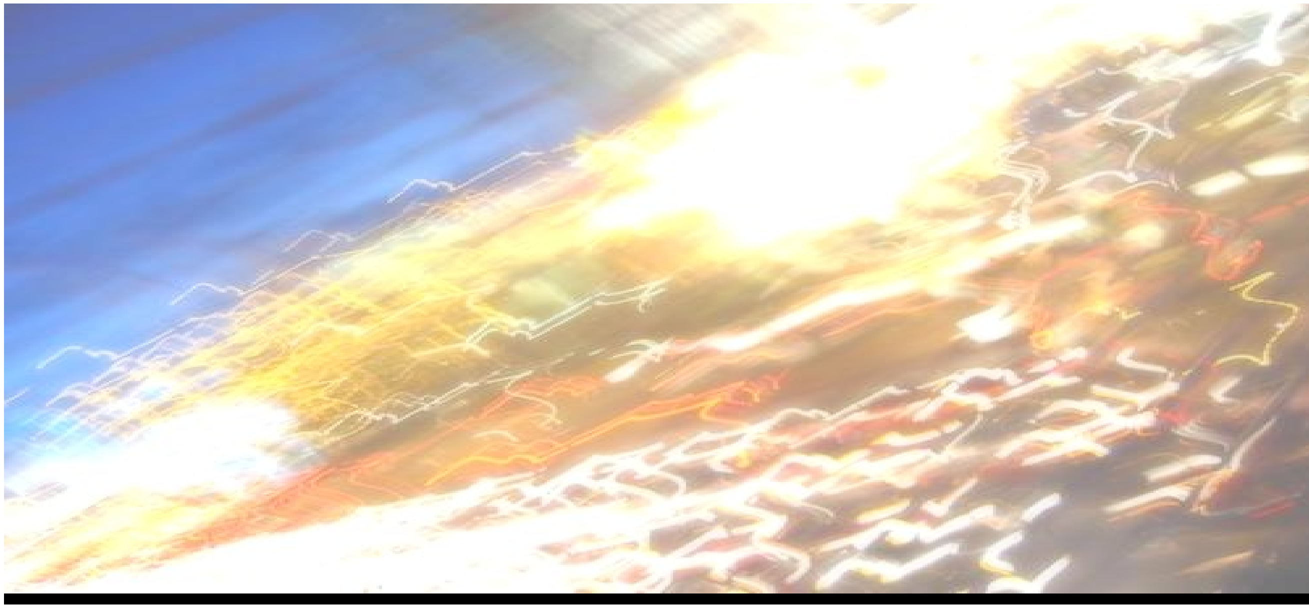


Climate Change & TERI's Knowledge Sharing Endeavours

Amit Kumar & Gaurav Gandhi
TERI, India

25 years of excellence in Research and Innovation

Outline

- Need
- Goals
- TERI's activities in climate change & renewable energy fields
- TERI & web based sharing
- Asia Pacific RE Knowledge Hub
- Challenges

Need

- Renewable energy has emerged as a viable option for the climate change mitigation.
- In Asia Pacific a lot of developmental activities are being carried out in the energy sector at different levels.
- However, synthesis of best practices and consolidation of knowledge is lacking.
- Similarly, many stakeholders do not have access to the relevant information and knowledge.

Goals

- To reach out the widest possible audience
- In view of Asia Pacific's current energy landscape, facilitate transition to alternatives viz.
  - Renewable energy
  - Energy efficiency and conservation
  - Innovative regulatory practices
- To provide an active tool for learning and knowledge dissemination
- To provide a ready reference to experts and suppliers in the field of energy

TERI's climate change activities

- Climate change mitigation and CDM project development
- Impacts, vulnerability, and adaptation assessment
- Climate modeling
- GHG inventorization
- Capacity building and outreach

TERI's renewable energy activities

- Resource assessment
- RE technology/product development
- Performance evaluation and field testing
- Feasibility study and investment analysis for RE projects
- Project development under clean climate initiatives
- Distributed generation and delivery models for electricity in rural areas
- Renewable energy policy development and planning
- Dissemination of knowledge and capacity building

TERI and web based knowledge sharing

Web based sharing

- India Energy Portal http://www.indiaenergyportal.org
- Asia Pacific Renewable Energy Hub http://www.aprekh.org
- ENVIS (Environment Information System) Centre on renewable energy and environment) http://www.terienvis.nic.in
- EduGreen http://edugreen.teri.res.in/
- Youth for Ethical Action and Respect for Nature http://www.yearnindia.net/

…Web based sharing

- PACCIFY (Programme for Awareness on Climate Change Issues Featuring the Youth) http://edugreen.teri.res.in/paccify/index.htm
- Sustainable Habitat Design Advisor http://www.sustainable-buildings.org/

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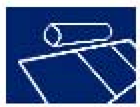
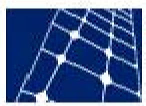
Applications

Renewable energy options available today can meet demand for diverse applications like village electrification, grid power generation, decentralized energy supply, and transportation. The following sections discuss these applications of renewable energy in detail.

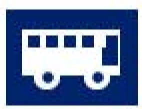
Distributed Power Generation
Distributed generation (DG) is the integrated or stand-alone use of renewable energy technologies based on locally available resources for electricity generation close to the point of consumption.



Decentralized Energy Supply
Renewables can supply thermal energy in different temperature ranges. Some of these options can also be adopted as demand side management (DSM) measures.



Grid Conected Power Generation
Renewable energy resources can also be harnessed for supplying grid-quality electric power to the national grids thereby complementing the mainstream grid power.



