PROMOTING ENTREPRENEURSHIP IN RENEWABLE ENERGY–
SHARING THE LESSONS LEARNT

Prepared for

YES CAMPAIGN

BY

IT POWER INDIA

Power India

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1. ENERGY – SITUATIONAL ANALYSIS

Over two billion people in developing countries do not have access to reliable forms of energy. Nine out of ten Africans have no access to electricity. Providing clean energy on a sustainable basis is vital not only for fighting environmental issues like global warming but also for reducing poverty and misery in Africa, parts of Asia and Latin America[1]. Access to affordable, modern energy services is increasingly seen as a pre-requisite for sustainable development and poverty alleviation. It is a condition for achieving the UN's Millennium Development Goals, including the goal to halve the proportion of people in poverty by 2015. Limited access to adequate and appropriate energy, including electricity, means that value-adding income-generating activities are constrained.

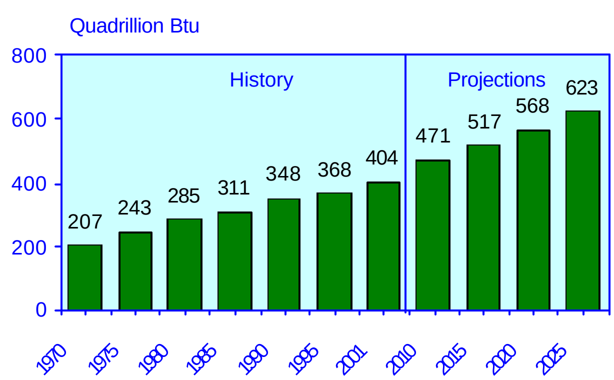
Modern forms of energy empower human beings in countless ways by reducing drudgery, increasing productivity, transforming food, providing illumination, transporting water, fuelling transportation, powering industrial and agricultural processes, cooling or heating rooms, and facilitating electronic communications and computer operations, to name just a few. Given that they can so dramatically increase human capabilities and opportunities, adequate energy services are integral to poverty alleviation and environmentally sound social and economic development.

1.1. World Energy Scenario

World energy consumption is projected to increase by 54 percent from 2001 to 2025 (IEO2004). Much of the growth in worldwide energy use is expected to be in the developing world, with Asia alone accounting for 40 percent of the total projected increment in world energy consumption and 70 percent of the increment for the developing world.

Oil is expected to remain the dominant energy source worldwide through 2025. There will be increase in world oil demand by 1.9 percent annually from 77 million barrels per day in 2001 to 121 million barrels per day in 2025 (IEO2004).

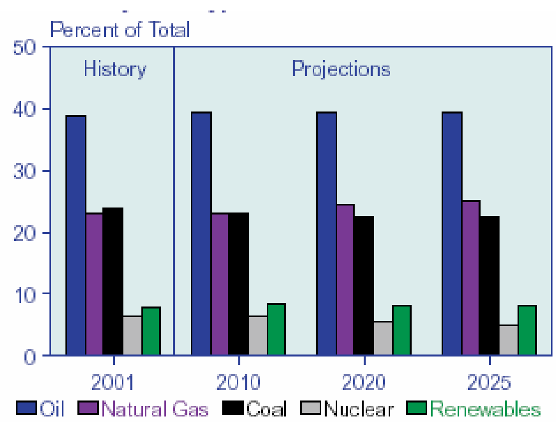
In 2001, developing nations consumed about two-thirds (64 percent) as much oil as the industrialised nations and by 2025 they are expected to consume 94 percent as much as the industrialised nations. Consumption of natural gas is projected to increase by 67 percent to 151 trillion cubic feet in 2025.



World Marketed Energy Consumption 1970-2025
Source : IEO2004

[1] Klaus Toepfer, Executive Director, UNEP

Coal remains an important fuel in the world's electricity markets and is expected to continue to dominate energy markets in developing Asia. With the projected growth in coal consumption averaging 1.5 percent per year through 2025, coal's share of total world energy consumption is assumed to decline slightly from 24 percent in 2001 to 23 percent in 2025. The worldwide net electricity consumption is projected to nearly double between 2001 and 2025, from 13,290 billion KWh to 23,072 billion KWh.

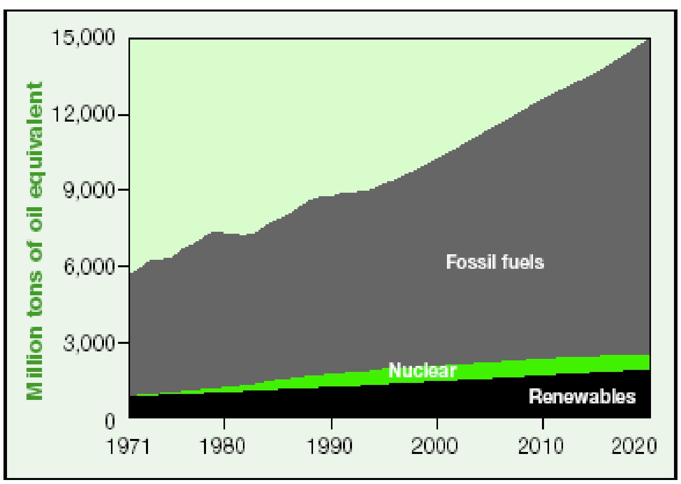


World Energy Consumption – Shares by Fuel Type; Source : IEO2004

Electricity generation from nuclear power is projected to increase from 2,521 billion kWh in 2001 to 3,032 billion kWh in 2020, before declining slightly to 2,906 billion in 2025. Renewable energy sources especially hydroelectric power, biomass, wind power, and geothermal energy will account for a growing share of world energy consumption. Today hydropower and biomass together contribute around 15 percent. Moderate growth is projected in the world's consumption of hydroelectricity and other renewable energy resources over the next 24 years, averaging at 1.9 percent per year. Projections indicate that consumption of renewable energy for electricity production worldwide will grow by 57 percent, from 32 quadrillion Btu in 2001 to 49 quadrillion Btu in 2025.

1.2. Energy Consumption

Developing nations of the world are largely expected to account for the increase in world energy consumption. In particular, energy demand in the emerging economies of Asia, which include China and India, is projected to more than double over the next quarter century. In the developing world as a whole, primary energy consumption is projected to grow at an average annual rate of 2.7 percent between 2001 and 2025. In contrast, in the industrialised world, energy use is expected to grow at a much slower rate of 1.2 percent per year over the same period, and in the transitional economies of Eastern Europe and the former Soviet Union growth in energy demand is projected to average 1.5 percent per year.



Share of Fuels in Global Energy Supply
Source: WEA, 2000

Region	*Energy Consumption (Quadrillion Btu)*			
	1990	*2001*	*2010*	*2025*
Industrialised Countries	182.8	211.5	236.3	281.4
EE/FSU	76.3	53.3	59.0	75.6
Developing Countries	89.3	139.2	175.5	265.9
Asia	52.5	85.0	110.6	173.4
Middle East	13.1	20.8	25.0	34.1
Africa	9.3	12.4	14.6	21.5
Central and South America	14.4	20.9	25.4	36.9
Total World	**348.4**	**403.9**	**470.8**	**622.9**

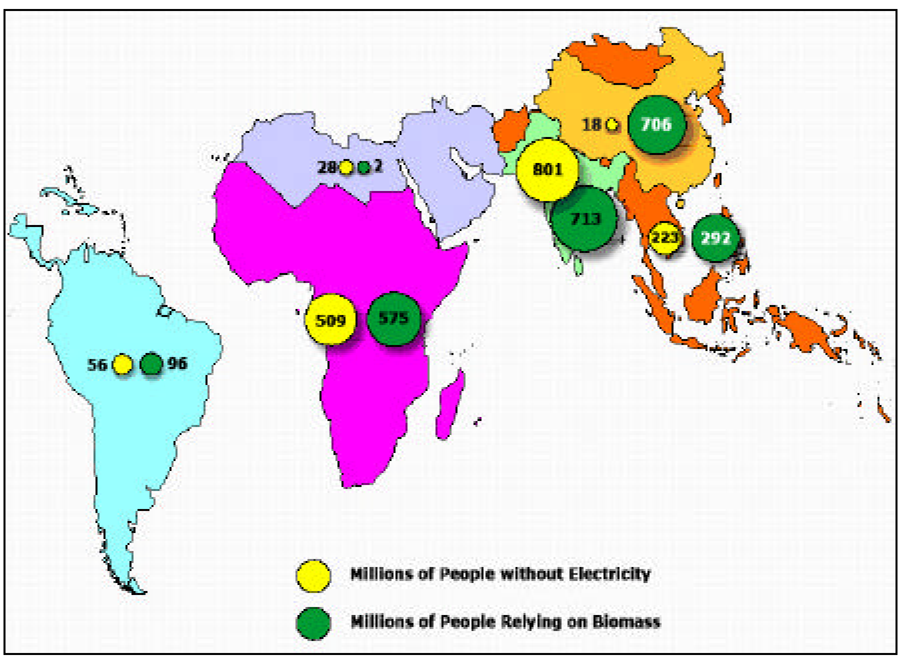
World Energy Consumption by Region; Source : IEO2004

1.3. Energy Crisis and Solutions

Analysis of the long-term availability of energy resources, starting with conventional and unconventional oil and gas, indicates that these resources could last another 50–100 years and possibly much longer with known exploration and extraction technologies and anticipated technical progress in upstream operations.

Type	**Reserves (Exajoules)**	**Resources (Exajoules)**
Oil		
Conventional	6,004	6,071
Unconventional	5,108	15,240
Natural Gas		
Conventional	5,454	11,113
Unconventional	9,424	23,814
Coal	20,666	179,000
Total	**46,655**	**235,238**

World Fossil Fuel Reserves; Source: WEA, 2000



Access to Electricity (%); Source: IEA Analysis

There are quite a few major global issues associated with energy use. Many of the current practices have lead to an energy crisis, which in turn hinders the adoption of sustainable energy practices.

- More than 2 billion people do not have access to affordable, modern energy supplies, including gaseous and liquid fuels, electricity, and more efficient end-use technologies. This restricts the opportunities for economic development and improved living standards available to them. Women and children are disproportionately burdened by a dependence on traditional fuels.
- Wide disparities in access to affordable commercial energy and energy services run counter to the concept of human development and threaten social stability.
- Unreliable supplies are a hardship and an economic burden for a large portion of the world's population. In addition, dependence on imported fuels leaves many countries vulnerable to disruptions in supply.
- Human health is threatened by high levels of pollution resulting from inefficient energy use at the household, community, and regional levels.
- Energy-linked emissions contribute to air pollution and ecosystem degradation.
- Emissions of anthropogenic greenhouse gases, mostly from the production and use of energy, are altering the atmosphere in ways that may already be having a discernible effect on the global climate.

