Delivering Energy Services for Poverty Reduction:

Success Stories from Asia and the Pacific

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Regional Energy Programme for Poverty Reduction
UNDP Regional Centre in Bangkok

Foreword

The Asia-Pacific region faces tremendous inequalities in the use of modern forms of energy. Inadequate access to energy services has entrenched poverty, slowed down improvements in health and education, exacerbated inequities and contributed to environmental degradation.

Cost-effective solutions exist that provide clean, efficient and affordable energy services to the region's poor and remote communities. Yet these solutions have not received the political and financial support they deserve.

Developing countries in Asia-Pacific stand at a crossroads. If they make the right choices today they can invest in energy options that will improve economic opportunities for the poor while limiting negative impacts on the environment.

UNDP's efforts in implementing energy projects in Asia-Pacific have generated a wealth of experiences in expanding energy services in the region. A selection of these projects, all of which have had positive impact on people's lives, are documented and presented in this report.

This report outlines experiences from UNDP and its partners in designing and implementing energy projects. It provides evidence to support the case that improved access to energy services supports poverty alleviation and the achievement of the Millennium Development Goals.

We hope that these experiences, and the lessons that have emerged from them, will be useful in informing future energy interventions in Asia-Pacific that reduce poverty and generate sustainable development.

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Acknowledgements

This report represents years and in some cases more than a decade of experiences in learning by doing in countries from the Asia-Pacific region. The report benefited from the valuable contributions and collaborative efforts of many people, including staff working on sustainable energy in the UNDP Regional Centre for Asia Pacific and in UNDP Country Offices.

This is an initiative under the Regional Energy Programme for Poverty Reduction (REP-PoR) based in UNDP's Regional Centre in Bangkok. The programme seeks to enhance knowledge sharing in the region on experiences gained from initiatives promoting energy as a tool for poverty reduction and sustainable development. REP-PoR focuses on enhancing equitable access to appropriate, reliable and affordable energy services to reduce human and income poverty. In line with UNDP's overarching goals in supporting countries in their efforts to achieve the Millennium Development Goals (MDGs), it contributes towards their achievement through broad-based interventions in three thematic areas: improved access to energy services for the poor and unserved, efficient use of energy focusing on micro-, small- and medium-sized enterprise, and access to financing for sustainable energy. In order to mainstream energy into the poverty reduction agenda, the regional energy programme provides three strategic services: support for policy advocacy, capacity development, and action research and knowledge management.

This publication was designed, reviewed and revised by the REP-PoR team, which is led by Nandita Mongia and includes Thiyagarajan Velumail, Sooksiri Chamsuk and Thomas Lynge Jensen. We appreciate the substantive contributions from Rebecca Roberts and Sanna Salmela-Eckstein. We would like to recognise the efforts of Ines Havet, who was responsible for synthesising and analysing key findings and recommendations. The collective input of all team members in sharing their experiences and providing guidance has gone a long way in the finalisation of this report.

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Contents

Boxes, Tables and Figures

Boxes

Tables

Figures

Executive Summary

Efforts by countries in the Asia-Pacific region to meet the Millennium Development Goals (MDGs), especially the goal of halving the number of poor, will be impaired unless adequate attention is paid to the crucial role energy services play in the development process. As many as 1.7 billion people in Asia-Pacific rely on traditional biomass for fuels and 1 billion do not have access to electricity.

This report was developed as part of UNDP's ongoing efforts to enhance knowledge by sharing experiences on energy projects for poverty reduction in the region. Through a process of peer review and selection, twelve case studies have been compiled to examine their experiences, particularly in terms of their design, implementation and outcomes. These cases range from small, local pilots to full-scale, national projects.

The cases presented in this report are based on the premise that satisfying people's needs for modern forms of energy can be an effective entry point for reducing poverty, creating new jobs and business opportunities, improving standards of living, health and education, and contributing to country progress in achieving the MDGs.

Meeting the energy needs of poor communities calls for a shift in focus from a supply-side to a more demand-oriented approach, meaning paying greater attention to end-users and energy services. This requires providing energy in useful, convenient and affordable forms to poor rural households and businesses, where the need is the greatest. It also means that the energy provided needs to be in an appropriate form to improve productive applications and enhance opportunities for income generation.

In many rural areas of the Asia-Pacific region, the extension of the electricity grid to villages is planned for far into the future or is not cost-effective. Since the initial needs of rural households are relatively modest, they can often benefit greatly from small-scale off-grid solutions. Even where electricity is available, insufficient attention is often paid to cooking and heating needs of the poor and to mechanical power to reduce the burden of repetitive and time-consuming tasks, which disproportionately affect women and children.

Although the projects considered here offer promising approaches, most of them encountered significant social, economic and technical challenges. However, they are considered successful because they have been largely positive in improving people's lives. They have expanded access to modern energy services, promoted the efficient use of energy and increased access to financing.

Our hope is that the experiences drawn from these projects will be useful for others that are helping communities – especially poor, rural communities – in creating initiatives to take advantage of more affordable, efficient, safe and convenient forms of energy.

Based on the case studies reviewed, the factors that contributed to successful energy projects can be summarised as follows:

- Projects should involve participatory consultations both at the community level and in policy development at the national level in order to ensure the needs and priorities of communities are addressed.

- Regardless of whether an integrated or a single-issue approach is used, projects must remain focused on securing benefits to reach development objectives that improve the livelihoods of the poor.

- Gathering and analysing accurate and realistic information on the socio-economic context, the barriers to improved energy access and the benefits of different options is critical to ensuring projects reduce poverty and enhance development outcomes.

- Cost-effective solutions exist and can provide affordable, efficient and quality energy carriers and energy services to meet the divergent and differentiated needs of rural populations.

- Projects can be designed to provide energy services that can free up people's time, reduce the burden of difficult and repetitive tasks, increase productivity and reduce expenditures on energy.

- The use of appropriate energy carriers and end-uses for productive purposes can expand opportunities for income generation. However, it should not be assumed that productive uses will occur automatically as a result of the provision of energy services, especially with the expansion of electricity.

- Projects that are able to offer a combination of energy carriers, technologies and end-uses will be more likely to satisfy a range of people's needs and priorities, including cooking and heating needs, mechanical power and electricity for illumination and communications.

- While the main focus of capacity development efforts has been the transfer of information on energy technologies, effective capacity development is best centred on the acquisition of knowledge based on a prior understanding of the local socioeconomic context, technical practices and policy environment.

- The outcomes of energy projects are more likely to be sustained when projects take into consideration technical and financial sustainability, coordinate with local institutions and develop business skills in addition to technical skills.

- Taking into consideration local energy project experiences can help to develop national policies that are adapted to local conditions. At the same time, energy projects that advance national development objectives are more likely to be mainstreamed into national policies if they are flexible and adapt to changing conditions.

Overview

This report was developed as part of UNDP's ongoing efforts to enhance knowledge by sharing experiences from implementing projects on energy for poverty reduction in the Asia-Pacific region. Twelve projects deemed successful were selected from UNDP's portfolio of energy projects in the region.

The outcomes of these diverse projects vary according to their country setting, and project objectives and implementation approaches. However, the selected projects were considered successful because they have been largely positive in improving people's lives. They have demonstrated that improving access to energy services can be an effective entry point to achieving diverse and multiple development outcomes. This can be achieved by promoting the efficient use of cleaner fuels and end-use technologies, decentralized energy solutions and financing for energy.

The projects were selected based on a process of peer review by UNDP staff. The criteria used in determining successful projects were the following:

- Creation of sustainable livelihoods, including micro-enterprises;
- Improved access to services, such as infrastructure, education, health and clean water;
- Positive macroeconomic impacts, including growth and employment;
- Links to national policies, including national development strategies and priorities;
- Sense of ownership of the initiative at the local or national levels;
- Use of consultative and participatory processes;
- Interventions tailored to the country context; and
- Capacity development in monitoring, analysis and reporting.

Case studies were compiled to examine the experiences of selected projects in terms of their design, implementation and outcomes. As shown in Table 1, they range from small, pilot community projects to larger, national projects.

Table 1: List of selected case studies

Case study no.	Case study title	Country	Type	Cost (approx. in US$)	Timeframe (as of 2007)
1	A photovoltaic mini-grid system for the Apolima Island	Samoa	Solar PV	225,000	2003-Present
2	Capacity development for the rapid commercialization of renewable energy	China	Renewable energy technologies	25 million	1999-Present
3	Community-based micro-hydro project catalyzes holistic development and poverty reduction	Nepal	Micro-hydro, biogas, SHS	20 million	1996-2009
4	Community energy cooperative expands small businesses and livelihoods	Cambodia	Modern biomass	42,000	2006-Present
5	Compressed natural gas as a transport fuel for poverty reduction	Bangladesh	CNG	1.5 million	2001-03
6	Conserving energy and promoting energy-efficient stoves in Thatta	Pakistan	Primarily improved cooking stoves	82,000	2005-06
7	Energy conservation for a small textile dyeing company	Viet Nam	Energy efficiency for manufacturing	1,000	2006-07
8	Energy-efficient straw-bale housing	Mongolia	Energy efficiency in housing insulation	1.8 million	2002-07
9	Poultry power: Recycling wastes to run an orphanage	Bangladesh	Biogas digester	36,000	2002-03
10	Powering growth centres with solar photovoltaics	Bangladesh	Solar PV	28,000	1999
11	Rubber drying plant uses solar and biomass energy to improve incomes	Thailand	Solar dryer and biomass	33,000	2003
12	Women deliver energy services in isolated communities	Bangladesh	SHS	150,000	2000-Present

Other projects were also consulted in this report although full case studies were not compiled. They are:

13. Biomass energy for rural development (India)
14. Community-based micro-hydro power station improves access of remote village to Energy (Sri Lanka)
15. Empowering rural women and promoting energy efficiency in Thatta (Pakistan)
16. Fuelwood savings project: Conserving fuel in palm sugar production (Cambodia)
17. Improved cooking stoves for energy efficiency in village households (Sri Lanka)
18. Pacific islands energy policy and strategic action planning (PIEPSAP) project (multi-country)
19. Removing barriers to small-hydro power development for sustainable livelihoods (Bhutan)
20. Revitalisation of a micro-hydro power plant for rural electrification (Indonesia)
21. Sustainable local environment and resource management through industry-community cooperation (India)

The results of this exercise offer possible lessons not only for future projects specific to energy and poverty reduction. These lessons are also relevant for informing national policies and securing budgetary support to replicate successful solutions and outcomes. Nonetheless, this report focuses primarily on project solutions to address the needs of the poor that are participatory and inclusive, and promote empowerment in addition to widening people's opportunities to improve their livelihoods.

