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Natural Resources and Pro-Poor Growth: The Economics and Politics

PART II

Chapter 12

Renewable Energy and Pro-Poor Growth

Access to energy is one of the keys to development and economic growth. However, current systems are not able to provide energy to all in a sustainable and affordable way. This chapter explores the role that renewable energy can play in providing a more sustainable and secure energy supply and support the achievement of the MDGs.

12.1. Overview

Access to energy is one of the keys to development and economic growth, as it provides light and heat, and powers productive machinery and telecommunication equipment. Yet in spite of admirable accomplishments in providing energy for human purposes, it is increasingly clear that current systems are unable to provide energy to all people in a sustainable and affordable way. It is estimated that 1.6 billion people (Flavin and Aeck, 2005; ITDG, 2004) do not have access to modern forms of energy, most of them living in rural areas in developing countries, far from centralised energy systems. Fossil fuel-based energy systems also contribute to greenhouse gas emissions and climate change. Hence recognition is growing that new patterns of energy supply and consumption are needed to move towards more sustainable development.

This chapter explores the role that renewable energy can play in providing a more sustainable and secure energy supply for sustaining economic growth and supporting the achievement of the MDGs.[1] More specifically, it addresses the following two questions:

- What are the potential benefits of renewable energy in supporting pro-poor economic growth and development?
- What policies and measures are needed to harness the potential benefits of renewable energy in supporting pro-poor economic growth and development?

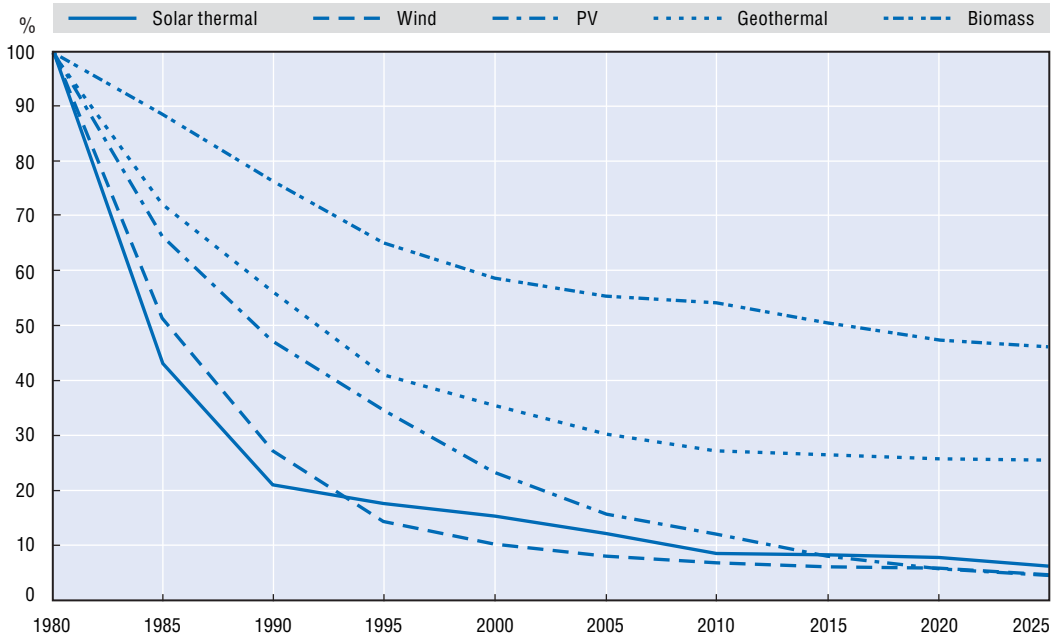
12.2. Recent trends in renewable energy: Renewables on the rise

Over the past decades conventional energy options, largely based on fossil fuels, were seen as economically more attractive than renewable energy applications. However, the economic case for various forms of renewable energy is improving rapidly. Three important trends are favouring renewable energy:

First, the volatile world market prices for conventional energy sources, in particular oil, pose great risks for large parts of the world's economic and political stability, with sometimes critical effects on energy-importing developing countries. Concerns have been expressed that the rising cost of oil, which exceeded USD 140 a barrel in 2008, may slow down recent economic progress in Africa and lead to tighter financial constraints (AfDB, 2006). Moreover, dependence on imported fuels leaves many energy-importing countries vulnerable to disruption in supply, which might pose physical hardship and an economic burden for others. This situation has encouraged many countries to look for alternatives to make them less vulnerable to shocks in the fossil fuel markets.