The solution to the above-listed issues lies in renewable energy sources, which can meet the present world energy demand with a surplus and without the negative effects. These resources can enhance diversity in energy supply markets, secure long-term sustainable energy supplies, and reduce local and global atmospheric emissions. They can also provide commercially attractive options to meet specific needs for energy services, particularly in developing countries in the rural areas, create new employment opportunities, and offer possibilities for local manufacturing of equipment.

Resource	Current Use	Technical Potential	Theoretical Potential
Hydropower	9	50	147
Biomass Energy	50	> 276	2,900
Solar Energy	0.1	> 1,575	3,900,000
Wind Energy	0.12	640	6,000
Geothermal Energy	0.6	5,000	140,000,000
Ocean energy	Not Estimated	Not Estimated	7,400
Total	**56**	**> 7,600**	**> 144,000,000**

Renewable Resource Base (Exajoules/year); Source: WEA, 2000

1.4. Energy Use and Impact on Environment

The harvesting, processing, distribution, and use of fuels and other sources of energy have major environmental implications. Consequences include major land-use changes due to fuel cycles such as coal, biomass, and hydropower, which have implications for the natural as well as human environment. About half of the world's households use solid fuels (biomass and coal) for cooking and heating in simple devices, causing air pollution that is probably responsible for 4–5 percent of the global burden of disease. The chief ecosystem impacts relate to charcoal production and fuel wood harvesting.

Among energy systems, solid-fuel cycles create significant risks for workers and have the greatest impact on populations. In communities, fuel use is the main cause of urban air pollution. In addition, there are also the emissions from vehicles and stationary sources. Diesel-fuelled vehicles, which are more prominent in developing countries, pose a growing challenge for urban health. The chief ecosystem impact results from large-scale hydropower projects in forests, although surface mining also causes significant damage in some areas. At the regional level, fine particles and ozone are the most widespread health damaging pollutants from energy use, and can extend hundreds of kilometers from their sources. Similarly, nitrogen and sulphur emissions lead to acid deposition far from their sources. Such deposition is associated with damage to forests, soils, and lakes in various parts of the world. At the global level, energy systems account for two-thirds of human-generated greenhouse gas increases. Thus energy use is the human activity most closely linked to potential climate change. Climate change directly impacts human health and ecosystems significantly.

At least half of gross energy consumption in most developing countries occurs in rural communities. The bulk of this energy is derived from locally available traditional energy resources. It provides energy services via rudimentary technologies, which are limited in capability and generally inefficient. Modern, commercial energy sources, generally provide a small part of the energy consumed by rural people, mainly because of supply and affordability constraints.

In rural communities, in addition to households need for a minimum amount of energy, there is an increasing demand for energy in the provision of rural services such as water supply, health care and education, and for productive activities such as agriculture and small industries. Ideally, all these needs should be met in an efficient, cost-effective and environmentally sustainable manner. In many cases, this is really only possible through a transition from the use of inefficient traditional energy sources and technologies, to more efficient technologies and renewable sources of energy.

People value reliable services in the South Pacific

A mini grid has been installed on one of the outer islands in Tuvalu in the South Pacific, using diesel generators. This mini grid operates for only a few hours per day (mainly in the morning and the evening), due to difficulties in supplying diesel to the remote island and also due to the cost of running the mini grid. Charges for households are as high as 30 Australian Dollars per month even for this limited service. The mini grid provides electricity for a range of services including lighting, television, video, radio, music, electric fan and fridge freezer. In addition to this diesel mini grid, some people are also willing to lease a solar home system for around 9 Australian Dollars per month. The solar home systems installed only provide enough electricity for lighting, and radio/music, but people value the reliability of being able to switch on a light at any time of night, and are willing to pay extra for this facility.

Source: G8 Renewable Energy Task Force, Final Report, 2001

1.5. The Role of Renewables in Off-grid Areas

Some of the basic every day activities that people take for granted like drinking clean water, listening to the radio, or even reading at night, , require electricity. These services seem very basic, but greatly affect the quality of life. It is estimated that to provide electricity for such household, community and commercial activity, people need about 50 kWh per person per year. The annual costs of extending electricity services to the rural population have not been accurately estimated, but overall investments in the electricity production and distribution systems of developing countries is about US$40-60 billion annually [2]. Despite these investments, approximately 2 billion people remain without electricity.

The lack of adequate energy services in rural/off-grid areas of developing countries has social dimensions as well as serious environmental and health effects. Many of these problems are exacerbated by the almost exclusive reliance of rural populations in most areas on traditional fuels coupled with simple technologies characterised by low energy efficiency and harmful emissions.

- ❖ Some 2 billion people – one-quarter of the world population – have no access to electricity. In the absence of vigorous new policies, 1.4 billion people will still lack electricity in 2030.
- ❖ Four out of five people without electricity live in rural areas of the developing world, mainly in South Asia and sub-Saharan Africa. But the pattern of electricity deprivation is set to change, because 95% of the increase in population in the next three decades will occur in urban areas.
- ❖ Some 2.4 billion people rely on traditional biomass wood, agricultural residues and dung for cooking and heating. That number will increase to 2.6 billion by 2030

Source: IEA, World Energy Outlook, 2002

- ❖ Indoor air pollution kills two million women and young children every year through acute respiratory infection, eye diseases, and complications during pregnancies
- ❖ In rural sub-Saharan Africa, many women carry 20 kg of fuel wood for an average of five km every day. The effort uses up a large share of the calories from their daily meal, which is cooked over an open fire with the collected wood.
- ❖ Poor people in the developing world are constantly exposed to indoor particulate and carbon monoxide concentrations many times higher than WHO standards. Acute respiratory illness affects as much as 6% of the world population.
- ❖ The WHO estimates that 2.5 million women and young children in developing countries die prematurely each year from breathing the fumes from indoor biomass stoves.

Indoor Air Pollution, Source: World Bank

The dispersed character of rural populations and their low commercial energy consumption result in poor capacity utilization efficiency for transmission and distribution systems and other energy infrastructure. Extending an electric grid to a few households in a rural setting can result in energy costs of up to seven times the cost of providing electricity in an urban area. Thus conventional approaches to extending energy infrastructure are economically inefficient, for both public and private providers, which is another reason why the energy

[2] NDC 2000: Feinstein 2001

problems of rural populations are given low priority by governments. In rural areas of developing countries, the poor lack access to electricity and modern fuels. They rely primarily on human and animal power for mechanical tasks, such as agricultural activities and transport, and on the direct combustion of biomass[3] for activities that require heat or lighting. Biomass fuels are typically used for cooking, heating space, heating water for bathing, and meeting some of the industrial heating needs. Kerosene is used predominantly for lighting. It also used to a small extent in rural industry.

Renewable energy is energy obtained from sources that are essentially inexhaustible. Where such energy, is abundant, expandable and decentralised, renewable energy systems, such as solar photovoltaics (PV) and small hydropower, wind and biomass systems are the most affordable and accessible options to provide off-grid electricity services. Many renewable energy technologies, because they are small in scale and modular, are well suited to the energy needs in off-grid areas[4] and can be expanded as demand grows. They also have a good potential for continued reduction in cost as a result of field experience and larger volumes of manufacture. As such, renewables ought to be seriously considered as the key to meet the key challenges in rural electrification.

2. RENEWABLE ENERGY ENTERPRISES

2.1. Renewable Energy: Definition and Sources

Renewable energy, which means energy supplied from inexhaustible sources, generally depends on energy flows through the earth's ecosystem from the insolation of the sun and the geothermal energy of the earth. The forms of renewable energy can be distinguished as:

- Biomass energy[5]

Biomass is a rather simple term for all organic material that stems from plants (including algae), trees, and crops. Biomass sources are therefore diverse, including organic waste streams, agricultural and forestry residues, as well as crops grown to produce heat, fuels, and electricity (energy plantations). The world derives about 11 percent of its energy from biomass. Energy in the form of electricity, heat, steam, and fuels can be derived from these sources through conversion methods such as direct combustion boiler and steam turbines, anaerobic digestion, co-firing, gasification, and pyrolysis.

- Wind energy[6]

Winds develop when solar radiation reaches the earth's highly varied surface unevenly, creating temperature, density, and pressure differences. Wind turbines, both large and small, produce electricity for utilities and remote villages.

- Direct use of solar energy[7]

Solar energy, provided by the sun, is constantly replenished and will not produce harmful pollution unlike fossil fuels. Solar energy may be used passively, to heat and light buildings, or technology may be used to harness the sun's energy by collecting it and transforming it to generate electricity. Current technologies include photovoltaics, concentrating solar, solar hot water, and more.

[3] wood, crop residues, dung
[4] providing standalone or mini-grid systems
[5] plant growth driven by solar radiation
[6] moving air masses driven by solar energy
[7] as for heating and electricity production

- Hydropower

Hydroelectricity, which depends on the natural evaporation of water by solar energy, is by far the largest renewable resource used for electricity generation. Hydroelectricity is obtained by mechanical conversion of the potential energy of water. Hydroelectric means making electricity from water power. Hydroelectric power uses the kinetic energy of moving water to make electricity.

- Marine energy[8]

Tidal energy is the energy transferred to oceans from the Earth's rotation through gravity of the sun and moon. Wave energy is mechanical energy from wind retained by waves. Ocean thermal energy is energy stored in warm surface waters that can be made available using the temperature difference with water in ocean depths. Salt gradient energy is the energy tapped from salinity differences between freshwater discharges into oceans and ocean water.

- Geothermal energy[9]

Geothermal energy is generally defined as heat stored within the earth. The earth's temperature increases by about 3°C for every 100 m depth, though this value is highly variable. Heat originates from the earth's molten interior and from the decay of radioactive materials.

A wide variety of renewable energy technologies are available or under development to provide inexpensive, reliable, and sustainable energy services.