The rest of the report is divided into four sections. The next section briefly outlines why and how improving access to energy services is needed to achieve the Millennium Development Goals and national development strategies. Section 3 reviews energy services that address the energy needs of end-users and identifies approaches to developing energy interventions for poverty reduction. Section 4 focuses on critical project strategies drawing from the experiences of the case studies. It also focuses on the 'building blocks' needed for energy projects that provide sustainable solutions. Finally, the last section provides a summary of the main factors that have contributed to the success of projects.

1

Energy, poverty reduction and development

Efforts by countries in the Asia-Pacific region to meet the Millennium Development Goals (MDGs), especially the goal of halving the number of poor, will be impaired unless adequate attention is paid to the crucial role energy services play in the development process. Improving access to affordable and clean energy services for the poor is a prerequisite to achieving multiple development benefits, including economic, social and environmental objectives (UN Millennium Project et al, 2005).

1.1 Poverty reduction and the Millennium Development Goals

Energy deeply influences all aspects of poor people's lives. Yet millions of households in the Asia-Pacific region still lack access to safe and reliable energy carriers. As many as 1.7 billion people in Asia-Pacific rely on traditional biomass for fuels and 1 billion lack access to electricity (UN Millennium Project et al, 2005).

The poor also spend a high proportion of their incomes on poor-quality energy substitutes. On average, a poor family in the Asia-Pacific region spends some 28 percent of its household expenditure on fuels, electricity and transportation (UNDP, 2007c). The poor also devote a large portion of another important asset, their time, on energy-related activities – women and young girls may spend many hours a day gathering fuelwood and water, cooking and agro-processing (UN Millennium Project, 2005).

Energy's importance to development is well documented and there is an empirical basis to the relationship between access to modern energy and human development (UN Millennium Project, 2005). As shown in Box 1, energy directly affects income poverty and other dimensions of poverty, such as gender inequality, poor health, lack of education, lack of access to infrastructure services and poor environmental quality. A country's ability to provide equitable access to energy services is therefore at the heart of any country's effort to achieve the MDGs and reduce poverty.

Box 1: Energy and the Millennium Development Goals

- Goal 1 on poverty eradication: Energy inputs such as electricity and fuels are essential to cook food and generate jobs, and for industrial activities, transportation, commerce, micro-enterprises and agriculture.
- Goal 2 on education: Electricity attracts teachers to rural areas and allows illumination for after-dusk study. Many children, especially girls, do not attend primary school because their labour is needed to meet family subsistence needs such as carrying wood and water.
- Goal 3 on gender equity: Women are responsible for most household cooking and water-boiling activities taking time away from other productive activities and participation in education and social activities.
- Goals 4, 5 & 6 on health: Waterborne and respiratory illnesses and mortality are caused by unboiled water and the effects of indoor air pollution from traditional fuels and stoves. Health clinics need electricity for illumination and refrigeration.
- Goal 7 on the environment: Energy production, distribution and consumption have many adverse effects on the local, regional, and global environment, such as air pollution, land degradation, acidification of land and water, and climate change.

Source: UNDP (2005).

1.2 Micro-macroeconomic dimensions

Since energy is a prerequisite to catalysing development and poverty reduction, securing the supply of primary energy and the demand to sustain the provision of energy services are paramount to achieving development objectives (UN Millennium Project et al, 2005).

Increases in oil prices have important implications for energy security, macroeconomic growth and poverty reduction. While global energy prices affects every country, those that are highly oil dependent or that rely heavily on imports tend to be more exposed than others (UNDP, 2007c). Asia-Pacific's oil intensity remains higher than the global average and is likely to stay quite high. In India and China, for example, growth in demand is expected to cause oil consumption to rise by about 3 percent per year (UNDP, 2007c).

The direct effect of global energy prices on an economy is felt through a worsening balance of payments and the ensuing contraction of the economy or increased external borrowing required to restore the balance of payment equilibrium (UN Millennium Project et al, 2005). This can influence a country's ability to service foreign debt, attract foreign investment and manage fiscal resources (UN Millennium Project et al, 2005).

A UNDP study on the effects of recent oil price hikes in the Asia-Pacific region shows the dramatic effects of energy price increases on the poor (UNDP, 2007c). They have had to cut back on their consumption of oil products, have reverted to inferior fuels or made other cuts in their household budgets (UNDP, 2007c). In India and Indonesia, for example, rural communities surveyed indicated that they have cut back on kerosene for cooking and instead have reverted wholly or partly to using biomass and dung cakes (UNDP, 2007c).

A country's ability to expand, diversify and optimise its energy resource portfolio and level of energy services is therefore essential to sustain poverty reduction and economic growth (UN Millennium Project et al, 2005). In Bangladesh, a programme to encourage the use of locally available natural gas was initiated to reduce the amount of petroleum being imported for transportation and the resulting severe pressure on the country's balance of payments (Case Study no. 5). Other projects reviewed in this report have explicitly sought to reduce dependency on imported fossil fuel, including the case studies from Cambodia (Case Study no. 4) and the Pacific Island Countries (Case Study no. 18).

1.3 Energy in national and local development strategies

Energy is generally acknowledged as a national priority for governments and its importance for economic growth is recognised in national development and energy strategies. But governments typically focus on the supply of high-end fuels and centralised electricity generation and grid extensions that are biased toward the provision of expensive forms of energy to urban and peri-urban centres. In Cambodia for instance 85 percent of the population lives in rural areas, yet only large urban areas have access to grid electricity (UNDP, 2007b).

Box 2: Energy and strategies for poverty reduction in Asia-Pacific

A review of nine Poverty Reduction Strategy Papers (PRSPs) from the Asia-Pacific region revealed the following:

- All nine PRSPs placed strong emphasis on the role of energy as a driver of macroeconomic growth.
- Relationships between energy and social development goals received comparatively little consideration. Only four PRSPs explicitly linked energy with gender equality, two linked energy with health, and none devoted serious attention to links between energy and education.
- All the PRSPs reviewed stressed access to electricity as the most critical energy need. Attention focused on large-scale power plants and grid-based technologies, although some PRSPs highlighted physical constraints to rural grid extension.
- The primary energy needs of the poor such as cooking, heating and mechanical power for productive uses received very little attention. Only three mentioned, but did not discuss in detail, the management of traditional biomass fuels. Only one mentioned the need to improve access for the poor to modern household fuels for cooking and heating.

Source: UNDP (2007a).

Current approaches to energy, whether energy supply or use, are often intended to support economic growth alone without sufficient weight given to equitable access to energy services for the rural poor (UNDP, 2006a). In Indonesia, an estimated 70 percent of subsidized kerosene is consumed by non-poor households (UNDP, 2007b). In Viet Nam, most rural households rely on traditional biomass yet the government does not have a programme to reduce dependence on fuelwood (UNDP, 2007b).

As shown in Box 2, national development strategies may neglect energy services that improve livelihoods, education and health outcomes (UNDP, 2006a).

Cost-effective solutions exist and can provide affordable, efficient and quality energy technologies and energy services to meet the divergent and differentiated needs of rural populations. They are often neglected for more expensive solutions that can be a drain on national budgets (UNDP, 2006a). In Mongolia, heating subsidies account for almost 50 percent of the annual national budget (Case Study no. 8). In Cambodia, a rural energy project showed that it was able to provide clean, decentralised electricity at a tariff comparable to the existing subsidised tariff (Case Study no. 4).

National development strategies and budgetary expenditures therefore need to be redirected to programmes for improving cost-effective access to modern energy services for the poor, especially the rural poor. They need to be supportive of the diverse sectors that require energy as an input, such as agriculture, water infrastructure, microenterprises, health and education (UNDP, 2007b). At the sub-national and local levels, strategies for placing energy services firmly at the centre of local development planning processes and budgets will be needed to ensure the implementation of solutions tailored to rural community needs and the delivery of other development programmes (UNDP 2007b).

2

Energy services that reduce poverty and provide multiple benefits

The provision of energy services that address the needs of the end-users requires demand-driven approaches. As illustrated in Box 3 this means focusing on productive uses, especially fuels for cooking and heating as well as mechanical power. A number of options exist for providing energy services to the poor, including renewable energy, biomass and fossil fuels combined with cleaner, more efficient energy technology.

Box 3: Demand-driven energy services: Availability, affordability and efficiency

Demand for energy is a 'derived demand' because people do not want energy itself but the 'energy services' it provides, such as lighting, cooked food, refrigeration, telecommunications, education and transportation. Energy services can also include other benefits such as mechanical power. From the perspective of the consumer, it is the availability and affordability of energy services, not merely the source of energy itself, which is important.