Second, in the last few years, renewable energy technologies have experienced substantial improvements in cost, performance and reliability, making them competitive today with conventional energy sources in a range of applications. Figure 16 shows how the cost of electricity generation from renewable energy sources has dropped significantly over the last 25 years and it is expected to decrease further in the coming years.

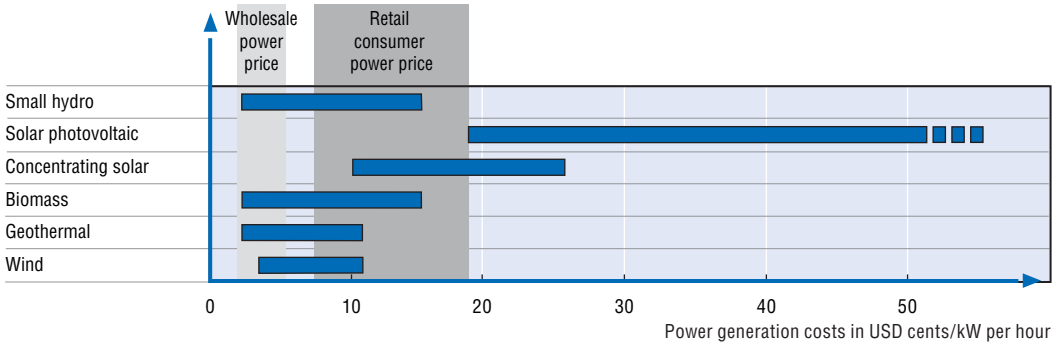
Figure 12.1. **Renewable energy: Electricity generation costs as a percentage of 1980 levels, historical and projected**



Source: UNDESA (2005).

The steady fall of prices for renewables has considerably improved the cost competitiveness of several renewable energy options, making them better placed to compete on the energy market. According to the OECD/IEA, small hydro-power and biomass are already competitive in many wholesale electricity markets whereas, in certain regions, wind and geothermal energy is cheaper than conventional energy sources on the retail consumer market (Figure 12.2). Other technologies, such as solar (photovoltaic or PV), solar water heaters and biomass, are often the most cost-effective options to provide energy services in off-grid areas in developing countries.

Figure 12.2. **Cost competitiveness of selected renewable power technologies**



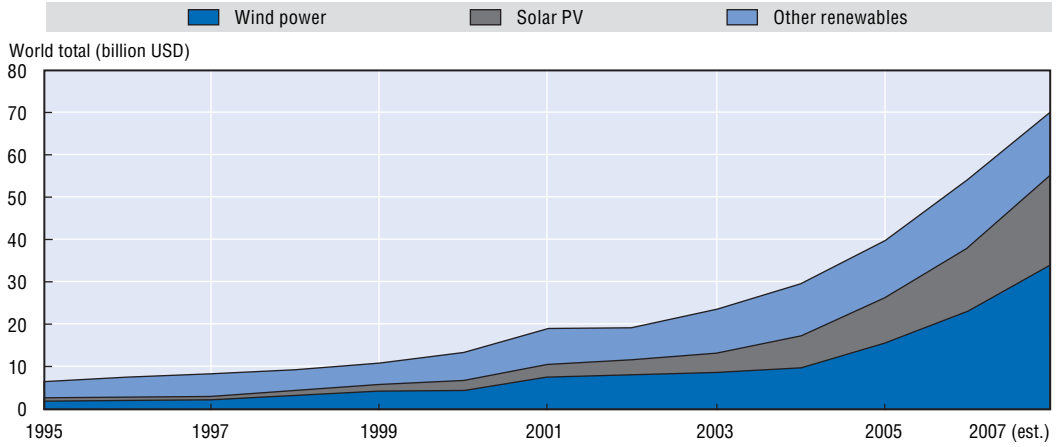
Source: Renewable Energy: RD&D Priorities, OECD/IEA (2006).