Technology	Energy product
Biomass energy	
Combustion	Heat (cooking, space heating)
Gasification/power production	Electricity, heat (CHP).
Gasification/fuel production	Hydrocarbons, methanol, H_2
Hydrolysis and fermentation	Ethanol
Pyrolysis/production of liquid fuels	Bio-oils
Extraction	Biodiesel
Digestion	Biogas
Wind energy	
Water pumping and battery charging	Movement power
Onshore wind turbines	Electricity
Offshore wind turbines	Electricity
Solar energy	
Photovoltaic solar energy conversion	Electricity
Solar thermal electricity	Heat, steam, electricity
Hydropower	Power, electricity
Geothermal energy	Heat, steam. electricity
Marine energy	
Tidal energy	Electricity
Wave energy	Electricity
Current energy	Electricity
Ocean thermal energy conversion	Heat, electricity

Renewable Energy Conversion Technologies; Sources: WEA 2000

[8] such as wave energy, marine current energy, and energy from tidal barrages
[9] from heat stored in rock by the natural heat flow of the earth

2.2. Advantages and Benefits of Renewable Energy

Renewable energy technologies provide only a small share of global energy production today (2%), but have the potential to meet world energy demand many times over and are ready for use on a large scale. The advantages of shifting from conventional to renewable energy are enormous and also compelling. Renewable energy technologies impose significantly lower social, environmental, and health costs compared to the conventional counterparts. Generating power locally with renewable energy technologies reduces or eliminates transmission and distribution losses, which range from 4-7 % in industrialised nations to more than 40% in parts of developing world. Renewable energy technologies can be installed rapidly and in dispersed small or large-scale applications, which imply getting power to areas where it is urgently needed, delaying or avoiding investment in new power plants or power lines, reducing investment risks, and promoting socio-economic development. It has been estimated that investments required over a 10-year period to make renewables competitive worldwide within two decades would be far lower than the economic costs of a single 10% increase in oil prices and would be modest in comparison with existing flows in energy sectors worldwide.

Technology	Investment Costs ($/kW)	Total Generating Costs (cents/kWh)
Non-renewable		
Natural gas CC	500-700	3.0-4.0
Coal	1,000-1,300	4.0-5.5
Nuclear	1,200-2,000	3.3-8.0
Renewable		
Wind	800-2,000	3.0-8.0
Biomass (25MW)	1,500-2,500	4.0-9.0
Small hydro	800-1,200	5.0-10.0
Solar thermal electric	4,000-6,000	12.0-18.0
Solar PV	6,000-8,000	30.0-80.0

Cost Comparison for Selected Energy Technologies
Source: Renewable Energy World, Vol.6, No.2

Economic benefits of renewable energy

- Continuing cost reductions occur through increasing scale of manufacturing and deployment.
- Costs are not affected by swings in fossil fuel prices.
- Modularity, low operating costs.
- Installation of distributed generation units helps reduce pressure to build new power grid generating capacity and transmission lines.
- Very short construction times give much greater flexibility in energy planning and investment.
- Local employment and income generation result from manufacturing, project development, servicing, and utilization.

Source: G8 Renewable Energy Task Force, Final Report, 2001

Around the world, using renewables stimulates local economies by attracting investment and by creating employment. Many of the jobs are high wage and hi-tech and require a range of skills often in rural or economically depressed areas. Many of the components for renewable energy systems are now manufactured or assembled in developing countries, creating local jobs, reducing costs and keeping capital investments at home.

Renewables and Climate Change

In a recent report, the Inter-governmental Panel on Climate Change (IPCC) highlights the importance of introducing technologies with improved environmental performance to mitigate climate change. The report predicts an impact on the renewable energy companies due to shifting priorities and resources to reduce carbon in the atmosphere:

> *"For the crucial energy sector, almost all greenhouse gas mitigation and concentration stabilisation scenarios are characterised by the introduction of efficient technologies for both energy use and supply, and of low- or no-carbon energy (sources)." … "Other industries including renewable energy industries and services can be expected to benefit in the long term from price changes and the availability of financial and other resources that would otherwise have been devoted to carbon-intensive sectors."*

Source: G8 Renewable Energy Task Force, Final Report, 2001

2.3. The Benefits of Renewable Energy Enterprises

International development stakeholders and investors have too often ignored the potential of local enterprises to innovate in the area of essential energy services. This was because often the enterprises were too small, they operated in remote, rural areas, there was no formal book-keeping and because development agencies and governments often believed that centralised programs were the best means to deliver those services.

Women Entrepreneurs Making Improved Cooking Stoves
Source: IT Power India

Today, the focus has shifted from one of technology, demonstrations and gifts to that of empowerment, markets and investments. With market restructuring, the focus is also shifting from centrally planned programmes to public-private partnerships and the creation of competitive environments conducive to the private sector. Real opportunities are emerging in the commercial and private sectors to produce and deliver clean, modern and affordable energy services to people who do not have them. There is now a general recognition that one of the most potent engines in this shift towards local capacity to produce and distribute modern energy services is an enterprise powered by an entrepreneur.

The potential benefits of each enterprise investment include not just the direct financial returns typically of interest to the entrepreneur and their financiers, but also indirect returns such as job creation, lower pollution levels, and improved rural livelihoods. Further, successful businesses can also induce other entrepreneurs to enter the clean energy sector.

There are various enterprise development programme models available to demonstrate how small amounts of targeted support can be leveraged to solve several pressing problems at the same time through new and environmentally sound energy services delivered in a local and commercial context.

2.4. Resources for Implementation of Renewable Energy Technologies

At the global level, over 85 % of the energy production from renewable energy takes place in the industrialised countries. This does appear as a somewhat inconsistent situation, considering that developing countries have a much larger potential for renewables like wind, biomass, hydro and solar energy than industrialised countries. What prevents the adoption of such renewables in developing countries is the lack of resources.

The skills and capacities that play a crucial role in the implementation of Renewable Energy Technologies (RETs) include:

- **Financial:** Availability of funds through credit schemes is one of the essential resources for implementation of RETs. Micro credit schemes for renewable energy have been initiated in quite a few instances in the past. Renewable energy projects of multilateral and bilateral donors assist in developing related markets in developing countries. However, attention must be paid to the sustainability and replicability of these projects. The implementation of the Kyoto flexibility mechanisms like Clean Development Mechanism (CDM) could represent a strong incentive for further mobilisation of private capital for renewable energy projects in developing countries. Tax relief, concessionary grants and subsidies are important resources in those developing countries that can afford these measures.
- **Institutional:** Renewable energy has to be integrated into energy policies. Energy markets should be opened to provide Independent Power Producers (IPPs) with the possibility to invest in such power projects. There also have to be clear legal guidelines for the production and feed-in of electricity from renewable energy sources, in order to create security for private sector investment. Whenever possible, these projects should be given preference over conventional energy projects. Renewable energy can play a major role, especially in the context of rural electrification, NGOs, businesses, or government agencies that promote renewable energy constitute an important resource. Examples include the India Renewable Energy Development Agency (IREDA) and the Indian Ministry of Non-Conventional Energy Sources (MNES), the Centre for the Development of Renewable Energies (CDER) in Morocco, the Chinese Renewable Energy Industries Association (CREIA), and the Egyptian New and Renewable Energy Authority (NREA). Diffusion of renewable energy also depends on functioning markets.
- **Technological:** Technological resources are generally difficult to create through human intervention. Solar insolation, wind regimes, availability of biomass or water at a given location are some factors which cannot be influenced through government policy. However, the technological potential of renewable energies in developing countries is very high. Effective technical and quality standards for such technologies are needed and governments and the private sector play a major role in defining them. Renewable energy technologies should also be adapted to match the needs and the socio-cultural backgrounds of users.
- **Supportive:** Other supportive resources required include a population that is aware and informed about the benefits and risks of renewable energy technology, a private sector that has access to adequate information on the market potential, skilled technicians, and a government that is open to the utilisation of renewable energy in the context of its energy policy. These conditions can be created through information campaigns, and through lobbying by NGOs and renewable energy business associations. Organisations that provide related consultancy and advice also play an important role. Integration of RETs into the national education system and the promotion of scientific studies which measure the potential for renewable energy will accelerate implementation of such technology.

2.5. Role of Policy Makers and Private Sector

Most of the barriers for implementation and commercialisation of renewable energy technologies can be overcome through well-designed and effectively implemented public policies, including research, development and demonstration, financing and financial incentives, pricing and market reform, voluntary agreements, regulations and market obligations, information dissemination and training, procurement initiatives, capacity building, planning techniques, etc. A combination of policies is often needed to overcome the barriers to greater renewable energy use in any location. Based on the various case studies and experiences, the following initiatives have been envisaged for policy makers and the private sector in promoting RETs:

- High-level government commitment for sustaining policies and programmes in the long term wherein such support will also provide legitimacy for new technologies and encourage investment from the private sector.
- Involvement of the private sector in production, marketing and adoption of RETs, creating a market environment for innovation and competition.
- Transformation of markets, integrating policies into market transformation strategies.
- Keeping the policies in place for a decade or more in order to ensure market development, and revising and updating policies as appropriate.
- Pricing of energy in ways that stimulate greater adoption of renewables.
- Taxing fossil fuels, based on their adverse environmental and social impact, with some of the tax revenues supporting RETs.
- Enacting regulations or market obligations to stimulate widespread adoption of RETs.
- Providing education and training to increase awareness and improve know-how related to RETs.
- Capacities building in public sector to implement effective policies and programmes, and train and support the businesses that manufacture, market, install and service RE systems.

2.6. Technical and Financial Support in RE Sector

TECHNICAL SUPPORT

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH is an international cooperation enterprise for sustainable development with worldwide operations. It provides viable, forward-looking solutions for political, economic, ecological and social development in a globalised world. GTZ promotes complex reforms and change processes, often working under difficult conditions. Its corporate objective is to improve people's living conditions on a sustainable basis. The development projects supported by GTZ cover a wide spectrum of thematic areas and tasks. Within the framework of international cooperation, GTZ undertakes technical cooperation tasks. GTZ's work encompasses not only the dissemination of technical knowledge, but also the transfer of organisational and business-related know-how.

The International Solar Energy Society (ISES)

ISES is a multi-faceted, global membership organisation. With its long history, and the extensive technical and scientific expertise provided by its members, the Society is a modern, future-oriented NGO. ISES has been serving the needs of the renewable energy community since its founding in 1954. A UN-accredited NGO with a presence in more than 50 countries, the Society supports its members in the advancement of renewable energy technology, implementation and education all over the world.

Membership of ISES gives a broad spectrum of services, activities, networks and support mechanisms. A tailored package of professional services is enhanced by global interaction, rapid access to information, concrete projects and a community of like-minded individuals. Reaching out to all areas of sustainability and energy supply, ISES contributes to sustainable development, a safe environment, scientific responsibility and economic prosperity.

ISES aims to:

- Encourage the use and acceptance of RETs.
- Nurture a global community of industry, individuals and institutions in support of renewable energy.
- Create international structures to facilitate cooperation and exchange.
- Build and distribute publications for various target groups to support the dissemination of RETs.
- Bring together industry, science and politics at workshops, conferences and summits on renewable energy.
- Advise governments and organisations in policy, implementation and sustainability of renewable energy activities worldwide.

