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ITDG

PRACTICAL ANSWERS
TO POVERTY

Sustainable Energy for Poverty Reduction: an Action Plan

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Executive summary

Sustainable development will only happen if poverty is tackled and the environment is protected. It is a false dilemma to say that we either tackle poverty or we save the planet. ITDG and Greenpeace believe that poverty can be tackled without costing the Earth. Crucial to both is the rapid expansion of clean, sustainable and renewable energy.

There is now a growing consensus amongst policy makers that energy is central to reducing poverty and hunger, improving health, increasing literacy and education and improving the lives of women and children.

Some 1.6 billion people in the world, more than a quarter of humanity, have no access to electricity and 2.4 billion people rely on wood, charcoal or dung as their principal source of energy for cooking and heating. This fuel is literally killing people. Two and a half million women and children die each year from the indoor pollution from cooking fires.

The poor face another threat, paradoxically because of the over consumption of energy. Industrialised countries' excessive fossil fuel consumption is driving climate change, and the poor are bearing the brunt because poverty makes them the most vulnerable and least able to cope. Thousands have already died and millions more made homeless due to extreme weather events. The Intergovernmental Panel on Climate Change described Africa, the world's poorest region, as "the continent most vulnerable to the impacts of projected change because widespread poverty limits adaptation capabilities".

The rapid expansion of clean and sustainable energy offers a win-win for the poor and the environment. For the poor, particularly the rural poor, without basic energy services, renewable energy is often the cheapest option. For industrialised countries a massive uptake of renewable energy will help to achieve the dramatic emissions cuts needed to avoid climate change. The growth of renewable energy is both necessary to provide energy services without choking the planet and to create the economies of scale necessary for a global expansion of renewable energy.

This report reviews some international actions taking place to provide sustainable energy services to some of the world's poor. Three countries, China, Peru and Mozambique, have been analysed to demonstrate how they are addressing access to energy. Examples are given of implementing energy initiatives, which demonstrate the clear role that sustainable and renewable energy technologies have in fulfilling the energy needs of poor people in these countries.

The cost of getting energy to the world's poor is not prohibitive. To light up the homes of 1.6 billion people with clean sustainable energy will cost in the region of US \$9 billion a year for ten years. This compares with between

US \$250 and US \$300 billion a year spent on subsidising fossil fuels and nuclear power.

World leaders at the World Summit on Sustainable Development have a historic opportunity to face the greatest threat to our collective survival because of our unsustainable use of energy. They must decide to answer the needs of nearly two billion poor people who lack access to sustainable modern energy services and also to change the conventional energy development path of industrialised countries towards renewable technologies.

An action plan for sustainable energy for poverty reduction

Sustainable, clean energy can play a key role in reducing the huge burden of poverty and environmental degradation around the world. In order to maximise the role of clean and renewable energy in poverty reduction significant steps forward must be made to:

- implement strategies which will allow access to clean energy for the world's two billion poorest people in ten years
- greatly expand global renewable energy markets particularly in the North to create economies of scale
- stimulate clean and renewable energy markets in developing countries to increase energy options available for sustainable development

Clean renewable energy is defined as modern biomass, geothermal, wind, solar, small scale hydropower and marine energy.

The action plan sets out a clear agenda for achieving the win-win goal of poverty reduction and action on climate change.

International declaration

An international declaration must produce a 'Sustainable Energy Action Plan' to both:

- massively expand the use of renewable energy North and South, and
- ensure access to sustainable and renewable sources of energy to the two billion of the world's poorest people who currently do not have access to basic, modern energy services, in ten years as a fundamental part of achieving the Millennium Development Goal of halving the people in poverty by 2015.

In order to implement this plan we call on all governments to:

- Ensure that International Financial Institutions (IFIs) immediately target 20 per cent of energy sector lending and support towards renewable

energy development and energy efficiency programmes and phase out such lending in five years.

- Phase out subsidies to conventional energy sources within ten years, with a transition plan and flexible time frames to avoid undue hardships on developing country economies overly reliant upon conventional energy sources and exports.
- Make available the finance and infrastructure needed to create systems and networks to deliver the seed capital, institutional support and capacity building to support and facilitate the creation of sustainable energy markets of the developing world.
- Target aid towards halving the number of deaths from indoor air pollution from cooking stoves by 2015 by increasing support for clean cooking strategies.
- Provide one billion people with improved, clean stoves by 2015.

1 Introduction

1.1 Background

There does not have to be a conflict between the goals of reducing poverty and protecting the environment ...

There is a false dilemma at the heart of the debate around sustainable development: “to eradicate poverty or to save the planet.” Politicians often exploit this apparent dilemma, accusing environmentalists of putting the environment above poverty reduction and accusing the developmentalists of doing the opposite. However there does not have to be, and indeed cannot be, a trade-off to achieve sustainable development. It is possible to both protect the rich resources of the planet and attack poverty. The crucial issue is how. This paper shows how the rapid expansion of sustainable and renewable energy can reduce poverty without costing the earth.

The world faces a crucial decision at the beginning of the 21st century. For our own survival and the planet's, it is essential to cut back greenhouse gas emissions in order to reverse, or even slow down, the current rate of global warming, and to dramatically cut the current obscene levels of poverty. There must be a commitment to both. There are internationally agreed targets on poverty reduction, the Millennium Development Goals, and greenhouse gas emission reductions, the Kyoto Protocol. But neither will be achieved if the right decisions are not taken at the World Summit on Sustainable Development.

Central to all this is the use of energy in all its forms. The rich industrialised countries burn fossil fuels at a phenomenal and unsustainable rate and are primarily responsible for causing global warming. Meanwhile nearly two billion of the world's poorest people never get to switch on a light bulb and are suffering the worst impacts of climate change because poverty means they are least able to cope.

To tackle these common causes, a coalition is building between environmental and development organisations. As a part of this move, ITDG and Greenpeace have joined forces to demonstrate the huge potential for sustainable and renewable energy technologies to provide clean, appropriate and efficient energy services to the world's poorest people. There is no need for developing countries to follow the unsustainable fossil fuel patterns of industrialised countries. A long term view is required and urgent action needed so that developing countries are not locked into unsustainable, and ultimately more expensive, energy paths, but are able to harness local indigenous sustainable energy resources which can help tackle poverty.

Energy and poverty

Energy and poverty are linked. Energy is crucial to reducing poverty and hunger, improving health, increasing literacy and education, and improving the lives of women ...

Energy is central to reducing poverty, providing major benefits in the areas of health, literacy and equity. More than a quarter of humanity has no access to modern energy services. In sub-Saharan Africa 80 per cent of people have no access to electricity.

However the first energy priority of people living in poverty is how to meet their household energy needs for cooking and heating. They depend almost exclusively on burning biomass – wood, charcoal and dung.

Poor people spend up to a third of their income on energy, mostly to cook food. Women, in particular, devote a considerable amount of time collecting, processing and using traditional fuel for cooking. In India, two to seven hours each day can be devoted to the collection of fuel for cooking¹, whereas in rural sub-Saharan Africa, many women carry 20 kilograms of fuel wood an average of five kilometres every day². This is time that could be spent on child care, education, socialising or income generation. The World Health Organisation estimates that 2.5 million women and young children in developing countries die prematurely each year from breathing the fumes from indoor biomass stoves³.

The UN Commission on Sustainable Development (CSD) identified access to sustainable energy services as an essential element of sustainable development last year. The Commission stated that, “to implement the goal accepted by the international community to halve the proportion of people living on less than US \$1 per day by 2015, access to affordable energy services is a prerequisite.”⁴

Although the Millennium Development Goals to reduce poverty omit any specific reference to the role of energy, access to energy services is a crucial element in achieving the goals.

The goal of halving poverty by 2015 will not be reached without energy to increase production, income and education, create jobs and reduce the daily grind involved in having to just survive. Halving hunger will not come about without energy for more productive growing, harvesting, processing and marketing of food. Improving health and reducing death rates will not happen without energy for the refrigeration needed for clinics, hospitals and

¹ UNDP, UNDESA and World Energy Council (2002) quoted in the International Energy Agency's World Energy Outlook 2002; *in press*.

² <http://www.allafrica.com>, *ibid*

³ *ibid* 1

⁴ Commission on Sustainable Development, ninth session, Agenda Item 4, Decision, Energy for Sustainable Development, Section 6.22

vaccination campaigns. The world's greatest child killer, acute respiratory infection, will not be tackled without dealing with smoke from cooking fires in the home. Children will not study at night without light in their homes. Clean water will not be pumped or treated without energy.

Poverty and climate change

Poor people are most vulnerable to global warming because they lack the resources to cope with crises resulting from climate change ...

If the world continues following a 'business as usual' energy path, the current projections of increased energy demand threaten a massive disruption of the global biosphere. Climate change is a direct threat to sustainable development itself, especially in developing countries that are the most vulnerable, yet least able to cope.

Thousands have already died and millions more made into homeless refugees due to extreme weather events caused by the changing climate⁵. The impacts of climate change are being felt world-wide from the Arctic to the Antarctic. The recent Third Assessment Report (TAR) from the Intergovernmental Panel on Climate Change (IPCC) is the clearest scientific analysis yet of the climate impacts which are happening now and can be expected in the coming years⁶. The impacts on millions of poor people living in the developing world are harsh and "Africa is the continent most vulnerable to the impacts of projected changes because widespread poverty limits adaptation capabilities"⁷. Poverty limits their capacity to cope adequately to climate changes such as increased drought, famine, floods, threats of epidemics, cyclones, and other catastrophes.

Climate equity

The rich world is mainly responsible for greenhouse gases and must take the first steps to combat climate change ...

The paradox is that those who are the most vulnerable to climate change are the ones who have done least to pollute the planet. And the real polluters will be the last to pay.

⁵ While it is not possible to identify one particular flood or drought as directly caused by climate change as there are several other contributory factors. The World Disasters Report of the International Federation of Red Cross and Red Crescent Societies (2001) identified the increase in the number of hydro-meteorological disasters such as floods, wind storms and drought as a major cause in the increasing number of people being affected. It further identified global warming as one of the "root causes" which "need identifying and tackling." Also see Parry, M. et al 2001, *Millions at Risk: Defining critical climate change threats and targets in Global Environment Change*. 11:3; 1-3.

⁶ IPCC Third Assessment Report Reference

⁷ IPCC The Regional Impacts of Climate Change, Chapter 2: Africa.

The Climate Convention acknowledges that the industrialised world is mainly responsible for the build up of greenhouse gases. It calls for “differential and shared responsibilities” so there is “global interdependency and shared responsibility”⁸. In other words the poor are least responsible for climate change and efforts to combat the problem must be taken in the first place by the industrialised countries. In the future, developing countries will also need to take measures but without compromising their rightful aspirations to achieve sustainable economic development.

Most governments and politicians in the industrialised world now acknowledge the global impact of climate change. At a limited but significant level, some have even taken the first tentative steps to move away from carbon based fuels and expand renewable energy technologies. However, industrialised countries are selling to developing countries the same sources of energy which are increasingly being rejected in the North⁹. Furthermore, the expansion of large power generating capacity has not been able, and will not be able in the coming decades, to supply the much needed energy services of the poorest people.

The role of sustainable, clean renewable energy

Expanding renewable energy is a win-win objective – cutting greenhouse gas emissions in the industrialised world and getting cheaper energy in the long run to the world’s poor ...

To achieve the dramatic emissions cuts needed to avoid climate change – of the order of 80 per cent in Organisation of Economic Co-operation and Development (OECD) countries by 2050 – will require a massive uptake of renewable energy. The targets for renewable energy must be greatly expanded in industrialised countries both to substitute for fossil fuel and nuclear generation and to create the economies of scale necessary for a global expansion of renewable energy.

Fossil fuel and nuclear energy sources are polluting and expensive and, because of local, regional and global impacts, they are unacceptable sources of power for sustainable development. But new sustainable renewable energy sources are developing and prospering, even if they are in an unfair market fighting against huge subsidies, estimated at between US \$250 billion and US\$300 billion a year, to fossil fuels and nuclear. For example, wind power is a global industry growing at over 30 per cent per year.

We have a 20-year window of opportunity in order to choose our global energy pathway. Shall we choose to continue down the ‘conventional’ energy development path, using fossil fuel and nuclear technologies? Or shall we

⁸ Framework Convention on Climate Change.

⁹ In the UK, a coal-fired power station has not been built since 1972, yet the UK government continues to fund the development of coal power stations in the developing countries.

choose – North and South – to pursue a truly sustainable development path of sustainable, clean renewable energy?

In other words, should the South suffer from the dumping of polluting technologies which locks them in to a cycle of energy production which will become more expensive due to international agreements that will increasingly put a high price on carbon intense fossil fuels? Or should there be an expansion of the new renewable energy that can underpin economic development but not at the expense of the planet and its people?

For the billions of mainly rural poor without access to basic energy services and with no prospects of getting such access under 'business as usual' scenarios, renewable energy can often be the cheapest option in the long run, even when the social and environmental costs are currently not included in the costs of fossil fuel technologies. For immediate sustainable purposes, there is clearly a need for public financial support to get these technologies to the places where they're most needed: rural communities and the urban poor. That said, all renewable sources of energy will need high level political commitment in order to compete with other traditional and polluting sources.

An agenda for action

A plan of action to get energy to the poor must be agreed at the World Summit on Sustainable Development ...

World leaders at the World Summit on Sustainable Development have a historic opportunity to tackle the greatest threat to our collective survival – our unsustainable use of energy. The world leaders can and must decide to answer the needs of the two billion poor people who lack access to sustainable modern energy services. They also can and must decide to change the conventional energy development path of industrialised countries towards renewable technologies.

This report reviews some international actions currently taking place to provide sustainable energy services to some of the two billion who currently lack access. Three countries, China, Peru and Mozambique, have been analysed to demonstrate how they are currently addressing the problem of energy access. In particular, examples are given of implementing energy initiatives, which demonstrate the clear role that sustainable and renewable energy technologies have in fulfilling the energy needs of poor people in these countries. These case studies are detailed in the Annexes.