Due to the inefficiency of commonly used items such as batteries, candles, kerosene and charcoal, the poor often pay higher unit costs for energy than do the wealthy. The use of more efficient carriers can reduce the large share of household income spent on cooking, lighting and keeping warm, thus saving families much needed income for food, education, health services and other basic needs. They can, for example, boost household income by providing lighting that extends livelihood activities beyond daylight hours. They can power machines that can reduce repetitive tasks such as grinding or milling and that result in valuable time savings, increased output and higher value added.

Source: UN Millennium Project (2005).

It can be a challenge to develop energy services that are efficient, reliable and accessible while also being affordable. Paying attention to energy needs, and who needs them, helps to identify the appropriate approach for poverty reduction. These include fuel substitution, electrification – especially using decentralised systems – and energy efficiency.

2.1 Meeting energy needs

As shown in Table 2, a substantial fraction of the population in Asia-Pacific relies on traditional biomass fuels – fuelwood, dung or agricultural residues – for meeting cooking and heating needs. In addition, many also rely on human- or animal-based mechanical power for a variety of manual activities or transport. They may rely on kerosene wick lamps, batteries or candles for lighting. Other important needs are electricity for illumination, appliances and communications.

Table 2: Number of people relying on traditional biomass in the Asia-Pacific region

	Millions	% of the total population
China	706	56
Indonesia	155	74
Rest of East Asia	137	37
India	585	58
Rest of South Asia	128	41
All of Asia	**1,701**	**n/a**
All of the developing world	**2,390**	**52**

Source: UN Millennium Project et al, 2005.

Cooking and heating needs. Sustainable, reliable and least-cost access to cooking fuels is among the most basic energy needs for the world's poor. Most food must be cooked before it can be ingested and transformed into human energy. The amount of energy required for cooking varies with the type of food, fuel and stove used and with cooking practices. More than 80 percent of the heat generated while cooking with wood on a traditional three-stone fire does not end up 'in the pot' compared to half when kerosene or LPG is used (UN Millennium Project et al, 2005). For food preparation and process heat, other energy carriers are generally more suitable than electricity, such as natural gas, LPG or ethanol. The case studies from Pakistan (Case Study no. 6) and Bangladesh (Case Study no. 9) provide examples of cooking and heating projects.

Mechanical power. Mechanical power produced in engines can displace human and animal labour and greatly increase economic productivity and livelihoods. It has a variety of valuable uses, including transportation, pumping water, irrigation, intensification of agriculture (tractors and farm equipment) and processing of agricultural products (moving, crushing, grinding). Access to mechanical power for water pumping and transport, food milling and agricultural processing has a particularly direct effect on freeing up women and children's time for human development. The case study from Nepal demonstrates the benefits of improved energy services for grinding and milling (Case Study no. 3).

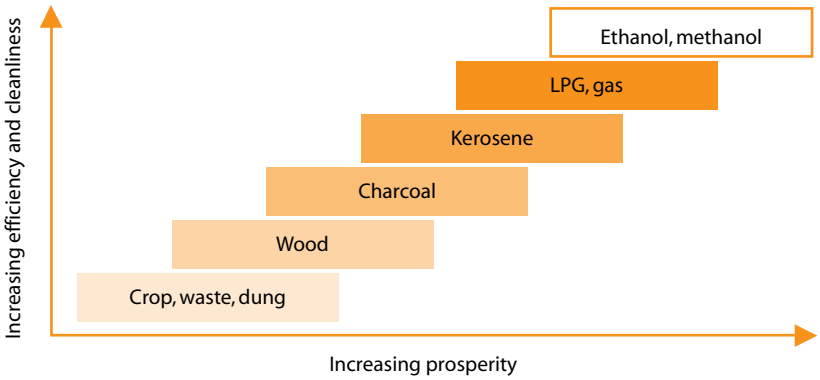
Electricity for lighting, appliances and communications. Electricity is important to support productive activities both at home and in small business, and the delivery of social services such as education, health care and a functioning public sector. It also produces illumination for use at home, which allows work or study in the evenings and supports modern information and communication systems. A number of case studies in this report – Samoa (Case Study no. 1), Nepal (Case Study no. 3), Bangladesh (Case Study no. 10) and Cambodia (Case Study no. 4) – sought to improve access to electricity.

2.2 Approaches to improving access to energy services

The provision of energy services that address the needs of end-users – in particular the poor, women and vulnerable – requires appropriate approaches to achieve poverty reduction. Among these the main approaches are fuel substitution, electrification and energy efficiency to help the poor move up the 'energy ladder.' The importance of electricity versus fuels for the poor varies based on their differentiated needs and the economic and social circumstances that enable their use (UN Millennium Project et al, 2005).

Fuel substitution. Poor households often lack access to modern fuels and must rely on traditional fuels, which represent the lowest rungs on the 'energy ladder' (Figure 1). The order of fuels on the energy ladder corresponds to their efficiency and 'cleanliness' at end-use. More efficient and 'cleaner' fuels such as charcoal, coal, kerosene, liquefied petroleum gas (LPG) and finally modern biofuels such as ethanol and methanol represent successively higher rungs on the ladder (UN Millennium Project et al, 2005). Although modern fuels tend to be more costly – at least from a monetary perspective – than traditional fuels, they provide people with far greater opportunities for income generation. Case studies from Bangladesh (Case Study no. 9) and Nepal (Case Study no. 3) sought to encourage the use of more efficient fuels.

Figure 1: Relationship between fuel usage and prosperity



Electrification. Electricity represents the highest rung on the 'energy ladder' and produces different energy services than fuels. Electricity is essential for modern communications, industry and the provision of public services such as public lighting, education, and health care. It can be distributed through centralized electricity grids or through decentralized systems in which the electricity is consumed near or at the point of generation. Many renewable energy applications are engineered to provide decentralized electricity but can also be connected to the grid when the electricity is generated on a large scale, such as is often the case for wind farms. In the case studies from Samoa (Case Study no. 1), Nepal (Case Study no. 3), Bangladesh (Case Study no. 10) and Cambodia (Case Study no. 4) mini-electricity grids were set up that rely on renewable energy.

Energy efficiency. Increased energy efficiency – whether during generation and production, transport or transmission, or end-use – can have wide-ranging benefits. The ability to capture the full extent of these benefits will depend on the initial cost of less efficient appliances and that of replaced energy-efficient technologies and on the existing technical standards for energy efficiency. Many opportunities exist for improving energy efficiency in the rural sector such as charcoal production, the use of cooking fuels and in lighting (whether kerosene or electricity-based). The case studies from Pakistan (Case Study no. 6), Mongolia (Case Study no. 8), Viet Nam (Case Study no. 7) and Thailand (Case Study no. 11) sought to improve the energy efficiency of energy end-use technologies.

3

Energy projects that deliver

Considerable progress has been made in delivering energy projects that take into consideration the needs and priorities of the poor in the last decades. Projects nevertheless still encounter challenges at each stage of the project cycle – design, implementation, and monitoring and evaluation.

Challenges include developing energy approaches that generate not only income for the poor but also additional development benefits and that can be mainstreamed into national programmes and budgets. This requires the use of transparent, evidence-based participatory processes that encourages not only direct consultation of project participants, but also community ownership and management of energy systems. Another challenge is identifying cost-effective technologies that can be replicated on a wide scale. This means developing energy systems that are flexible enough to accommodate differential needs and benefits, while still taking advantage of the economies of scale that large systems may offer. Attention also needs to be paid to developing the capacity of project participants, community-based organisations and local institutions and applying innovative financial and micro-financing mechanisms to ensure the sustainability of project outcomes.

3.1 Approaches to energy projects

Different project approaches have been used in expanding energy services for the poor and rural areas – projects either focusing on addressing a specific issue or taking on a more integrated approach to solving development and energy challenges. The experiences from the case studies in this report also suggest that a successful strategy is the ability to link access to energy services to income-generation opportunities and other development benefits. Where projects are able to support national objectives and inform decision-making, they are more likely to be mainstreamed in national programmes and budgets.

3.1.1 Integrated and single-issue projects

The two main approaches to energy development projects are the 'integrated approach' and the single-issue approach. The choice of approach used depends primarily on the specific programme objectives or funding sources. Regardless of which approach is selected, projects must remain focused on securing benefits that improve the livelihoods of the poor and support development objectives.

An integrated approach addresses the needs of communities based on their identified priorities for improving livelihoods. This might include a focus on multiple end-uses to address a range of development objectives or it might include a focus on multiple energy delivery technologies. In either case, the approach makes it possible to address a number of issues simultaneously.

The range of potential options an integrated project can consider is quite broad since there is no a priori or predetermined interest in a particular issue or technology (UNDP, 2004b). An example of an integrated approach is that of Nepal's rural energy development programme. Although the main activity of the programme is the development of micro-hydro energy systems, it also provides solar home systems, bio-gas and improved cooking stoves that generate a variety of energy services including lighting, communications, mechanical power and clean water (Case Study no. 3).

On the other hand, a single-issue approach starts with an identified issue and works to find the communities that will benefit the most from the approach. A single-issue (or single-technology) approach focuses on specifics - be it a particular technology or specific concern (UNDP, 2004b). A focus on renewable energy solar technology or climate change are examples of single-issue approaches.

While single-issue projects may not be intended to simultaneously address a number of issues at the same time, they are still able to generate multiple benefits. In these situations, it is still useful to determine the priorities of communities to ensure that the intervention has a positive impact on people's livelihoods. For example, a successful project in Pakistan worked closely with communities to design, test and deliver a range of affordable and locally appropriate home improvement products. These included improved energy-efficient stoves to reduce fuelwood consumption and expenditures as well as indoor air pollution (Case Study no. 6).