The Energy and Resources Institute (TERI):

The Energy and Resources Institute (TERI) is a dynamic and flexible organisation with a global vision and a local focus. It was established in 1974. A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector, from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities, from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in.

United Nations Industrial Organisation (UNIDO):

The United Nations Industrial Development Organization (UNIDO) helps developing countries and countries with economies in transition in their fight against marginalisation in today's globalised world. It mobilises knowledge, skills, information and technology to promote productive employment, a competitive economy and a sound environment. UNIDO generates and disseminates knowledge relating to industrial matters and provides a platform for the various actors in the public and private sectors, civil society organisations and the policy- making community in general to enhance cooperation, establish dialogue and develop partnerships in order to address the challenges ahead. UNIDO designs and implements programmes to support the industrial development efforts of its clients. It also offers tailor-made specialised support for programme development. During 2003, UNIDO's technical cooperation programmes and projects totalled some US$94.6 million. New project approvals in 2003 amounted to about US$84.4 million. Technical cooperation is funded mainly through voluntary contributions from donor countries and institutions, as well as by the United Nations Development Programme, the Multilateral Fund for the Implementation of the Montreal Protocol, the Global Environment Facility and the Common Fund for Commodities. Under its new approach, where integrated programmes are the main instrument for the delivery of technical cooperation, 51 programmes are in place and most are in operation. Of the US$146.7 million already committed, 40% has been allocated to Africa, 20% to the Arab region and 40% to central and eastern Europe, Asia and Latin America.

FUNDING SUPPORT

Basel Agency for Sustainable Energy (BASE):

BASE is a non-profit foundation and the United Nations Environment Programme (UNEP) collaborating centre, which aims to mobilise investment in energy efficiency and renewable energy. BASE helps to build strategic partnerships between entrepreneurs and investors to finance sustainable energy in developing and industrialised countries. The services of BASE include:

- Serves as an information clearinghouse and communication centre in the field of financing sustainable energy.
- Acts as an independent broker to help project developers access funding and help investors identify profitable investment opportunities.
- Provides a platform for entrepreneurs and investors to build partnerships.
- Promotes innovative financing instruments.
- Develops practical tools to facilitate investment in sustainable energy.

Photovoltaic Market Transformation Initiative (PVMTI)

The Photovoltaic Market Transformation Initiative (PVMTI) is an initiative of the International Finance Corporation and the Global Environment Facility, which aims to promote the sustainable commercialisation of PV technology in the developing world by providing examples of successful and replicable business models that can be financed on a commercial basis. Since its launch in June 1998, PVMTI has committed more than US$19 million to nine projects in India, Kenya and Morocco and is in the process of finalising additional projects for the remaining US$6 million available.

The PV market in India is characterised by:

- An unacceptably high incidence of system failure in the field;
- Inadequate marketing, distribution, customer support and after sales service, attributable to private sector markets being suppressed by subsidy programmes;
- A general lack of consumer awareness of PV technology and its benefits;
- Dependence on end-user subsidy;
- Underdeveloped availability of consumer finance which is crucial to make solar home systems affordable.

The PVMTI programme aims to build up financing, distribution and service capability of the PV systems. This will be achieved through the provision of finance for sustainable and replicable commercial business models, the financing of business plans with commercial loans at below-market terms or with partial guarantees or equity instruments, and the provision of technical assistance to PV businesses on planning, financing operations and technology. The cost of the action is 30m USD, of which USD 15m are intended for investment in India.

Triodos Renewable Energy for Development Fund (TREDF)

Triodos Renewable Energy for Development Fund provides finance and business development support to promote accessibility of energy in developing countries. The Fund focuses on renewable solutions with the ultimate objective to contribute to the quality of life of the poor, while simultaneously working at a cleaner world. The Fund can serve entrepreneurs who provide renewable energy solutions to unelectrified communities, for instance in rural areas. Funding is also provided to institutions that provide finance to the end-users, for instance solar home systems.

The Fund finances businesses that distribute and/or use the following technologies:

- Solar (photovoltaic and thermal) systems
- Small-scale wind turbines
- Biomass
- Small-scale hydro
- Hybrid technology solutions

The Fund finances the following types of organisations and companies:

- Financial institutions, such as micro finance institutions and lease companies that provide finance to end-users, for example for solar home systems.
- Trade channels: finance to allow local manufacturers and importers/wholesalers to finance their purchase of components and renewable energy equipment.
- Distributors and retailers who distribute energy services or sell (renewable energy) equipment to end-users, for instance through networks of local agents.
- Project developers who focus on bringing power production capacity to underserved and/or off grid areas.

Department for International Development (DFID):

The Department for International Development (DFID), UK was established in 1997, as the successor to the Overseas Development Administration, previously part of the Foreign & Commonwealth Office (FCO). DFID's overall aim is to reduce global poverty and promote sustainable development, in particular through achieving the Millennium Development Goals. DFID's assistance is concentrated in the poorest countries of sub-Saharan Africa and Asia, but also contributes to poverty reduction and sustainable development in middle-income countries, including those in Latin America and Eastern Europe. DFID works in partnership with governments committed to the Millennium Development Goals, with civil society, the private sector and the research community. It also works with multilateral institutions, including the World Bank, United Nations agencies, and the European Commission.

Global Village Energy Partnership (GVEP)

The Global Village Energy Partnership brings together developing and industrialised country governments, public and private organisations, multilateral institutions, consumers and others in an effort to ensure access to modern energy services by the poor.

Through networking it aims to help reduce poverty and enhance economic and social development for millions around the world. Its work is phased out into a 10-year "implementation based" programme. The Partnership's objectives are to:

- Catalyse country commitments to village energy programmes and guide policies and investment in this area.
- Bridge the gap between investors, entrepreneurs and energy users in the design, installation and operation of replicable energy–poverty projects.
- Facilitate policy and market regulatory frameworks to scale up the availability of energy services.
- Serve as a marketplace for information and best practices on the effective development and implementation of energy-poverty projects/programmes.
- Create and maintain an effective coordination mechanism for addressing energy–poverty needs.

The Global Village Energy Partnership builds on existing experience and adds value to the work of its individual partners. The Partnership will help achieve the internationally recognised Millennium Development Goals. It will also address gender issues in order to reduce health and environmental hazards and increase social and economic welfare.

United Nations Development Programme (UNDP):

UNDP helps countries strengthen their capacity to address challenges in the energy and environment sectors at global, national and community levels, identifying and sharing best practices, providing innovative policy advice and linking partners through pilot projects that help poor people build sustainable livelihoods.

UNDP's Energy and Environment Practice works in six priority areas:

- Frameworks and strategies for sustainable development
- Effective water governance
- Access to sustainable energy services
- Sustainable land management to combat desertification and land degradation
- Conservation and sustainable use of biodiversity
- National/Sectoral policy and planning to control emissions of ODS and POPs

2.7. Infrastructure for Renewable Energy Development

Although energy can contribute to sustainable development, its performance in this respect will depend on many factors, which include attitudes and behaviour, information and technologies, the availability of finance and supporting institutions, and, in particular, policies and policy frameworks that encourage change in the desired direction. The broad strategies for encouraging sustainable energy systems are straightforward. But achieving them will require wide acknowledgement of the challenges and stronger commitment to specific policies. The strategies are largely aimed at harnessing market efficiencies to the goal of sustainable development and using additional measures to speed up innovation, overcome obstacles and market imperfections, and protect important public benefits.

An energy system comprises an energy supply sector and the end-use technology needed to provide energy services. The energy supply sector involves complex processes for extracting energy resources (such as coal or oil), for converting these into more desirable and suitable forms of energy (such as electricity or gasoline), and for delivering energy to places where demand exists. The end-use part of the system transforms this energy into energy services (such as illumination or mobility). Energy services are the result of a combination of technology, infrastructure (capital), labour (know-how), materials, and energy carriers.

The structure and size of the energy system are driven by the demand for energy services. Energy services, in turn, are determined by driving forces, including:

- Economic structure, economic activity, income levels and distribution, access to capital, relative prices, and market conditions.
- Demographics such as population, age distribution, labour force participation rate, family sizes, and degree of urbanisation.
- Geography, including climatic conditions and distances between major metropolitan centres.
- Technology base, age of existing infrastructure, level of innovation, access to research and development, technical skills, and technology diffusion.
- Natural resource endowment and access to indigenous energy resources.
- Lifestyles, settlement patterns, mobility, individual and social preferences, and cultural mores.
- Policy factors that influence economic trends, energy, the environment, standards and codes, subsidies, and social welfare.
- Laws, institutions, and regulations.

3. RENEWABLE ENERGY ENTERPRSIE INTITATIVES (CASE STUDIES)

3.1. Renewable Energy Projects and Local Skills

Most of the rural renewable energy systems are usually located at remote places and the different systems require regular maintenance. Though village operators are trained in the basic day-to-day operation and maintenance of renewable energy systems, they don't have the full knowledge, skills and equipment to handle larger or more detailed maintenance and repair jobs. For example, village micro-hydro power and solar systems can breakdown for months or longer, just because a spare part costing only $10–$20 US is not available or the local training was insufficient and did not teach them how to correct a relatively minor problem. For bigger maintenance and repairs, technicians or electricians have to be called in from far off locations where skilled labour is available. The remoteness of the location often means further delay because the place is sometimes only accessible by foot, and the journey could take several hours or even days, depending on where the system is located. This involves difficult coordination, communication and high costs, leading to long delays in project repair, with much needed money flowing out of the district. Availability of local skilled labour and manufacturing facility for spares is essential for project sustainability and in developing local responsibility.

The renewable energy enterprise initiatives must necessarily support traditional livelihoods to alleviate the poverty of the local communities. Capacity should be build locally to design, upgrade, operate and maintain the renewable energy systems. The primary objectives of the initiatives should be to enable the communities to manage natural energy resources and positively influence socio-economic development in the region through assistance in:

- Building local capability to manufacture/facilitate more renewable energy systems
- Building capacity among the local entrepreneurs to operate/maintain/manage such systems

The capacity building activities in terms of installing, operating and managing the systems will benefit the local community in the following ways:

- Improved employment opportunities for the local youth
- Enhanced availability of skilled labour locally
- Reduction in down time
- Establishment of enterprises dealing with spares and other component requirements of the system
- Reduction in costs of operation and maintenance
- Enhanced replication potential of such enterprises or income-generating activities

3.2. Renewable Energy and Entrepreneurship: Case Studies

Case Study 1: Paper and Power Project

Country and location: Nepal, Lekhani

Implementing Agency: Himalayan Light Foundation's Home Employment and Lighting Package (HELP)

Funding Agency: United Nation Development Program/Global Environment Facilities (UNDP/GEF) Small Grants Programme

Programme/Project Objectives and Strategies:

- Provide collateral free solar home systems to rural poor communities, especially the poorest of the poor who do not have access to rural credit systems in mitigation of the global climate change.
- Provide useful skill development training to produce handicrafts locally for sustainable income generation under the clean light.
- Help the villagers use their leisure hours in productive income-generating activities
- Increase purchasing power of local communities by providing skills in quality production, which can be sold for cash income.
- Encourage women's participation in more productive activities.