Transportaion
Renewable energy resources can offer environment-friendly alternatives to the petroleum fuels.

Updates

A Case Study on Solar Technologies
200 kW SPV power plant having 2690 numbers of poly-crystalline silicon PV modules each of 75 Wp capacity.
more

Events

- World Future Energy Summit
  21 - 23 January 2008
  Abu Dhabi, UAE
- Energy Expo 2007: 3rd International Exhibition & Conference
  7 - 9 December 2007
  Ahmedabad, India
- ENERGAIA International Renewable Energies Exhibition
  6 - 8 December 2007
  Montpellier, France

more

News

- Chennai Petroleum seeks to set up new wind power capacity
  Mint, 21 November 2007
- Capital to earn credits
  The Hindu, 20 November 2007
- Hybrid solution
  The Economic Times, 13 November 2007

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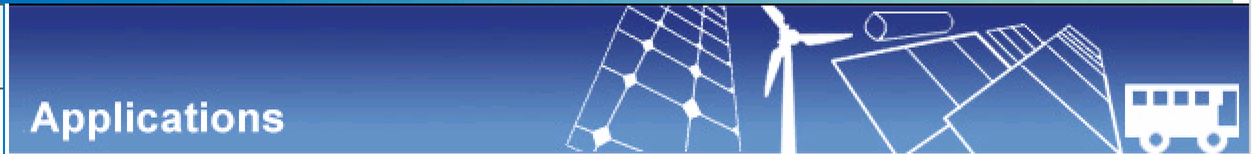
Applications

Applications ▸ Distributed Power Generation

Distributed Power Generation

- Solar
- Wind
- Biomass and biogas
- Liquid biofuels
- Small hydro
- Industrial and Urban waste
- Hybrids
- Geothermal
- Hydrogen and fuel cells
- Others

Distributed generation (DG is the integrated or stand-alone use of small, modular electric generation close to the point of consumption; using either combustion-based technologies, such as reciprocating engines and turbines, or non-combustion based technologies, such as solar and wind energy, or fuel cells. In such locations where grid extension is practically not feasible for techno-economical reasons, distributed generation plants could offer a cost-effective option. A distributed power generation system, therefore, could also be an isolated renewable energy resources based power supply intended to provide a village with energy for various applications. In addition to the environmental aspects also the shorter construction period can be considered as a key driving force accelerating the development. Essentially, reneweable energy resources based distributed or decentralized generation has tremendous promise for providing efficient and environmentally friendly electricity supplies in the developing countries. Moreover, being based on locally available resources, such systems induce a degree of self-reliance that is not possible with imported fuels/fuels transported from long distances. This section details out distributed or off-grid power generation options based on different renewable energy resources and technologies.



Distributed Power Generation ▸ Biomass and biogas

Biomass and biogas

Technology

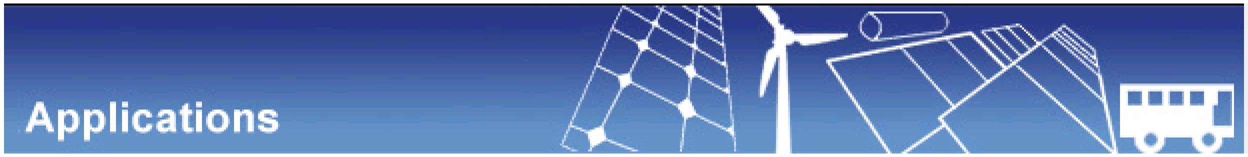
Solar
Wind
Biomass and biogas
Liquid biofuels
Small hydro
Industrial and Urban waste
Hybrids
Geothermal
Hydrogen and fuel cells
Others

Biomass power is the electricity that is produced from biomass fuels. Biomass includes plant materials and animal products, and biomass fuels include residues from the wood and paper products industries and residues from food production and processing. Gaseous fuels produced from solid biomass, animal wastes, and landfills are also used as biofuels. The majority of biomass electricity is generated today using the steam cycle, which employs a boiler to produce steam. The biomass is burnt in the boiler to provide the required heat. The steam thus produced is made to turn a turbine, which is connected to a generator.

Solid biomass can also be converted into a fuel gas in a gasifier. Here inside a gasifier, a very hot, oxygen starved environment is created. Heat reactions take place inside the gasifier at various stages to produce an energy-rich, flammable gas. This biogas can be used to provide the required heat energy in a boiler in order to produce steam for running the turbines. Biogas can also be produced through a process known as anaerobic digestion. The gas is produced in an airtight container, which contains a mixture of bacteria. Complex chemicals, such as fat and protein, are broken down progressively into simpler molecule. The final product is a biogas containing methane and carbon dioxide. The biogas can be used for heating or for electricity generation in a modified internal combustion engine. However, advanced gasification technologies, with sufficient energy to fuel a gas turbine, are necessary for converting animal waste to a biogas. Numerous researches are currently underway to develop such combined-cycle generating plants.

Biomass and biogas power plants are the most suitable option for distributed power generation in many parts of the world. This is primarily due to the ease of availability of biomass fuel in many parts. A variety of raw material, including agricultural wastes, urban wastes, and so on can be used as a fuel in these power plants, thus offering the possibility of flexible operation. Biomass and biogas technologies can convert renewable biomass fuels into electricity (and heat) using modern boilers, gasifiers, turbines, generators, and fuel cells.