3.1.2 Energy as an input to income generation

Expanding access to reliable modern energy services increases opportunities for income generation for the poor when the energy services provided are designed for productive applications. This increases the affordability of basic energy services and also their accessibility. It is therefore a very powerful approach to meeting the energy needs of the poor and simultaneously increasing their incomes.

Some challenges to implementing this approach are the provision of energy services that do not address the productive needs of communities, a lack of appropriate skills to take advantage of improved energy services, and inaccurate assessments of the market potential of new products.

As shown in Table 3, almost all the case studies in this report expand income-generation opportunities for the poor, women or marginalised groups. This means relying on one or more of the following four approaches:

Table 3: Strategies used by case studies

Case study no.	Case study title	Income-generating activities	Livelihood improvement	Level of activities	Energy technology
1	A photovoltaic mini-grid system for the Apolima Island (Samoa)	Jobs in the PV sector	Environmental conditions, household appliances	Community demonstration project for replication	Solar PV
2	Capacity development for the rapid commercialization of renewable energy (China)	Renewable energy sector, variety of micro businesses	Investment opportunities in renewable energy	National policies and 5-year development plans	Renewable energy technologies
3	Community-based micro-hydro project catalyzes holistic development and poverty reduction (Nepal)	Primarily farming and agro-processing	Fuelwood consumption, time use, environmental conditions	Links between national and community-based initiatives	Micro-hydro, biogas, SHS

Table 3: Strategies used by case studies (continued)

Case study no.	Case study title	Income-generating activities	Livelihood improvement	Level of activities	Energy technology
4	Community energy cooperative expands small businesses and livelihoods (Cambodia)	Variety of micro businesses	Environmental conditions, fuelwood consumption	Community demonstration project for replication	Modern biomass
5	Compressed natural gas as a transport fuel for poverty reduction (Bangladesh)	Jobs in the CNG sector	Transport costs, urban air	Links between national and community-based initiatives	CNG
6	Conserving energy and promoting energy-efficient stoves in Thatta (Pakistan)	Primarily cooking stoves	Fuelwood consumption, time use	Community	Primarily improved cooking stoves
7	Energy conservation for a small textile dyeing company (Viet Nam)	Textile industry	Working conditions	Community demonstration project for replication	Energy efficiency in manufacturing
8	Energy-efficient straw-bale housing (Mongolia)	Insulation material sector	Fuelwood and coal consumption	Community	Energy efficiency in building insulation
9	Poultry power: Recycling wastes to run an orphanage (Bangladesh)	Poultry farming and baking	Working conditions	Local social service	Biogas digester
10	Powering growth centres with solar photovoltaics (Bangladesh)	Market sales and agriculture	Evening working hours	Community	Solar PV
11	Rubber drying plant uses solar and biomass energy to improve incomes (Thailand)	Rubber sheet drying	Fuelwood consumption	Community	Solar dryer and biomass
12	Women deliver energy services in isolated communities (Bangladesh)	SHS production and sales	Diversification of income sources	Community	SHS

Energy services that free up people's time. The provision of energy services is an important factor to freeing people's time from repetitive and burdensome tasks or to providing electrical power to extend working hours. In Bhutan, the provision of electric mills powered by decentralised micro-hydro energy has reduced the time and drudgery involved in tasks such as rice milling (Case Study no. 19). In Bangladesh, a solar PV system providing lighting to a local market meant that farmers trading in the market were able to increase their incomes by 45 percent. They were able to extend their market business hours into the evening and spend more daylight hours carrying out agricultural activities in the field (Case Study no. 10).

Energy services that reduce fuelwood consumption and energy expenditures. Improving the productivity of end-uses like cooking or heating and production processes like agro-processing can reduce fuelwood consumption and save money on energy expenditures. For example, a project from Pakistan that provided improved cooking stoves to poor households in rural Pakistan resulted in savings of 40 to 60 percent in fuelwood consumption and 50 percent in expenditures on energy (Case Study no. 6). In Thailand, for example, a group of rubber workers were able to increase their annual incomes by improving the quality of the rubber they processed with drying plant technology fuelled by a combination of biomass and solar energy. The technology saved them substantial amounts of fuelwood and their income rose by over US$100 per person, a substantial increase in relation to the income of US$300 per person they earned during the four months of the drying season (Case Study no. 11).

Electricity appropriate for income generation. Where provided, electricity needs to be designed to expand the ability of the poor to engage in income-generation activities. An example is that of a project to rebuild an abandoned micro-hydro power plant in Java, Indonesia (Case Study no. 20). The plant electrified over 300 households providing them with lighting and the ability to use telecommunication equipment for news in the evening. The project was unable however to provide energy services that enabled income-generation activities during the daytime. The plant was designed to produce electricity during the evening only while productive activities usually take place during the daytime.

The provision of electricity also requires that systems have the appropriate load factor to meet end-use needs. Some energy technologies such as photovoltaics provide a limited amount of expensive electric power that can be used for operating light bulbs, radios, TVs and other low-load electrical appliances, but they generally do not supply sufficient electricity to operate stoves, ovens, other major appliances, welding machines, grinding mills and many other productive uses that can typically be operated with other sources of electricity (UNDP GEF, 2004). For instance in Cambodia, as a result of a pilot to provide more affordable electricity from modern biomass, small businesses were established including two welding shops, a water purification company, an electrical repair shop and a beauty salon (Case Study no. 4). In Nepal, the decade-old rural energy development programme successfully resulted in the creation of carpentry units, saw mills, huller and grinding mills, and communication centres (Case Study no. 3).

Energy delivery enterprises. Energy enterprises themselves can act as a source of income generation while at the same time expanding access to energy services. The expansion of energy services is more likely to become a reality if the availability of energy services stimulates enterprises development or enables the poor to run energy enterprises that generate profits from their operations. Women in Pakistan were trained in the assembly and sale of improved cooking stoves and geysers (Case Study no. 6). Women in Char Montaz Island in Bangladesh were trained to become SHS entrepreneurs earning them an annual 15% profit rate. Profits have been used for investments in other income-generating activities, such as raising poultry and live-stock, and fishing (Case Study no. 12).

3.1.3 Energy services that provide multiple benefits

Energy services can act as a tool for development, by providing a wide range of benefits. If designed with social equity in mind, energy projects can address social and environmental considerations in addition to stimulating economic development that benefits the poor. Making the link between access to equitable energy services and these additional benefits is important in creating synergies with other national development objectives.

As illustrated in Table 4, the case studies presented in this report show how the provision of energy services that focus on poverty reduction and the needs and priorities of communities can also support the achievement of the MDGs. In addition to improved incomes and reducing hunger (Goal 1), the main additional benefits were health (Goals 4, 5 and 6) and educational benefits (Goal 2), gender equity (Goal 3), and improved environmental conditions (Goal 7).

The availability of adequate clean energy can reduce household air pollution, provide clean water and address greenhouse gas emissions. In Sri Lanka, the introduction of an energy-efficient cooking stove has reduced fuelwood use in households, greenhouse gas emissions and cooking time. It has also improved the health of women due to less smoke emissions and the resulting physical exhaustion (Case Study no. 14). In Nepal, the rural energy development programme has improved sanitation and established infrastructure for potable drinking water through the provision of biogas digesters and micro-hydro systems (Case Study no. 3).

The case studies confirm the premise that access to modern energy services can play a critical role in improving educational opportunities for children. In Nepal, access to lighting in homes has allowed home study for children beyond daylight hours. It has also enabled the use of electronic educational media and communications in schools. By powering grinders and mills, the physical hardships associated with burdensome, repetitive tasks that often fall under the responsibility of girls have been reduced (Case Study no. 3). The use of cleaner, more efficient fuels and technologies in an orphanage in Bangladesh has been able to generate savings that have been used for improvements to the education of the children and their technical and vocational skills. The facility has also been expanded to accommodate more orphan children (Case Study no. 9).

Table 4: MDG goals supported by the case studies

Case study no.	Case study title	GOAL 1 Poverty alleviation	GOAL 2 Education	GOAL 3 Gender	GOALS 4, 5 & 6 – Health	GOAL 7 Environment
1	A photovoltaic mini-grid system for the Apolima Island (Samoa)	•				•
2	Capacity development for the rapid commercialization of renewable energy (China)	•				•
3	Community-based micro-hydro project catalyzes holistic development and poverty reduction (Nepal)	•	•	•	•	•
4	Community energy cooperative expands small businesses and livelihoods (Cambodia)	•	•			•
5	Compressed natural gas as a transport fuel for poverty reduction (Bangladesh)	•			•	•
6	Conserving energy and promoting energy-efficient stoves in Thatta (Pakistan)	•		•	•	•
7	Energy conservation for a small textile dyeing company (Viet Nam)	•				•
8	Energy-efficient straw-bale housing (Mongolia)	•	•		•	•
9	Poultry power: Recycling wastes to run an orphanage (Bangladesh)	•	•		•	•
10	Powering growth centres with solar photovoltaics (Bangladesh)	•				•
11	Rubber drying plant uses solar and biomass energy to improve incomes (Thailand)	•				•
12	Women deliver energy services in isolated communities (Bangladesh)	•	•	•		•

Table 4: MDG goals supported by the case studies (continued)

Case study no.	Case study title	GOAL 1 Poverty alleviation	GOAL 2 Education	GOAL 3 Gender	GOALS 4, 5 & 6 – Health	GOAL 7 Environment
9	Poultry power: Recycling wastes to run an orphanage (Bangladesh)	•	•		•	•
10	Powering growth centres with solar photovoltaics (Bangladesh)	•				•
11	Rubber drying plant uses solar and biomass energy to improve incomes (Thailand)	•				•
12	Women deliver energy services in isolated communities (Bangladesh)	•	•	•		•

3.1.4 Scaling up and linking projects to national priorities

Successful community-level initiatives offer an important starting point for expanding access to equitable energy services where they offer solutions that take into consideration local realities. Evidence has shown that neglecting local realities often results in unsustainable, supply-driven programmes because they tend to bypass the energy needs of the poor (UNDP, 2006b).