Third, according to the most recent assessment report from the Intergovernmental Panel on Climate Change, there is very high confidence that human activities, primarily the combustion of fossil fuels, are responsible for the global warming trend which has been

observed over the past decades. The evidence is also increasingly showing that climate change will eventually damage economic growth, mostly in developing countries. In a recent publication, Sir Nicholas Stern has shown that the benefits of strong, early action on climate change, among other things through the promotion of renewable energy, will outweigh the cost of dealing with the effects of climate change in the future (Stern, 2006).

Taken together, the volatility of the oil markets, the increased cost competitiveness of renewable energies and the growing concerns about the future costs of climate change have thrown new light on the use and potential of renewable energy sources. Policy makers and investors alike have increasingly turned their attention to renewable energy and recent years have seen a steady increase in investment in renewable energy (Figure 12.3) with a record investment in new renewable energy capacity of USD 55 billion in 2006 (REN21, 2008).

Figure 12.3. **Annual investment in renewable energy world total, 1995-2007**
(USD billion)



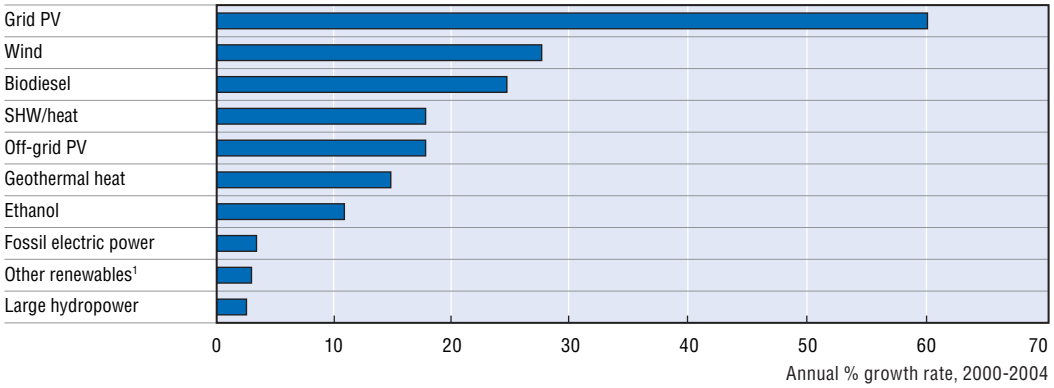
Source: REN21 (2008).

In fact, renewable energies, led by wind, biodiesel and photovoltaic technologies, represent the fastest growing of all energy industries. The worldwide annual growth rate for grid-connected solar PV, for instance, was as high as 60% between 2002 and 2004 (Figure 12.4) and according to market analysts this trend is likely to continue in the future (UNDESA, 2005).

In spite of these advances, the main markets for renewable energy today are in the industrialised countries (with the limited exception of emerging economies such as Brazil, China and India, which have developed markets in biofuels and wind energy).

In developing countries, and especially in Africa, 2 billion people depend on traditional biomass such as wood and dung for cooking and heating, with associated impacts on health, particularly for women and children (UNDP, 2000). Modern renewable energy technologies such as solar, wind, micro-hydro and geothermal resources, remain largely untapped, despite the relative abundance of sunshine, wind, water and underground thermal heat. The figure below gives an overview of the energy potential for solar energy and wind energy in different regions around the world. Globally, Africa accounts for almost half the potential in solar energy and nearly a quarter of the potential in wind energy.

