisms do not cover operational costs. Thus several MHP systems, with limited economic, financial and technical sustainability, are not delivering the intended energy services.

Barriers to expanding energy access through mini- and micro-hydro power are described below.

Policy barriers. Hydroelectric power is a major source of revenue for Bhutan, and large hydroelectric projects are built mainly to generate electricity for export. The 1994 Hydropower Master Plan targets large hydro power projects (over 5 MW); no consolidated plan currently exists for off-grid MHPs. As a result, the development of the small hydro power sector has been erratic and dependent on *ad hoc* donor interest. The Electricity Act of 2001 encourages the private sector to engage in off-grid power generation, but the implementing rules and regulations are not yet in place.

Insufficient publicity. Neither rural communities nor the private sector are adequately aware of the RGoB electrification programme. Nor do they recognize the potential of micro-hydro power or understand much about its productive uses.

Underdeveloped private sector in mini- and micro-hydro. In Bhutan, no private or cooperative entities are involved in the electricity sector. Reasons for this include a lack of an appropriate legal and regulatory framework allowing private-sector involvement, the small size of Bhutan's industrial sector and a lack of financing.

A lack of technical capacity. Remote areas lack local capacity to manufacture, repair and maintain MHP equipment. Currently, all electro-mechanical parts are imported through turnkey assignments, while local companies are only entrusted with civil works. This lack of capacity has prevented immediate repairs in existing systems, rendering many of them dysfunctional. At the national level, there is a lack of capacity to design, evaluate and implement MHP projects, and to conduct hydro resource assessments and feasibility studies.

A lack of financing. Currently, the price of grid electricity for households is heavily subsidized. Consequently, the Bhutan Power Corporation (BPC, the national utility) is struggling to finance its existing power infrastructure, let alone the electrification of new and remote off-grid areas. No private or cooperative entities are involved in the power sector, and self-sustaining finance mechanisms at the user level are yet to be seriously explored.

2. Project overview

Implementation arrangements. The Community Micro-hydro for Sustainable Livelihoods project was executed by the Department of Energy (DoE) of the MoEA. UNDP Bhutan and the GNH Commission conducted project implementation oversight. The Sengor Micro-hydropower Management Committee, established by the project at the village level, is responsible for local management tasks.

Goals and activities. The project sought to provide electricity to the Sengor community by constructing a 100 kW MHP. It also sought to encourage the Sengor community to use the electricity to establish rural enterprises and generate income. The overall goals of the project were to improve the socio-economic status of the Sengor community (through enhanced livelihoods and poverty alleviation) and reduce greenhouse gas (GHG) emissions from fossil fuel-fired power generation. The project also aimed to develop a model policy framework for community-based energy services and a viable community micro-hydro delivery model.

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Inauguration of the MHP.

Funding and timing. The project was funded through a consortium of the Global Environment Facility (GEF), the RGoB and the local community. The total budget was USD 1,090,000. In kind contributions from the RGoB and local community came to USD 210,000, or roughly 19.2 percent of the total budget. The project commenced in August 2005 and finished in June 2009.[8]

Project site profile. The project was implemented in Sengor (Mongar District), a village lying 370 km from the capital city of Thimphu at an altitude of almost 3,000 metres above sea level. Sengor has a population of 278 and is located within the core zone of Thrumshingla National Park.

Sengor has 57 households, consisting of:

- 25 domestic households;
- 13 commercial/institutional establishments, including a temple, shops, hotels and offices;
- 15 households belonging to staff working in the Community School, National Work Force, Department of Roads, etc.;
- a rice mill;
- a school;
- a dormitory for the children of National Work Force staff (attending the Sengor school); and
- a milk processing unit.

Sengor is a mixed farming community; the main source of income is the sale of livestock products including butter, cheese and milk. Weaving and carpentry are the most common skills among women and men, respectively.

Grid electricity has not been extended to Sengor village (and is not likely to be) for two reasons: it lies in the core zone of a national park; and the cost of grid extension in this mountainous region is prohibitively high. Sengor lies within the Saleng *gewog*, which is to be electrified through SPV systems under the Rural Electrification Master Plan.[9]

[8] Completion was originally planned for 2008, but had to be rescheduled due to delays.

[9] A *gewog* is an administrative block of several villages.

Prior to the project, households used a range of energy equipment including traditional stoves, diesel generators and SPV systems (see Table 1). Fuelwood was the main source of energy for cooking, lighting and heating. Free fuelwood supplied by the RGoB was not sufficient, meaning that women and children had to collect fuelwood from surrounding forests; this burden was greatest during winter, when men left for lowland grazing pastures with milch cattle.