Finally, an action plan for achieving the goal of sustainable and renewable energy technologies for the two billion is presented. This provides a clear and concerted agenda for change, involving direct action from all stakeholders (international agencies, national governments, local governments, communities, NGOs and private sector companies) towards the unified goal of providing sustainable energy to reduce the huge burden of poverty and impede the massive disruption of the global biosphere. The goal is to provide clean, sustainable energy to those without.

1.2 Who are the two billion without access to modern energy?

Current use of biomass

More than a third of humanity rely on wood and animal dung for cooking and heating. Some 2.5 million women and children die each year due to indoor pollution from cooking fires ...

It is estimated that about 2.4 billion people (52 per cent of the population in developing countries)¹⁰ rely on biomass fuels (wood, animal dung, charcoal and crop residues) for cooking and heating. In addition there are many small industries, such as food processing, metal working and brick making, which use biomass as their primary fuels. Table 1 shows the current population dependent on biomass.

Table 1: Population who depend on biomass fuels

Region	Population using biomass (millions)	Percentage share in total population
China	706	56
Indonesia	155	74
Rest of East Asia	137	37
India	585	58
Rest of South Asia	128	41
Latin America	96	23
North Africa/Middle East	8	0.05
Sub-Saharan Africa	575	89
Developing Countries	2,385	52

Source: World Energy Outlook 2002; in press

The reality for these people is stark. Women and children can spend up to seven hours a day gathering firewood, leaving less time for other activities such as child-care, education and income generation. Smoke from the burning of biomass on open fires kills 2.5 million of women and children¹¹ a year. Smoke is a major factor contributing to the contraction of acute respiratory infection, which kills more children under five than malaria or TB¹². In addition, prolonged exposure to smoke dramatically increases the likelihood of very young children and women developing chronic lung

¹⁰ WEO 2002, *in press*

¹¹ UNDP, UNDESA and World Energy Council (2002) quoted in the WEO 2002; *in press*

¹² WHO Press Release, Environmental hazards kill at least three million children aged under five every year, March 2002, (<http://www.who.int/phe/cep>).

disease, as well as raising the risk of still births, and is now being linked to blindness and immune system changes¹³. Simple, low-cost solutions to deadly indoor air pollution are available, including chimney stoves, smoke hoods, switching to cleaner fuels and improved ventilation. Clean renewable sources of energy and efficiency in the use of biomass, provide another long term solution.

At the moment the majority of these people live in rural areas. However, urbanisation is one of the defining trends in the developing world today. In 1950, 29.7 per cent of the world's people lived in cities; by 1999 the figure was 47 per cent. Nearly four times as many people now live in cities, with most of this growth taking place in developing countries.

Cities generate three quarters of global CO₂ emissions. It is expected that by 2025 over 60 per cent of the world's population will be living in urban areas. Many poor people living in cities in the developing world are still dependent on traditional fuels (wood and charcoal) for their principal energy needs.

Access to electricity

More than a quarter of humanity don't have access to electricity. It will take 80 years to light up Africa under current trends...

Over 1.6 billion people do not have access to electricity. Table 3 shows the percentage of rural households with access to electricity in the South, although this does not make a judgement on the quality of supplies which is often very poor in many areas of developing countries. If current trends continue, by 2030 1.4 billion people will still not have electricity¹⁴. At the current rate of connections it would take more than 40 years to electrify South Asia and almost 80 years for sub-Saharan Africa.

This report argues that it does not have to be 'business as usual'. There are quicker, often cheaper and certainly more sustainable ways of delivering the modern energy services that people need through the expansion of renewable energy sources.

¹³ World Bank Group 'Indoor Air Pollution, Energy and Health for the Poor' (Issue No.1, September 2000 <http://lnweb18.worldbank.org/>)

¹⁴ WEO 2002, *in press*

Table 2: Electricity access in 2000

Region	Population without electricity (millions)	Population with electricity (millions)	Electrification Rate (%)
Developing Countries (total)	1634.2	2930.7	64.2
Africa	522.3	272.7	34.3
Developing Asia	1041.4	2147.3	67.3
Latin America	55.8	359.9	86.6
Middle East	14.7	150.7	91.1
Transition Economies	1.8	351.5	99.5
OECD	8.5	1108.3	99.2
World	1644.5	4390.4	72.8

Source: World Energy Outlook 2002, in press

Table 3: Percentage of rural population with access to electricity

Region	Percentage of rural population with access to electricity
South Asia	19
China	94*
Sub Saharan Africa	4
Rest of Africa	21
Latin America	27

*In China there are still 70 million people with no electricity (see Annex A)

Source: Rural Energy Services: A handbook for sustainable energy development, Anderson et al, ITDG Publishing, London, 1999.

1.3 Energy service options

People need the services energy provides for lighting, studying, processing of food. These services will help halve poverty, reduce hunger, improve health, increase literacy and give women more choice...

Energy services are currently provided by a wide range of sources including fossil fuels (diesel, gas, oil), large scale hydro, nuclear and renewable energy (biomass, solar, wind, small scale hydro). However, it isn't the energy itself but the services which energy provides that are important to people's needs: additional hours for studying because of improved lighting, cooking food, pumping water etc. This is clearly illustrated below, with reference to the Millennium Development Goals.

Sustainable energy is central to achieving the Millennium Development Goals

Halving extreme poverty: freeing up time spent gathering fuel, increasing income and employment through enterprises that need energy (such as workshops, sawmills, welding and metalworking, etc).

Halving the number of people living with hunger: approximately 95 per cent of the food we eat has to be cooked, and most foods need energy for processing of some kind. Hunger is related to poverty, so efforts to eradicate poverty should help eradicate hunger. Energy is needed to process food (such as grinding cereals) and to produce food (such as water for irrigating agricultural land)

Achieving universal education: extended study opportunities in the evening, access to information and communication technologies and long distance learning materials.

Promoting gender equality: reducing drudgery of arduous tasks, mostly undertaken by women, such as grinding and food preparation, increased opportunity for enterprise, opportunities for evening education due to lighting for night classes.

Reducing mortality / improving health: through reducing indoor air pollution from household smoke, better health facilities through vaccination, refrigeration services and modern hospital equipment.

Ensuring environmental sustainability: conventional energy is a contributor to greenhouse gas emissions and local environmental and social degradation, but newer cleaner technologies can provide a sustainable alternative.

These services can all be provided by modern renewable energy sources:

Table 4 shows the various options to supply the electricity that provides many of the above services. Low power refers to appliances that do not require transmission or distribution lines, such as battery-charging, lights, radios, television or computers. High power refers to equipment that requires larger amounts of power such as milling, sawmills or water pumping.

Poor people will use electricity for lighting, battery charging, radios and running small domestic appliances. They are unlikely to use electricity for cooking and heating as the high cost is prohibitive. In the short term improved use of wood, charcoal and biogas will be the main alternative for cooking.

It must be noted that large hydro power is not considered to be a renewable energy option due to the huge negative impact it has on the local environment and on the people displaced by water flooding. There is also strong evidence to show that large hydro power schemes emit levels of greenhouse gases often equivalent to fossil fuel power plants, due to the decaying of biomass covered by the reservoir.

Table 4: Comparison of different electrification options

Electricity Source	High Power	Low Power	Capital Cost per connection	Running cost	Comments	Social and environmental impacts
Grid Connection	√√√		Low-High (depending on remoteness)	Low	Can supply all services but can be expensive to supply sparse rural areas.	Requires centralised production, often from fossil fuels producing greenhouse gas emissions. Locally polluting and socially disruptive. Lack of local control.
Diesel Generator	√√		Medium	High	Well known, available but expensive to run. Also supply of diesel to rural areas can be irregular.	Causes local atmospheric, noise and ground pollution.
Micro Hydro	√√		Low-High	Low	Good option for supplying many energy services. Long lifetime.	Depends on water availability. Low environmental impact.
Pico Hydro		√√	Low	Low	Good for household energy other than cooking.	Depends on water availability. Very low environmental impact.
Solar Home System		√√	High	Low	Expensive household option. Low running and maintenance costs. Provides power for lights and TV.	Pollution free.
Solar Lantern		√	Medium	Low	Portable, simple, cheaper than SHS could run radio, not TV.	Pollution free.
Wind Generator	√	√√	Medium	Low	Can provide large scale capacity as well as small scale. It can be competitive with conventional power generation.	Depends on wind availability. Very low environmental impact.

2 International initiatives to get energy to the poor

2.1 Existing international initiatives

There is a growing agreement amongst policy makers that energy and poverty are linked. There is an abundance of international initiatives which try to get energy to the world's poor, but billions are still without ...

Getting clean sustainable energy to those who do not have energy has been rising up the international policy agenda in recent years. This reflects a recognition to improve poor people's access to improved basic services such as health and education, transport and water supplies. Recent evidence has demonstrated the importance of energy in supplying services as well as generating jobs and income. Recent pronouncements about energy by important international institutions include:

- **UN Commission for Sustainable Development 9th Session (CSD9)** acknowledged that access to sustainable energy services is an essential element of sustainable development stating that: "To implement the goal accepted by the international community to halve the proportion of people living on less than US\$1 per day by 2015, access to affordable energy services is a *prerequisite*."¹⁵
- **G8 Renewable Energy Task Force**, commissioned by the G8 in 2000 to report on how the barriers to the expansion of renewable energy can be overcome particularly in the South and how the G8 should support the dissemination of renewable energy for the world's poor. It made significant policy recommendations on how to achieve access to renewable energy supplies for 800 million people in developing countries. Unfortunately the recommendations were not fully supported by all G8 members, but they do represent the views of a large group of recognised international experts in the field from governments, industry and NGOs.
- **UNDP and the World Energy Council** have published the World Energy Assessment with recommendations about how the provision of energy to poor people could be accelerated. In addition, the forthcoming UNDP publication "Energy for Sustainable Development: A Policy Action Agenda" discusses critical energy policies, illustrated with concrete examples, necessary to address development objectives, including economic growth, equity and environmental protection. It is expected to be available in September 2002.
- **The European Union Initiative on Energy for Sustainable Development (ISED)** aims to contribute to providing the access to energy necessary for the achievement of the MDGs. The EU proposes to work with developing countries towards creating the necessary

¹⁵ Commission on Sustainable Development, ninth session, Agenda Item 4, Decision, Energy for Sustainable Development, Section 6.22

economic, social and institutional conditions in the energy sector to achieve their national development goals, in particular by providing and improving energy services for the 'energy poor'.

- **The Department for International Development in the UK** will publish its "Energy and the Poor" paper at WSSD. This emphasises the important role of energy as an enabling factor for achieving the MDGs. However, there remains no commitment to targets or timetables for the expansion of renewable energy sources. Other bilateral agencies such as DANIDA (Denmark), USAID, DGIS (Netherlands), BMZ (Germany) and SIDA (Sweden) are also actively involved in small scale renewable energy activities for poverty reduction.
- **National Governments** in developing countries are preparing Poverty Reduction Strategy Papers (PRSPs). These define their commitment for reducing poverty and make proposals for the actions needed to provide improved services in a number of sectors to achieve the MDGs. The first completed PRSPs show that while only 50 per cent of the papers make a specific priority of the need for energy investment, energy will be an essential enabling factor in the achievement of the strategy for all other sectors and all MDGs.
- **The UN Conference on Finance for Development at Monterey, March 2002** declared a financial commitment to fund the achievement of the MDGs, each of which requires investment in improved energy services. Although the conditions attached to divestment of financial resources, particularly those from the US, raises questions about its value. Furthermore, the vast majority of industrialised countries fall far short of meeting the UN goal of 0.7 per cent of GNP for development aid contribution. Official development aid to Africa has fallen by some 6 per cent each year since 1995.¹⁶
- **Organisation of Economic Co-operation and Development (OECD)** has issued a statement of intent to participate in a global effort to provide energy services to those currently without access and to encourage the involvement of private finance. However the International Energy Agency, which represents OECD, says that with current policies there will be little improvement in the availability of modern energy to those who currently lack access, particularly in sub-Saharan Africa (electrification rate 0-20 per cent) and South Asia (electrification rate 40-70 per cent), where growth prospects are limited by affordability¹⁷.
- **The World Bank's new Energy Strategy**¹⁸ proposes direct help to the poor by providing finance and technical assistance for: facilitating access to modern fuels and electricity; supporting energy needed for social services (education, communications, health); improving the macro and fiscal balances by replacing inefficient application of public funds by more directed subsidies for the poor; encouraging private investment; improving regulation of the energy industry; and removing market barriers

¹⁶ OECD (2002), quoted in WEO 2002, *in press*.

¹⁷ IEA World Energy Outlook 2002, *in press*

¹⁸ World Bank Business Renewable Strategy 2002

to renewables. For the areas of the world with the most acute problems of access to energy services (Africa and South Asia), the World Bank will focus on demand-driven infrastructure investments through such mechanisms as “Community-Driven Development” (CDD) (currently US \$2 billion per year in all sectors), Social Investment Funds (SIF), reform and privatisation of transmission and distribution, and investment in rural energy and renewables. However, this very positive World Bank Energy Strategy must be balanced with their on going financial support to huge traditional fuel projects. Currently, the way the World Bank is encouraging private energy investments is largely facilitating the increased use of conventional fuels instead of developing the use of renewable sources.

- **Private investment** in energy infrastructure rose strongly during the 1990s to US \$46 billion per year in 1997, but has declined sharply since the Asian financial crisis, and in 1999 was less than US \$15 billion. It has now recovered to US \$30 billion in 2000. This investment is concentrated in generation and divestiture (privatisation) in Latin America and East Asia; only a quarter of foreign direct investment in energy goes to South Asia and Africa. Many investors have withdrawn from this type of investment, though some, such as Electricité de France (EdF) still see it as a high growth area with a lot of potential, but high risks. The main risks are seen as being in countries without strong contract enforcement legislation, with undeveloped regulatory environment and with potential economic or political weaknesses. There is very little private investment going into distribution, which is the major requirement from most countries for increasing access by the poor, both in urban and in rural areas. The dispersed population in rural areas, with low spending power does not present an interesting opportunity for international private investors, but can represent a market for local investors and local small companies which understand the market and can provide cost-effective services.