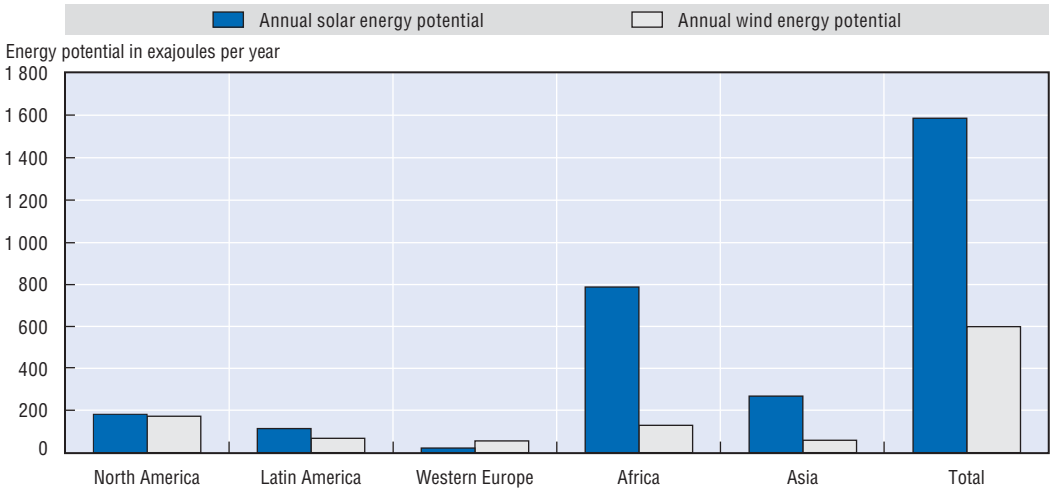
Figure 12.4. **Renewable energy growth rates (UNDESA, 2005)**



1. Geothermal, biomass and small hydropower.

Source: REN21 (2005); OECD/IEA (2004).

Figure 12.5. **Technical potential for solar and wind energy in selected regions**



Source: UNDP (2000).

Africa is also home to more than 15% of the world's potential in geothermal energy, and estimates show that potentially the continent can add more than 80 exajoules of energy from biomass to its energy budget, more than four times as much as all industrialised countries combined (UNDP, 2000).

Box 12.1. **Geothermal energy potential in Africa**

Geothermal energy is the natural heat from the earth's interior stored in rocks and water within the earth's crust. At an international level, approximately 8 100 MW of geothermal power are generated, out of a global potential of 60 000 MW.

Geothermal power exploitation has numerous advantages over other energy sources. Among its benefits are the near zero emissions (true for modern closed cycle systems that re-inject water back to the earth's crust), and the small amount of space required for geothermal power development compared with other energy sources such as coal-fired plants. Geothermal power plants require approximately 11% of the total land used by coal-fired plants and 12% to 30% of land occupied by other renewable technologies.

Box 12.1. **Geothermal energy potential in Africa** *(cont.)*

Kenya was the first country in sub-Saharan Africa to exploit geothermal energy on a significant scale. At present, the country has exploited 57MW of its total potential and plans are underway to increase electricity generation from geothermal energy to 576MW by 2019. Ethiopia's geothermal power installed capacity is 8.5MW, although less than 2MW has been tapped so far.

	Potential generation in MW
Kenya	2 000
Ethiopia	> 1 000
Djibouti	230-860
Uganda	450

Source: Karakezi and Kithyoma (2003).

12.3. What role can renewable energy play in supporting pro-poor growth?

No country has been able to develop its economy beyond subsistence level without access to more than a minimum level of modern energy (G8, 2001). In fact, none of the MDGs can be met without major improvement in the quality and quantity of energy services in developing countries (World Bank, 2005).

Energy is needed for household cooking, lighting and heating; to power small industries and enterprises; to run health centres; to light schools; to power communication technologies; and to fuel transport systems. Renewable energy can play an important role in meeting these development challenges, especially in rural areas for which access to centralised systems is a distant prospect.

One advantage of renewable energy is that it can provide cost-effective and reliable energy services to people in the rural areas where a large part of the world's poor people live. Conventional approaches to electrification, for example through centralised power plant and power line distribution, often by-pass rural communities because they are located too far from the grid, making it too costly to reach them (ITDG, 2004). According to a World Bank study of several developing countries, the cost of grid extension to rural areas typically ranges from USD 8 000 to USD 10 000 per kilometre, not including the cost of materials, which adds an additional USD 7 000. This high cost, coupled with very low capacity utilisation of such grids because of very small loads, makes extension economically unviable for utilities (Flavin, 2005).