Table 1: Energy-fuelled equipment used in Sengor prior to the MHP project (2006)

Equipment	No. of units
Radio/tape recorder	41
Bukhari[10]	40
Kerosene lamp	38
LPG stove	34
Diesel generator	13
Television	8
Traditional stove	8
SPV system	7
Water boiler	5
Smokeless stove	2

Apart from fuelwood, energy sources used included liquefied petroleum gas (LPG) and kerosene for cooking, and diesel generators, SPV lighting and dry cells for lighting. The lack of electricity meant that appliances such as rice cookers and refrigerators were not used.

3. Implementation strategy

3.1 Constructing the MHP

The project's primary output was the construction of a 100 kW MHP. A joint-venture company was awarded a turnkey contract for complete design, equipment supply, construction, testing and commissioning. The plant was completed on 8 May 2007, and officially handed over to the community on 14 February 2009. After the plant was commissioned, a feasibility study on community-based rural enterprises utilizing surplus energy from the plant was conducted by the DoE.

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Construction of the intake reservoir.

3.2 Creating a local institutional structure

To ensure that the MHP was managed by the community, a Sengor Community Micro-hydro Demonstration Organization (SCMHDO) was established. Sengor's livestock community-based organization was also entrusted with responsibility for the MHP, thereby integrating the SCMHDO into the existing institutional arrangements.

[10] *Bukhari* is a metal stove for heating.

The SCMHDO's primary role is monitoring day-to-day operations of the MHP. It is guided by a Steering Committee headed by the district Administrator, an Advisory Committee with representation from the DoE, and a Community Development Committee headed by a village representative. SCMHDO operations are governed according to community mobilization guidelines; the latter emphasize the involvement of the local community in MHP planning, design, implementation and management, and electricity-based income generation.

To promote MHP sustainability, USD 25,000 was provided as O&M seed money in the community's account.

In accordance with the project plan, the DoE, in collaboration with the BPC, conducts periodic technical checks and provides back-up support in case of major damages to the MHP.

3.3 Establishing the tariff structure

The BPC tariff structure and the expected recurring costs of the MHP (including O&M costs and depreciation of MHP assets) provided the basis for the MHP tariffs. Because the BPC tariff is highly subsidized, the Sengor MHP charges a higher tariff (see Table 2).[11] The minimum monthly energy bill is BTN 30 (USD 0.61), and consumers pay an additional BTN 30 per month to meet O&M costs.[12]

Table 2: Tariff structure for Sengor MHP

Energy consumption range	Rate per kWh (BTN)
1-50 kWh	1.10
50-100 kWh	1.20
Above 100 kWh	0.30

The community is fully aware of the BPC rates, but have nonetheless opted to pay the higher tariffs. This comes from a realization that, since Sengor is located within a national park, it is highly unlikely that the grid will be extended to the village. Furthermore, with the use of the MHP, the community has been able to reduce its overall expenditure on energy (as discussed in Section 4.1).

3.4 Encouraging productive uses of electricity

To provide loans to villagers for income generation and enterprise development, the project established a Community Collateral Fund (CCF) and provided a start-up sum of USD 50,000. The CCF is managed by Bhutan Development Finance Corporation Limited (BDFCL), a banking institution. Guidelines for the use of the CCF have been formulated and disseminated to the Sengor community, the district administration and the BDFCL.

In essence, the BDFCL provides loan facilities to villagers against the CCF as collateral. The maximum duration of a non-performing loan is 360 days, after which the BDFCL can recover the loan from the CCF at 70 percent on the balance of the loan outstanding. The remaining 30 percent is then written off by the BDFCL. The BDFCL branch in Mongar also provides necessary administrative assistance to the community, including a field officer for collection of instalments, disbursements and loan approvals. Aside from managing the CCF, the BDFCL conducted 'Group Guarantee Lending and Saving Scheme' training for the Sengor community.

To further encourage enterprise development, the project conducted training programmes on poultry farming, vegetable production, tourism and hotel management. The programmes were informed by community consultations (also conducted by the project). The project brought together several other institutions in this development effort, including the Thrimshungla National Park Authority, Regional Agriculture Marketing Services and the Ministry of Agriculture.

[11] In comparison, BPC tariff structure charges a rate of BTN 0.75 for 0-80 kWh consumption range, BTN 1.40 for 81-300 kWh and BTN 1.85 for consumption above 300 kWh.

[12] BTN 1 = USD 0.02017, as of 23 September 2011 (www.xe.com).