There are some disadvantages to the use of biomass technologies. Most of available biomass fuels contain less concentrated energy and therefore require some sort of preparation and handling before they can be used in a biomass power plant. These factors contribute to higher costs. In addition, there are other challenges to increasing the use of this technology for distributed power generation. A large amount of research is required to develop high-yielding energy crops, low-input energy-crop farming practices, and also for improving biomass technologies to increase the overall efficiency.



Biomass

Biomass has been one of the main energy sources for the mankind ever since the dawn of civilisation, although its importance dwindled after the expansion in use of oil and coal in the late 19th century. There has been a resurgence of interest in the recent years in biomass energy in many countries considering the benefits it offers. It is renewable, widely available, and carbon-neutral and has the potential to provide significant productive employment in the rural areas. Biomass is also capable of providing firm energy. Estimates have indicated that 15% - 50% of the world?s primary energy use could come from biomass by the year 2050. Currently, about 11% of the world?s primary energy is estimated to be met with biomass.

For India, biomass has always been an important energy source. Although the energy scenario in India today indicates a growing dependence on the conventional forms of energy, about 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country?s population depends upon it for its energy needs.

India produces a huge quantity of biomass material in its agricultural, agro-industrial and forestry operations. According to some estimates, over 500 million tonnes of agricultural and agro-industrial residue alone is generated every year. This quantity, in terms of heat content, is equivalent to about 175 million tonnes of oil. A portion of these materials is used for fodder and fuel in the rural economy. However, studies have indicated that at least 150-200 million tonnes of this biomass material does not find much productive use, and can be made available for alternative uses at an economical cost. These materials include a variety of husks and straws. This quantity of biomass is sufficient to generate 15 000-25 000 MW of electrical power at typically prevalent plant

Biomass Gasification

Biomass gasification is the process through which solid biomass material is subjected to partial combustion in the presence of a limited supply of air. In what is known as a gasifier, solid fuel is convertedm by a series of thermo-chemical processes like drying, pyrolysis, oxidation, and reduction to a gaseous fuel called producer gas. The ultimate product is a combustible gas mixture known as ?producer gas?. If atmospheric air is used as the gasification agent, which is the normal practice, the producer gas consists mainly of carbon monoxide, hydrogen, and nitrogen. A typical composition of the gas obtained from wood gasification, on volumetric basis, is as follows:

Carbon monoxide 18 ? 22%

Hydrogen 13 ? 19%

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Statistics

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The section on statistics provides details of deployment of renewable energy technologies in the overall context of energy utilization at the country/regional level along with other relevant data needed for further analyses.

India Energy Portal

IEA Renewable Energy Statistics

Ministry of New and Renewable Energy (India)

SWERA

Key Development & Data Statistics (World Bank)

Indicator Graphs(UNEP)

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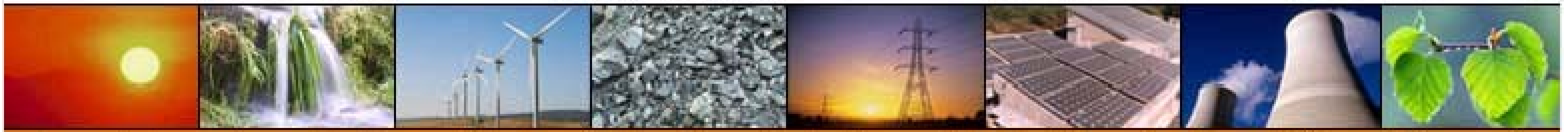
India Energy Portal



Energy Sectors> Renewable Energy Petroleum & Natural Gas Coal Power Distributed Generation Energy Efficiency & Conservation

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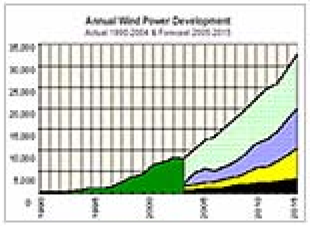
Energy Statistics

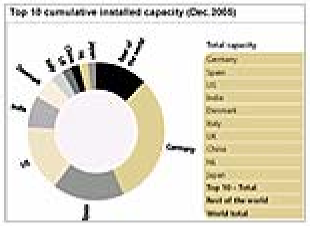
A dedicated section on Energy statistics provides users an insight into Indian as well as global energy scenarios in terms of resources, demand, supply, and installations; among others.

Energy Maps

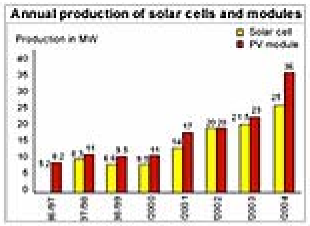
Forecast of 2015 (Short term)



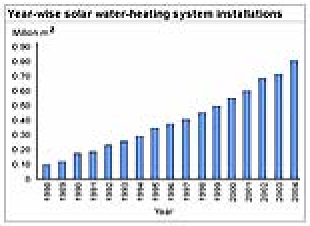
Top 10 cumulative installed capacity (Dec. 2005): Wind



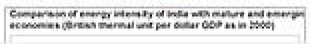
Annual production of solar cells and modules



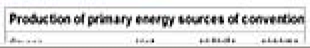
Year-wise solar water-heating system installations



Comparison of intensity of India with mature and emerging economies (British thermal unit per dollar GDP as in 2000)