Since these types of projects are typically implemented in the form of small, pilot initiatives, they may receive little attention and remain untapped as a source of information on successful project models with the potential for replication. Yet they offer opportunities for awareness-raising, learning and informing broader development strategies, policies and funding, as shown in Box 4.

Box 4: Cambodia's first rural energy cooperative

The first member-owned rural energy cooperative in Cambodia was successfully established in 2005, which operates its own electrification and distribution system.

In addition to its cooperative ownership model, key components of the project include its financial sustainability and ability to provide cost-effective energy. The cooperative ensures the provision of electricity from modern biomass at a rate comparable to the subsidised electricity tariff and at half the rate of diesel-powered generators provided by the private sector. The estimated cost of electrifying a household is US$400 when all costs are considered. Project costs include those associated with developing community capacity and cooperatives, generating energy from biomass gasifiers, constructing the local grid and planting trees for fuel.

Based on the performance of this pilot, the national rural electricity planning team has recommended the model be incorporated into Cambodia's rural energy strategy.

Source: See the case study entitled *Community energy cooperative expands small businesses and livelihoods development*.

National policy frameworks and decision-making processes provide opportunities for the widespread replication of energy projects if they are acknowledged within national development priorities and budgetary allocations. As illustrated in Box 5, feeding practical on-the-ground experiences into decision making can help to ensure that local-level experiences are incorporated into national policies.

Box 5: National energy policies and institutions that build on decentralisation and community management in Nepal

Despite a long history of promoting large hydroelectricity infrastructure, almost 90 percent of the energy needs in Nepal are met through biomass such as fuelwood, crop residues and animal dung. Two related developments of the 1990s provided the initial impetus for decentralised rural energy development: the demand for devolution of power from the centre which resulted in the Local Self-Governance Act of 1999 and the experiences of the Rural Energy Development Programme (REDP).

REDP has contributed greatly to the decentralised delivery and community management of micro-hydro and other rural energy technologies that do not rely on large-scale hydroelectricity. Micro-hydro systems allow the expansion of sustainable electricity to remote locations and help to alleviate poverty. However, the need for a policy framework and institutional mechanisms to encourage a community approach to decentralised energy development was recognised only slowly, but was eventually articulated in the national plan and supported through a UNDP project in the early 2000s. The initiative resulted in wider acceptance at the national level of a holistic approach to rural energy development based on community-managed micro-hydro systems.

This wider acceptance was made possible through regional consultations that gave a voice to stakeholders and local communities. A greater recognition of the need for institutions at different levels - centre, district and community – has also been registered as well as for the equal and equitable participation of both men and women in a transparent, consensus-based decision-making processes.

Source: UNDP, 2006a.

At the same time, energy projects that advance national development objectives are more likely to be mainstreamed into national policies if they are flexible to changes in national priorities and take into consideration the local context. A multi-country technical assistance project in the Pacific Island Countries was initiated in recognition of the limited success of previous attempts to use 'templates' for national energy policy development. Instead the project focused on the specific situation of the participating countries (Case Study no. 18).

Another example is from China where a renewable energy initiative sought to strengthen the country's capacity to achieve the goal of 16 percent of the country's energy supplied by renewable sources by 2020 (Case Study no. 2). This project was flexible to changing circumstances and able to take advantage of other ongoing national initiatives to create synergies and to leverage the programme's impacts. As a result, the programme successfully mainstreamed most of its major activities into national initiatives. The project led to changes in the legal framework on renewable energy and the project findings were mainstreamed into the country's five-year plan. It is now being implemented throughout the country's municipalities with the help of additional funding from new partners.

3.2 The building blocks of energy projects

There is a need to provide energy services using proven, robust technologies that are cost-effective, financially sustainable and can be implemented at scale. Solutions need to be based on the needs and priorities of participants determined through information gathering and participatory processes. Attention also needs to be paid to developing the capacity of project participants and local institutions and applying innovative financial and micro-financing mechanisms to ensure the sustainability of project outcomes. These are the basic building blocks of successful energy projects for poverty reduction and need to be considered at each stage of the project cycle – design, implementation, and monitoring and evaluation.

3.2.1 Consultative processes and participation

Consultations are crucial first to identify and then to deliver the kinds of energy services needed to meet local demand and evaluate their outcomes. Project outcomes are more likely to be sustainable if the intended beneficiaries are consulted directly and participate in its management and delivery (Box 6). Past experience indicates that bottom-up participatory consultations that feed into decision-making processes increase the choices of the poor; in contrast, inflexible top-down planning favours elites and the status quo (DFID, 2002).

Box 6: Success factors of the Pacific Islands Energy Policy and Strategic Action Planning (PIEPSAP) project

The PIEPSAP project provided support to Pacific Island Countries in energy policy formulation. The general approach of the project was an emphasis on transparency and accountability in policy formulation, inclusiveness of political and operational levels of government, and broad participation of consumers and civil society. This process contributed to making the approach to energy policy in the participating countries more transparent. The use of participatory methods and clarity of accountability and organizational roles in policy formulation has become the norm. The main success factors of the project were:

- The demand-driven and flexible 'menu of options' approach
- Value-added through regional energy planning cooperation and regional integration
- Clearly defined criteria for cooperation and integration
- Open and proactive sharing of information with all stakeholders
- Solid working relations with numerous agencies and projects
- Flexibility of project concepts to respond to the needs of a variety of organisations
- Successful cooperation with other initiatives and support to numerous initiatives executed by other agencies

Source: From the project entitled *Pacific islands energy policy and strategic action planning (PIEPSAP) proje*ct

Although a participatory approach is critical to successful projects, it does not come without challenges. As shown in Box 7, immediate survival needs may make it difficult for some to participate.

Box 7: Social, economic and cultural barriers to involvement in projects

- *Power imbalances in communities.* Communities are not harmonious groups with a common set of interests and priorities. There are often strong divisions along the lines of age, religion, class and gender. Power differentials make it difficult for some people to voice opinions that contradict general views and may even affect who participates in specific meetings. Outside officials may only invite 'community leaders' (generally men) to participate in consultations.
- *Intra-household and intra-family relations*. Some women may find it difficult to speak out in front of their husbands or fathers. They may also believe that discussions relating to family matters (even issues relating to workloads) are not for public forums.
- *Different constraints to participation*. Different people or groups of people may have different responsibilities and workloads. Women often having less time to devote to new activities. Attending specific meetings may raise problems for women if meetings are set at times of the day when women tend to be occupied. Women's responsibilities for childcare may also make it difficult to participate.
- *Different abilities to participate*. Given differences in education, there are often varying literacy levels within a community. The more educated may also have more experience putting their arguments forward to outsiders and more confidence dealing with new people.
- *Perceived benefits of participation*. Different people may make different calculations about the costs and benefits of their involvement in participatory processes. Given the already high demands on most women's time, they often find little time to participate.

Source: UNDP (2003).

The case studies in this report illustrate that practical measures exist to promote active involvement in community consultations. The following are some key features of consultations identified in the case studies reviewed:

Inclusive consultations. Different people may have different needs on the basis of class, ethnicity, age, family composition and other factors. Urban, middle class women, for instance, do not necessarily accurately represent the views and priorities of poor, rural women. In Nepal, the rural energy development programme actively sought the representation of specific groups in the community organisations responsible for the management of micro-hydro systems. Not only were women included but measures were taken to ensure the poorest and often marginalised Sherpa and Dalit also participated (Case Study no. 3).

Consultations adapted to the context. While open discussions may facilitate participation, specific measures may also be needed to overcome the deference or muting of those not accustomed to speaking in public or in front of other community members. For example, in far western Nepal, cultural barriers prevented women from participating in public functions. Separate male and female community organisations allowed women not to feel overpowered by men and to become actively engaged. The community organisations worked together in higher level groups (functional groups) composed of an equal number of men and women, allowing the women to become equal participants in decision-making (UNDP, 2001) (Case Study no. 3).

Consultations that develop leadership skills. For those who are not accustomed to assuming positions of authority, considerable groundwork may be needed to develop self-confidence and assertiveness skills necessary for dealing with authorities and partners. In Pakistan, community-based organisations were given training to prepare project proposals, mobilise resources and manage the organisations (Case Study no. 6). In western Nepal, women were offered training to enhance their leadership skills including adult literacy and visioning exercises about their lives and the role of energy in it (Case Study no. 3).

Consultations that are flexible in finding solutions. Being flexible and keeping an open mind to new ideas can help find innovative solutions to often difficult and complex energy poverty challenges. The participation of poor marginalised groups in micro-hydro development schemes in Nepal was eased by allowing non-cash contributions in the form of labour, fewer connection points to allow for lower electricity tariffs and in-kind payment for electricity with labour or food grains (Case Study no. 3).