Various renewable energy options exist for providing decentralised energy services in rural areas in a cost-effective way. These include, for instance, solar home systems, wind pumps, solar dryers, small hydro, biofuels and village scale mini-grids. The main advantage of such localised energy services is that they can make use of locally available energy resources (sunshine, wind, water and biomass) and therefore avoid the high costs associated with installing extensive grid connections.

The introduction of renewable energy technologies can promote economic development and increase the welfare of people in rural areas. Box 12.2 illustrates how the installation of a micro-hydro system in Nepal has benefited local communities in various ways and has spurred economic growth in the area.

Box 12.2. **Cost-benefit analysis of a micro-hydro system in Nepal**

The Daunekhola micro-hydro system was installed in 1998 with support from the Rural Energy Development Programme (REDP), a joint undertaking of the United Nations Development Programme (UNDP) and the government of Nepal. The programme involves 116 households in the community in Pinthali and makes use of a micro-hydro system with a power capacity of 12 kW, using water from the nearby Daune Khola river.

The installation of the Daunekhola micro-hydro system improved the economic welfare of the community in several ways. Lighting with the new system both reduced household expenses and generated additional income. Electrification has had a positive effect on the health and education of households. It also makes household chores easier and increases the capacity for interaction among members of the community. Access to information through radio and television is another benefit. With increased industrial activity, two jobs have been created in the village. Significantly, an increase in agricultural productivity has been realised through irrigation made possible by the water flowing out from the system. A cost benefit analysis assesses the total present value of the system at about NPR 20 000 000 (Nepalese rupees) or about USD 250 000.

Source: Gorkhali (2005).

Another important advantage of renewable energy systems is that, after the initial investments for installing the system, operational and maintenance costs are relatively low compared with those of conventional energy systems. This can benefit small entrepreneurs by reducing the overall costs of running their businesses and make them less vulnerable to fluctuations in fossil fuel prices.

The potential economic benefits from investing in renewable energy will vary from country to country and from case to case and depend on the appropriate mix of renewable energy used (solar, wind, geothermal, hydro-power or biomass). Nevertheless, experience from the past has shown that adding renewable energy to the energy portfolio of a country can have two major benefits.

First, at the national level, as the use of renewable energy largely depends on locally available resources, it can reduce the need for imports of fossil fuels and as such improve the balance of payments of oil-importing countries. In addition, an increased use of renewable energy can also diversify the energy portfolio of a country and improve price stability in times of rising fossil fuel costs. This leads to enhanced energy security and a more reliable and sustainable energy basis for fuelling economic growth.

Second, at a more local level, studies have indicated that the increased use of renewable energy can offer important opportunities for the creation of local employment and income generation activities through production, distribution, marketing, maintenance and servicing of renewable energy technologies. According to a study from Goldemberg (2004), renewable energies can create up to 116 229 jobs per TWh (terawatt hour) produced as compared with 1 145 for conventional energies (oil, coal and natural gas).[2]

It should also be noted that renewable energy technologies do not solely consist of the expensive, hi-tech solutions of industrialised countries. Locally-developed technologies for delivering fundamental energy services, such as efficiency-improved cooking stoves (built with soil as the main construction material), have been found to provide substantial

economic benefits by saving on both fuel costs and time spent collecting fuel, thereby liberating money time for investment in human development.

Environmental impacts should be taken into account when considering appropriate energy options. Ecosystems support energy systems through services such as water flows for hydro-power and biomass production. Renewable energy technologies are only "renewable" if they do not erode the ecosystems upon which they depend. Every energy production system, even those considered to be "environmentally friendly", has some impact on ecosystems. Degradation of ecosystems will affect future energy choices and potential for their sustainable development.

Box 12.3. **Sustainable small-scale biofuels promoting rural development in Kenya**

While large-scale biofuel development raises concerns over rising food prices, deforestation and competition over land, the potential for small-scale biofuel production to improve energy security and promote rural development should not be ignored. One project in Kenya explores the potential for using the seeds of the jatropha plant as a source of biodiesel and other valuable by-products. A crucial feature of jatropha is that is can be grown on non-agriculturally productive land and requires little water, thereby minimising competition with food crops. By producing biofuel feedstock in addition to food crops, smallholder farmers can generate their own energy sources and increase food production efficiently. Financial risk is also reduced by diversifying income from solely perishable food crops. Biodiversity values can also be enhanced if biofuels are produced on degraded lands such as those abandoned after grazing.