Production of primary energy resources of conventional energy in India



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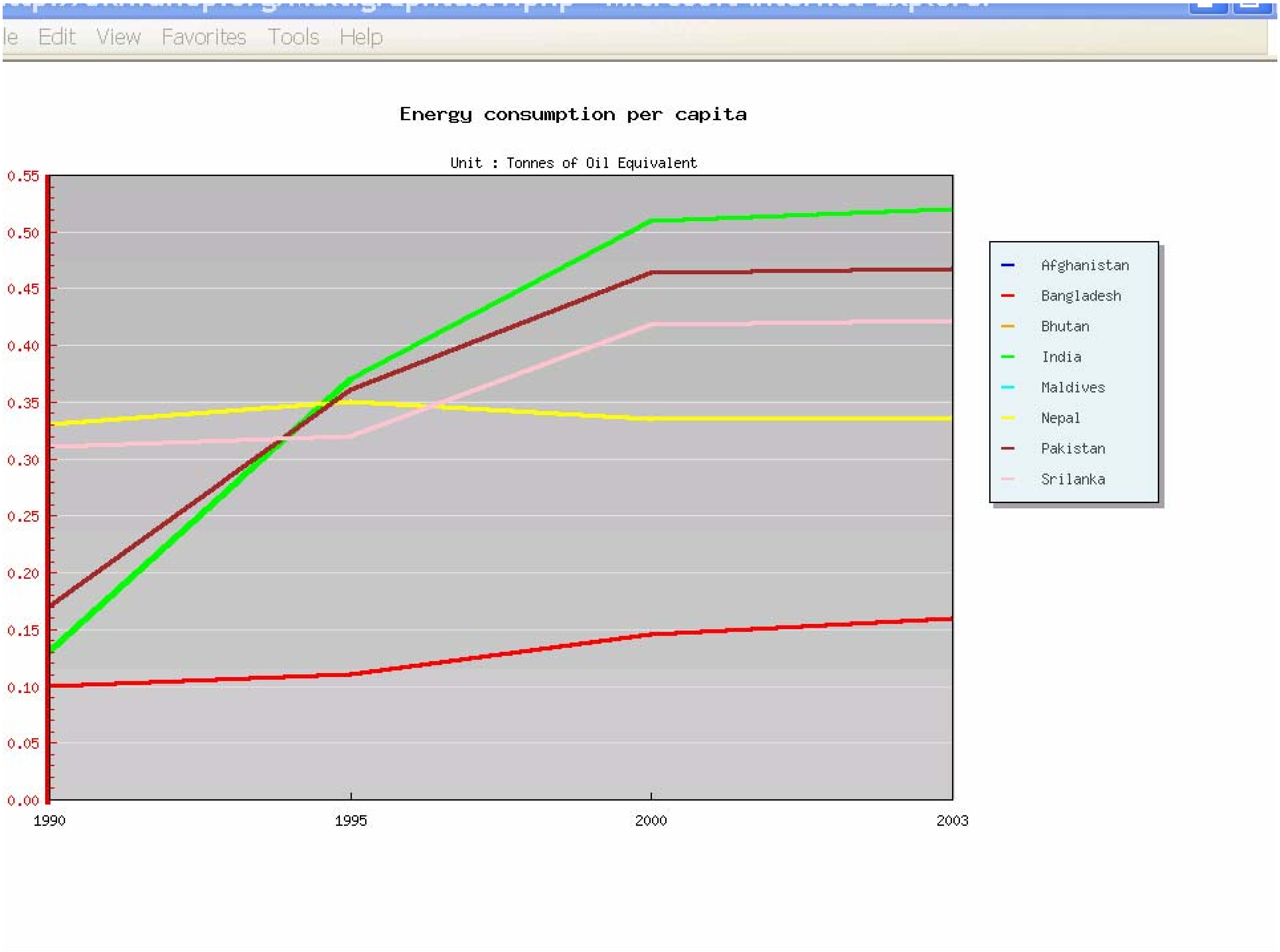
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Energy consumption per capita
Unit : Tonnes of Oil Equivalent
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1990
1995
2000
2003
Afghanistan
Bangladesh
Bhutan
India
Maldives
Nepal
Pakistan
Srilanka

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This section presents case studies/best practices, categorized thematically. Each case study also provides all the relevant project information such as project location, date of commissioning, and specific features.

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- Wind power development by the private sector ...
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- Biomass-based Power Generation and Co-generat...
- Off-Grid Renewable Energy Development (Techni...

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Sustainable Rural Electrification

Title	Sustainable Rural Electrification
Keywords	Environmental Governance, Human Capacity Building, Environmental Technologies
Country	Bhutan
Location	N.A.
Participants/partnerships	International Organisation, Central Government
Duration	1997 - Ongoing
Funding	1) Amount: $12.90M, 2) Sources of funds: ADB $10M, Borrower $2.9M
Background	The objectives of the Project are: to provide opportunity for cash-generating business, job creation adequate education, and health services to rural people in Bhutan through electrification by indigenously generated hydropower and solar panels.
Objectives	The scope of the Project includes: Part A: Rural Electrification by 33 kV and 11 kV distribution system; Part B: Remote rural electrification by solar panels for schools, hospitals, and other local community facilities; and Part C: Small-scale pilot Supervisory Control and DataAcquisition System (SCADA)
Description	Full Case study
Barriers/Overcome	N.A.
Outcomes/Impacts	N.A.
Critical Instruments and its impacts	Awareness, Organisational Arrangement, Capacity Building, Technology, Design Planning and Management
Lessons Learned	N/A, on-going project
Replicability	N.A.
Themes	Decentralized energy supply -> Household -> Biomass and biogas Decentralized energy supply -> Household -> Solar Distributed Power Generation -> Solar Distributed Power Generation -> Biomass and biogas Distributed Power Generation -> Wind Distributed Power Generation -> Small hydro

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- Policies for development of...