3.2.2 Assessments and analysis

Gathering and analysing accurate and realistic information is critical to ensuring projects are designed and implemented effectively. This information often also forms the basis of project evaluations that assess the impact of the project on important outcomes. Information can be collected from existing sources, commissioned studies or consultations. Some assessments and analyses used in the case studies reviewed in this report include:

Socio-economic context. People's time use and their associated energy consumption can provide important information for the design and implementation of projects especially when disaggregated by gender and income levels. As shown in Table 5, data can be collected to illustrate time use and energy costs associated with different energy services and the resulting time and energy savings from improvements in access to energy services. A study in northern Pakistan revealed that a considerable portion of household budgets was spent on fuels yet women in very poor households were unable to purchase fuelwood or kerosene and spent a considerable portion of their time searching and gathering fuelwood (Case Study no. 6). A project was therefore designed to make cooking stoves more efficient to reduce the time and effort devoted to gathering fuelwood.

Table 5: Examples of data on energy services and their benefits

Type of data	Energy services		
	Cooking	Mechanical power	Electricity
Time use and energy cost	Cooking and gathering fuelwood	Grinding food manually	Lack of lighting
Improved energy service	Cooking using either improved cook stove or LPG	Grinder for food processing	Space lighting
Time and energy savings from improved energy service	Time freed up for income generation	Productivity gains Time freed up for income generation	Work or study at night
Socio-economic indicators	Income Hunger and nutrition Health (less air pollution)	Income Health (less injuries)	Income Education

Needs and barriers. A project in China demonstrated the importance of having realistic information on the needs and barriers to sustainable energy development. A country needs assessment was carefully undertaken serving as a background to design the programme. This was considered a key factor in the success of the project (Case Study no. 2).

It is also important to understand how men and women would likely diversify their income as a result of improved access to energy services. For instance income diversification may be preferred at particular times of the year owing to seasonal workloads (e.g. harvest, birthing of livestock). Rural women may be interested in higher-value enterprises requiring little land, such as poultry or vegetable gardens.

Project viability. Feasibility studies can determine the social, financial and technical viability of an initiative. In Cambodia for instance the financial feasibility of a biomass-fuelled mini-grid was gauged based on an assessment of community members' willingness- and ability-to-pay for the service, while the feasibility of the community ownership model was determined based on factors associated with social cohesion (Case Study no. 4).

Market assessments are also useful tools in determining the viability of a proposal. They can help to scope and assess market conditions for new energy services. A project in Nepal determined that the lack of a well-defined market assessment resulted in a skills development programme that was unable to provide the appropriate skills needed for participants to generate income given the prevailing market conditions and available infrastructure. (Case Study no. 3)

Identification of benefits. An assessment of the expected benefits of a project can help to identify and deliver the most effective options to achieve development objectives. This means identifying the full range of benefits that energy development projects can generate in terms of time and energy savings, income generation and improvements in education, health and environmental conditions. For instance, in Bhutan, a proposal to develop micro-hydro systems was not initially considered a good investment for the government based on financial considerations. By demonstrating that the project was expected to yield additional benefits, the government was able to understand the full range of potential benefits and their contributions to human development and decided to invest in the initiative (Case Study no. 19).

Estimating and measuring impacts of interventions can help to determine the extent of benefits. For example, using straw bale in Mongolia has resulted in 50 percent savings in coal and fuelwood – or a two to three times higher savings than in buildings constructed with conventional materials – and in freeing up expenditures on heating fuels in poor households by 50 to 70 percent. The savings have been invested in education and other activities. In the Philippines, a study was commissioned to determine the benefits of a rural electrification programme. Unlike many earlier benefit assessments, this study took into consideration such non-monetary benefits as improved health, education or quality of life (Table 6).

Table 6: How a typical household in rural Philippines benefits from electricity

Benefit category	Benefit value (US$)	Unit
Less expensive and higher levels of lighting	$36.75	Per household per month
Less expensive and higher levels of radio and television use	$19.60	Per household per month
Adult education and electricity wage-income returns	$37.07	Per wage earner per month
Time savings for household chores	$24.50	Per household per month
Improved productivity for home business	$34 (existing home business), $75 (new home business)	Per business per month

Source: ESMAP (2002).

3.2.3 Awareness-raising

Awareness-raising enables organisations such as civil society organizations, research institutes and governments working with rural communities and the poor to use their community and information networks effectively in an effort to bring about change at the local level and introduce new ideas, approaches and technologies. The following are some features of awareness-raising drawn from the case studies:

Use of evidence and information. The use of reliable evidence and information ensures transparency and builds trust while advancing debate and managing expectations (Box 8). In Mongolia, negative public perceptions of the use of straw-bale slowed its introduction as a possible housing material because it was associated with vulnerability to fire, rodents and humidity. The project had to add awareness-raising activities to remedy this situation (Case Study no. 8). A project team in Viet Nam quantified energy and cost savings to demonstrate the expected benefits of energy efficiency measures to potential participating firms. This helped to initiate discussions with small- and medium-sized manufacturing firms about investing in energy efficiency (Case Study no. 7).

Box 8: Managing expectations in Nepal's rural energy development programme

The experiences from Nepal's rural energy development programme highlight the need to ensure people have realistic expectations about new initiatives.

In its pilot phase, REDP was able to demonstrate positive development outcomes. In response, villages and districts near the pilot area were increasingly interested in being included in the programme and demand rose dramatically. Given the upfront capital investment required for micro-hydro infrastructure, the programme expansion was limited by existing resources.

This led to some antagonistic feelings and perceptions towards the programme and to delays in the release of funding to local committees.

Source: See the case study entitled *Community-based micro-hydro project catalyses holistic development and poverty reduction.*

A range of activities targeted to audiences. Effective awareness-raising entails not one single action but a sequence of actions and events. They may range from demonstrations, advocacy, site visits, short films or other means that help to ground the often perceived complexity of energy technologies in reality. Road shows were organised in Pakistan in villages to display energy-efficient cooking stoves and raise interest for adoption of these technologies while dissemination workshops were

organised for the media and government representatives (Case Study no. 6). In Bhutan, technical staff from the Department of Energy were exposed for the first time to community-based projects through site visits to neighbouring countries to enhance their capacity to work with communities (Case Study no. 19).

Visual, practical and message-oriented tools can complement awareness-raising and sensitisation efforts and are supportive tools for educational purposes if they are targeted to the audience. In Pakistan, various printed materials were developed for the road shows and workshops organised to promote energy-efficient cooking stoves in Pakistan (Case Study no. 6).

3.2.4 Capacity development

While the main focus of capacity development efforts has been the transfer of information on energy technologies, effective capacity development needs to be adapted to the socioeconomic and policy context and build on existing knowledge and practices (UNDP, 2002). Some features of the capacity development approaches used in the case studies in this report are:

Capacity development tailored to the socioeconomic context. Developing activities to enhance capacities to suit the range of needs and adapting them to the socioeconomic profile of the participants will help to deliver effective capacity training for sustainable energy. Being innovative in how capacity development is delivered will help to tailor efforts to the individual, organisational and social capacity needs. Since women in Bangladesh often have less access to energy services than men, a project was designed to train women to become SHSs entrepreneurs, responsible for both assembling and selling the systems through a cooperative-run energy centre (Case Study no. 12).

Technical capacity development. Introducing new or improved technologies by providing the equipment is not sufficient to ensure these technologies are adopted and utilised to their full potential, maintained and operated properly or that they will save time as anticipated (Masika and Baden, 1997). In fact a lack of technical capacity

can often be the main barrier to the expansion of energy services as demonstrated by the CNG project in Bangladesh. The development of the technical capacity of private mechanics and engineers was required for the safe conversion of vehicles to CNG and to build the trust of consumers in using CNG (Case Study no. 5).

Operating equipment and machinery is often considered men's work and remains inaccessible to women. Technical capacity development can be designed so that they are more sensitive to women's needs, offered at times and locations compatible with women's family roles and adapted to women's levels of skills. In Bangladesh, a group of women who assembled and sold solar household systems (SHSs) required a dedicated technical assistance team to provide training in business and other skills, and guidance for a period of over 3 years. The case study showed that, had participants had a higher level of education, they likely would have needed less technical assistance (Case Study no. 12).

Management and business skills. Providing complementary training, especially in management and business skills, is an important means of ensuring that community projects are viable. Training in income-generation activities, basic accounting and literacy, and marketing is a powerful tool to help people diversify their incomes. In Nepal, training in nursery management, house-wiring, radio maintenance, vegetable production and goat rearing has been effective in developing the skills for new income-generation activities and exposing people to new livelihood options (Case Study no. 3). In Pakistan, training was provided to community-based organisations in project management, resource mobilisation, interpersonal communication skills, project proposal writing, reporting skills and information technology (Case Study no. 6).

Capacity of local institutions. Local institutions – local governments, communities and private service providers – are critical to the expansion of decentralised energy services for the rural poor. An initiative to develop SHS entrepreneurship in Bangladesh showed the need to ensure that organisations– in this case an existing NGO – have the necessary in-house capabilities or access to external technical capabilities to deliver the initiative to communities (Case Study no. 12). Another project described in Box 9 in Bangladesh illustrates the role of the private sector.

Box 9: Capacity development in Bangladesh's compressed natural gas sector

A compressed natural gas (CNG) project successfully brought together a broad section of personnel from the national petroleum company, the wider CNG industry in Bangladesh and experts in CNG from North America. This included meetings with North American CNG industry representatives, classroom-style presentations by CNG experts and 'hands on' experience at work sites. The combination of training methods enabled the national petroleum company and the private sector to assimilate the material in the context of their own experiences and needs.

A training program was also carried out in Canada, which was done to create a deeper understanding about the role of government in the development of an alternative fuels programme, CNG fuel technologies and their applications, regulatory frameworks, standards and codes, safety protocols for conversion and refuelling systems, emissions standards and related enforcement issues.