2.2 The role of the international institutions

Getting energy to the poor will require joined up planning, finance and implementation ...

Each of the major international development institutions, finance institutions, national governments, NGOs and the private sector energy developers, equipment suppliers and service providers has a role to play. The development organisations and national governments can provide leadership of ideas, targets and timetables for achieving them, applying renewable energy sources to their own facilities, facilitating the basis for leveraging private sector finance and enabling the private sector providers to operate in transparent, competitive markets. There is a new consensus emerging on the actions that are needed to deliver improved and clean energy services to poor people:

- *Creating mechanisms to respond to demand-driven development priorities*, such as the Social Investment Funds (SIF) and Community-Driven Development (CDD) programmes, to provide finance directly to poor communities. This will enable them to control how they invest in their own priorities for improved services, such as water supply, health, education and production. Clean energy services have an enabling role to play in the delivery of these services, and the SIF and CDD mechanisms provide a means for financing a significant part of the initial capital costs, and creating markets for local service companies to deliver equipment and services. Greater guidance on how to build energy services into PRSPs can usefully be developed along these lines. Experience so far is very positive, but there are still a lot of practical lessons to be learnt and methodologies to be developed.
- *Subsidy policy* should insist on directing any subsidies that are needed so that they benefit the poor. That is to target the poor and fund the user (not the supplier) as a contribution to initial capital costs only. Couple this with a removal of subsidies for fossil fuels supplies in a way which does not disadvantage the poorest. Both these would favour renewables, which place lower demands on operation and maintenance on poor communities.
- *Leveraging local finance sources*. Even poor countries such as Nepal are showing that there is local finance available, in local currency, to fund local projects. This in turn reduces the foreign exchange risk element.
- Prioritising *knowledge sharing* on best practice internationally is essential. The detailed practical knowledge of how to deliver energy services in the most cost-effective way needs to be shared amongst practitioners and policy makers. Some mechanisms such as the Private Participation in Infrastructure Advisory Facility (PPIAF) exist to provide technical assistance for infrastructure provision.
- *Private Sector Delivery* is also a key mechanism. This includes building the delivery capacity of local private sector service and equipment suppliers. Small local companies are often best placed to understand and respond to what is a fragmented and weak market. Such companies require local Business Development Services (BDS), including training in management and in technical skills. The current donor consensus for supporting enterprise development is to assist local BDS providers to develop products in response to the needs and demands of the local enterprises.
- *National Governments* must create an enabling environment for sustainable energy. Decentralisation of government services and finance can go a long way to empower local government services and municipalities to provide support in response to the needs of communities in their districts. National governments can also provide an enabling legal and regulatory environment. This should ensure that utility plans are realistic and affordable, and must enact legislation to allow the local generation and sale of electricity. In some cases divestiture of national utility ownership to private ownership can be beneficial if it introduces

competition and accountability to consumers through a regulator. Governments can also provide an enabling fiscal environment through setting appropriate fuel taxes to provide the right messages and import duties on energy equipment which do not act as a tax on poor people. Governments should apply the 'polluter pays' principle such that the externalities (environmental, social and infrastructure damage) caused by conventional fuel sources are internalised and equally provide incentives (eg. tax breaks) for non-polluting sources.

Each of these activities is necessary for the take-off of clean and sustainable energy markets in developing countries. The international donor community has achieved a consensus to finance the achievement of the Millennium Development Goals. This will only be possible with the shared commitment to making improved clean energy services available on a massive scale, with the involvement of both the public and private sector for finance, equipment and services. A consensus is now needed on the means to achieve this shift in policy and practice, learning from ideas which are now being implemented, but not yet widely understood (such as CDD and CDM).

The following is a list of targets proposed by different bodies for achieving improvements to the availability of clean and sustainable energy to poor people. WSSD could help to arrive at a consensus on what are ambitious but achievable goals if the political will is there and all the stakeholders were to play their part.

International targets for access to clean energy

- G8 – one billion people (of whom 800 million in developing countries) with access to services from renewable energy in ten years – half of this is grid connected.
- NEPAD – to increase Africans' access to reliable and clean affordable commercial energy supply from 10 per cent to 35 per cent or more in 20 years
- Choose Positive Energy (Greenpeace and Body Shop campaign) – two billion people to have access to clean and sustainable energy by 2012 (ie. in ten years).
- Global Energy Village Partnership (UNEP and Winrock) – 300 million people currently unserved to have access to clean energy in 10 years time (2012)
- Brazilian Energy Initiative – 10 per cent of global energy to come from new renewables by 2010.

2.3 Financing energy for the poor

The cost of getting energy to the poor will be in the region of US \$9 billion a year for ten years. This compares with more than US \$250 billion a year spent on subsidising fossil fuels and nuclear generation ...

Small amounts of energy can make a huge difference to the lives of poor people. The cost of providing energy depends on many factors such as where people live and the type of energy provided.

We estimate that the average cost for a low wattage electrical connection suitable for a poor family would be in the region of US \$300. This cost will be much less for switching to alternative fuels and low pollution cooking methods. With an average family size of five people we can assume that approximately 300 million homes will need new electrical connections to satisfy the needs of the 1.6 billion who don't have electricity.

The total cost of these electrical connections will be US \$90 billion. Spread of ten years this would be US \$9 billion a year. This compares with the estimated annual subsidy of US \$250-300 billion for fossil fuels and nuclear power.

It must be stressed that these are 'up-front' costs. Running costs will be minimal if using renewable sources such as sun, wind and water. These costs need to be spread over the life span of the energy installation and financial support, such as 'smarter' subsidies and soft loans, need to allow this. Cost will be expected to come down due to economies of scale as more systems are installed.

How much funds would be required from international aid, government grants, private investment, local community and individuals would depend upon the model of finance chosen. According to the G8 Renewable Energy Task Force Chairmen's Report for every dollar given to a project by an international financial institution, for example the Global Environment Fund, another five dollars can be pulled from other sources.

Also, it is suggested that after as little as 20 per cent of the market has been 'seeded', further seed capital and second-stage finance may no longer be required. Those optimistic projections regarding the power of markets must be balanced with the goal of meeting the needs of the poorest communities, who by the nature of their poverty are difficult to reach with market mechanisms. To reach them will require sustained subsidies and support.¹⁹

¹⁹ E&Co, Meeting the Unmet Demand for Modern Energy, October 2000

Table 5: Comparison of costs of renewable energy options

Technology	Number of homes supplied	Cost per unit (US \$)	Cost per home (US \$)
Solar home system, China (20 Wp) ²⁰	1	160 - 200	160 - 200
Solar home system in Peru (30 to 50 Wp) ²¹	1	500 - 700	500 - 700
Wind battery charger, Sri Lanka (200 Watts-rated) ²²	1 to 2	670	335 - 670
Solar Lantern, Kenya (6 Wp) ²³	1	100	100
Micro hydro plant (5kW to 100kW) ²⁴	25 to 500 (5 per 1kW)	1,136 – 5,630 per kW (av. 3,085)	227 – 1,106 (average 617)

Source: ITDG, ITDG Latin America, IT Power, IT Consultants, World Bank's Energy Sector Management Assistance Programme (ESMAP)

Export Credit Agreements (ECAs) are currently used almost entirely for large infrastructure projects, 50 per cent of which are for energy, but mostly large-scale generation projects such as coal fired power plants and large hydro projects. None are for renewable generation. Much could be done to apply ECA support to such projects to overcome what are often significant political risks. As acknowledged by the co-chairs report of the G8 renewable energy task force, the reform of ECAs and other international financial institutions to favour renewable energy sources would go some way to creating the necessary finance. In fact ECAs should commit to 20 per cent of their energy lending to renewables now and move to phase out all conventional energy lending over the next five years. The same should apply to other financial institutions.

Mechanisms such as the Private Participation in Infrastructure Advisory Facility (PPIAF) have been created to provide funds for technical assistance for the development of the private sector, and the Emerging Africa Infrastructure Fund (EAIF) and the Africa Rural Energy Enterprise Development Program (AREED) are pioneering new methods of channelling loan and equity finance to local enterprises in Africa. The experience of these initiatives needs to be synthesised, monitored and best practice models replicated.

²⁰ See annex A1

²¹ See annex A2

²² ITDG internal document, Rohan Senerath, Sri Lanka, March 2002.

²³ IT Consultants, Rugby, UK

²⁴ ESMAP Technical Paper 006, 'Best Practice for Sustainable Development of Micro Hydro Power in Developing Countries, August 2000.

3 An action plan for sustainable energy for poverty reduction

Sustainable, clean energy can play a key role in reducing the huge burden of poverty and environmental degradation around the world. In order to maximise the role of clean and renewable energy in poverty reduction significant steps forward must be made to:

- Implement strategies which will allow access to clean energy for the world's two billion poorest people in 10 years.
- Greatly expand global renewable energy markets particularly in the North to cut greenhouse gas emissions and create economies of scale.
- Stimulate clean and renewable energy markets in developing countries to increase energy options available for sustainable development.

Clean renewable energy is defined as modern biomass, geothermal, wind, solar, small scale hydropower and marine energy.

The following action plan sets out a clear agenda for achieving the win-win goal of poverty reduction and action on climate change. It lays out the actions to be taken at every level of decision making.

3.1 International declaration

An international declaration must produce a 'Sustainable Energy Action Plan' to both:

- massively expand the use of renewable energy North and South, and
- ensure access to sustainable and renewable sources of energy to the two billion of the world's poorest people who currently do not have access to basic, modern energy services, in ten years as a fundamental part of achieving the Millennium Development Goal of halving the people in poverty by 2015.

In order to implement this plan we call on all governments to:

- Ensure International Financial Institutions (IFIs) immediately target 20 per cent of energy sector lending and support towards renewable energy development and energy efficiency programmes and move to phasing out all lending for conventional energy sources in five years.
- Phase out subsidies to conventional energy sources, with a transition plan and flexible time frames to avoid undue hardships on developing country economies overly reliant upon conventional energy sources and exports.
- Make available the finance and infrastructure needed to create systems and networks to deliver the seed capital, institutional support and

capacity building to support and facilitate the creation of sustainable energy markets of the developing world.

- Target aid towards halving the number of deaths from indoor air pollution from cooking stoves by 2015 by increasing support for clean cooking strategies.
- Provide one billion people with improved, clean stoves by 2015.

3.2 National implementation

All countries

Timetables and targets

- Give priority to renewable energy projects through aggressive renewable energy planning with explicit targets.
- Commit to at least 10 per cent of primary energy to come from new renewables sources by 2010.
- Commit to use at least 20 per cent of renewable energy sources in all public buildings in the next 5 years.

Enabling environment

- Determine that all new energy developments for off-grid will be from renewable sources.
- Establish national plans and frameworks to expand domestic renewable energy markets.
- Establish a plan to phase out subsidies to fossil fuel and nuclear sources, currently estimated at between US\$250 and US\$300 billion annually, in ten years.
- Develop models for 'smart' subsidies to ensure that public funds are used to optimal effect to stimulate market development and to leverage private sector investment.
- Reform electricity regulations including removing legal barriers to decentralised power supplies providing access to grid for small generators, and providing disclosure to consumers of power sources.
- Establish mandatory Environmental Impact Assessment procedures for all new large-scale energy projects.
- Devolve decision making and financial power on energy supplies to local regions.
- Incorporate communities and local NGOs in energy decision making process.
- Create regulations that makes all energy decision making process in governmental level, transparent and with full public access.

- Remove incentives and other supports to conventional power sources and environmentally harmful energy technologies, and develop and implement market-based mechanisms which include the external social and environmental costs of power production thus enabling renewable energy technologies to compete in the market on an equal and fair basis.
- Provide financial incentives to non-polluting sources (tax breaks, low import dues, etc.).
- Base energy policies on demand side management and not supply-side.

Research and development

- Identify domestic new renewable resources (wind, solar, small hydro, tides, wave, geothermal) with detailed resource maps. Determine sustainable management plans for biomass resources.
- Develop quality standards for renewable energy technologies to ensure reliability and increase consumer confidence.
- Establish plans to support R&D of renewable energy technologies and strategies for cost-effective uses.
- Establish co-operation plans to share knowledge (technologies, implementation strategies, policies and R&D) and technology transfer: North-to-South and South-to-South. These mechanisms should be designed on an equitable membership basis, with partnership of governments, the private sector, NGOs and international institutions.

Developing countries

Targets and timetables

- Include access to clean energy services as a priority for poverty reduction in all sectors (health, water, education, SMEs, etc.) within Poverty Reduction Strategy Papers.
- To instigate significant programmes of installing improved cook stoves and reduction in indoor air pollution, linking into public health and energy strategies.

Enabling environment

- Instigate public health programmes which promote clean cooking. Promotion in this sector is best done by women, to women.
- Establish plans to use aid funding to leverage private capital for renewables expansion.
- Place trust fund resources with IFIs that can be accessed by private sector project developers on a cost-shared basis to assist with the development costs of renewable energy projects.

- Create local networks with the support of local and regional authorities to give public information on renewables energy options and help individuals and small groups to apply for financing small renewable projects.
- Strengthen institutional capacity to support renewable energy development including support to SMEs with servicing and equipment supply activities, in particular through business and technical training and strengthening of Business Development Service providers.
- Use the mechanisms for meeting demand driven infrastructure priorities such as the World Bank's Community Driven Development and Social Investment Funds which emphasise local decision making and local ownership and management. Such approaches involve communities in defining demand and responding to the local market realities, and have a much greater chance of producing cost effective solutions than supply-driven approaches. Experience of these approaches should be shared internationally.
- Use appropriate financing and subsidies to give low-income communities, households or entrepreneurs the ability to afford to invest in new energy technologies. There are good practice models that can be replicated. These success stories must be learned from to produce 'smarter' financing models.
- Include low income people as active stakeholders in energy planning to meet their needs in long term basis.