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Renewable Energy is Green, Clean and Sustainable Energy
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bout Us
rogrammes/Schemes
pecialized Centers/ nstitutes
esearch, Design and echnology Development
Ionthly Accounts
licies/Orders/Investment portunities
nnual / Five Year Plans
dministrative Approvals
nplementing Organizations
Ianufacturers / Industries
ublications / Reports
kash
25 Years of Excellence
Silver Jubilee Celebration
This is the newly designed Website, launched by the Hon'ble President of India on 22nd November 2007 at Vigyan Bhawan .
Click here to see some of the photos.
What's New
Press Release (Updated 28.11.2007)
Tender Notice (Updated 27.11.2007)
List of ETC - Manufacturers/Suppliers (updated 19/11/2007)
Photo Gallery
रजत जयंती समारोह
SILVER JUBILEE FUNCTION
The President, Smt. Pratibh Devisingh Patil releasing fou commemorative Postal Stamps o Renewable Energy, on the occasio of the Silver Jubilee function of th Ministry of New and Renewabl Energy, in New Delhi on Novembe 22, 2007.The Minister for New an Renewable Energy, Shri Vila Muttemwar and the Minister of Stat for Communications and Informatio

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Links

Links

We are regularly out on the web. When we find a great site we list it here for you to enjoy.
From the list below choose one of our weblink topics, then select a URL to visit.

- Distributed Power Generation (3)
- Decentralized energy supply (6)
- Liquid biofuels (1)
- Grid connected power generation (3)

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Links

Decentralized energy supply

Given the fact that the renewable energy resources are diffused and scattered, they provide an ideal option for decentralized energy supply as compared to conventional sources that need to be transported to the use-point. Another advantage of renewable energy resources lies in their ability to meet thermal energy requirements beside those pertaining to electricity. Indeed , renewables can supply thermal energy in different temperature ranges, for different applications, across varied sectors like agriculture, buildings, industry (including micro, small, and medium enterprises), and households. Some of these options can also be adopted as demand side management (DSM) measures because they help reducing demand of conventional fuels/electricity. These technological options are dealt with in detail in the following section.

	Web Link
	APFED Best Practices Database The BPP database is a collection of numerous best practices related to sustainable development
	Thermal applications of gasifier system in small industries TERI has been involved in several projects to improve thermal efficiency of biomass used in several of small and micro industries.
	UNEP: Environment Knowledge Hub Monthly per capita consumption of fuels in rural areas in South Asia
	Environment Knowledge Hub Primary cooking fuel usage, % of households in South Asia
	UNEP Environment Knowledge Hub Renewable energy indicators
	UNEP's Environment Knowledge Hub Renewable energy potential in South Asia

- Distributed Power Generation (3)
- Decentralized energy supply (6)
- Liquid biofuels (1)
- Grid connected power generation (3)

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The section on Directories has Directory of Experts, Suppliers & Manufacturers and Organisations.

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- Hydrogen & Fuel Cell Techno...
- Solar photovoltaic energy: ...
- Wind energy: A Compendium...
- Wind Energy...
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Solar photovoltaic energy: Trends and status

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Case studies

Hybrid minigrid- based on solar PV [2]

Country: India ***Province:*** West Bengal ***Area:*** Sunderbans
Implementation Level: Local level ***Duration:*** 1996-2003
Sponsors: Central subsidy, state subsidy, local area

Background

Sunderbans is part of the vast delta of the river Ganga, an area characterised by mangrove swamps and islands interwoven by a network of small rivers, waterways, creeks and tracts. The tidal swamp forests of the delta and their unique ecosystems are the habitat of the endangered Royal Bengal Tiger. The majority of the population in the Sunderbans is dependent upon agriculture and fishing, and on the mangrove for forest related resources such as firewood, honey, timber, tannin, charcoal, fruit and fodder. Prawn cultivation for export is another business opportunity for this region. To protect the natural habitat, environment and the bio-diversity of the region, the Sunderbans Biosphere Reserve was established in 1989. The reserve covers 8,630 sq. km, including about 5,366 sq. km of human habitat. The remote villages and hamlets of the delta suffer from a chronic shortage of energy due to the un-availability of grid power. It is extremely difficult, if not impossible, to extend high-tension transmission lines to these areas as most of the places are separated from the mainland and from each other by wide rivers and creeks. In the absence of grid power, the alternate fuel sources are kerosene for lighting and diesel generators for electricity. Since it is highly cost-prohibitive to draw transmission lines across very wide rivers and creeks, renewable energy is considered to be the right choice for providing clean energy to these remote settlements. Village-level minigrids based on biomass gasifier, solar photovoltaics, wind-diesel hybrid and tidal power technologies are used for supplying electricity for domestic and commercial applications. In addition, solar home lighting systems and portable lanterns are also used in many households.