Programme/Project Description:
The objective of the project was to provide the villagers solar home systems for lighting their homes. This was to be done through removing socio-economic barriers, reducing implementation costs and improving livelihoods. The project also helped improve their cash economy and encouraged them to use their skills to produce paper and paper products from locally available resources in order to pay the system cost. Not only was the system cost paid for but the families also had a new source of revenue.

Women Making Paper at Lekhani
Source: Himalayan Light Foundation

Achievements:
As per the objective of the project, among the 565 households of Lekhani Village Development Committee, solar home systems were installed in 92 households. The immediate outcomes from the project included displacement of kerosene lamps, and involvement of local community in making of paper, handicrafts and other household activities for income generation.

Approach:
The funding agency UNDP/GEF Small Grants Programme supported the project to achieve the goals of promoting renewable energy at the grass root level and protecting the global environment through community action.

The Himalayan Light Foundation under its HELP programme intrinsically combined the dissemination and use of solar electricity technology with income generation. Villagers participating in HELP were offered a skill-training programme, the tools to set up income-generating activities such as knitting, weaving, handmade paper product, thangka painting, etc. and a solar electricity system, which would extend the working day. Now, apart from agricultural pursuits, marketable products could be made at home in the spare time. The local Village Development Committee envisaging the benefits from the project supported the initiative by working together with Himalayan Light Foundation and was successful in implementing the project.

Key Success Factors:
- Innovative credit mechanism involving the whole community as a social collateral
- Project linked to income generation and employment opportunities
- Community skill development by training and capacity building
- Availability of group grants for micro level activities in the community

Case Study 2: Sustainable Community Solar Project

Country and location: Brazil, Itapipoca

Implementing Agency: Solar Electric Light Fund (SELF) and Institute for Sustainable Development and Renewable Energy (IDER)

Funding Agency: Solar Electric Light Fund (SELF) and Institute for Sustainable Development and Renewable Energy (IDER), Community Association of Macei (ASCIMA)

Programme/Project Objectives and Strategies:
- Delivering solar energy to a rural area.
- Encouraging the setting up of renewable energy cooperatives through revolving funds or other systems of credit that would facilitate the acquisition and maintenance of solar home systems.

- Encouraging additional projects to ensure productive use of energy so as to increase the income of rural families.
- Engaging local communities by offering technical and managerial training and entrepreneurship development.

Programme/Project Description:

Working with the Community Association of Macei (ASCIMA), a cooperative that serves 520 families living in eleven small communities in the settlement of Macei, SELF and IDER initially electrified fifty homes. The main source of income for the local population is from agriculture, cattle breeding, and fishing as well as production of local crafts. SELF and IDER fostered technical sustainability of this project by providing key locals with in-depth training in the basics of photovoltaic theory as well in solar home system design, installation, and maintenance. Training courses were carried out just prior to and during the installation period of the project's first fifty solar home systems.

SELF and IDER train Brazilian technicians to install and maintain SHS

Achievements:

Almost two years after the project implementation, IDER verified its local acceptance by the community by following up on the continued satisfaction of the end-users with their systems and the low default rate of monthly payments. The owners noted that they desired to continue improving on the quality and size of their solar home syatems, and many end-users noted health benefits as a major motivation to promote it to others.

Approach:

SELF, IDER and ASCIMA supported the project by creating a revolving fund. Utilising a revolving credit fund owned and managed by ASCIMA, the end-users purchased their $480 solar home systems by making a 10% down payment, followed by monthly instalments of $12.60 for a period of four years. All funds earned were used to finance additional solar home systems for the community as well as to provide local management of the project. SELF and IDER fostered technical sustainability of this project by providing key locals with in-depth training in the basics of photovoltaic theory as well in SHS design, installation, and maintenance. Training courses were carried out just prior to and during the installation period of the project's first fifty solar home systems. This served to increase the community's sense of long-term ownership of their individual property as well as a sense of commitment towards community improvement. The local population were happy to pay for the services, appreciating the benefits from the project.

Key Success Factors:

- Formation of renewable energy cooperatives for implementation, operation and maintenance of project.
- Availability of revolving credit fund for purchase and maintenance of solar home systems
- Increased income generation and employment opportunities due to productive end use of energy
- Training and capacity building of local community in terms of technology, design and maintenance

Case Study 3: Micro-Hydro for Community Development

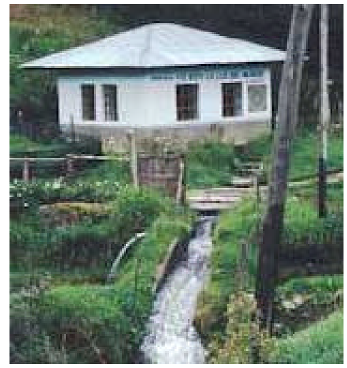
Country and location: Peru

Implementing Agency: El Tinte Cooperative, Intermediate Technology Peru (IT Peru)

Funding Agency: Inter-American Development Bank (IADB)

Programme/Project Objectives and Strategies:

- Delivering standardised quality of milk to the community by refrigeration through micro-hydro power.
- Creating income generation avenues for the rural community.
- Developing entrepreneurship opportunities among local unemployed.



Community micro-hydro plant; Source: ITDG Peru.

Programme/Project Description: The El Tinte Cooperative has four-hundred cows and produces about 500 litres of milk per day. Before they installed their micro-hydro power plant, they milked the cows by hand and carried the product to the river to cool it. The inconsistent quality of milk this method produced resulted in a low purchase price of $0.06 per litre rather than the full price of $0.11 per litre. But this was to change through the use of micro-hydro power for refrigeration. The energy from micro hydro improved the productivity of their enterprise in several ways. They started using a refrigerator to control the temperature at which the milk was stored, resulting in higher quality and better hygiene, fetching them a consistent sales price of $0.11 per litre. It provided an additional income of $671 per month. As the total system cost $35,000, the additional income allowed the cooperative to pay for the system within five years. In addition, the cooperative reduced its labour expenditure by using electric milking machines.

Today, the houses near the dairy have all been electrified, and distant houses are able to charge their 12-V batteries for domestic lighting. As a further benefit, the cooperative installed a grain mill. The members save the cost of transportation to the city for milling and it has create d a viable business locally.

Achievements: There are more than 15 micro-hydro plants operating in Peru, which provide the following energy services:

Battery Charging—Battery-charging services

Carpentry Workshop—Many of the micro hydro plants use the electricity for some sort of workshop (e.g., carpentry or blacksmithing). One carpenter converted a diesel-powered workshop to a micro-hydro one, powering a circular saw, drill, planer, and a small 600-W generator for lighting.

Minigrids—One of the entrepreneurs provides power to 30 families in the vicinity of his station. Income from this enterprise, in addition to battery charging, allowed him to repay his loan within five years.

Approach:

The El Tinte Co-operative was able to acquire its micro-hydro power station through a loan from a fund set up by the IADB, and managed by IT Peru. The rotating fund for micro-hydro power plants has funded 15 systems to date in rural Peru. The loans have to be repaid in five years at 8% interest. The credit amount varies from $10,000 to $50,000. The fund is capitalised with $400,000 at a 1% interest rate over 25 years, plus a technical assistance grant. The local communities have been able to utilise the hydro energy in terms of various small and medium-scale applications, which has helped them considerably in terms of income generation and livelihood creation.

Key Success Factors:

- Availability of long term concessional loan for the project implementation and operation through a revolving fund
- Setting up of 'Credit Operators' for analysis and administration of loans and to separate the financial decisions from the technical and organizational ones.
- Innovative end use application of energy for income generation
- Augmented entrepreneurship opportunities for enterprise development for the local unemployed

Case Study 4: Community Wind Pump

Country and location: Indonesia

Implementing Agency: Winrock International, Wind for Island and Non-governmental Development (WIND)

Funding Agency: United States Agency for International Development (USAID)

Programme/Project Objectives and Strategies: The purpose of the WIND project was to strengthen the local capability to adapt wind-based energy technologies to numerous end-use applications. The project managed to build a sustained interest in renewable energy and revealed the potential such projects have for economic development in a rural area in terms of entrepreneurship development and income generation.

Programme/Project Description: The community wind pumps were made possible through a market development initiative of Winrock International under the WIND programme. Totally, nine community-operated wind energy systems were installed. Each system has a working group, made up of local technicians, who carry out the routine maintenance and customer service tasks. The end-users have to pay a service fee, which is metered according to energy usage or volume of water.

Source: Bergey Wind Power Inc

Achievements:

Irrigation—Six of the sites use wind energy for irrigation. In these cases, the entrepreneurs used the water to diversify cropping to include high-priced vegetables, citrus, or lumber, or merely to bring additional land under cultivation. The citrus growers had access to a micro-enterprise assistance programme, which taught them to select products for size and consistency, establish efficient transportation links to the urban market, improve the freight packaging, and develop a brand name for the produce. One vegetable grower increased her production and profit fivefold.

Ice-making—Several entrepreneurs used the electricity to make ice for sale to local fishermen. The availability of ice enabled the fishermen to store their catch until the market demanded it.

Fishermen are now able to avoid the middlemen, and sell their produce to trawlers, which take their products as far as South Africa.

Other Applications—One of the priorities of the WIND project was to develop a wide range of capabilities when applying renewable energy. Entrepreneurs use the systems for a wide variety of applications from power tools to corn grinding to chick incubation. As these local communities developed technical capacity in these enterprises, they also increased their ability to reap economic growth from renewable energy resources.

Approach: USAID provided funding to Winrock International to develop 10 windpower sites in Indonesia as part of its contribution to the GEF. Each system has a working group, made up of local technicians who carry out the routine maintenance and customer service tasks. In some cases an NGO is involved in the project to conduct revenue collection and fund the working group. The end-users are liable to pay a service fee, which is metered according to energy usage or volume of water. The NGO assumes responsibility for revenue collection and receives 15% of the fees as operating costs. The remainder of the fees is put in a maintenance account. Once a certain amount is accumulated, the funds are used to expand the system in a manner that the community decides. In a few situations, a community committee is formed to assume the responsibility of managing the system.