Research and development

- Develop appropriate technology, with community involvement, for clean cooking. Cooking technologies must be developed to suit local cultural needs.
- Identify energy needs of rural, peri-urban and urban population. Establish a national, regional and local map of basic energy needs. Establish regular assessment of small and local industrial energy needs.
- Establish plans with IFIs and Export Credit Agencies (ECAs) for funding to identify energy needs, renewable market development, research and technology implementation.
- Develop national information programmes about conventional energy impacts, renewables options and financing possibilities.

Industrialised countries

Targets and timetables

- Adopt aggressive targets (at least 10 per cent by 2010) of primary energy from new renewables sources to massively expand renewable energy supplies to create the necessary scale of economies.

- Assign at least 0.7 per cent of GNP for Direct Aid to developing countries (not including any administrative or fix costs).
- Recycle public debt to renewables expansion projects.
- Reform IFIs and ECAs to provide 20 per cent of current energy lending for renewables and within 5 years to have all energy lending targeted on renewables.
- Remove subsidies to all fossil fuel and nuclear sources within the next 10 years.
- Implement, in particular the G8 countries, a timetable to fully finance a plan of action to achieve the targets for sustainable energy recommended in the 2001 Co-chairs report of the G8 Renewable Energy Task Force.

Enabling environment

- Development assistance must recognise that the principal energy needs of the poor is cooking. Bilateral and multilateral agencies should therefore provide increased support for clean cooking strategies linked to the health sector development, to significantly reduce deaths from indoor air pollution. Increase support for clean cooking strategies.
- Give priority in all bilateral aid and trade agreements to renewable energy sources.
- Prohibit all direct or indirect public funding to new fossils fuels or nuclear projects.
- Make mandatory total transparency to the public in prior discussions, negotiations and implementations of energy projects (domestic and with international impacts) that have direct or indirect public funds.
- Establish plans to support renewable energy industries for the creation of joint ventures to develop designing, manufacturing, assembly, and distribution/installation capabilities in developing countries and that empowers local communities.

Research and development

- Establish co-ordinated programmes and networks with developing countries for capacity building, training, and research of full life cycle of energy sources.

3.3 Other institutions

Inter-governmental Institutions

- Create an international database with all providers of renewable units, costs and maintenance options.

- Identify and analyse policies and measures to increase renewables' competitiveness, monitor the deployment of renewables, and make such information widely available.
- Verify and strengthen the Clean Development Mechanism (CDM) and Global Environment Facility (GEF) as mechanisms to implement renewable energy projects, for mitigating climate change, in particular small scale decentralised schemes aimed at poverty reduction

International Finance Institutions (IFIs and ECAs)

- Immediately commit to provide 20 per cent of current energy lending to renewable projects and within 5 years, have all energy lending targeted on renewables.
- Increase support to small renewable energy projects and establish programmes to develop efficient micro-finance mechanisms and organisations. In 5 years, 20 per cent of total amount of energy lending must be oriented to micro-finance mechanisms or organisations.
- Strengthen and give priority to programmes that encourage sustainable forest management and sustainable use of fire-wood and other traditional resources.
- Produce public annual reports on all financial flows and donor assistance patterns that support renewable energy.
- Produce public annual reports on stakeholders on international energy business.
- Give priority to development projects that consider explicitly using renewable energy sources.
- Establish mandatory requirements for Environmental Impact Assessment procedures before approving all new large scale energy projects and establish a minimum standards of energy-efficiency or carbon intensity for these projects
- Develop a common reporting methodology to permit assessment of the local and global environmental impacts for all energy projects.

Private financial institutions and private companies

- Produce Environmental Impact Assessment before financing any energy project.
- Make voluntary global commitments to procure and use renewables-based energy.
- Support the development of local technical skills and knowledge needed in the energy sector in developing countries. The private sector in the technology and banking sectors must be encouraged to form local partnerships to supply accessible and appropriate services to the poor.

- Support rules to internalise all social and environmental costs in every energy projects.
- Encourage the development of local technical skills and knowledge needed in the energy sector in developing countries.

Non-Governmental Organisations (NGOs)

All authorities should enable NGOs to have an active involvement in:

- Acting as key intermediaries between communities and the national and international agencies.
- Ensuring that poor communities are represented in policy making at all levels.
- Facilitating international knowledge sharing, on technology best practice and on policy approaches, essential for wide scale dissemination, through actively managed networks and research programmes.
- Encouraging South-to-South transfer of technology and experiences technology transfer through their networking and information exchange as well as facilitating information exchanges at the grass roots level.
- Being included in training on all aspects of implementing sustainable energy programmes.
- Ensuring access by authorities at all levels so they can fulfil a role in the monitoring and evaluation sustainable energy programmes.

3.4 The voice of the poor

Underpinning all the actions above, there must be a firm commitment to engaging with poor people themselves. People living in poverty, in particular women who bear the overwhelming burden for providing for the health and welfare of their communities, must have their say in the prioritisation of energy options if energy policy and services are to meet their needs and provide long term solutions. In energy sector planning, as elsewhere, the poor themselves are too frequently the invisible stakeholders.

Evidence shows that if the primary stakeholders are involved in the design and implementation of development initiatives they are much more likely to bring prolonged benefits. Local communities possess invaluable local expertise that should be taken into account in defining and implementing any energy project. As the end-users of the technology, their involvement at early stages of planning will generate ownership that helps achieve long term success. Projects characterised by high levels of community engagement will typically generate a greater sense of community empowerment, ensure that improvements are tailored to a community's specific needs, and create a much higher chance that the improvements will be well maintained by the community after installation.

Annex: National analyses for clean energy access

A 1 China case study

A 1.1 Chinese economy and energy

China is the most populated country in the world with a total approaching 1.3 billion people. Although this number is still increasing, population growth has slowed since 1970. Over the last two decades, China has experienced significant economic growth and social changes. Annual GDP growth was consistently around 10 per cent over the last two decades with GDP per capita reaching US \$800 in 2000 (up from US \$300 in the early 1990s). It is estimated China's economic growth will remain high for the next few years.

China's energy economy relies heavily on coal, which makes up more than 70 per cent of the total national energy supply. Intensive coal use is one of the main causes of urban air pollution and a deteriorating ecological environment. By the end of 2000, the total installed power in China was 315 GW, that means an increase of 16.5 GW or 5.5 per cent compared to 1999. Hydropower amounted to 77 GW, accounting for 15 per cent; thermal power amounted to 235 GW, accounting for 83 per cent and nuclear power amounted to 2 GW, accounting for 1 per cent of installed capacity. By the end of 2010, it is expected that the total installed capacity will reach 500 GW²⁵.

As the world's third largest country, China has extremely diverse geographic and climatic conditions, making the country rich in various kinds of renewable energy resources, such as solar, wind, geothermal, small scale hydro and biomass. China has a long history of using renewable energy and there has been a growing emphasis on this sector in recent years. There are nearly 300,000 solar home systems (100 W to 2 kW) installed in China today, along with 14,000 small wind turbines (up to 200 kW), 45,000 small-scale hydropower (50 kW to 25 MW) and up to 7 million household biogas digester systems installed for cooking. The total installed electricity capacity of these renewable energy systems is approximately 19,000 MW²⁶.

China's energy poor

Agriculture is the second most important sector (after industry) for the Chinese economy, even though only 15 per cent to 20 per cent of the land area (ie. 108 million hectares) is suitable for agricultural cultivation. More than 80 per cent of the population, about one billion people, live in China's rural

²⁵ The Current situation of China's Electric Power Industry, by Zhou Jia Ping, Director of general engineer office of Chongqing Energy Conservation Technical Service Center. [http://www.eva.ac.at/\(en\)/projekte/china_power.htm](http://www.eva.ac.at/(en)/projekte/china_power.htm)

²⁶ China Rural Energy Statistics, published by the Ministry of Agriculture, 2000.

areas and either directly or indirectly earn their livelihoods from the land. The proportion of people in China without access to electricity is quite small. However, in absolute terms, the numbers are still large. At present 70 million people in China still lack to electricity. Most of these people live in remote areas of the north western provinces. Villages without access to electricity are in remote and sparsely populated regions, where there is often limited access to roads, markets and other services. The people who live there are among the poorest in China.

Even though more than 94 per cent of the rural population is connected to electricity, there is still a heavy reliance on biomass for cooking and heating. Approximately 60 per cent of energy use in rural households is derived from biomass, particularly crop residue, animal dung, fuel wood and straw. The low quality and low efficiency of these energy resources results in considerable amounts of time being spent by rural households to collect sufficient materials to meet their needs. The lack of access to modern energy services is one of the main contributing factors to rural poverty in China, and results in serious indoor air pollution which is a big threat to the health of rural people.

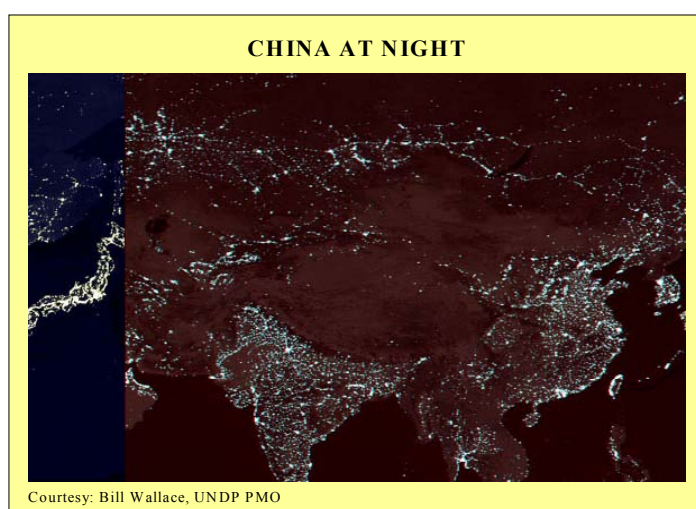


Figure A 1.1: China at night showing the unelectrified areas

Many surveys and studies on rural energy in China have shown that access to a reliable source of electricity is a high priority for most rural people²⁷. Rural households have also realised that access to high quality energy resources and energy efficient devices can save them time searching for biomass fuel for cooking and heating. Enabling people to use their time more productively would permit them to improve their life conditions.

²⁷ IDS (2002). *Energy, Poverty and Gender in Rural China*, a report for the World Bank by the Institute of Development Studies, University of Sussex, UK.

General description of the national context for renewable energy development and poverty reduction

National renewable energy policies and targets

The Government of China has adopted a wide range of policies to re-orient its coal-dominated economy. Policies have also been introduced to promote the use of renewable energy in order to address the problems associated with urban air pollution and other environmental pressures. Over the past 35 years, China has shown a strong commitment to relatively small hydropower (less than 25 MW), biogas, small wind turbines and solar home systems for rural electrification and energy use. The New and Renewable Energy Development Programme 1996-2010²⁸ declared a new commitment to renewable energy development. The programme aims to enlarge the contribution of renewable energy in the overall energy supply. The Electricity Law issued in 1995, along with several other recent policy documents²⁹, also support the development of renewables for national electrification and to meet rural energy needs, thus supporting the commercial development of renewable energy technologies in China.

In 2000, the Government of China published the tenth Five-Year Programme on Sustainable Development (2000-2005). As part of the National Development Programme, the New and Renewable Energy Industry Development Plan set the following national renewable energy development targets to be achieved by 2005:

- The use of renewable energy to reach 13 million tonnes of coal equivalent annually, thereby reducing CO₂ and SO₂ emissions by 10 million and 600,000 tonnes respectively
- To provide electricity to 1.3 million households (about 5-6 million population) in rural areas by means of renewable energy technologies
- To create 200,000 work places in the renewable energy industry
- To achieve a solar PV manufacturing capacity of 15 MW per annum.

National poverty alleviation policies³⁰

The Government of China has incorporated renewable energy development into its National Energy Policy and Energy Development Strategy as well as in its Poverty Alleviation Approach for Western China (which is one of the most rural and poverty stricken areas in the country). Over the last four decades China has made great progress in poverty alleviation. Between the

²⁸ Issued jointly by the State Planning Commission, State Economic & Trade Commission and Ministry of Science & Technology in 1995.

²⁹ Other Government of China policy documents include: *China 21st Century Agenda* published in 1995, *China Environment and Development and Ten Countermeasures* published in 1998, *Notice for Further Promoting the Commercialisation Development of Renewable Energy* in 2000 and *2000-2015 Renewable Energy Industrialisation Development Plan* in 2000.

³⁰ Poverty in China is defined by the international standard used by the World Bank which takes US \$1 per person per day as the poverty threshold. Those counties with an average per capita income below this level are state-defined "poverty counties" and government funded poverty relief is then channelled to these counties.

1970s and late 1990s the number of people living in poverty reduced from 250 to 58 million³¹. The measures employed for poverty alleviation include subsidised credit and training, micro-credit and rural infrastructure programmes. Rural electrification and rural energy supply are one of the main activities and an important indicator of poverty alleviation in China.

International aid projects and programmes on rural energy supply in poverty stricken regions

Apart from national programmes, international and bilateral aid projects are also playing an important role in improving rural energy supply. China has bilateral agreements which are supporting renewable energy development with many donor countries³². Assistance programmes focusing on rural energy supply include: Shell's 60,000 Solar Home Systems Programme in Xinjiang Autonomous Region; US/DOE's village power pilot programme and solar home systems project in Gansu province and Inner-Mongolia; and GTZ's Village power projects in Yunnan and Sichuan Provinces.

China has also received financial support from multilateral financing agencies such as the World Bank (WB), Global Environment Facility (GEF) and UNDP. The WB/GEF China Renewable Energy Development Project is to supply 10 MW of photo-voltaic systems to rural households in six north western provinces with a US \$20 million GEF grant over five years. It is the largest rural energy programme in China to date and is estimated to provide electricity to nearly 200,000 households in remote areas of the north western provinces.

Non-governmental organisations are playing a unique role in rural energy supply due to their flexibility, accessibility and creativity. There are numerous examples of projects which are developing sustainable and business-oriented approaches to rural energy supply in China³³ (some of which are described in the following sections).

International financial flows

Accessing international aid money is still a long and complicated procedure in China. All project proposals for bilateral and multilateral aid funds need to be endorsed by the Ministry of Finance on behalf of the Government of China, and its use approved by the Department of Foreign Capital, Utilisation of State Development & Planning Commission. These approval procedures normally take a large amount of time, effort and cost, creating a significant institutional barrier to project development.