Objectives

Although solar home lighting systems are the most widely accepted solar based electrification option in developing countries, they have limited scope for productive uses and overall community development, such as the provision of safe drinking water and vaccine refrigeration. Mini-grids are a better option, as they are able to generate three-phase AC electricity and distribute it through low-tension localised networks for many diverse applications. However, financing SPV mini-grids is a challenge as the cost of electricity is high compared to most other options. The objective of the mini-grid model is to implement a financing scheme that is based on a judicious mix of well-targeted central subsidy to take care of the initial cost of the generating unit; state and local area development funds to lay the distribution networks; and revenue collection from the

Results/impacts

Nine SPV mini-grids with a cumulative installed capacity of 344.5 kWp have been installed by WBREDA in Sunderbans. Together they serve about 1,750 consumers (a consumer is defined as a single household or shop/ commercial unit). The largest and most recent mini-grid has 110 kWp-installed capacities and serves more than 750 consumers. The total investments in setting up these mini-grids are U.S.$ million. Each of the 1,750 consumers, who typically would have used kerosene for lighting and diesel-based battery charging for TV viewing, has the potential of saving 228.2 kg CO_2 emissions annually, as per a study conducted in the year 2000. At the national level, setting-up mini-grids has avoided the use of diesel based mini-grids (the only baseline option, as grid extension is not technically feasible). Considering the emission rate of 1.3 kg CO2 per kWh for diesel -generated electricity, each 100 kWp mini-grid has the potential of saving about 180 tonnes of CO2 emissions annually.

Another survey in this region has reported upon the tangible benefits of SPV mini-grids. These benefits include the ability to do agricultural work at night, longer periods of work for small trades and businesses, and an ensuing increase in income due to these extended hours of operation. In addition, social benefits such as longer periods for studying, saving in time for cooking, entertainment, and facilitation in night movement and physical comforts are also realized.

Keys for success

The Sunderbans mini-grid model is a combination of economic instruments in the form of a judicious mix of central, state and local level developmental funding, community financing, public-private-local-community partnerships and it maintains a unique design, planning and management approach.

Critical instruments

Design, planning and management

Robust design based on the use of local material and expertise, good planning and effective management by involving the local community: The success of any village level scheme in providing basic services that are based on new technologies depends on how well it has been designed and implemented. First, the design should be such that it can be implemented in remote, geographically -challenged locations. For example, the transportation of any material in this area is by boat. The design should therefore not incorporate the transportation of heavy

Subsidies

Fee-for-service model that matches the paying capacity of the user to the level of the services provided and an effective use of various developmental funding for setting up the utility: In areas where grid extension is not feasible, communities often depend on fuels such as kerosene and diesel for meeting their electricity service requirements. Solar PV based options, though viable and user friendly, are beyond the means of the rural consumer if the delivery system follows an ownership model. While there are innovations through rural credit mechanisms that have improved the affordability of solar systems, mini-grids are found to be a better option for serving a large community with diverse needs. However, the challenge is how to maximize the benefits of subsidy agencies while ensuring that the consumer is happy with paying for the services. Though the MNES provides a subsidy of up to 50 percent of the capital cost, consumer financing of the remaining 50 percent in the case of expensive PV technology is found to be quite difficult. Innovations in accessing local developmental funds and state funds for setting up the village level utility, and ensuring its O&M from the sale of electricity, have brought clean electricity services within affordable limits to the rural consumer.

Partnerships

Unique case of public-private-local-community partnership with well defined roles and responsibilities: Though the role of various types of partnerships is well accepted in all aspects of sustainable development, one can actually see them work effectively in Sunderbans. To start with, there is intra-governmental partnerships where the centre, state and local government institutions have pooled-in resources to set up the utility. In addition, there are public-private partnerships in which WBREDA has worked effectively with the private sector PV supplier to set up and maintain the utility. The most effective partnerships have been forged between the state and the community. In these relationships, the village committees have been successful in managing the entire scheme under the technical supervision of the state.