Key Success Factors:

- Demonstration of cost recovery of renewable energy systems through end user fees
- Creation of local working groups for operation and maintenance of the system
- Involvement of NGO's and community committees for revenue collection
- Innovative end use application of energy for income generation

Case Study 5: Solar Energy Enterprises

Country and location: Bangladesh

Implementing Agency: Grameen Shakti (GS),

Funding Agency: Grameen Bank

Programme/Project Objectives and Strategies:

- Popularising and delivering renewable energy to the rural households.
- Marketing solar, biogas and wind energy on a commercial basis, focusing on rural areas.
- Providing services that alleviate poverty and protect the environment through applied research and development of renewable energy-based technologies.
- Undertaking a project to progressively manufacture and market efficient and affordable household-based photovoltaic systems.
- Providing capital, technology and management services to energy enterprises.

Programme/Project Description: In 1996, the Grameen Bank of Bangladesh, a micro-lending agency with more than 1,000 branches and 2 million members, initiated a programme of loans for photovoltaic home systems to serve those without access to electricity. The loans were administered by a non-profit rural energy company, Grameen Shakti, and called for a small down payment. Grameen Shakti's first initiative has been a 1,000-unit project to understand better a number of important issues concerning household photovoltaic systems.

Solar Powered Mobile Shop
Source: Renewable energy World, 2004

Achievements: Grammen Shakti has installed 22,500 systems, and trained 655 technicians and 800 customers. A shop owner at a bazaar rents a few of his solar powered lamps to a neighbouring shop. This increases income for the solar home system owner, gives another shop owner the benefit of electricity without purchasing the complete system, and improves business for both with extended working hours after dark. Shakti applications also include solar-powered mobile phones, which allow "village telephone ladies" to provide communication services for a fee, enabling them to earn up to $ 100 a month. Grameen Shakti encourages entrepreneurs to apply photovoltaic systems for generation of income. Some examples of application of the system for income generation are charging cellular phone, lighting rice mill, lighting saw mill, lighting shop, bazaar, micro-utility, radio/TV repairing shop, etc.

Approach:
Grameen Shakti is a specialised and leading organisation in the renewable energy sector in Bangladesh. It is currently implementing projects in renewable technologies, which includes the Photovoltaic Programme, Wind Energy Programme, and the Biomass Programme. Training of rural people as well as dissemination of these technologies is the core activity of each programme. In addition, Grameen Shakti works with other entrepreneurs in the private sector. Grameen Shakti targets to install 8000 systems till end of 2004. For this purpose, the organisation has already opened 38 branches. This network allows Grameen Shakti to quickly disseminate and commercialise any improvement in the technology. Since the systems are expensive for the rural people, it has introduced soft financing systems for the customer. This technology has been linked to some income-generating activities as well.

Key Success Factors:

- Development and implementation of special credit, savings and investment programs by Grameen Shakti for generation, storage, and utilisation of renewable energy technologies.
- Providing capital, technology and management services by Grameen Shakti to energy enterprises, including individuals, communities, businesses, non-government organizations (NGOs), private voluntary organizations (PVOs) which promote, produce and finance enterprises based on renewable energy sources.
- Direct linkages of the project to income generation and creation of employment opportunities

Case Study 6: Improved Watermills for Agro processing

Country and location: India, Uttaranchal

Implementing Agency: IT Power India

Funding Agency: DfID, UNAID, UNDP/GEF, UNESCO and EAP.

Programme/Project Objectives and Strategies: The project seeks to apply improved micro-hydro systems to energise the traditional watermills and prevent them from being taken over by the diesel mills. The watermill upgrades that will result out of the project will help in income generation for the watermillers, who are poor and live on less than 1$/day income. It will also make the watermills more accessible to women. The process of watermill upgrade manufacture, installation, agro-processing and servicing will also create jobs, opportunities for economic activity, and result in income generation.

Programme/Project Description: IT Power India broke up the intervention into small steps so that the community could participate in the entire process. The areas included hydro-mechanical technology, civil constructions, and business and financial systems. The interventions, which laid emphasis on technology transfer and local capacity building, resulted in reviving a centuries-old tradition with appropriate input from new technologies.

Rice Hulling with Improved Watermill
Source: IT Power India

The project also tries to scale up the efforts geographically to cover other districts. The replicability potential of the initiative is important because rough estimates indicate that there are around 70,000 watermills in the state of Uttaranchal, and over 500,000 in the whole of the Himalayas from Afghanistan to Myanmar, many of them defunct.

Achievements:

- Demonstrating the technical and commercial attractiveness of improved watermills with 5 systems directly supported and 50 indirectly.
- Training of over 75 watermillers, technicians and teachers on the technical and business aspects of watermills.
- Extending the applications from grinding flour to rice hulling and electricity generation.
- Capacity building of the Watermillers' Association at Chamoli, which is now a respected technology leader at the state level
- Introducing, financing concepts to the programme such as establishing cost recovery principles and a revolving fund and creating linkages with local banks.

Approach:
The successful implementation of the watermill upgrades project was based on the following approaches and activities:

- The new technology is more efficient and results in a faster grinding rate of 15-25 kg/hr from the traditional 5-10 kg/hr, which did help income generation. A spear valve and a penstock was introduced so that women could operate the system
- A training programme was carried out by the project for the three target groups in December 2001. Drawings and advice on manufacturing were provided to the two manufacturers, who currently manufacture the upgrades.
- The Watermillers Association was strengthened during the project through technical and financial support.

Key Success Factors:

- Demonstration and operation of more efficient and profitable renewable energy technology
- Provision of multi-purpose end use applications of energy for income generation
- Training and technology transfer to the local community
- Efficient and effective cost recovery techniques and financing mechanisms

Case Study 7: Solar Ice for Fish Preservation

Country and location: Egypt

Implementing Agency: Annapolis, Maryland, USA

Funding Agency: Ministry of Agriculture (MOA), Egypt

Programme/Project Objectives and Strategies: Demonstration of the benefits and advantages of the ice making business using solar energy to the fishermen community.

Programme/Project Description: Ice is extremely important when it comes to reduction of food spoilage. Within rural communities in developing countries, there is frequently a shortage of ice to support certain business activities. The result is loss of revenue, jobs and wasted food. Lake Nasser is an important source of fish for the people of Egypt. Thousands of tons of fish are caught by artisan fishermen, collected by transport boats, and taken to the market. The lake is very large and it does not have electricity. Some ice is provided to the fishermen by trucking from Aswan. But this is very costly and a significant portion of the catch spoils before reaching market. The project on Lake Nasser addresses a serious problem faced by developing nations. Every day thousands of tons of food spoil in rural areas where there is no electricity. This is particularly important for artisan fishermen and small-scale dairy farmers whose products are highly perishable. The project tries to address the above problems pertaining to preservation of fish by producing ice using solar energy.

Solar Ice Maker in Egypt
Source: AOL Home Town

Achievements: Two Solar Icemakers (ISAAC) were installed by Annapolis, Maryland in Upper Egypt to demonstrate the benefits and advantages of making ice using solar energy. The solar ice makers installed at Lake Nasser have 16 foot by 8 foot solar collectors. The capacity is about 110 pound of ice per day, depending on sunlight and ambient temperature. The Solar Icemaker does not require any electricity or fuel and does not use an ozone-depleting refrigerant. The ice maker uses solar energy to generate the refrigerant during the day. During the night, the refrigerant is absorbed while ice is formed. The daily ice production from the solar ice maker is around 5 kilogram per square meter of collector.

Approach: A private company Annapolis has initiated a project wherein the ice produced from solar energy is benefiting the local community in the preservation of fish, their main source of income. The demonstration project supported by the Ministry of Agriculture has been successful in motivating the local community and the unemployed to venture into the solar ice-making business. It has been observed that the quantity of ice is sufficient to support small-scale businesses, while maintaining sustainability in fragile environments, and to provide low-cost household refrigeration.

Key Success Factors:

- ❑ Application of renewable energy technology to meet the specific energy needs of local community
- ❑ Demonstration of enterprise development prospects of the project
- ❑ Significant increase in income generation of local community

Case Study 8: Solar Village Project

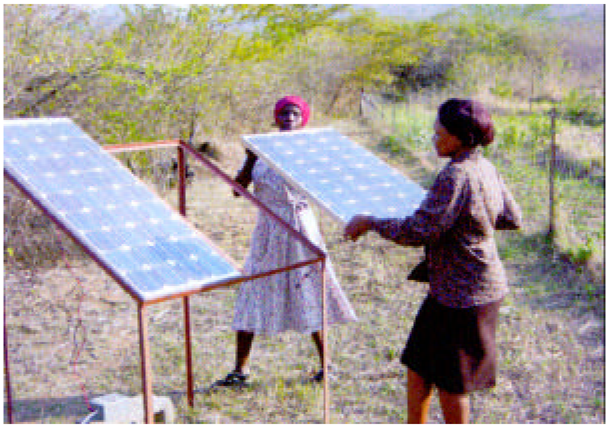
Country and location: Swaziland, Mphaphati

Implementing Agency: Ministry of Natural Resources and Energy, Swaziland and the community of Mphaphati

Funding Agency: United Nations Educational, Scientific and Cultural Organisation (UNESCO)

Programme/Project Objectives and Strategies: The aim of the project is to establish a sustainable demonstration project and to fulfil basic electricity requirements, using solar photovoltaics, within a rural community unlikely to receive grid-electrification in the immediate future. The solar village in Swaziland assists in providing the basic electricity requirements for a primary school and a market garden, and also serves as a demonstration project to promote the benefits of solar energy in Swaziland.

Programme/Project Description: The Mphaphati 'solar village' comprises a primary school with approximately 170 children, which was built by local community members, a small shop and a community managed market garden. It was a prerequisite that the community be directly involved from the onset to ensure that they accepted the ownership of the project as well as responsibility for the security of the equipment once installed. A local NGO was contracted to educate the community on creation of a maintenance fund and to help establish clear management principles for the system. To achieve this in a sustainable manner, the community formed a Solar Energy Committee.



Women involved in solar panel installation
Source: Renewable Energy World, 2003

Achievements:

- Prior to the installation, the teachers had to carry prepare for their lessons by candlelight. Additionally, they had to pay for and transport car batteries to be recharged. These batteries were used for powering televisions, radios, etc.
- This project has dramatically improved the teachers' standard of living and it is hoped that it will go towards encouraging and attracting good teachers to remain in rural areas.
- The provision of lighting to study later in the evening and the provision of audiovisual equipment assists the teachers in offering higher standards of education, thereby broadening career choices for students.
- The project also installed a TV and a video cassette player in one of the school rooms for use as an educational resource for the community, for instance in adult literacy, health education, etc.