Other organizations are also promoting productive uses of electricity in Sengor. For example:

- the Bhutan Tourism Council conducted basic hotel and tourism management training for local hoteliers and the community. Objectives included encouraging more professional ways of managing community tourism, improving the quality of food and services, conserving energy, and protecting the environment from the impacts of tourism; and
- with EU assistance, the Department of Livestock helped the Sengor community establish a community-owned milk processing unit and marketing infrastructure facilities for dairy products.

3.5 Developing local capacity

To assist the Sengor community in operating and managing the MHP, two community representatives received training in MHP O&M.[13]

A team from Sengor, including DoE representatives, undertook a study tour to Nepal and the Republic of the Philippines to share experiences in community-based micro-hydro power development policies, MHP management and O&M, electricity-based enterprises and income generation.

4. Impacts

Since May 2007, the project has provided electricity to all 57 households of the wider Sengor community. The project's contributions to Bhutan's achievement of Millennium Development Goals (MDGs) are described below.

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A restaurant reaping the benefits of electricity.

4.1 Impacts on income and livelihoods (MDG 1)

Following Sengor's electrification, a survey revealed that the annual average income of a local household had increased from BTN 85,548 in 2006 to BTN 94,216 in 2008 (a 10 percent increase). This can be attributed to the following factors.

Savings in fuel use, time and human energy. Following electrification, Sengor's use of other sources of energy was reduced significantly, as shown in Table 3. Access to electricity and the use of appliances such as rice cookers has drastically reduced the use of fuelwood, and consequently time and effort spent collecting it.

New enterprises and livelihoods enhancement. Since electrification, Sengor has experienced an inflow of enterprises from non-electrified areas, including a hotel from the nearby Gazamchu village. With electricity, hoteliers and shopkeepers are able to provide better services to customers, including cleaner rooms and kitchens, hot food, and fresh cheese and butter. These services make them more competitive with other hotels and shops on the nearby highway, while also reducing fuelwood expenses and saving time.

In regards to the use of the CCF, the progress has been slow. Two loan applications have been approved to date: one for establishing a poultry farm, and another for starting a cable television business. A water distillery is currently in the planning stage.

The Department of Livestock has established a community-owned milk processing unit and marketing facilities for dairy products, which has increased income from dairying and employment for local people.

[13] The training was conducted in Bhutan and Nepal.

Table 3: Annual energy use in Sengor before and after the MHP project

Energy source	Consumption before MHP (2006)	Consumption after MHP (2008)	Consumption reduction (%)
Fuelwood in winter			
– back-loads	11,835	0	100
– truck-loads	26	13	50
Fuelwood in summer			
– back-loads	6,235	0	100
– truck-loads	16	7	56.3
LPG (no. of cylinders)	133	89	33.1
Kerosene (litres)	4,503	1,105	75.5
High-speed diesel (litres)	1,250	0	100
Candles (nos.)	10,044	339	96.7
Dry-cell batteries (pairs)	2,739	741	72.9
SPV (light points)	10	0	100

4.2 Impacts on education and health (MDGs 2 and 4)

Educational benefits. Parents and school teachers have reported that study hours had increased from one to two hours in 2006 to 2.5 hours in 2008. Furthermore, children had previously studied by the light of candles or kerosene lamps, which adversely affected their eyes; with electricity, they enjoy a safer and more effective study environment. Children are also no longer required to assist their mothers with fuelwood collection.

Health benefits. Sengor's Basic Health Unit can now provide services at night, and has a refrigerator for storing vaccines and medicines. The Sengor community has also begun using electricity to boil drinking water, with 55 percent of households now owning water boilers.