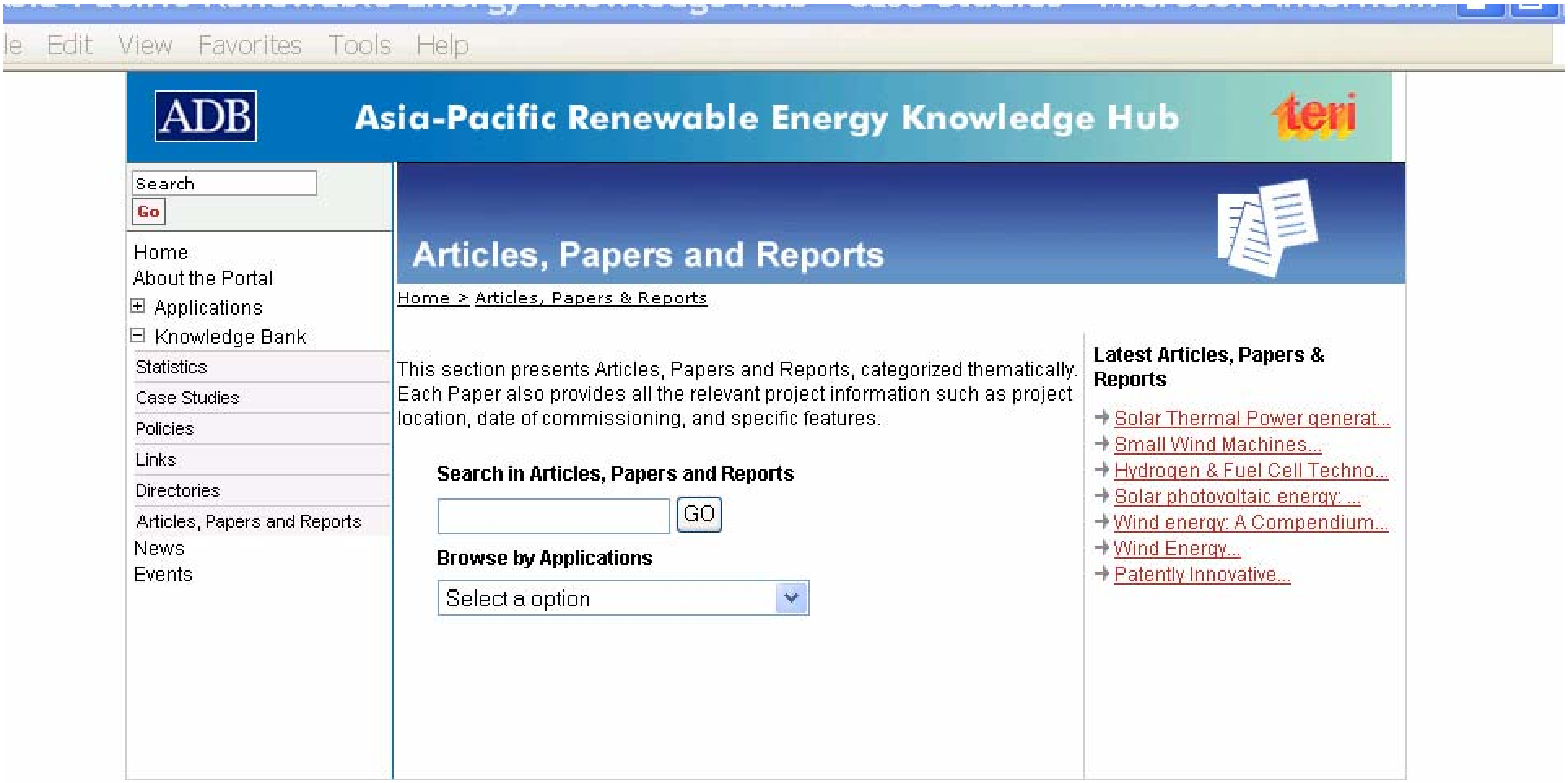
Lesson learnt

The Sunderbans model has provided the following lessons:

1. That the community is willing to co-finance rural electrification projects to the extent that they are expected to pay a fee for the service. In other words, a combination of public funds for setting up the mini-grid, and contributions from the community in the form of revenue from the sale of electricity, which can be used towards the O&M of the facility, is a viable financial model for rural electrification projects.
2. That the consumer finds it easy to accept the rural electrification scheme based on alternate technologies if the total investment by them including the application fees for the electricity connection, costs of internal wiring and fixtures, monthly bill etc. are of the same order as that of the grid based electrification.
3. With the provision of electricity and after having felt its benefit, demands for more connections, more connected load per household and more hours of availability have increased. Realistic demand assessment is thus a critical parameter for the success of such projects.
4. Considering the fact that renewable energy technology is a relatively new option for the community, procedures such as after sales service, revenue collection, etc., have been relatively easy because of the involvement of trustworthy government institutions and community representatives. Entrepreneurs in similar cases would be more successful if they already had a presence and acceptance in the community.
5. In planning a village level initiative such as the mini-grid, the project planning focuses more on the technical design and O&M aspects. Management aspects are often overlooked. Once the plant is commissioned, then management related problems may start surfacing and may require considerable effort to sort out.

Applicability

As compared to solar-home-systems based rural electrification where the onus of the battery replacement is on the user, the mini-grid model, or the fee-for-service model, takes care of the entire O&M requirements through monthly revenue collection. In addition, this model also facilitates development of local enterprise—both on the supply side (sales and services of the energy efficient devices) and on the demand side (small shops, entertainment centres)—thereby fostering the economic development of the region. This delivery model has the potential for replication in many remote inaccessible areas of developing countries. In many areas, it can serve the purpose of pre-electrification. The distribution network and institutional arrangements can easily be used for grid-electrification if and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Wind energy: Trends and Status

Prepared for
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Total installed capacity in Asia is as follows.

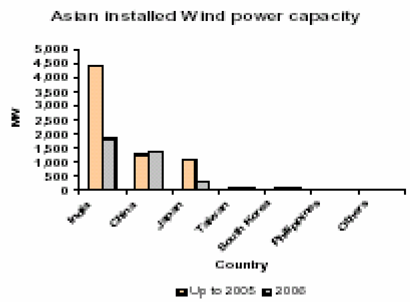
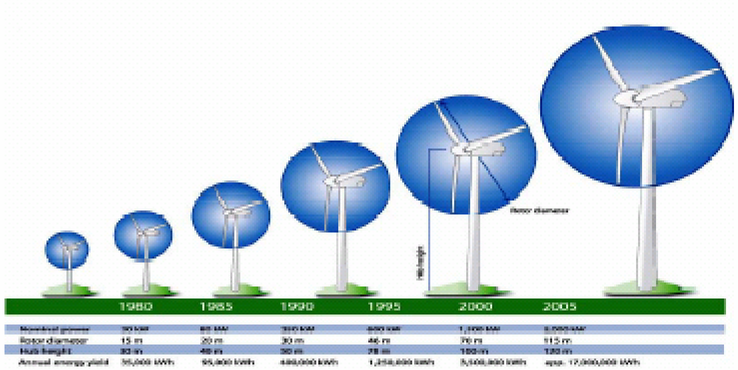