Approach: The project, implemented by the Ministry of Natural Resources and Energy, Swaziland and the community of Mphaphati and funded by UNESCO, addressed the problems of a rural community not connected to a grid. The project ensured local community participation by providing the ownership of the system to them and training them in operation and maintenance of the system. It also provided them with essential energy services for additional income generation, and enhanced the education levels of the local population.

Key Success Factors:

- Involvement of the local community in every project activity
- Community being made responsible for security of the installed equipments
- Educating and training of local community on creation of a maintenance fund and establishment of 'Solar Energy Committees'
- Training programmes for Solar Energy Committees on basic technical aspects for installing and maintaining solar energy systems.

Case Study 9 :

Country and location: India, Uttaranchal

Implementing Agency: AVANI

Funding Agency: CIDA, UREDA

Programme/Project Objectives and Strategies: The primary aim has been to demonstrate that solar energy is a reliable and continuous source of energy, which can adequately meet the basic energy requirements in homes and the cottage industry in the hilly villages.

Programme/Project Description: The main features of the solar energy programme include:

- Technical training of rural youth to assemble, repair and maintain the solar units, which has created a reliable maintenance network that encourages people to repose their trust in this technology and invest in it. Rural youth are now making a living out of manufacturing and selling solar lanterns, solar home lighting systems and water heaters.
- Establishment of a rural electronic workshop which serves as the training centre for the technicians.
- Creation of a village-level maintenance fund. This fund has been collected by the users at the village level to provide for any future replacement of the equipment.
- Formation of village-level solar committees. These committees play a pivotal role in the management of the technology at the village level.

Achievements:

Avani has set up four rural sales and service centres for popularising solar equipment in the rural areas. These sale and service centres are managed by the women's self-help groups, and each has a trained rural solar technician for servicing.

About 523 families are using solar energy to meet their needs for domestic lighting. The women and children are able to do their chores and study in adequate light. Most families now listen to their radios powered through solar energy. The community has demonstrated its willingness to pay for a technology, if sustainable financial and technical systems can be created at the village level. Having started with 4 villages, scaling up of the effort is being undertaken. The solar equipment is now available for sale to individual households and these households will be included in the maintenance network.

Approach:

AVANI is a voluntary organisation working in the middle ranges of the Central Himalayan region towards optimal utilisation of available resources. Its range of activities include promotion of appropriate and alternative energy entailing the harvesting of the sun and the rain to meet the needs of the people for energy and water. The AVANI approach includes technical training of the local youth on solar energy equipment, establishment of training centres, creation of a revolving fund for maintenance, and ensuring an active role for solar committees for efficient management of the system.

Key Success Factors:

- Involvement of local village community in the project activities
- Technical and operational training of the local unemployed youth by establishing local training centre for efficient operation of the systems
- Establishment and collection of maintenance fund for replacement of spares
- Management of the systems by solar committees

3.3. Lessons Learnt from Failures

Although millions of renewable energy systems operate successfully around the world, developing and least developed countries are also littered with failed projects, where systems have been wrongly specified, used incorrectly, or badly maintained experience shows that for a project to be successful, it needs to meet people's real needs, be affordable and reliable which includes:

- **Suitability**: A successful programme must be based on the wishes and needs of the people who will use it, and must be driven by their demand for services (light, water pumping, etc), rather than simply focusing on providing energy technologies. Local input is vital to ensure the appropriateness of a system. Without first investigating the needs, preferences, and abilities of the local people, systems may be badly specified and fall into disuse. Participation of the target population is a perquisite at all stages of the project, starting from concept development.
- **Affordability:** Well-designed subsidy programmes should be given a role in developing country markets. Examples from the past years of using subsidies to introduce renewable energy technologies particularly PV in rural areas show very clearly how subsidies are best implemented. In countries where there are already emerging renewable energy markets, care must be taken to ensure that subsidies do not kill off these markets. If those who benefit from them have an appropriate financial commitment, projects are far more likely to be viable in the long-term. One approach that often works very well is fee-for-service, whereby a company owns and maintains the system and users pay a monthly fee for use of the system. This makes it possible for people to get appropriate systems without needing to find the large up-front costs.
- **Reliability:** Ensuring that systems are well designed and installed using quality components, with adequate ongoing service and maintenance is vital to ensure the success of renewable energy projects. This means putting in place training programmes for those who will install, use and maintains the systems. Often the up-front capital costs of systems have been reduced by using components that are undersized or shoddily put together. This results in a shorter product lifetime and higher overall costs. Without a local infrastructure for maintenance and after sales service, systems may fall into disuse. Some degree of local manufacture or assembly is needed so that parts and knowledge are available locally. Local manufacture is also important for reducing costs and reliance on imports, which are subject to fluctuations in exchange rates. In addition, there are many advantages to be gained from making use of existing networks to establish distribution, servicing and financing infrastructures.

4. OPPORTUNITIES FOR INCOME-GENERATING ACTIVITIES IN RENEWABLE ENERGY

4.1. Approaches for a successful renewable energy enterprise

Brazil Rural Energy Enterprise Development Programme (B-REED)

B-REED, with funding from the United Nations Foundation, has been initiated as a partnership between the United Nations Environment Programme (UNEP), its Collaborating Centre on Energy and Environment (UCCEE) and the energy investment company E+Co. B-REED seeks to develop new sustainable energy enterprises that use clean, efficient and/or sustainable energy technologies to meet the energy needs of populations under-served by traditional means, thereby reducing the environmental and health consequences of existing energy use patterns, while stimulating local economic growth.

The B-REED approach will offer rural energy entrepreneurs, or existing companies looking to enter or expand into the sustainable energy business, a combination of enterprise development services and start-up financing in the form of debt or equity. This enables them to transform their business plans into early stage companies capable of accessing mainstream financing. B-REED's services will include training, hands-on business development services and, for the most promising businesses, early-stage investment and assistance in securing later stage commercial financing. B-REED will work with local NGOs and development organisations to promote clean energy enterprise development. B-REED will also work closely with financial institutions to enhance their capacity to integrate clean energy enterprises into their investment portfolios.

Financing Renewable Energy Enterprises in Central America (FENERCA)

FENERCA, a USAID initiative, and supported by UN agencies seeks to promote the development of renewable energy enterprises and projects, while increasing the capacity of financial institutions and NGOs. Under the Financiamiento de Empresas de Energia en Centroamerica (FENERCA) Programme, five Latin American countries have integrated environmental and economic sustainability into their energy agendas. The programme which was executed between 2000 and 2003 provides enterprise development services, assists in securing financing, and provides regulatory and policy alternatives to local governments.

The project has enabled entrepreneurs to structure and, in some cases, initiate clean-energy-producing projects. As a result, several rural communities have gained access to clean energy services. In addition, urban areas have benefited from increased grid capacity. Residential, industrial, and commercial sectors have benfited through improved health, education, lighting, refrigeration, drinking water, cooking, and recreation. Of the approximately 120 proposals identified under the FENERCA programme, 24 received enterprise development services and 15 have business plans under review. Two enterprises are delivering new clean energy, and three are under construction.

Indian Renewable Energy Enterprise Development Fund (IREED)

This project implemented by The Renewable Energy and Energy Efficiency Partnership (REEEP) aims to attract funding for an Indian private equity fund targeting renewables. REEEP is a coalition of progressive governments, businesses and organisations committed to accelerating the development of renewable and energy efficiency systems. Initiated at the Johannesburg World Summit on Sustainable Development (WSSD) in August 2002 by the UK Government, the REEEP provides an open and flexible framework within which governments work together to meet their own sustainable energy objectives according to their own timetables.

Although various Indian banks and financial institutions are providing debt financing to renewable energy ventures, access to equity funds has been limited. Now two financial institutions, BTS Investment Advisors Private Limited (BTSIA) and Rabo India Finance Pvt. Ltd. (Rabo India) have come together to create the Indian Renewable Energy Enterprise Development (IRRED) fund, a private equity fund that can invest in renewable energy projects and earn superior returns on its investments. It is expected that the renewable energy sector in India will benefit tremendously by the entry of private equity capital and International Development Agency funds into the sector through IREED, resulting in a higher number of renewable energy generation projects being setup, benefiting India by way of incremental power supply as well as conservation of fossil fuels. The Fund will offer private investors an ideal entry point into the renewable energy sector through a professionally managed fund. The creation of the fund is also expected to encourage carbon credits trading (under the Kyoto Protocol) by way of the credits generated through the renewable energy projects being set up under IREED.

4.2. Project Opportunities in Renewable Energy

The projects that can be implemented using RET's can address one or more of the following areas:

- Rural house-hold electrification

Solar home systems, small-scale wind and family-sized hydropower schemes can provide electricity for lighting and low power appliances such as a radio or a cooling fan. Families can also use portable solar lanterns with a fluorescent lamp, which provides better lighting than kerosene lamps or candles.

- Energy for Education and Health

Health centers can use solar photovoltaic (PV) or wind power to generate electricity for the refrigeration of medical supplies, lighting, equipment sterilization and telecommunications. Affordable clean energy supports better education. Basic facilities such as lighting, computers and audio-visual equipment can make a huge difference in schools that previously had unreliable, little or no power.

- Grid feeding/Isolated minigrids

Wind farms, small-scale hydropower, biomass, geothermal and other renewable energy technologies are cheaper than conventional alternatives in many situations. These renewable technologies can be connected either to small local mini grids or to a national grid for demand side management and peak shaving options.

- Water

Rural communities can use solar photovoltaic or wind powered equipment to pump water for drinking, livestock and in some cases irrigation. Renewable energy can also power water purification systems to make clean drinking water.

- Cooking

Biomass (such as wood, straw and animal dung) and biogas (principally methane from composting) provide the cheapest option for cooking in many rural areas and some rural communities are successfully using solar cookers. Millions of households now use improved cook stoves, which consume much less fuel.

- Agricultural and Commercial

Small-scale hydropower provides direct mechanical power for processing agricultural crops such as grains. Water mills are still an important part of many rural economies. Solar photovoltaic systems can support income-generating applications such as evening lighting in shops and charging batteries for local people. Solar drying plays an important role in rural agro processing. Solar water distillation is of growing importance, particularly in places where global warming is exacerbating the problem of sea water contaminating fresh water supplies.