While logistically challenging for both organisers and participants, this approach was effective in 'breaking the mould' such that participants were able to recognise and explore the many different approaches and techniques that can be used in building a CNG industry.

Source: See the case study entitled *Compressed natural gas as a transport fuel for poverty reduction*.

3.2.5 Community ownership and management

Various cases in this report demonstrate that it is not enough just to make energy resources available, but that it is necessary to ensure that end-use devices critical to women and men are actually made available to them and are managed and even owned by them. For a variety of reasons - geographical sparseness, locally available renewable resources, centres spaced far from each other, electricity grid connection planned far into the future - the most cost-effective option for a community may be a stand-alone system (UN Millennium Project et al, 2005). Different models exist for managing and owning small-scale energy systems that can support energy development where there is capacity to operate, maintain and service the systems. These include:

Community management. An example of community management is that of Nepal's rural energy development programme, which supports community members, both men and women, in working in micro-hydro functional groups (Case Study no. 3). These groups deposit revenue (grants, subsidies, loans, equity and tariffs) in the Community Energy Fund and make payments for the micro-hydro system. The installation, operation and management of the micro-hydro system and other energy interventions (such as biogas, improved cooking stove, solar PV) is done entirely by the functional groups. The groups work using a transparent, participatory, inclusive and consensus-based decision-making process. Village women are empowered because they have developed the necessary accounting and literacy skills to manage the systems as well as participating in decision-making.

Community ownership. In Cambodia, the first member-owned cooperative in the country was successfully established that runs its own electrification and distribution system. It is based on community participation through a community energy cooperative model. The cooperative consists of representatives from households and was formed to own, operate, maintain and manage the electricity generation and distribution system and is responsible for the power plant both financially and technically. It has been successful at providing electricity at half the cost of the electricity from diesel-fuelled systems run by private entrepreneurs and with less negative environmental impacts (pollution, noise) (Case Study no. 14).

3.2.6 Technical considerations

Energy projects have a significant technical component to them and require technical support to be effective. Challenges include the need for flexible technologies that are available on a small scale while still taking advantage of the economies of scale that large systems may offer (UNDP GEF, 2004). There is a need to provide energy services using proven, robust technologies that are cost-effective and can be implemented at scale. However, it is not simply the question of choice of technology that is of concern and who benefits and uses it, but the choice of a system as a whole – including the details of who is involved in implementation and how the technology is managed, maintained and repaired (UNDP, 2004bc). Some technical challenges revealed through the case studies in this report are:

Affordable technologies adapted to local needs and conditions. Accessing local research can lead to technological developments whereby existing technologies are adapted to local needs and practices and generate lower-cost solutions (Box 10). In southern Thailand, a rubber drying plant powered with biomass and a solar dryer was installed with the assistance of the Regional Centre for Renewable Energy Development and Energy Efficiency. While technical difficulties arose – drying compartments were too large and insufficiently insulated – these are expected to be resolved in the future with the continued help of the regional energy centre (Case Study no. 11).

Long-term maintenance and warranties. Long-term maintenance of small-scale energy systems and some end-uses remains one of the more difficult problems faced by modern energy technologies and end-uses. Technical warranties, either international or national ones, for the installation, operation and maintenance of systems can help to avoid these problems. For instance in Bhutan, before an initiative to develop community-based micro-hydro systems began, the sustainability of existing micro-hydro energy systems was undermined due to incorrect installation in the beginning, when responsibility for operation and maintenance was not clearly defined or when substandard hardware systems or poor quality services were provided. (Case Study no. 19)

Technical standards for replication. Once technical problems have been worked out, the identification of technical standards can ensure that the project can be more widely replicated. For example, the Aga Khan Planning and Building Service in Pakistan developed, tested and disseminated a number of improved housing products to make them affordable, locally appropriate and environmentally friendly, such as the improved cooking stoves and geysers in the northern part of the country (Case Study no. 6). A similar programme in Sri Lanka, first initiated in 1999, disseminates a widely affordable cooking stove for US$1.75 per unit. Currently 25,000 units are sold per month, primarily to rural households (Case Study no. 14).

Box 10: Technical considerations in designing a solar PV system in Samoa

An initiative to install a decentralised PV system in Samoa to replace an inefficient, noisy and polluting diesel generator was faced with a number of technical challenges to met peak demand. Solutions were devised as follows:

Load and capacity. The new system expanded the number of hours of available electricity, allowing energy use to be spread out over a 24-hour period. To even out electricity use and limit the need for additional, relatively costly capacity, households agreed not to use high-demand, 'low-value' appliances (electric kettles, cookers, toaster ovens or fry pans), to conserve energy during times of cloudy weather and to obtain advice before purchasing and using new appliances.

Environment. High ambient temperatures, high humidity and the salt-laden air have caused premature failures of inverters and charge controllers in other countries. In Samoa, to prevent system failures, components were sealed against salt, insects and moisture. Proper ventilation was included in the design of the inverter and controller housing structure as a measure against the high ambient temperatures.

Flexibility. The project was able to take advantage of new technologies to increase the reliability of the pilot PV system. Use of "stacked" inverters instead of a single large inverter increased system reliability since the failure of one inverter unit will not cause the whole system to lose power. Future increases in peak power can be met by simply adding more "stacked" inverters. The new technology also saves substantially in stand-by ('sleep mode') power requirements.

Simplicity. The system was designed with as many components in common as possible, thereby minimising maintenance and spare parts requirements. By combining all loads into one system, limited maintenance servicing is required resulting in relatively low maintenance costs.

Source: See the case study entitled *A photovoltaic mini-grid system for the Apolima Island.*

Cooperation between technical and non-technical staff. While technical support is critical to the success of energy projects, the ability of technical and non-technical experts to work together is equally important. Many energy experts come from technical or scientific backgrounds and therefore may have little exposure to development projects that sometimes seem more appropriate in the field of management or the social and political realms. In Bhutan, for instance, a project which by its nature was focused on the installation of technical equipment required some difficult changes in perspective for technical staff from the Department of Energy. In order to make the project more cognisant of local needs and priorities, the project implementers had to learn to respect community views, consult communities on the design and implementation of the project and involve community members in participatory progress reviews (Case Study no. 19).

3.2.7 Financial sustainability

Economic barriers can limit the poor's access to energy services. High upfront equipment costs, irregular incomes and lack of access to credit can prevent the poor from obtaining energy services. Different mechanisms such as grants, fees-for-service, micro-financing and subsidies have been used to finance community energy programmes and ensure they are affordable to project participants. However projects need to incorporate a financial 'exit' strategy so that energy solutions can be sustained by project beneficiaries once the project funding ends. This means designing and implementing projects that are financially sustainable and that are eventually self-financed.

Project grants and cost-recovery fees. Charging a fee to recover the cost of providing energy services helps to ensure its efficient use and long-term sustainability. In Mongolia, the nearly full funding of straw-bale by donors and the government has created the perception that it is a no-cost insulation material, bringing into question the financial sustainability of the initiative (Case Study no. 8). In Thailand, a project to power a rubber processing plant was fully funded by donors and other partners. Once the funding ran out, there were no resources available for needed upgrades and the plant is now operating at half capacity (Case Study no. 11).

Approaches need to nevertheless recognise that the poor may be excluded from accessing modern energy services if such services can only be provided on the basis of full-cost recovery. What has been central to successful models is that the consumer does not bear the full cost of the equipment that generates or uses the energy or the cost of the technical assistance to develop the programme. In Bangladesh participants paid a fee-for-service to use the lighting provided by a PV system in a marketplace in the evenings. The fee was enough to support the costs of routine and periodic maintenance (Case Study no. 10).

The feasible level of cost recovery will depend on whether cost-effective solutions are available and sufficient energy savings or additional income can be generated from the improved energy service provided to pay for the cost of the service. An example from Viet Nam shows that with a modest investment significant energy savings can be achieved from an energy efficiency programme. The project invested US$810 and the resulting annual energy savings to the firm was estimated to be US$5,500 (Case Study no. 7). In Mongolia, straw bale insulation for building has been shown to be not only an effective insulation material but a more cost-effective one compared to other insulating materials. It also reduces dependence on coal and health care costs due to indoor air pollution (Case Study no. 8).

Financing and micro-financing. Innovative financing and micro-financing mechanisms can support the effective implementation of energy initiatives, particularly where upfront costs are high. In Bangladesh, poultry owners have been reluctant to adopt a biogas digester technology that has been shown to reduce fuelwood costs substantially, in part because financial institutions have been reluctant to finance these kinds of small-scale energy projects (Case Study no. 9).

Financing modalities have to be workable and flexible enough to adjust to income levels and the financial cycle of consumers. For example, consumers may be willing to pay more when they have more income during harvest time or pay in the form of grains or products like baskets (UN Millennium Project et al, 2005). In Bhutan, a community-mobilisation fund acted as a catalyst fund, where poor community members were allowed to access the funds to initiate small power-based enterprises such as electric threshers, livestock rearing and other products. The loans are paid back at relatively low interest rates (Case Study no. 19).

Where a range of financing mechanisms are used, the rate of penetration of service increases and is more viable (UN Millennium Project et al, 2005). Potential financing mechanisms include equity, loans, self-financing from revenues, subsidies, grants and donations. In Nepal, to encourage rural energy systems to be financially sustainable, the government set up self-governing energy funds at the district and community levels. Resources from central-level agencies are deposited in district energy funds and are in turn allocated to community energy funds. Other sources of funding include community member contributions, revenues from fee-for-services and donor contributions. The community energy fund is owned by groups of rural households and the funds are invested in the construction and maintenance of rural energy systems (Case Study no. 3).