³¹ Zhang, Aimei (1993). *Poverty Alleviation In China: Commitment, Policies And Expenditures*, UNDP publication.

³² Such as the UK, USA, Japan, the Netherlands, Denmark, Germany, Australia etc.

³³ WWF initiated a programme of small credit loans for rural households to promote small-scale biogas systems in rural areas of HuBei province. The W Jones Foundation and the Shell Foundation have supported a small-scale biogas programme in remote areas of Yunnan province, and the Greenstar Solar Community Centre has initiated a joint venture entity with villagers in Tibet to deliver solar powered handicrafts for sale internationally, in order to ensure the economic viability of the solar power systems.

Successful deployment models

Nationwide Rural Energy Offices

China has had very successful experiences with the dissemination of energy supplies to rural areas. This is largely a result of the widespread institutional infrastructure dedicated to rural energy. In the early eighties, rural energy offices were established at the county level, under the auspices of the National Rural Energy Office, which falls within the administration of the Ministry of Agriculture. The Rural Energy Offices are staffed by technicians, outreach workers and government officials. Their main function is to disseminate government subsidies for rural energy supplies at the village level and provide technical assistance to villagers and rural households. Rural energy service options vary by region, according to local conditions and opportunities. Over 20 years of operation, the Rural Energy Offices have installed 180 million energy saving cook stoves and nearly 7 million household biogas systems in rural areas of China.

Direct government subsidy for rural energy

Rural electrification in China still relies on direct government subsidy and international assistance. Over the last three years the Government of China has allocated US \$240 million to Solar PV village power systems in 900 remote villages of Tibet, Ningxia and Shannxi provinces. Subsidies are also available for energy saving cook stoves, small-scale biogas systems and solar home systems. The subsidy typically covers 30 per cent (though it can be as high as 70 per cent) of the total system cost.

A 1.2 Examples

Solar Home Systems

China has one of the largest Solar Home System programmes (SHS) in the world, having installed more than 150,000 systems in the last 10 years and are aiming to double this number in the next few years³⁴. Initially a purely subsidised market, SHSs are now also sold commercially to wealthier segments of the rural population. Most of these have been sold in remote areas of the north western provinces where private photovoltaic (PV) distribution and after-sales service networks have been established.

Solar Home Systems typically consist of a PV panel with a mounting frame, 12 volt battery, control box, several DC energy efficient light bulbs and installation components. The panel capacity usually ranges from 20 to 50 Watts. The smaller panels can power two or three efficient lightbulbs for several hours a day, whilst larger systems can also provide power for a radio and a TV for several hours.

³⁴ Report on the *Commercialisation of Solar PV systems in China* prepared by the National Renewable Energy Laboratory, USA and Centre for Renewable Energy Development, China. China Environmental Science Press, 2001



Figure A 1.2: Solar Home System in husbandry area of Qinghai

SHSs are typically sold on a cash basis in rural areas by both State owned and private PV companies. Although most of the systems are sold with government subsidy or international aid programmes, which can cover up to 50 per cent of the retail value, the government has realised that adopting a business model is vital to achieving a sustainable market. An on-going World Bank/GEF Renewable Energy Development Project is to pay US \$1.50/Wp of installed capacity directly to the dealers rather than to the customers in order to stimulate the SHS commercial market and ensure system quality and after sales service.

The average cost for a 20 Wp system is between US \$160 and \$200 (total cost before subsidy). The payback period for users varies, depending on what it replaces. For many, grid connection is not an option or is unreliable. Users are therefore willing to purchase a SHS for the convenience and reliability.

Renewable Energy Village Power Systems

Compared to off-grid home systems such as SHSs, Renewable Energy Village Power Systems (REVPS) offer a more comprehensive solution to providing reliable electricity services to people in remote areas where grid connection is not possible and access to diesel and coal is limited.

A village power system, acting as a mini-grid, can supply better quality and more consistent electricity services to rural households to provide for their basic needs, as well as power for minor productive loads such as ventilators, refrigeration and mechanised hand tools. Access to more stable, reliable and higher power electricity services improves living standards for rural communities.

REVPS have been widely applied in China's north western areas and coastal islands. As renewable energy sources can be intermittent it is desirable to design a system which combines different renewable energy technologies, thereby improving the level of system service and reliability. The 'Hybrid'

combination works with two (or more) resources. The most common village power systems incorporate a solar photovoltaic (PV) and wind system. About 70 PV/wind village power systems have been installed in China in the past two decades.

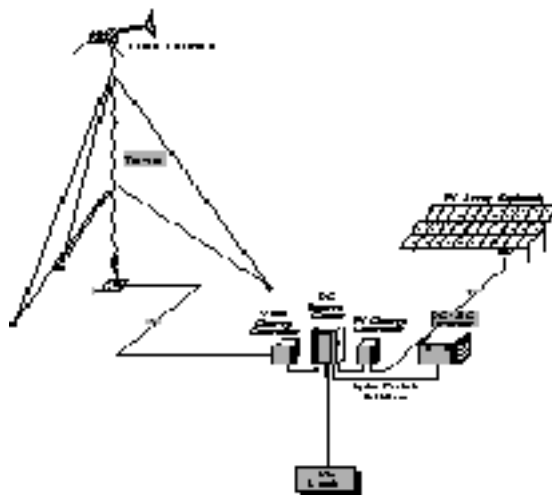


Figure A 1.3: PV/wind village power system configuration

Arrays of PV modules and one or more wind turbines feed a battery bank through a charge controller. The battery bank's DC current is then converted to 220v AC to feed mini grids for domestic, social or productive use. Larger systems might consist of more substations with separate control systems and battery banks. In the larger systems, power is transmitted to homes and buildings by a three-phase mini-grid. The systems are modular and can be well adapted to increased demand. The capacity varies from a few kW to 100 kW providing electricity to hundreds of households.

The investment cost of PV village power systems can be as high as US \$17,500/kWp, while PV/wind combined systems are generally cheaper. The initial investment cost is the main expenditure but there are also minor costs for system operation and replacement of parts, particularly the batteries after 5-7 years. In most of China's village power systems there is a 15kWh per month consumption limitation for each connected household. The tariff charge is about US \$0.12-0.18/kWh below 15 kWh and US \$0.24~0.36/kWh above 15kWh consumption per month (with a technical upper limit to consumption). The tariff can cover the salary of the local technicians and some operating costs, but it is not enough to cover the battery cost, nor capital cost recovery. Unlike SHSs, the investment cost of community-scale village power is high for rural households and can only be realised through national rural electrification subsidies and international aid programmes, but in many cases there are cheaper than extending the grid as well as diesel and coal. The Chinese government recently launched a solar PV village power system programme in 900 unelectrified villages in Tibet, Ningxia and Shannxi.

China's biogas programme

China has one of the most successful biogas programmes in the world. Millions of biogas systems have been installed throughout the country. Since 1985 there has been a dedicated and comprehensive development plan for biogas dissemination in China. It has been incorporated in the national five-year economic development plans and fed through to each level of national administration (state, province, prefecture, county, district and township). Activities have included planning biogas development, training technicians, setting up demonstration projects and organising communication between the various offices and technicians. This has resulted in an extensive institutional structure with more than 10,000 biogas offices across China training more than 30,000 technicians and installing almost seven million household level biogas digesters. Although the initial programme was accompanied by a subsidy programme, today many households are able to afford the full cost of the biogas installations; the programme is largely self-financing and the technology at a stage of maturity³⁵.

Biogas is mainly a mixture of methane and carbon dioxide along with other trace gases, produced by the anaerobic (oxygen free) biological decomposition of organic matter. This decomposition occurs in air-tight vessels usually located below the ground as shown in Figure 1.4. The digesters are fed animal and human wastes as well as other organic matter. As microbes decompose these materials a gas is formed. For household level digesters this gas can be burned and is typically used for cooking, lighting and space heating. Modern digesters for household applications usually have a volume of 6 m² to 8 m², with a gas production capacity of about 0.2 m²/day.

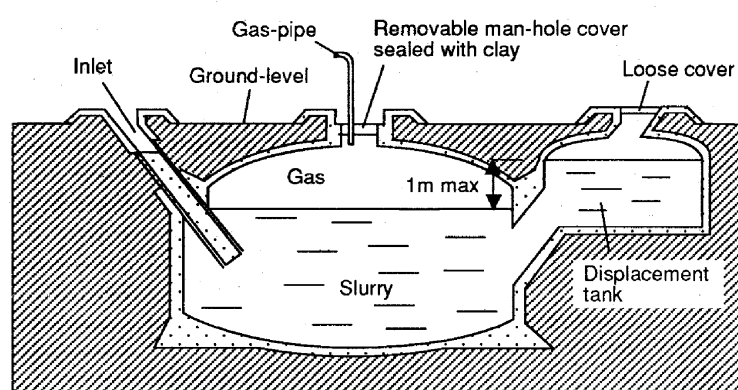


Figure A 1.4: Schematic of a typical Chinese biogas digester³⁶

The Chinese biogas programme first started with subsidies in the range of 10 to 50 per cent towards the cost of the digesters, but these were phased out

³⁵ The information is taken from Brown, C.A. (1998). *An investigation into the role of biogas in rural China today*. University of Oxford.

³⁶ Hislop, D. (1992). *Energy Options: an introduction to small-scale renewable energy technologies*, London: IT Publications

for all but the poorest farmers. In isolated areas the government continues to support loan systems to pay for the biogas technology.

One recent programme implemented by the South-North Institute for Sustainable Development (SNISD) and funded by the Shell Foundation is the Integrated Biogas Systems for Poverty Reduction and Natural Resource Conservation project in Baima Snow Mountain Nature Reserve, Yunnan Province³⁷. The aims of this project are to reduce the poverty of the farmers in the regions by providing new means of income generation, as well as to supply methane for cooking and lighting which has the knock-on effect of reducing firewood demand in these areas. The technology introduced is known as the '3-in-1' system, which is an integrated biogas, pig production and latrine system. To date 50 systems have been installed and these have been found to:

- produce enough methane to reduce firewood use by up to 50 per cent;
- increase the productivity of pig raising;
- provide significant health benefits and time-saving (especially for women).

Most farmers in the region could not afford the '3-in-1' systems without a subsidy, although they can and do contribute some cash, labour, time and take out a loan. A subsidy (about 50 per cent of the system cost) was available through a local rural credit co-operative. For wider dissemination, funding is available through various sources including the Chinese Poverty Alleviation Programme, the Forest Conservation Programme and foreign donations. Micro-credit is also increasingly available for small loans. Another promising development is the emergence of a privately owned biogas installation company, although there is concern that the technology is being diffused into the country-side without adequate technical backup and support. The programme has found the '3-in-1' systems to have a pay-back of one to five years, depending on the amount of firewood that is displaced and number of pigs raised.

³⁷ The information about this programme is taken from a Validation Report produced for the Shell Foundation by A. Barnett, P. DeLaquil, D. Stuckey and D. Shijun, May 2002.

A 1.3 Conclusions and recommendations for China

Conclusions

Renewable energy technologies offer a feasible solution for the energy poor in China.

For people living in remote areas of the country without access to electricity, renewable energy technologies, such as small hydro, wind energy and PV are often the most technically viable and in many cases, the most cost-effective options. Biomass and biogas applications not only provide energy for cooking and heating to rural households leading to improved social conditions, but can also benefit China's environment locally and regionally.

Government subsidies and international aid programmes are still the major financing sources for rural energy supply but there is a transition towards a market based approach.

People without access to modern energy services live mainly in the most remote and sparsely populated regions of the country: they also have limited access to roads, markets and other services and are among the poorest in China. Whilst some renewable energy technologies are more economic than conventional energy sources in certain situations, provision of rural energy supply will continue to rely on government subsidies and international aid programmes for some time to come, as there is a gradual shift towards a more market-based economy within China. The provision of any energy source in these situations will require subsidies – even the 'market economy' will not remove the need for some poor-targeted subsidies.

Rural electrification is becoming increasingly challenging.

Although tremendous progress has been achieved in the provision of rural energy supply, there are still 70 million people without access to electricity in China and the population is still growing. These people, compared to those who have access to electricity, are most likely to be living in more remote areas in harsh climates. As a result, rural electrification in terms of the technical solutions and cost is becoming more challenging. Furthermore, rural people long for more reliable and better quality energy services to meet their increasing requirements for living, education and production. This can only be supplied on a sustainable basis by renewable energy sources.

Recommendations

More focus on the sustainability issues of rural energy systems.

Access to electrical power does improve living standards in rural communities. However, provision of improved energy, including electric power supply, must be on a sustainable basis, economically, socially and environmentally, if it is to ultimately improve living standards and lift people out of poverty.

Business approach on rural energy supply.

Experiences tell us that adopting business approaches and encouraging the private sector to provide rural energy services are essential to ensure the

sustainability of the systems in long term. But any form of energy supplies has always needed some form of subsidy.

Streamline the delivery of international aid programmes for rural energy supply.

China should adopt more efficient approval procedures to expedite international aid programmes. Compared to other developing countries, the current complicated and prolonged procedures prevent China from receiving increased international assistance.



Figure A 1.5: SHS Shop in Lhasa, Tibet

A 2 Peru case study

A 2.1 General context

With an area of 1,300,000 km² and a population of 26 million, Peru is the fourth largest country in South America, and the fifth most populous. Geographically, it is divided into three regions each having their own natural features: the Coast, an arid zone located along the littoral of Pacific Ocean; the Highlands, located along the Andes; and the Jungle, bounded by the Andes and Amazonia. Politically, the country is divided into departments (see Figure A 2.1).



Figure A 2.1 – Map of Peru

The number of Peruvians living in poverty increased from 42 per cent to 55 per cent in the six years to 1991, following the severe social and economic crisis of the 1980s.³⁸ Organisations such as the National Fund for Social Compensation (FONCODES) were created in the early 1990s as part of a National Programme for the Fight against Poverty. The Fund exists as a focal point for public sector investments in poverty alleviation, financing social investment projects submitted by communities themselves or by any organisation representing an organised community and seeking a social benefit to it.