However, the qualities that make the jatropha plant attractive for cultivation also imply invasive tendencies. Careful management and planning is required to contain this risk. Jathropha is not a panacea which will work for every community in every country. Alternative bioenergy choices appropriate to local communities' conditions should be explored.

Source: Presentation by "Trees on Farm Network, World Agroforestry Center in Kenya" made CSD 15 side Event, New York 2 May 2007. Report available at *www.iucn.org*.

12.4. Policies and measures for harnessing the potential benefits of renewable energy

Despite the availability of renewable energy resources (sunshine, wind, biomass and hydro) and the clear benefits for stimulating pro-poor growth, renewable energy has not yet realised its potential on the ground. The main reason for this is that the existing energy markets include a number of obstacles that frustrate the development of markets for renewable energy for the poor.

This paragraph will discuss some of the policies and measures that can be taken by national governments better to harness the potential benefits of using renewable energy. As a complete discussion of the possible policies and measures that are available to governments is beyond the scope of this chapter, the focus will be on those policies and measures that might have direct beneficial effects on poor people's access to energy.[3] These include:

- creating the right environment for attracting private investment;
- establishing a pro-poor playing field for decentralised energy technologies;

- developing renewable energy sector policies and measures;
- installing small-scale financing systems for renewable energy;
- bridging the gap between development projects and small local entrepreneurs.

12.4.1. *Attracting private sector investment*

As was noted above, the potential of renewable energy has been discovered by the capital markets. Private investment in, for instance, grid-connected wind parks and biofuel plantations, is rising sharply. In order to be able to benefit from the current interest in renewable energy projects, governments may consider attracting renewable energy investors as part of their private investment promotion policies. Apart from generic institutional and regulatory frameworks, governments could consider specific policies, including long-term power purchase agreements. Box 12.4 provides the example of how India successfully created the right investment climate for attracting private sector investment in wind energy projects.

Box 12.4. **Wind energy in India**

Over the past couple of decades, shortage of power has emerged as one of the major constraints on growth in India. From enjoying a power surplus in the 1950s and 1960s India has moved to a situation of shortage since the mid-1970s, and has experienced severe energy deficiencies since then. Since India is relatively poorly endowed in terms of conventional energy resources, it has started to look into the potential of energy generation from non-conventional energy sources, especially wind and solar power.

The government of India initially gave impetus to grid-quality power generation by wind turbine technology in the 7th National Five Year Plan (NFYP), which ran from 1985 to 1990. Since then, wind power generation has won a positive response from industries, entrepreneurs and the business community. By the start of the 8th NFYP, grid-quality wind power generation had become the thrust of India's ministry of non-conventional energy services (MNES). The MNES has formulated a series of policy incentives and fiscal incentives that have been successful in the development of the wind power sector. On top of this policy, individual state governments have added supplementary incentives. This total package of incentives has created an attractive investment climate, which has spawned a surge of investment in the sector. In 2003, India stood fifth in the world wind energy rankings, with over 1 700 MW of installed capacity, distributed over the states of Tamil Nadu (61%), Gujarat (14%), Maharahtra (12%), and Andhra Pradesh (7%). The private sector has dominated investment (97%) in these regions.

Source: Television Trust for the Environment (2005), *www.tve.org/ho/doc.cfm?aid=1678&lang=English*, accessed 16 November 2007.

12.4.2. *Creating a pro-poor playing field for decentralised energy technologies*

Several decentralised renewable energy technologies have become commercial products on the international market. These include, for instance, solar home systems and micro hydro generators, solar dryers, and lately also highly efficient wood stoves. To promote distribution of these technologies to the dispersed poor, governments can put into place measures that minimise the investment burden. This can be done by applying specific import duty waivers and has been carried out in, for example, Kenya and Mali (Box 12.5).