The following table provides details of possible renewable energy project opportunities:

RE Technology	Specification	Applications
Solar Thermal Space Heating Systems	Systems with average collector area of 25 m^2	New Buildings to be constructed
Solar Thermal Space Cooling Systems	Systems with average collector area of 25 m2	Hotels, Offices and large houses
Solar Hot Water Systems	Domestic Systems capable of supplying 200 lpd of hot water Non-domestic systems with average size of 2500 lpd of hot water	Houses and apartment Blocks Commercial and light industrial sector
Solar dryers for agriculture	Systems with an average collector area of 200 m2	Fruit, tobacco and other agro-processing industries
Industrial Process Heat through Solar Thermal	Systems with an average collector area of 1000 m2	Textiles, Fertilizers and other process industries
PV Village electrification systems	600 Wp stand-alone systems and 10 kWp mini-grid systems	villages which are yet to be electrified
Solar Electrification PV Pumping Systems	Solar Home Systems of 80 Wp and Solar lanterns Micro-irrigation systems with a 3kWp array PV powered booster pumps with a 100 Wp module for urban water pumping	Off-grid rural communities Replacement of existing minor irrigation pumps with PV for irrigation Urban water supply networks
PV Professional systems	PV drinking water systems with a pump and purifier powered by a 3 kWp array Standalone lighting systems of 100 Wp size PV Power packs of 1.5 kWp size PV grid tied systems of 25 kWp size PV Systems for automation of 200 Wp size PV telecom systems of 10 kWp each	Communities without water services Local administrative bodies and institutional users Small business, commercial sector Support in distribution feeders Banking / ATMs standalone IT centres Telecom and PV repeater stations
PV health & education systems	Refrigeration and lighting systems of 500 Wp each Lighting and computers powered through 500 Wp systems	Remote health centres and clinics. Remote schools and educational establishments

RE Technology	Specification	Applications
Wind electric generation	Unit sizes of 1 MW wind energy generators Unit sizes of 100 kW Wind energy generators	Grid connected wind farms Stand-alone off-grid systems for electricity and water pumping
Wind pumps	4 m diameter deep well pumping systems	Farms and communities without electricity or water supply
Hydro power	Small hydro power developments Canal drop schemes with average size of 200 kW	Grid connected electricity generation Irrigation canal network to power farms and communities
Hybrid Systems	Wind PV hybrid systems of size 5 kWp PV-diesel hybrid systems with 3 kWp array size	Community, commercial and industrial systems
Biogas systems	Large biogas plants of 500 m3 or 1000 m3 Capacity Small biogas plants of 15 to 100 m3 capacity	Institutions such as government cattle and poultry farms Farms and households
Gasification plants	Briquetting-cum gasification plants of 30 kWe gasifier output	manufacturing units, communities, rural industries
Urban waste to energy plants	Solid and liquid waste power plants	Cities generating large amounts of urban and industrial waste

4.3. Actual income-generating opportunities in renewable energy: Examples

Sustainable Agriculture by Wind Power

An onion grower in Indonesia was accustomed to working 1,040 hours per season, hauling water to irrigate his crop. These efforts produced a crop valued at $550. Using a wind-powered community water pump, this farmer was able to increase his crop and his income fourfold and reduce his labour to 100 hours per season. In return for the water service, the farmer pays a fee of $0.10 per cubic meter of water used to the community committee that manages the water-pumping system. This amounts to about $40 per month in expenditures during the six-month dry season. His profit of more than $1,400 per season makes the cost worth it, particularly since his children can now attend school instead of working in the fields. (could give the farmer a name for greater authenticity)

Source: IT Power India

Solar Powered Sawmill

Source: Grameen Shakti

Hanif is a sawmill operator in the small village of Dhalapara in central Bangladesh. Hanif earns $0.20 per cubic foot for sizing timber brought to him by local villagers. He normally is able to size 200 cubic feet per day, earning $ 548 per month after his pay outs in terms of his assistant's salary and the cost of fuel for the diesel-powered mill. In 1997, Hanif was able to take advantage of a Grameen Shakti programme that provided solar energy systems on credit. For $270, Hanif was able to purchase a 17-W PV system including a photovoltaic panel, battery, charge controller, and two fluorescent lamps. The system enabled his business to operate an additional four hours per day, increasing his cash flow by 50%. These profits were high enough for him to repay the system costs within two months. He is now the owner of a second sawmill in a neighbouring village.

Improved watermill for grain grinding

The watermill (locally called *gharat*) at the foot of Gadora village, Uttaranchal is one of 22 mills on the same stream. The mill is owned by Jyanti Prasad Mattiyal and has been passed down from father to son through several generations. The traditional mill, was able to produce an output of 5 kg per hour of flour. This was insufficient to give the miller a living income and he operated the mill only occasionally in collaboration with his father, while he worked at the local school. In 1999, the miller took a soft loan sponsored by Winrock International in order to procure an upgraded gharat system. The improved gharat at Gadora has been operating since April 2000. The output of the mill has increased to around 20 kg per hour, even increasing to above 25 kg per hour in the monsoon. More and more villagers have begun to access Mattiyal's mill, attracted by the speedier milling and prefer it to the diesel mill, which is twice as expensive. The mill now operates all day, every day of the week, to meet the demand for flour grinding in the village and from surrounding villages. On special occasions, it runs all night to meet the demand. The total cost of the equipment for the upgrade, including civil works, was approximately Rs. 15,000. In a typical year, the mill generates a cash surplus of Rs. 20,000. Payback for the upgrade can was extremely rapid. Mattiyal has long-since given up his job at the local school in order to operate his mill full-time. He has also invested in a cross-flow turbine in a new mill-house next to his gharat, which he uses for rice-hulling and generating electricity. The mill has provide d him and his family not only with flour but also an adequate income.

Source: IT Power India

Improved Cook Stoves

Rashid Piri is an intrepid inventor and craftsman living in Zambia's capital, Lusaka. Along with more than 90% of Zambia's population at the start of the 21st century, Mr Piri's household cooked their meals on traditional stoves, using charcoal or firewood. The task was less than pleasant: the stoves are only 10% efficient, last just 12 to 18 months, and produce substantial indoor smoke and soot. Then he learned about the Ziko – an improved stove invented in another part of Africa, which is more than twice as effic ient and lasts 8 years.

Source: Open for Business, UNEP

After buying one and testing it, he discovered that the improved stove would produce not only better cooking energy, but would also reduce household consumption and cost of charcoal and the exposure to indoor smoke and soot. Mr Piri concluded that the business of making and selling improved stoves, was a good idea. He set up RASMA Engineering to make and sell the improved stove. Today he produces and sells approximately 50 energy efficient cook stoves per month. Through the provision of enterprise development services and $20,000 in equity from the Africa Rural Energy Enterprise Development Programme (AREED), RASMA has been able to increase its production to 600 stoves per month. RASMA has purchased various machines as well as a second-hand vehicle to transport the goods.

Solar Entrepreneur in Nigeria

Attah Frederick is a qualified electrical engineer from his local university in Bauchi, Northern Nigeria. After graduating from the university, Fred set to work constructing and maintaining power lines. His interests in computing lead him to take a professional qualification in computer engineering a couple of years later. Around that time, the British government was helping to fund a health project in a nearby state and Fred was asked by a friend if he would be interested in working for him putting together the solar equipment being supplied from the UK. This was the opportunity he had been looking for, and Fred agreed. Working alongside British solar engineers Fred soon soaked up the essentials of the solar business and was quickly able to diagnose faults and put set right the flaws in many of the installations around his local area. Fred now had all the skills he needed to be-come a true solar entrepreneur.

Fred was invited to join a formal training course being funded by a UN aid agency. This was a two-week course which took around 30 participants from the basics of volts and amps right through to design techniques and on to practical installations on site. Always keen to get more experience, Fred volunteered to help out a visiting solar engineer from the UK. During their time together, Fred was able to hone his practical and theoretical skills and understand more broadly the world market for solar energy products.

Source: The Solar Entrepreneur, June 2004

During his 3 years in the solar business, Fred has installed over 100 solar systems, totalling around 25,000Wp of installed capacity, as well as repairing and renovating a number more. He has worked on everything from a humble solar home system of a few watts to multi-kilowatt installations like the one supplying power to the University of Jos' Ornithological Research Institute. Fred has become distributor for Bright Light Solar in the UK and is a member of a wider network of solar companies in the country that shares skills, training opportunities and work-load. His position in the Bright Light network helps Fred to smooth out the project-based nature of the solar business and to get help and technical advice from colleagues in Nigeria and from counterparts overseas.

5. CONCLUSIONS

There is much greater awareness today regarding the damage to the earth's climate due to industrialisation, over-farming, pollution and the increasing use of carbon-based fuels such as coal and oil. "Global warming threatens to permanently disrupt the delicate balance of the climate, and could create deserts in currently fertile regions and bring arctic weather to temperate areas such as northern Europe. These changes would affect every member of the human population, bringing greater poverty to the poorest countries and health problems such as skin cancer and asthma to millions of people." [10] In such a situation it becomes imperative that the youth be made aware of the need for, and, participates in, promoting renewable energy systems. Further, in many of the developing countries, there is the whole issue of unemployment and the attendant problems it creates. Developing entrepreneurship in renewable energy, offers a workable solution as we have perceived in the case studies discussed in this report.

Though steps have been taken in this direction, the entire process is still beset by problems. Most of the entrepreneurial endeavours in the renewable energy sector at present are donor driven, which raises serious concerns regarding the sustainability of the projects once the grant ceases to exist. The main barriers in popularising the concept of renewable energy enterprises seem to be the high upfront costs in the rural scenario due to lack of basic infrastructure such as transport, communication, skilled personnel, etc. As mentioned earlier in the report, promising initiatives and approaches are coming up to support entrepreneurship ventures in renewable energy among youth and local rural communities through training, marketing, feasibility studies, business planning, management, financing and linking to banks and community organisations.

Access to finance seems to be the main constraint for renewable energy market development. Even though credit may be available, it is often too expensive or available for too limited a period to be useable. Successful entrepreneurship ventures require one-time seed capital to carry out activities such as market surveys, personnel training, establishing sales and service networks, and writing a business plan.

The following conclusions can be drawn based on this study on youth entrepreneurship in renewable energy:

- ❑ Awareness to be increased regarding entrepreneurship and enterprise development prospects in renewable energy as an option for self-sustenance among youth.
- ❑ Information and details concerning entrepreneurial and enterprise development opportunities in renewable energy should be available to the youth at a single source.
- ❑ Interaction and linkage of youth entrepreneurs with prominent business and other stake holders in renewable energy sector has to be established.
- ❑ Benefits and advantages of entrepreneurship and enterprise development should be incorporated in the education curricula.
- ❑ Youth entrepreneurship ventures need follow-up support to make the business sustainable.
- ❑ Efforts should be made towards motivating and driving the youth to take up the new challenges of renewable energy enterprise development.

[10] www.eu2004.ie

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