Targeted subsidies. Programmes that involve subsidies can decrease the initial penetration cost if they subsidise upfront costs rather than ongoing costs. Where recurring costs are a barrier, carefully designed subsidies with appropriate exit strategies and low-cost billing schemes can limit long-term costs and reduce waste (UN Millennium Project et al, 2005). In a project in Bangladesh a subsidised upfront cost to SHS entrepreneurs was recovered through monthly instalments over a period of three years. As a result of significant increases in the volume of sales of the systems over the project period, the manufacturers of the systems have been able to pay back the loan that funded the costs of the equipment (Case Study no. 12).

3.2.8 Institutional support and coordination

Energy has historically been managed as a monopoly and the level of decentralisation in the energy sector has been relatively limited compared with other sectors such as health, education and other infrastructure services (UNDP et al, 2005). Nevertheless, local institutions – governments, agencies, NGOs, private energy providers – are important players in the expansion of energy services for the poor.

The active involvement of local institutions can allow rural people's demand to be more accurately profiled, facilitate participatory planning to strengthen the poor's voice in decision-making, allocate resources to priority energy needs and improve accountability frameworks at the local level (UNDP, 2006a). As illustrated in Box 11, a more active role and greater responsibilities for local institutional actors in Nepal effectively accelerated access to energy services for the rural poor.

Box 11: Decentralisation accelerates rural energy services delivery in Nepal

Before the UNDP-supported Rural Energy Development Programme (REDP) began in 1996, rural energy initiatives in Nepal were based on a centralised, top-down approach. This caused coordination problems on the ground that impeded the delivery process.

By moving towards a decentralized institutional approach, the authority to plan local energy programmes has shifted from the central institutions such as the National Electricity Authority (NEA) to the districts. The responsibility to manage and deliver energy services has also been decentralised to communities under the oversight of district committees. A number of institutions have been formed at all levels - community, district and central - to develop local capacities for planning, management and monitoring of energy services for rural households.

This decentralised approach to rural energy service delivery has nurtured local authorities' leadership, led to a strong sense of ownership among the communities, and successfully accelerated the delivery of energy services to rural areas.

Source: UNDP (2005a).

Coordination between sectors. More than one ministry typically controls different forms of energy services. Moreover, the delivery of modern energy often cuts across multiple sectors (UNDP, 2007b). For example, biomass is often managed by the ministry of agriculture, electricity by the ministry of energy and often no ministry is responsible for mechanical power for agricultural processing. This poses the formidable challenge of dealing with multiple sectoral ministries that have different degrees of decentralisation on the ground (UNDP, 2006a). In Bhutan, the involvement of local agencies in a micro-hydro scheme afforded an opportunity for the community to consolidate assistance from the various local agencies. For instance the officials supported communities to engage in intensive stall fed livestock rearing that required new energy inputs (Case Study no. 19).

Private sector involvement. Involving the private sector and fostering public-private partnerships are often effective measures for the development of energy systems and energy entrepreneurship (UNDP, 2007b). For example, in Viet Nam, a project provided overall assistance on energy efficiency to firms. Energy consultants provided the actual technical assistance while the owner of the participating firms covered the costs of the energy efficiency solutions. The technical assistance involved a range of services: system design; monitoring and verification; selection of equipment suppliers; installation of measuring meters; and data processing for the certification of energy savings and carbon dioxide equivalents (Case Study no. 7).

3.2.9 Market development

Like other commercial and service markets, the markets for new energy technologies and end-uses can grow in an organic manner. However, the expansion of energy services is more likely to become a reality if the availability of energy services is effectively used to stimulate enterprises development in rural areas and the rural poor are encouraged to run energy enterprises that generate profits from their operations (UNDP, 2006).

Supply chains. Choosing to deliver basic energy services to communities may involve adopting new technologies for which efficient supply chains often do not yet exist (Box 12). This is often the case with renewable energy technologies. In Mongolia, for instance, a lack of sufficient quantities of construction-quality bailed straw hampered wider commercialisation of the construction material and limited mass market deployment (Case Study no. 8). In Bangladesh, the lack of availability of quality CNG conversion kits and cylinders compatible with different the types of vehicles used in Bangladesh was a challenge in the development of the CNG sector (Case Study no. 5).

Box 12: Commercialisation of renewable energy technologies in China

Up to the late 1990, China's renewable energy markets were poorly developed and activities focused largely on research and development, and pilot demonstrations. Because of a lack of financial incentives, renewable energy technologies (RETs) were still not financially competitive compared with conventional fossil fuel energy sources and technologies. An assessment of RET market potential showed that increasing the market orientation for RETs was essential in order to improve the efficient utilisation of resources.

In order to boost and strengthen national RET markets a programme was designed to remove major barriers to RET market development. Barriers included insufficient demand, low rates of return on RET investments, high degree of investment risk, and insufficient knowledge and experience of policy makers and private sector professionals about RETs. The programme included capacity development, technical certification programmes, and legislative and regulatory reforms.

Source: See the case study entitled Capacity development for the rapid commercialisation of renewable energy.

Improving the supply chain and delivery mechanisms often requires developing the local capacity to deliver energy technologies and end-use applications (UNDP, 2007b). Examples include the SHSs manufactured by women in the remote community of Char Montaz in Bangladesh (Case Study no. 12) and the improved cook stoves and geysers assembled by community-based organizations in Pakistan (Case Study no. 6). In both cases, participants who were involved with assembling the equipment also acted as salespersons. In Sri Lanka, village potters were trained and continue to be trained in the manufacturing of improved cook stoves (Case Study no. 14).

Energy hubs and infrastructure. The effective delivery of energy services benefits from energy hubs or centres in order to disseminate energy services for the poor and those who lack energy access the most. An innovative solution is provided by the development of 'energy centres' in the Char Islands in Bangladesh. Women were trained to become entrepreneurs in SHSs and these were built, sold and repaired at the energy centres, which also provided battery recharging and micro-credit services (Case Study no. 12).

Developing markets is especially challenging for remote areas which suffer from serious infrastructure and communication-related bottlenecks and where poor communities are greatly limited by their lack of education and skills. In Nepal, where there has been effective development of skills among communities, there still remain limitations in translating these skills into profitable business enterprises and increased income, in part because of a lack of sufficient roads and infrastructure (Case Study no. 3).

4

Success FACTORs

Based on the experiences summarised in this report, a number of principles of successful energy projects can be gathered and summarised as follows:

- *Projects should involve participatory processes both at the community level and in policy development at the national level in order to ensure the needs and priorities of communities are addressed.* Projects should be sensitive to the different roles and entitlements between wealthier and poorer members of participating communities, between men and women, and of disadvantaged groups. Consultations should ensure that the poor, women or vulnerable are included.

- *Regardless of whether an integrated approach or a single-issue approach is used, projects must remain focused on securing benefits to reach development objectives that improve the livelihoods of the poor.* An integrated approach addresses the needs of communities based on the community's identified priorities for improving livelihoods. On the other hand, a single-issue approach starts with an identified issue and works to find communities that will benefit from the approach.

- *Gathering and analysing accurate and realistic information on the socioeconomic context, barrier to energy access and the benefits of different options is critical to ensuring projects are designed to reduce poverty and enhance development outcomes.* A common problem in energy development is a lack of understanding of the role energy can play in reducing the burden associated with repetitive or time-consuming tasks and freeing up people's time for income-generation activities, education, health and other basic needs.

- *It is not enough just to make energy available, but it is necessary to ensure that end-use devices critical to women and men are actually made available to them and are managed or owned by them.* This means not only consulting men, women and vulnerable groups directly to understand their energy needs, but also including them in the implementation, management and ownership of a project.

- *Energy end-uses and services for productive purposes can expand opportunities for income generation. It is therefore a very powerful approach to meeting the energy needs of the poor and simultaneously increasing their incomes. However, it should not be assumed that productive uses will occur automatically as a result of the provision of energy services, especially with the expansion of electricity*. Expanding access to reliable modern energy services increases opportunities for income generation for the poor when the energy services provided are designed for productive applications in a way that increases the affordability of basic energy services and also their accessibility. While different approaches can be used, they are all based on improving productivity and livelihood options.

- *Cost-effective solutions exist and can provide affordable, efficient and quality energy carriers and energy services to meet the divergent and differentiated needs of rural populations*. Solutions can be scaled up and mainstreamed, but this requires harnessing the lessons from experiences and building on them, as well as adapting technical solutions to the community needs.

- *A combination of energy sources and technologies is generally needed to satisfy the range of people's needs and priorities, including cooking and heating needs, mechanical power and electricity for illumination, communications and other needs*. Projects can be designed to provide energy services that can free up people's time, reduce the burden of difficult and repetitive tasks, increase productivity and reduce expenditures on energy. Energy efficiency and conservation can provide energy savings, the provision of fuels for cooking and heating needs can reduce the burden of fuelwood collection, indoor air pollution and energy expenditures, which are especially burdensome on women and children, and mechanical power can reduce the burden of repetitive and burdensome tasks, such as milling and grinding.

- *While the main focus of capacity development efforts has been the transfer of information on energy technologies, effective capacity development is best centred on the acquisition of knowledge based on a prior understanding of the local socioeconomic context, technical practices and policy environment*. Being innovative in how capacity development is delivered will help to tailor efforts to the individual, organisational and social capacity needs.

- *The outcomes of energy projects are best ensured when projects take into consideration technical and financial factors, coordinate with local institutions and develop business skills in addition to technical skills*. This involves addressing issues of quality, fit-for-purpose, standards and warranties for maintenance, high up-front costs, a lack of access to credit, a lack of capacity of local institutional partners and energy entrepreneurs.

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