Box 12.5. **Promoting solar photovoltaic systems in Africa**

The main market for solar photovoltaic systems in Africa can be found in Kenya, where over 200 companies and thousands of technicians are involved in promoting small solar systems for rural households. Imported solar panels are installed in combination with locally manufactured batteries to power small television sets and electric lights and to charge mobile phones. The government has promoted the development of the market by waiving import duties and VAT. The solar systems have accordingly become directly affordable for the rural poor, leading to a massive market with over 200 000 systems installed to date. In Mali, the government has taken a similar measure for the promotion of the rural application of solar home systems for a period of five years. Also, the government of Tanzania has waived duties on solar equipment since 2001. Both countries have observed a rapid growth of the solar market.

Source: Vleuten, Stam, Plas (2007).

12.4.3. Developing renewable energy sector policies and programmes

Building a supportive macro-economic framework, as described above, may not be enough to ensure rapid introduction of renewable energy technologies. Building awareness and human capacity and creating incentives for developing an efficient and competitive private sector requires specific attention. Therefore, additional ***renewable energy sector policies and measures*** may be required, for instance to support the creation of a renewable energy sector, and to improve the quality level of a local renewable energy market. These can include, for instance, business development support, training, and technical standards and regulations. On the international level there is a significant base of aggregated experience of renewable energy policies and programmes from which governments can learn. Donors can support respective knowledge transfers. The World Bank, for example, has compiled such information in its Renewable Energy Toolkit.

12.4.4. Small-scale financing for renewable energy

Because of the high up-front costs of most renewable energy options and the low cash capacity of poor households, mechanisms, regulation and institutions which provide innovative ***small-scale financing*** should be stimulated in order to reach the poor. The financing can either be channelled directly to poor households or indirectly to local entrepreneurs serving those households. For small-scale micro-finance institutions that provide micro-credit or enterprises that lease equipment and use prepaid meters for fee-for-service provision seem to be the most promising options. The effectiveness of various consumer loan models is probably country-specific, and depends on cultural, financial and legal factors. Boxes 12.7 and 12.8 describe some experiences from different small-scale financing schemes in the pro-poor renewable energy market.

12.4.5. Bridge the gap between large scale development projects and small-scale electricity providers

Large-scale government and international donor efforts to provide technical and financial support for the development of the energy sector are important. However, local entrepreneurs in the informal sector hold the key to energy service provision in the early stages. Local entrepreneurs have low operating costs and can adapt quickly to changing markets but often work in isolation without business support and with limited technical

Box 12.6. **Improving energy access in rural Argentina with renewable energy**

Jujuy is one of 24 provinces of Argentina, located in the northwest part of the country with many rural, poor communities. Before 1996, all electricity services in the area were provided by the provincial energy department, an arm of the provincial government, and were either not reliable or did not reach many rural areas. With the passage by parliament of two laws in 1995-6, the electricity sector was reformed, privatising the distribution of electricity. However, the government then mandated that small or remote villages and sparsely populated areas that could not be feasibly connected to the national grid should be given electricity access (which the central government would subsidise). If the company failed to provide the rural market with the quantity and quality of services specified, it could be penalised by losing the concession for the grid-connected market, which was clearly the more lucrative investment. To respond to rural access challenge, the newly privatised company, Empresa Jujeña de Sistemas Energeticos Dispersos (EJEDSA), provided small hydro-systems, diesel-powered systems (gensets), hybrid PV-wind mini-grid systems, and small solar home systems (SHS) to the area. After almost nine years of continuous work, including undergoing an economic crisis, EJEDSA increased the number of rural connections in Jujuy province by 3 400, benefiting close to 14 000 inhabitants in the region. The majority of these were provided with access to renewable energy (mainly SHS), and the electricity supplied was of sufficient quantity and quality to provide basic illumination and social communications. The results obtained to date indicate that the privatisation of public utilities can, under some circumstances, serve as the most efficient model for development of a renewable energy-based electricity supply in remote areas.

Source: UNDESA (2005).