The Peruvian government has declared the development and use of renewable energy resources to be of national interest in the fight against

³⁸ In 2000, according to the Instituto Nacional de Estadística (National Institute of Statistics), 48.4 per cent of the national population (26 million people) live in poverty; 50.2 per cent of this portion is rural population. 15 per cent of the national population live in extreme poverty; 82 per cent of this portion are in rural areas.

poverty, making renewable sources the preferred option for sustainable development in rural and remote areas.

The government's Energy Sector Reference Plan for 2001-2011 sets a number of objectives for poverty reduction, renewable energy development and rural electrification, seeking to encourage the population to find energy solutions in accordance with its social, economic and cultural characteristics and local sources of renewable energy.

The government's principle objectives with regards to renewable energy are:

- To make major advances in the exploitation of renewable sources, especially in providing energy to regions where the energy supply is normally restricted and to the national borders.
- To minimise differences concerning the electricity coverage and to extend its supply to rural areas and the national border.
- To meet the basic calorific energy requirements for the majority of the population and to reduce the dependence upon biomass.

Table A 2.1: estimated amount of government investment (US \$ million)

Renewable energy	2001-2005 (US \$m)	2006-2010 (US \$m)	2011-2015 (US \$m)	2001-2015 (US \$m)
Solar water heaters	19.4	18.2	23.2	60.8
PV systems	16.4	8.5	3.2	28.1
Wind power	0.0	9.5	27.0	36.5
Small hydroelectric systems	10.3	9.1	1.4	20.9
Total	46.2	45.3	54.8	146.3

Renewable energy and the reduction of poverty

Because of its geographic location, Peru has great potential for the development of renewable energies, such as geothermal, small scale hydro, solar, wind, and biomass. Despite this potential, the development of these technologies has been largely untapped.

Geothermal

There are about 300 hot springs in the country, ranging in temperature from 49°C to 89°C, found along the Western Mountain Range and, to a lesser extent, in the Inter-Andean valleys and the Eastern zone. These are very useful for water and space heating.

Small scale hydroelectric power

Peru has great potential for hydroelectric power generation. Because of the great number of water resources in lakes, water streams and waterfalls, there are opportunities for generating electricity through small hydroelectric power plants along the Andes and their adjacent valleys.

The generation of hydroelectric power for small villages in the Peruvian Highlands is widespread. For most of the existing projects in Peru, small Pelton-type turbines have been manufactured.

Until 2001, according to official data, 50 hydroelectric power plants, each producing less than 500 kW, had been installed. The greatest installed capacities are concentrated in the departments of Huancavelica, Apurímac, and particularly Lima, where 16 hydroelectric power plants of small capacity are located. However, according to consulting companies specialised in this sector, the real number of hydroelectric power plants producing less than 500 kW installed in the country may be as many as 250. Therefore it seems that this technology has been given a great boost in relation to the other alternatives.

Solar

The average solar radiation on a horizontal surface in the Peruvian Highlands is greater than 5 Kwh/m² per day and in the Jungle, 4-5 Kwh/m², which means Peru has a high potential for the use of solar power.

The private sector has created a market for solar water heaters, especially in Arequipa. Government support has created a similar market for photovoltaic modules, using them for different types of projects such as: electrification of communities in frontier zones or rural areas, installation of solar refrigerators, telecommunication systems at distance education centres, radio communication systems and lighting in health posts and centres. Photovoltaic module-operated telephony systems have also been installed by Entel Perú and Telefónica. Greenpeace and Engineers Without Borders are involved in setting up solar powered remote communications in the Amazonas. These provide communications links (computers and radio) with outlying communities and officials such as health workers.

Not all applications of solar power have had the same impact. Technologies such as solar cookers have not had the success of solar water heaters, and their use has not become widespread in spite of efforts to achieve this. Solar cookers do not suit the local cultural cooking methods and have therefore not been popular.

Solar drying of food and the use of greenhouses have shown a slow but sustained growth in some zones of the country. In many cases, this growth is due to the contribution of international technical co-operation organisations such as GTZ Germany, the International Potato Centre and the US Agency for International Development (AID), among others. Local institutions such NGOs, technological institutes and universities also help to spread this

through promotion, dissemination and research projects, as has the Government itself through its ministries of Agriculture, Energy and Mines, etc. In this respect, it must be noted that socio-cultural factors are extremely important. In many cases this has not been taken into account, which has caused some projects to fail.

Wind

The Peruvian coast has great potential with average wind speeds reaching 8m/sec in Malabrigo, San Juan de Marcona and Paracas, and values around 6m/sec along the rest of the coast. Measurement stations have been installed in almost all departments of the country, 31 in all, but the best conditions for wind power are found along the coast. There are currently two wind power-operated electric power plants in Peru, both intended for public service.

Biomass

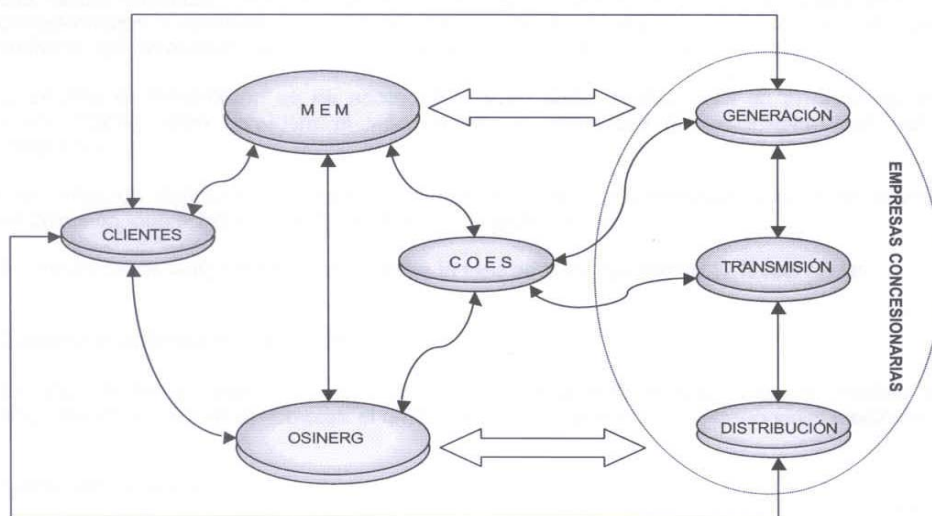
Biomass is a major energy source within the National Energy Balance, particularly firewood. Bagasse, a by-product of sugar cane milling, is a traditional fuel and supplies part of the heat needed by the sugar manufacturing process. The use of biodigesters is not widespread; some projects in the northern zone (Cajamarca) failed, only a private project is operating in Arequipa at a milk processing and packaging plant.

A 2.2 Peru's energy policy

Within the framework of the Government's overall policy on the fight against poverty, the energy sector directs the Government's efforts towards the promotion of private investment in electricity and hydrocarbon-related activities, and participates directly in expansion of the electrical grid.

As a result of the structural reforms made from 1992 through the Electrical Concession Law and the regulations issued under this law, the national energy system has attained a degree of complexity, particularly due to a great number of intervening agents (see figure A 2.2). However, the high concentration of generation and distribution markets does not allow a greater competition. Figure A 2.2 shows the agent intervention process in the electrical sector.

Figure A 2.2: organisation of the electrical supply sector in Peru



MEM: Ministry of Energy and Mines

OSINERG: Supervising Body for Investment in Energy, an organisation with functional autonomy. Its mission is to supervise the compliance with legal and technical provisions related to the activities in the energy sector.

COES: Committee on Economic Operation of the System, in charge of giving a guarantee to ensure the electric supply. It is made up of generating companies and transmission system companies

Cientes: clients

The legal framework in the electrical sector has been directed toward the promotion of investment. Electrical activities can be developed by individuals or companies, whether national or foreign, public or private, through concessions or authorisations. The Government acts not only as a supervisor, regulator or source of grants, but is also responsible for the expansion of the electrical frontier and other activities where it has an electrical market share.

To supplement the private sector's actions, the rural electrification plan implemented by the Ministry of Energy and Mines' (MEM) Executive Directorate of Projects has authorised 350 electrification projects since 1993. They include the construction and commissioning of more than 7,000 km of transmission and subtransmission lines and an increase in the generating capacity (151 MW) in remote areas of the country. The increase in the installed capacity is mainly due to the installation of new electric generating units producing 100 to 25,000 kW and the installation of more than 500 photovoltaic systems.

International technical co-operation and funding

International technical co-operation has contributed, to a certain extent, to promoting the use of renewable energy in Peru. In this respect, it is worth

mentioning two programmes: the PROER (Programa de Energías Renovables) and the GEF.

PROER was a fund for renewable energy projects from the Dutch government, consisting of a donation of US \$5 million, and giving rise to a line of credit from 1996. During the fund administration by COFIDE (Financial Corporation for Development, Second-floor Banking), the funds were little used, despite the loans being attractive.

This programme did not have the expected success and stopped operating due to the restrictions on eligibility criteria, lack of training of operating personnel in intermediate financial institutions, as well as the general caution and specific preferences of the potential beneficiaries.

The Global Environment Facility (GEF) project is currently operating as a part of the work project of the World Fund for the Environment (WFE), "Promotion of the Renewable Energy Adoption through Barrier Elimination and Implementation Cost Reduction". The project coordinators are the Ministry of Energy and Mines, the National Environment Council (CONAM), and the United Nations Development Programme (UNDP/PNUD).

The project's overall objective is to assist the Peruvian Government in eliminating barriers to sustainable photovoltaic electrification in remote rural areas. The specific objective is to achieve a market growth of 6,000 to 7,000 photovoltaic systems per year through the promotion of rural energy service companies. At the end of this project, 12,500 photovoltaic systems are expected to have been installed. It is estimated that 1,523 panels, of 53 W each, have been installed to date.

Fund for promotion of micro-hydroelectric power plants (MHPPs)

This is a funding model that combines subsidised loans with technical assistance through a joint effort of the technical co-operation, the governmental organisations (local, regional and central governments) and the community. This is aimed at meeting the small needs for energy in remote rural areas in Peru.

This Revolving Fund was created in 1994 with initial capital of US \$400,000, which was increased to US \$700,000 in October 2001. To date, 24 loans for implementation and/or rehabilitation of MHPPs in different remote rural communities in Peru have been placed.

PRONAMACH (National Project for Watershed Management and Soil Preservation)

From 1991, this project was authorised to channel part of the National Housing Fund's resources into the funding of rural electrification works. In addition, technical and financial support of the international technical co-operation was available. In Peru, there is no specific renewable energy funding from the private sector.

Government investments in renewable energy

The Reference Plan³⁹ takes into account investments in solar energy, wind power and small hydroelectric power plants producing less than 500 kW.

It considers two scenarios for the 2001-2015 period – Scenario I where US \$146 million will be invested, and Scenario II where US \$183 million will be invested, over the whole period. The investment is mainly aimed at solar water heaters, 42 per cent and 53 per cent, respectively.

In relation to this funding, the recently enacted Rural Electrification Law provides for the creation of the Rural Electrification Fund.

A 2.3 The market for renewable energy

Identification and characteristics of the population without access to electricity

The new Rural Electrification Law clearly defines those with no access to electricity to include populations in rural areas, remote localities and frontier zones of the country. In these areas 45 per cent of population live in poverty, with 19 per cent in extreme poverty.

Rural electrification projects are characterised by the fact that the return on electrification investment is not necessarily attractive to the private sector and requires subsidisation by the Government because of their high profitability in social terms⁴⁰.

Electrification rate

Currently the rate of electrification is 70 per cent nationally, but only 20 per cent in rural areas. It is estimated that around 20 per cent of the population without electricity live on the outskirts of great urban centres, and so could be supplied with electricity inexpensively by expanding the electric network or creating mini-networks to transmit the electricity generated by small hydroelectric power or diesel plants. The other 80 per cent (over 6 million people) live mainly in small rural and remote localities where photovoltaic systems would be the best alternative in terms of minimum cost.

Privatisation and rural electrification

Since regional electricity companies were privatised within the framework of the Electrical Concession Law (see Figure A 2.2), and dealing with the Investment Undertaking, those receiving grants must invest 50 per cent of the economic tender in the expansion of the electrical grid in remote zones within the service area of the concession.

Projects to supply remote areas with electricity consisted of installing long distribution lines with small loads, resulting in losses to the generating companies. Decentralised renewable energy options have not been included

³⁹ Reference Plan 2001-2010, Ministry of Energy and Mines.

⁴⁰ Fuel subsidies were eliminated in 1990.

in these projects. In addition, the expected economic and social development has not been achieved in electrified areas.

Generally, the grid-based rural electrification policy has been a failure. Recent research⁴¹ on 40 electrification projects funded by the World Bank and USAID demonstrates that they have the following characteristics:

- High investment costs that continually increase.
- Apart from the lowest power consumption per family (less than 1 kWh/day and load factor less than 0.2), substantial technical and non-technical losses in the distribution system are recorded.
- Electricity sales revenue does not cover continual costs of network operation and maintenance (generally 15 to 30 per cent of supply cost).
- Even when this revenue covers operating and maintenance costs, distribution companies have to face financial losses for 10 to 15 years.

The demand for renewable energy

A large part of Peru's population, about 6 million people, live in remote rural areas or frontier zones without an electricity supply and are a potential market for renewable energy.

Most of the energy demand in rural areas relates to energy for cooking purposes. This demand is met by firewood or charcoal and, to a lesser extent, kerosene. These traditional sources of energy are difficult to replace with electricity.

However, there are other requirements that can be satisfied with electricity, such as lighting and use of minor electrical appliances, such as radio and television.

Other characteristics identified through surveys are:

- Average monthly family income in these areas is low.
- The main activity is production, especially farming, and there is a high percentage of casual workers.
- Electricity is mainly consumed for lighting purposes, and there is a potential for the average use of two light bulbs per family.
- Families are dispersed, and there is a low concentration of houses.