Figure 7 Total installed capacity in Asia

State of art of technology

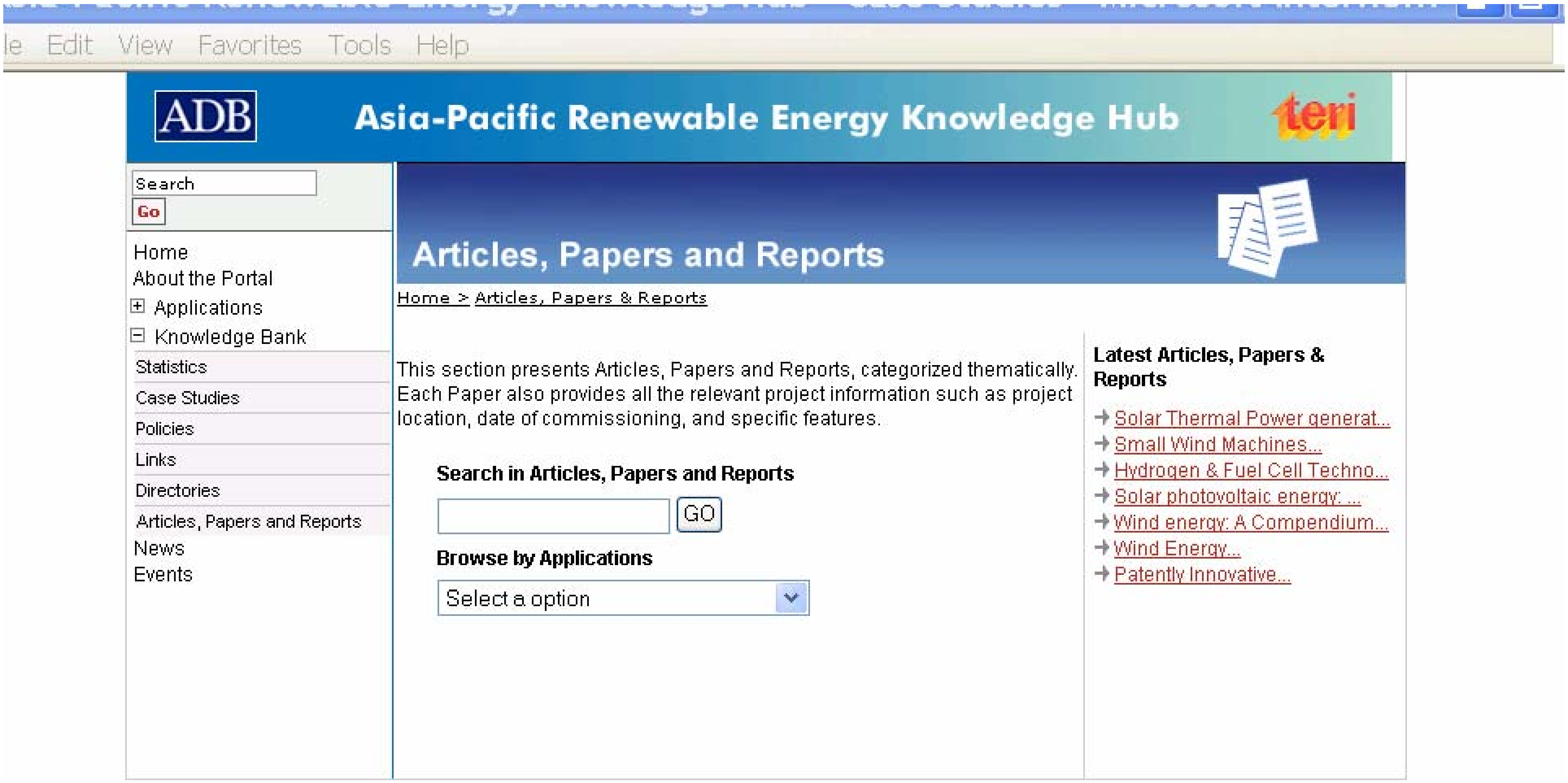
Figure 8 gives brief idea about turbine developments since 1980. Size of turbines increased from 30 kW in 1980 to 5MW (5000 kW) in 2005. 5MW turbine is designed and developed by REpower and is operating in Germany since 2004 (shown in figure 9). So far this is the largest wind turbine available in the world.

Presently, wind turbines of 800kW, 1250kW, 1300kW, 1650kW, 1670kW2000kW, 2300kW, 2500kW, 3000kW and 3600kW are also available and installed successfully.



Source: www.energieverbraucher.de

Figure 8 Trends in wind turbines' capacities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Chennai Petroleum seeks to set up new wind power capacity

Source : Mint
Date : 2007-11-21

In an effort to further benefit from tax incentives offered by the government for wind power projects, CPCL (Chennai Petroleum Corporation Ltd)plans to expand its wind power capacity from the existing 17.6 MW. Chennai Petroleum, a subsidiary of state-owned Indian Oil Corporation Ltd, is the first public sector firm in the country to set up wind energy projects. The company planned to use the power generated from its existing wind power facility in a `5.8 million gallon per day seawater desalination plant' that is coming up near Chennai and will be `commissioned by March 2008'. Drawn by the underlying tax benefits and potential earnings, several oil and gas companies are looking to invest in wind power projects in the country. Other companies with such plans include Hindustan Petroleum Corporation Ltd, Bharat Petroleum Corporation Ltd and Oil and Natural Gas Corporation Ltd.

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ENERGAIA International Renewable Energies Exhibition

From Thursday, December 06 2007 - 8:00am
To Saturday, December 08 2007 - 5:00pm
Every day

Location: Montpellier, France
Contact: Conference Secretariat

La Cotonnière - Les Nouvelles 13830 Roquefort (France) Tel: +33 (0)4 42 71 73 29 / +33 (0)4 42 73 09 33
Fax: +33 (0)4 42 73 29 38 Web site: www.energaia-expo.com

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