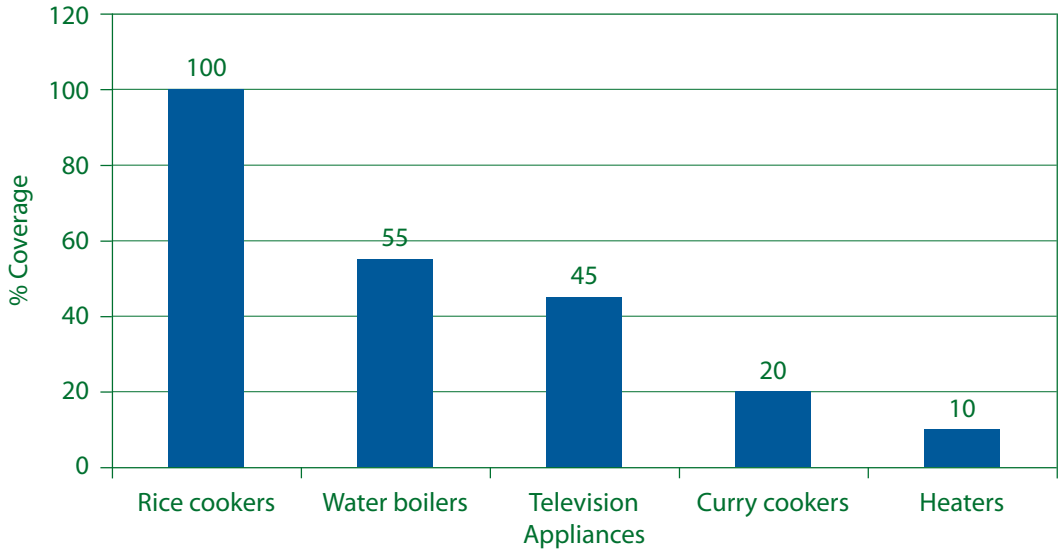
4.3 Impacts on gender equality and women's empowerment (MDG 3)

Extended educational opportunities. In Sengor, as in other villages, the Ministry of Education provides informal education to women and men. These classes are conducted after school hours; with access to electricity, they have been extended into late evenings.

Improved communications and information services. Sengor's electrification has allowed many households to install telephones, and Bhutan Telecom (Bhutan's telecommunications utility) has extended its mobile telephone coverage to the village. The introduction of televisions helps women to keep abreast of national and international affairs.

Improved health. Prior to electrification, women used inefficient traditional stoves that led to respiratory and eye problems. Electrification has resulted in 100 percent of households using electrical rice cookers, and over 50 percent using water boilers (see Figure 1). These appliances have eliminated smoke and fumes in the kitchen, improving health levels.

Figure 1: Percentage of Sengor households with electrical appliances (2008)



More disposable time. Since the above-mentioned cooking devices do not need constant supervision, they have freed women's time for other pursuits such as weaving. The burden of gathering firewood imposed on women and children has also been radically reduced.

4.4 Environmental sustainability (MDG 7)

GHG emissions reduced. In its first year of operation, the Sengor MHP produced 58,479 kWh of electricity. This substitution for the previously-used fossil fuels and wood equates to an annual reduction of 52.6 tonnes of CO_2 emissions.[14]

Reduced pressure on forests. As mentioned above, Sengor is located in the core zone of the Thrumshingla National Park. Since all households now use electricity for cooking, the local demand for fuelwood has been greatly reduced. Consequently, the park has been able to reduce Sengor's annual quota of wood from two to one truckload per household, reducing pressure on the forest.

5. Project sustainability

5.1 Sustainability measures

From the outset, the project sought to institute measures to ensure long-term sustainability of the MHP. These have included:

- establishing the SCMHDO, a community development organization, to monitor day-to-day MHP operations;
- training community MHP operators;
- providing community seed money (USD 25,000) for MHP O&M;
- providing community training for income-generating activities;

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The power house.

[14] This calculation is based on a study of the Chendebji MHP (Trongsa, Bhutan), which found that 1 kWh of electricity from an MHP replaces 0.9 tonnes of CO_2 (Department of Energy, 2008).

- establishing the CCF to finance income-generating activities; and
- arranging for DoE back-up O&M support after project completion.

The SCMHDO-DoE arrangements demonstrated their effectiveness in May 2009, when heavy rains damaged the MHP structures and left the community without electricity. Fortunately, the flood did not affect the power house, and the community managed to restore electricity within three days. In the case of a BPC-managed plant, the repairs would have required an assessment visit by a technician and a contractor from Thimpu, and hence would have taken much longer. Damage assessment by the project estimated that USD 25,000 of community seed money would be needed for repairs.

5.2 Promoting productive uses of energy: a persistent challenge

A key project objective was to promote the use of energy for productive purposes, thereby contributing to the socio-economic development of the village. However, this has proven a challenging task for the reasons outlined below.

Prevailing habits and preconceptions. Most Sengor households have had limited education and depend on livestock for their livelihoods. The project has found it difficult to change prevailing habits and preconceptions among the people, and to convince them to consider alternative income-generating activities.

Small and medium enterprises (SME) sector limitations. Enterprise development in Sengor is also affected by the overall challenges for the SME sector in Bhutan. While SME comprise 85 percent of the country's business establishments, their development is hindered by the lack of entrepreneurial talent and business skills, access to financing, absence of clear sector policies, poor physical infrastructure and concomitant high transportation costs.