Main barriers to development

There are several barriers to a greater development of renewable energy, including:

Financial

The high initial cost of renewable energy technology implementation puts this energy beyond the means of low-income families, even when the cost of a

⁴¹ GTZ, *Basic Electrification of Rural Houses*, Energy and Transportation Series, 1996

photovoltaic system over its life-cycle is lower than that of the traditional sources of energy (lanterns, candles, batteries, etc).

This high initial cost is mainly due to low volumes and the high costs of transportation and installation in remote areas, and constitutes a barrier to promotion of photovoltaic systems. In general, the users have neither loan histories nor loan guarantees. Therefore there is need for appropriate financing mechanisms to encourage uptake of renewables.

Information

There are two types of information barriers to the development of renewable energy. Firstly, there is not a widespread demand for information on the technical and environmental virtues of renewable energy, and the population remain sceptical about electricity supply from solar or wind power.

Secondly, there is limited reliable and detailed data on the amounts of solar radiation and wind in Peru, meaning that it is difficult to identify those areas with sufficient solar radiation or winds at an average minimum speed to generate power.

Technical Standards

To date, there are few companies operating electricity systems based on renewable energy in Peru. Communities have not established companies to provide the services required, and local entrepreneurs do not have the relevant knowledge and incentives to work in this sector.

Normative

Until recently, technical standards on equipment and components for this type of energy did not exist.⁴² Recommended practices for installation and maintenance of photovoltaic and wind power systems also do not exist. This leads to a lack of consumer confidence in private installations of such systems and also imposes restrictions on the market growth.

Human resources

In rural areas, there is an almost total lack of technical capacity in relation to manufacturers and installers of photovoltaic and thermosolar systems. The users do not have information on operation and maintenance of this type of systems available.

Renewable energy and integrated development

In Peru, renewable energy technologies must be disseminated within a framework of integrated development that considers the fight against poverty and the unemployment in these areas as well as local environmental issues.

⁴² Recently, a draft Peruvian technical standard on solar collectors has been issued for the public's comments, and a draft standard for configuration, installation and testing of photovoltaic systems producing up to 500 W is being prepared.

Therefore, a proposal for renewable energy-based electrification should be made to:

- Meet the demand for energy in an integrated manner.
- Apply technologies appropriate for the environment in each zone; with a simple methodology which allows such technologies to be easily assimilated by the population and be replicated by using the existing infrastructure in the zone.
- Reduce technological and financial dependence.
- Relate the supply of energy to the production and service processes' needs, concentrating mainly on the production.
- Make use of 'smart' poor-targeted subsidies.

A 2.4 Projects implemented in Peru

Photovoltaic-based electrification in the Island of Taquile

In 1996, the Renewable Energy Center of the Universidad Nacional de Ingeniería (UNI) installed 100 photovoltaic systems for housing in the Island of Taquile, Andean altiplano, under a contract with the Ministry of Energy and Mines. In 1998, a further 72 photovoltaic systems were installed in Taquile and the neighbouring islands of Uros and Soto.

Each family committed itself to pay, under a contract with the UNI, US \$500 to US \$700 for the installation of a photovoltaic system, depending on its capacity (35 Wp or 50 Wp). The options for payment depended on the initial instalment and the form of payment (5 to 36 months). One hundred buyers paid an initial instalment of US \$150, and three buyers paid for their systems in cash.

Using the first loans collected, a revolving fund was created to fund the 72 photovoltaic systems installed in 1998. This technology is now widely accepted in the region of Lake Titicaca, and many families expect to buy a photovoltaic solar system under the similar conditions.

Benefits to users

Hitherto, each inhabitant consumed 100 kWh/year generated by kerosene used in lamps with an average efficiency of 10 per cent, equivalent to 10 kWh/year of electric light. Now, using solar energy in Taquile, each inhabitant consumes 11.86 kWh/year, with a real efficiency of 8.30 kWh/year. (This consumption can be broken down into 59 per cent for lighting, and 41 per cent for radio and television, with an efficiency of 70 per cent.) The cost of the traditional system was US \$0.31 per kWh, and the cost of the solar system is US \$0.84 per kWh, but the annual energy expenses dropped from US \$31 per inhabitant to US \$10 per inhabitant. Therefore it is increasingly cost effective in the long run.

For a large part of the rural population the costs of lighting (candles, gas-filled lamps and kerosene for burners) and batteries used for radio and television

are higher than the cost of photovoltaic electricity, which also allows a better service to be provided. The photovoltaic technology is easily accepted by rural population and, where it is known, is considered useful and desirable.

The experience in Taquile and other sites has demonstrated that it is not convenient to install centralised photovoltaic systems for basic rural electrification of houses. A photovoltaic system must be installed in each house separately and independently.

The Taquile project has demonstrated that there is a real possibility of achieving sustainable basic rural electrification. To ensure success, users of photovoltaic systems must ultimately be the owners of such systems and suitable technical assistance must form an integral part of the project.

Fund for Promotion of Micro-Hydroelectric Power Plants

This fund consists of a financial model based on loans subsidised through technical assistance and interest from individual clients (rural micro-entrepreneurs). It is a loan fund applied for one energy technology – micro-hydro power – considering the installation of new systems and the rehabilitation and/or repair of existing systems. The scope of work is nationwide, even though the northern zone of the country (Cajamarca, Amazonas, Lambayeque) is a priority.

The amount of loans ranges from US \$10,000 to US \$50,000, with an interest rate of 10 per cent. The payback period is one to five years, and the grace period varies, depending on the client's financial situation. The types of guarantee vary according to the status of the client, collective or individual. In the case of collective clients, they must demonstrate a positive cash flow, including short-term and medium-term investment plans. In the case of individual clients, they must give collateral for an amount equivalent to or greater than 30 per cent of the loan received; electromechanical equipment may form part of the guarantee.

It must be highlighted that the last agreement with the Interamerican Development Bank (IDB) considers an active programme of promotion of small enterprises initiatives and creation of employment using the generated energy in all population centres benefiting from implementation of micro-hydroelectric power plants.

Within the framework of this fund, four activities are developed in each project:

- Promotion and its benefits
- Technical and financial assistance
- Organisation for sustainable management
- Recovery of loans

The involved institutions include:

- Interamerican Development Bank (IDB), which furnishes capital for creation of the fund and also a part of costs of technical assistance.
- AFIDER, a local independent organisation located in the northern part of the country and which helps in preparing financial documents and recovering loans.
- ITDG Latin America, which executes the technical project, furnishes financial resources for technical assistance, and is responsible for the loan return to the IDB.
- Joint financiers, organisations contributing grants for financing power plants; the most important organisations are the regional government and the central Government through FONCODES⁴³, the local governments and some private organisations and some private investments. The beneficiary groups are municipalities, communities, individuals, and co-operatives.

To date, this model has placed 22 loans for a total of around US \$800,000, leveraging a further US \$3 million. These have enabled an additional installed capacity of over 1.5 MW to be put into operation in remote areas, benefiting more than 15,000 rural inhabitants.

A 2.5 Proposals for developing the renewable energy market in Peru

There is great potential for the development of renewable energy in Peru within the framework of sustainable development and the fight against poverty, but the following problems must be addressed:

Lack of information

There is a need for more and better data on the natural resources available in terms of solar radiation and wind power across Peru. Additionally, there should be greater promotion and dissemination of information on renewable technologies in rural areas, remote areas and frontier zones, demonstrating the advantages for domestic lighting, electrical appliances and production purposes.

Funding and guarantees

The number of renewable energy systems installed must be increased to allow the industry to benefit from economies of scale. Rational financial or loan schemes must be implemented, taking account of the experiences in Taquile and the Fund for Promotion of Micro Hydroelectric Power Plants.

⁴³ FONCODES, National Fund for Social Compensation, is a decentralised body of the Ministry of the Presidency, responsible for executing support projects for the social development with the Government's nonreturnable investments, on a national basis.

A 3 Mozambique case study

Introduction

Mozambique is a large country in Southern Africa. Its people are sparsely populated across its 784,000 square kilometres. The capital, Maputo, is close to the border with South Africa and prospers from good trading relations. However the transport and telecommunications infrastructure are very poor between Maputo and the provinces further north.

Since its vicious civil war ended in the early 1990s Mozambique has prospered. Economic growth is one of the fastest in the region, averaging 10 per cent per annum over the period 1996 to 1999. Mozambique has qualified within the Highly Indebted Poor Countries (HIPC) initiative of the World Bank which provides some respite from crippling debt repayment.

Of Mozambique's 18.3 million people, 67.9 per cent live in rural areas, and average life expectancy is only 39.3 years, which is less than previously expected due to AIDS⁴⁴. Both by a World Bank calculation, based on incomes and from the UNDP, and an index based on other development indicators, Mozambique is one of the poorest countries in the world. The average income (GNP per capita) is US \$210 per year. However, in absolute terms, 78 per cent of the population live on less than US \$2 per day. The human development index⁴⁵ is 0.341, which is the poorest in the region. By comparison China's human development index is 0.718 and the life expectancy is just over 70 years.

A 3.1 Energy access in Mozambique

National context

Mozambique is endowed with a variety of energy sources. Along with isolated fossil fuel resources Mozambique is rich in renewable energy resources. Some of Africa's great rivers flow through the country, and in the mountains in the northern and eastern provinces, there are many sites suitable for micro-hydro. As with other countries in sub-Saharan Africa there is abundant sunshine, which could be put to a variety of uses. Despite these relatively abundant resources for opening up access to modern energy, the vast majority of energy use, 91 per cent of the national total, is derived from fuel-wood and charcoal.

⁴⁴ UNDP Human Development Report 2002

⁴⁵ As defined by the United Nations Development Programme (UNDP), the Human Development Index is a measure of life expectancy at birth, adult literacy levels, school enrolment, and income per capita based on purchasing power parity; it has been developed as an indicator of human development, ref. UNDP's Human Development Report, www.undp.org/hdr2001

Efforts to connect more households to the national grid have been hampered by the combination of high poverty levels, a widely scattered population and limited public resources. In addition to this during the civil war infrastructure was specifically targeted for attack, this has meant that there is no national grid linking the centres of population. The isolated supplies that exist are managed by Electricidade de Moçambique (EDM), a para-statal energy supply company, and electrification rates in Mozambique at 7.2 per cent⁴⁶ are the lowest in the Southern Africa Development Community (SADC) region.

Access to modern energy services

A recent study⁴⁷ identified that only 1 per cent of households located in rural areas have access to electricity. The level of electrification has hardly changed in 25 years. In addition to this many larger town and administrative centres outside of Maputo and its surrounding areas also lack electricity. Mozambique has a very low access to modern energy services. According to the UNDP traditional fuels account for 91.4 per cent of total energy use. The chart below shows that despite a constantly rising population modern energy consumption has remained nearly constant.

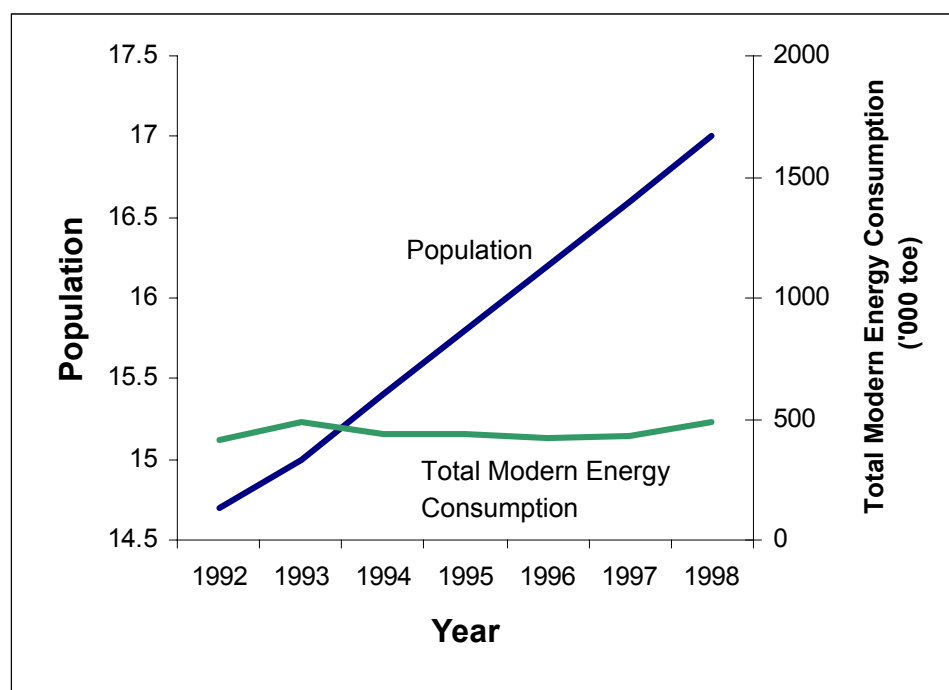


Figure A 3.1: Total modern energy consumption against population

Source: *African Energy Data And Terminology Handbook*,
African Energy Policy Research Network

⁴⁶WEO 2002, *in press*.

⁴⁷ Integrated Household Energy Planning Project (of the University Eduardo Mondlane, Maputo)

Of the non-renewable resources, there is potential for large hydro schemes in Mozambique, utilised for example in the huge Cahora Bassa dam. These supply vast amounts of power, Cahora Bassa alone produces more than four times the total electricity consumption of Mozambique. However they are hugely expensive, and have a direct negative social and environmental bearing on the areas which are flooded. In addition as there is no connected national grid infrastructure, the utilisation of large scale energy represents even greater costs in the additional infrastructure. The majority of the Mozambique's people need neither huge amounts of power nor can afford the share of the cost of its installation and transmission.

National context for renewables

Renewable energy is highly dependent on available resources. In Mozambique there is relatively good access to biomass as many areas are forested, although current use of biomass is not renewable, the potential exists. Where the resource is used only by a rural population the sustainability of the forest is less threatened than where areas are cleared for providing biomass fuel, often in the form of charcoal, for urban areas. For example there has been significant deforestation around Maputo for this reason.

It is clear that the main energy source currently used in Mozambique is biomass (over 91 per cent of total energy consumption), and this can be generalised as wood in rural areas and charcoal in urban households. If sustainably managed, this can be a renewable fuel and even carbon neutral.