Box 12.7. **PSAES: The German-Senegalese Photovoltaic Project**

Where private energy entrepreneurs cannot serve the pro-poor market because of low revenues, NGOs sometimes fill the gap with specific payment schemes to supply the largest possible target group with energy access. Studies of villages that had access to electricity supply for a number of years showed that high subscription costs were preventing many households from effectively gaining access. In Diaoulé and Ndiébel this barrier was addressed by the German Senegalese Photovoltaic Project, adapting electricity tariffs to the ability of different groups to pay. As illustrated by the table, three groups were identified. The differentiated prices are shown in the right column.

Group	Income source	Cost of access (euros)
Poor	Agriculture only	4.5
Middle	Agriculture and cash transfers/payments in kind	9
Well-off	Trades and employees (teachers, nurses, etc.)	22

The power stations are managed by village committees that deal with protection of the facilities, billing, requests for connection, system extension, elimination of fraud and payment collection. As a result, the access level is now 93% in Diaoulé and 98% in Ndiébel. All of the households connected use electricity for lighting and around 2.5% also use it for productive purposes (*e.g.* selling ice and fresh drinks, engaging in crafts, etc.).

Source: Sarr and Thomas (2005).

Box 12.8. **Solar home system electricity provision: Yeelen Kura, Mali**

Yeelen Kura, meaning "new light" in the Bambara language, aims to supply electricity to some 5 000 households spread across 20 villages in the cotton-growing region of Koutiala through the introduction of solar home systems, using a fee-for-service approach. The customer "hires" the SHS and pays a service fee monthly in advance. Yeelen Kura retains ownership of the SHS and takes responsibility for the cost of maintenance. This ensures that the SHS will continue to work in the longer term. The service fee depends on the size of the SHS and the amount of the subsidy.

In Yeelen Kura, three service levels have been introduced, varying from two to four power points and, if chosen, a connection for radio/TV, for five hours a day. Customers pay a fee that depends on the service level for which customers opt. Fees for the services are determined in such a way that in principle they are affordable by the customer. The fees are comparable to the cost of the lamp oil, candles and batteries, for example, that the SHS replaces and should reflect the costs of maintenance and operation of the company.

The head office of Yeelen Kura is in Koutiala, and some 15 local energy stores have been set up in bigger rural villages within a radius of 400 km, where one or two employees are stationed. Out of 35 employees, 20 are responsible for installing, maintaining and, if necessary, repairing the systems, collecting the monthly fees, and carrying out the local book-keeping. They also have a commercial responsibility. In the future these rural energy stores will also be able to offer other energy services.

Source: NCDO, 2006.

and financial management skills. This leads to a disconnection between local activities and large-scale donor and government efforts. This gap can be bridged by systematically building the capacity of small and medium-sized enterprises, by promoting decentralised approaches and by more directly encouraging the participation of local entrepreneurs and investors in the design and delivery of energy services.

12.5. Conclusion

Governments and investors are increasingly interested in renewable energy technologies. Apart from their great potential to satisfy the non-served energy needs of the poor in a sustainable way, they offer attractive economic benefits and an opportunity for job creation.

The case studies presented above show how governments of various countries have succeeded in developing the right policies and programmes for the successful adoption of renewable energy technologies. Successful countries attribute their success to a combination of an active government and a committed private sector.

National governments have demonstrated successful support of renewable energies through measures in the fields of attracting foreign direct investment, developing supportive fiscal policies, developing sectoral programs, and supporting small-scale financing for renewables.

In addition, the international policy environment is becoming increasingly supportive of oil-independent and climate-neutral (low carbon-emitting) energy sources. With various renewable energy technologies now mature and with their introduction challenges

increasingly well understood, it would be sensible to consider the increased application of these technologies.

Notes

1. It should be noted that renewable energy should be used in conjunction with energy efficiency as the two are highly complementary. Renewables increase the supply of energy services, and efficiency reduces the demand (UNDESA, 2005).
2. Photovoltaic energy is usually generated (and used) in small modules of 100 watts and the generation of 1 TWh would require typically 10 million modules to be installed and maintained.
3. It should be noted that each country has unique circumstances and should design its own system, and combination of policies, based on needs, circumstances and available resources.

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