5.3 Expansion potential

The RGoB plans to have the Sengor MHP model replicated in the villages of Soe and Lingzhi, Thimphu District. The sites have been identified and construction has begun.

Community management and productive uses of energy can lower O&M costs and improve the ability of users to pay for electricity. The viability of 21 grid-connected and stand-alone MHPs operated by the BPC can therefore be improved by incorporating these elements into their operation.

Currently, the RGoB favours developing MHPs in rural areas where grid-based electrification is economically unfeasible. A national policy framework, implementation guidelines and finance mechanisms for community-based MHPs are yet to be developed. However, the MoEA has accepted a Community Micro-Hydro Energy Policy formulated by the project. The policy contains the following guidelines and manual, to be used by stakeholders in the development and implementation of community-based micro-hydro projects:

The intake reservoir after construction.

UNDP/Energy Access for Poverty Reduction

- Community Micro-Hydro Energy Policy Guidelines;
- Guidelines for Community Mobilization for Community Organization;
- Electricity Pricing Study and Tariff Setting;
- Working Guidelines on the Operation and Management of the Sengor Community Micro Hydro-Project; and
- General Operation and Management Manual for Micro-Hydro Plant.

6. Lessons and good practices in expansion of energy services for the poor

6.1 Establish an enabling environment

Expansion and replication of projects like Sengor MHP requires an enabling environment that includes:

- coherent policies;
- harmonization of government and donor efforts;
- inter-agency coordination;
- national capacities; and
- a sustainable financing mechanism.

6.2 Align donor efforts with government plans

At this point, grants and soft loans from the Asian Development Bank and other donors have been made available for extensions to the grid and for SPV systems. No new funding for MHP projects has been forthcoming, except for the 2006 Chendebji MHP project.[15] Ideally, community-based micro-hydro development and RGoB rural electrification plans should complement one another. In fact, it almost appears that the two are in competition with each other. Measures to align donor efforts in the sector with RGoB plans are urgently needed.

6.3 Align project objectives with national priorities

It is essential that project formulation and design are aligned with RGoB policy and plans. The Sengor project was designed in the context of the 9th Five-Year Plan and the vision of electrifying the country by 2020. The project is also aligned with Bhutan's laws, which encourage rural electrification (including off-grid and renewable solutions). Specifically:

- the Electricity Act of 2001 (Article 61.1) states that "the Minister shall undertake to promote, support and provide rural electrification through public and private participation";[16] and
- the Decentralization Act of 2002 calls for block development committees to "administer, monitor, and review the maintenance of community micro hydros" (Article 9.2) and invests them with "financial power to approve rates of locally generated power" (Article 10.7).[17] The district development committees are required "to give direction and approve rural electrification schemes in accordance with the Electricity Act 2001" (Article 10.9), while the *dzongkag* (district) administration must "implement rural electrification schemes" (Article 13.7).[18]

The Sengor MHP project is also fully aligned with Bhutan's development philosophy by promoting:

- equitable and sustainable socio-economic development;
- preservation and promotion of culture;
- conservation of the environment; and
- good governance.

[15] The Chendebji MHP is a community-managed 70 kW plant (Trongsa District) that was developed as a pilot Clean Development Mechanism (CDM) project (National Environment Commission, 2006). The project was funded by the E7 Fund for Sustainable Energy Development and Implemented by the DoE. It was registered as a CDM project in May 2005 and 474 certified emission reductions were issued for the period August 2005 – November 2006.

[16] National Assembly of Bhutan, 2001.

[17] 'Hydel' is an abbreviation for 'hydroelectricity development'.

[18] Asian Development Bank, 2006.

7. Conclusions

The Sengor MHP did not merely deliver electricity to the community. By encouraging productive uses of electricity, it sought to ensure that energy access enhances livelihoods and reduces poverty. While this has proven to be a challenge, it is essential to achieving financial sustainability of community-based MHPs. Simultaneously, the project ensured community involvement during planning, implementation and O&M, thereby generating a sense of community ownership and empowerment.

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For more information: http://asia-pacific.undp.org
UNDP Asia-Pacific Regional Centre | United Nations Service Building, 3rd Floor, Rajdamnern Nok Avenue, Bangkok 10200
Tel: +66 (0) 2304 9100 | Fax: +66 (0) 2280 2700 | E-mail: aprc@undp.org | http://asia-pacific.undp.org

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United Nations Development Programme
Asia-Pacific Regional Centre
United Nations Service Building
3rd Floor, Rajdamnern Nok Avenue
Bangkok 10200 Thailand
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