Other renewable energy technologies:

Solar

There is a good solar resource availability with radiation levels in the range 4.9 to 5.7 kWh/m²/day. Despite this the market for solar photo voltaic (PV) is very small with a few private enterprises importing units. The markets for these are for higher income households, and NGO projects. Many people in Mozambique use old car batteries for supply of small amounts of electricity (predominantly for lighting and powering radios). The batteries are transported to a central location where they may be charged for a fee. The existence of this activity is a suitable entry point for small scale decentralised electricity.

Wind

Wind power is marginal with average windspeeds around 2.2m/s. There are higher average windspeeds on the coast of 3-4m/s but many inland areas have a wind average of less than 2m/s. As a benchmark 4m/s is often used as a minimum for utilisation of wind energy for generating electricity, therefore there hasn't been any development of wind generators in Mozambique.

Wind-pumps are effective in lower windspeeds. These multi-blade machines rotate slowly continuously lifting water. They are manufactured in Kenya and South Africa and there are a few units installed in Mozambique.

Small-Scale Hydro

Micro-hydro represents a possibility for decentralised energy supply with a minimal environmental impact and can provide some of the energy services to benefit the people of Mozambique without necessitating a huge spending for power lines. For continuous supply of electricity it is necessary to have a perennial stream.

Due to the geography of Mozambique areas where there are suitable sites for micro-hydro plants are concentrated in the provinces of Manica, Tete and Niassa. During colonial times the Portuguese installed several micro-hydro systems in these three provinces for milling grain. These can and are being refurbished, both for their original purpose and for generating electricity. There is sparse information about the available resource. Better mapping would enable an accurate estimation of the possible role that micro hydro could have for widening access to modern energy.

Poverty reduction

At a national level the Mozambique government has prepared a Poverty Reduction Strategy Paper 2001-2005, called the PARPA (Plano de Acção para a Redução da Pobreza Absoluta). This is a requirement for the International Monetary Fund. The overall objective of the PARPA is to reduce poverty by about 30 per cent over thirteen years, from 70 per cent in 1997 to below 60 per cent in 2005 and 50 per cent by 2010. Within the document it identifies energy (along with roads and water, as infrastructure) as a fundamental area for action. With the objective to “expand electrification and promote its use for agro-industrial and domestic purposes” the principle targets are to:

- Electrify 25 administrative posts, through the use of solar energy systems.
- Install power plants in 42 district headquarters.
- Expand the national grid through the building of new lines: 110 KV, Xai-Xai Lindela; 110 KV, Nampula-Nacala; 110KV, Nampula-Chiure-Pemba; 110KV, Gurue-Lichinga; 400 KV, Songo-Nacala.
- The electrification of 60,000 new houses in urban, peri-urban and rural areas.

In addition to the government there are many agencies active in Mozambique with a specific mandate to work on poverty reduction programmes. Some are more focussed on relief, for example to address the situation during and immediately after the floods of 1998 and 1999. Others are active in the various sectors of development, health, agriculture, education, access to

services etc. The connection between energy and these development efforts is increasingly being made.

Access to international financing

For various reasons (poverty, colonial legacy, civil war) Mozambique has a large number of international NGOs active in all areas of 'development'. Many are responsible for grassroots delivery of services but are increasingly working with government structures in the different provinces. In macro-economic terms the country's net resource flows in 2000 comprised: US \$564m in official grants, US \$105m from official creditors, and US \$81m foreign direct investment. In 2000 Mozambique imports were more than three times higher than its exports.

Market analysis for renewables

There are a few isolated suppliers of renewable energy systems in Mozambique. In the neighbouring countries of South Africa and Tanzania there are manufacturers which are more established. Any model for implementation of renewable energy systems would need to identify local entrepreneurs, who are sensitive to local needs and conditions, to undertake installation and maintenance activities.

Current costs of technology available in the local market:

- Cost of 50Wp PV system – US\$1,200 (compared with US\$1,061 as an average for the region)
- Cost of a 100 litre Solar Water Heating system – US\$650 (compared with US\$583.5 as an average for the region)
- Wind Pumps (no price given for Mozambique, but Kenya, Zambia and Zimbabwe had units for sale for about US\$3,500)
- Micro Hydro – a new system costs around US\$30,000 for a 35k W plant.

A 3.2 Four examples of implementation

Micro-hydro

Micro-hydro plants, usually run-of-the-river which divert a portion of a small river or stream, have a separate pipe running parallel to the stream to a power-house. They produce between a few kW to about 200kW, and the power is either used directly (e.g. grain milling) or for decentralised electricity generation, with a micro-grid to distribute the electricity to the various users in the community. Where suitable conditions exist micro-hydro is likely to be the most appropriate and least cost means of providing improved energy services to rural communities. At the same time it is free of carbon or any other pollutants and can be community managed.

Three provinces in Mozambique have locations where there is suitable resource for micro-hydro development. These are Manica, Niassa and Tete. There are some units which are operational in these provinces. The

government of Mozambique attaches a high priority to electrification of centres of population which currently have no access to grid electricity. Mini-hydro is often the means for supplying this energy need, for example Lichinga in Niassa province is served by a mini-hydro plant with some back-up support from diesel generators.

There is good opportunity and feasibility for the successful development of a sustainable small hydro programme in Mozambique. There are difficulties to be overcome in making schemes financially sustainable, and this can be met by differentiating between energy for basic household needs and energy which can be used for economically productive end uses for which payment can be expected.

Grid

Mozambique has no national grid backbone, although there are cross-border transmission lines from Cahora Bassa, and between Maputo and South Africa. Individual centres have their own local grids, managed by the parastatal supplier, EDM. Much of the electricity generated in Mozambique is exported to South Africa

There have been grid extension efforts for rural areas. In February 2002 a loan from OPEC for US \$6.9m was agreed for the purposes of improving rural infrastructure in the provinces worst affected by the recent floods (Gaza, Inhambane, Maputo, and Nampula). Within the proposal 816-km of medium and 68-km of low voltage lines will be installed, and single phase connection to 6,703 households. In addition, 1,800 street lighting points will be constructed along main roads. There are more grid extension projects proposed but because of the size of Mozambique and the distances between the centres of population the costs of these projects is inordinately large.

A grid electrification strategy for Mozambique would likely follow a large hydro path, with all the attendant social and environmental damage associated with this technology. Large hydro (not renewable) has already been implemented on the Zambesi with the huge 2,040 MW Cahora Bassa dam which was built in the early 1970s. There are other large projects proposed on the Zambesi (600 MW Cahora Bassa North and the 1,200 MW Mwpanda Uncua Dam). While economies of scale might make this power seem cheaper per kW/h in fact the additional costs and power-losses involved in transmitting electricity to poor communities in all areas of the country are not economical. Therefore the benefit of large hydro and grid extension in general will not benefit the vast proportion of Mozambique's population. Hence decentralised renewables, appropriately financed and resourced is the only sustainable solution.

Biomass

The majority of the population in Mozambique is dependent on traditional fuels for their daily cooking needs. The World Bank's Energy Sector Management Assistance Programme estimated the total wood fuel

consumption in Mozambique to be 11.5 million cubic meters, which is about 640m³ per person per year. In an attempt to reduce deforestation, the government has increased the tax on operators who have logging concessions. Further, despite increasing the fines for illegal logging, this still takes place extensively to supply the urban charcoal demand⁴⁸.

Recent participatory research in a peri-urban areas of Beira has shown the energy need for a typical Mozambique household. A household where the husband had left was found to use charcoal for cooking and kerosene for lighting. The charcoal cost about US \$ 5 a month, and the 5 litres of kerosene needed each month cost US \$2.10. These energy costs are expensive when the wage that the female head-of-household receives for her job with the municipality was 26 dollars monthly. In other words she has to pay over 27 per cent of her income for energy; in the UK the average household spending on energy is 4 per cent⁴⁹. Living in peri-urban area electricity connection is technically feasible but the connection charge, of US \$180, is not affordable. Another problem identified with electricity was that there was no way of regulating how much was used which often results in high bills at the end of each month. This is yet another clear illustration of the poor in developing countries paying far higher prices per unit of energy than the better off.



Figure A 3.2: Charcoal Kiln being prepared, this practice contributes to wide scale deforestation in an expanding radius around centres of population in Mozambique.

Image courtesy of Chaposa project (www.sei.se/chaposa)

Charcoal is an important activity in Mozambique. Most households in urban centres rely on this for their energy needs. Charcoal has many environmental problems, the preparation of charcoal is often inefficient and as it takes place

⁴⁸ Source, Mozambique News Agency

⁴⁹ WEO 2002, *in press*

on a large scale it is responsible for large scale deforestation in areas within a radius of 200km of large cities. There are many interventions which can improve the charcoal chain, both for the livelihoods of people involved and for the environment. Sustainable natural resource management, can ensure that the resource from which the fuel wood is taken is sustainably managed. Efficient combustion both when the charcoal is first produced in a kiln and also with improved stoves, when it is finally used, can reduce the amount of wood needed.

There are several organisations active in biomass projects in Mozambique. One network for organisations active in household energy is the recently launched SPARKnet⁵⁰. This brings together stakeholders for the purposes of informing policy and contains documents on gender, forestry, health, and Policy aspects of household energy.

Solar

There are an estimated 25,000 car batteries sold for the purpose of home electrification. A car battery is carried (often significant distances) to a point where it can be re-charged for a fee, the small amount of power is then typically used for lighting or for television and radio. The power at the charging station is usually provided by a diesel generator or from grid electricity supply. This activity is often expensive and time consuming due to the transport involved.

Based on the economics which apply to this system there has been an estimation of a short term market of about 20,000 solar systems. However given that many parts of Mozambique are unlikely to be connected to any centralised grid supply, the total possible number of solar PV systems for blanket coverage is over two million households. This would need extensive subsidy due to the high up-front costs of solar home systems but through appropriate financing mechanisms to cover these costs which allow suitable pay-back then this can be far cheaper than kerosene etc. particularly as maintenance costs are minimal. Neighbouring South Africa has recently announced a plan to electrify 50,000 rural households with solar home systems.

⁵⁰ www.sparknet.info

A 3.3 Recommendations

Based on the above calculation for widespread access to modern energy in renewable parts of Mozambique, it is certain that decentralised supply of electricity from renewable sources is the most cost effective and sustainable way of meeting the electricity need. Although it has been identified that there are possibilities for micro-hydro in the provinces of Tete, Manica and Niassa, better resource mapping would be needed so that the exact resource can be known and the planning for the installation of units can be made. For rural populations where there is no micro-hydro availability, then solar photovoltaic is an option. The costs for this technology would be brought down if there is a large increase in the number of units used for rural electrification and if there is manufacturing capacity in the region

Basic energy needs for the poor in Mozambique for cooking will continue to be met by traditional biomass. This can be a renewable technology if the resource is sustainably managed. Therefore it is necessary that where there are increasing populations which put a strain on fuel-wood sources that resources are managed sustainably to prevent deforestation.

The environmental impact of increased biomass use around larger towns needs to be mitigated by:

- Switching to other cleaner fuels
- Better forest management by local communities
- Reducing the health impact of cooking with biomass through programmes of awareness-raising and promotion of cleaner cooking technologies.

Glossary

AREED - African Rural Energy Enterprise Development
BDS - Business Development Services
BMZ - Federal Ministry for Economic Co-operation (Germany)
CDD - Community-Driven Development
CDM - Clean Development Mechanism
CSD - Commission on Sustainable Development
DANIDA - Danish International Development Agency
DFID - Department for International Development (United Kingdom)
DGIS - Directorate-General for International Co-operation (the Netherlands)
EAIF - Emerging Africa Infrastructure Fund
ECA - Export Credit Agreement/Export Credit Agency
EdF - Electricité de France
GEF - Global Environmental Facility
IEA - International Energy Agency
IFI - International Financial Institution
IPCC - Intergovernmental Panel on Climate Change
ISED - European Union Initiative on Energy for Sustainable Development
ITDG - Intermediate Technology Development Group
OECD - Organisation of Economic Co-operation and Development
PPIAF - Private Participation in Infrastructure Advisory Facility
PRSP - Poverty Reduction Strategy Papers
SIDA - Swedish International Development Agency
SIF - Social Investment Funds
TAR - Third Assessment Report
UN - United Nations
UNDESA - United Nations Department of Economic and Social Affairs
UNDP - United Nations Development Programme
UNEP - United Nations Environment Programme
USAID - US Agency for International Development
WHO - World Health Organisation
WSSD - World Summit on Sustainable Development

China case study

GDP - Gross Domestic Product
GEF - Global Environmental Facility
GTZ - Deutsche Gesellschaft für Technische Zusammenarbeit
IDS - the Institute of Development Studies
PV - photovoltaic
REVPS - Renewable Energy Village Power Systems
SHS - Solar Home System
SNISD - South-North Institute for Sustainable Development
UNDP - United Nations Development Programme
USDOE - United States Department of Energy
WB - World Bank
WWF - World Wide Fund for the Environment

Peru case study

AFIDER (a local independent organisation located in northern Peru and which helps in preparing financial documents and recovering loans)

COES - Committee on Economic Operation of the System

COFIDE - Financial Corporation for Development

CONAM - the National Environment Council

FONCODES - National Fund for Social Compensation

GEF - Global Environmental Facility

IDB - Inter-American Development Bank

ITDG - Intermediate Technology Development Group

MEM - Ministry of Energy and Mines

MHPP - micro-hydroelectric power plant

PROER - Programa de energias renovable (Renewable Energy Programme)

PRONAMACH - National Project for Watershed Management and Soil Preservation

UNI - Universidad Nacional de Ingenieria

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EDM - Electricidade de Mocambique

GNP - Gross National Product

HIPC - Highly Indebted Poor Countries

NGO - Non-government organisation

OPEC - Organisation of Petroleum Exporting Countries

PARPA - Plano de Accao para a Reducao da Pobreza Absoluta (document of Strategy for the Reduction of Poverty and Promotion of Economic Growth)

SADC - Southern Africa Development Community

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