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Wind energy development with special reference to India

Wind as a source of electricity produces minimal quantities of GHGs (greenhouse gases), which has attracted governments to ambitious targets for wind energy in many parts of the world. Although, wind energy is generally developed in the industrialized world for environmental reasons, it has attractions in the developing world because it can be installed quickly in areas where electricity is urgently needed and establishing power grid is difficult.



Current research on renewable energy and development

A compilation of annotated bibliographies from different leading periodicals on current research on renewable energy and environment.



Technological developments

Some of the recent technological developments in the field of development are discussed.

Web updates

This section picks up some of the web resources available in the fields of renewable energy and environment.



Conferences/workshops/seminars

Covering some of the major forthcoming events in the field of environment, renewable energy, and sustainable development...

Overview of off-grid power supply through renewable energy system in Sunderban islands

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Abstract

Electrification of Sunderban islands in south Bengal, by WBREDA (West Bengal Renewable Energy Development Agency) for domestic and commercial lights, power for tiny industries, water for drinking, and for entertainment through SPV (solar photovoltaic) devices, wind, biomass, and biogas energy has been virtually revolutionizing the living standard of people. This also reinforces the fact that energy is the driving force for economic development and welfare. Though the concept of rural electrification is nearly four decades old, there are hardly any success stories to mention. Here is a successful model in remote areas running with the involvement of people in operational management of installations. In this case, people are affording power at a higher rate than the rate in the main land since this happens to be the best option amongst all alternatives. The impact on the society in terms of better illumination level with respect to kerosene lanterns and associated hazards, adding employment and trading opportunities, and exposure to outside world is of great significance. From the social benefit point of view, both consumers and suppliers are happy since electricity at the consumer's disposal is an essential input for day-to-day living. Besides, in this case sophisticated technology has been utilized in a sustainable manner for a class of people who deserve special attention for development. The cost-benefit signals a positive advantage in places where conventional power

supply through extension of grid line is not possible. Although, in grid-connected rural areas these natural resources deserve harnessing in order to improve tail end voltage, energy security, and supplement over all deficits between supply and demand. These power supply units in the islands are the beginning of large programmes, with sign of price of energy sliding downwards against upward trend for conventional power.

Introduction

Solar photovoltaic electrification

SPV electrification in West Bengal started in 1994 with the electrification of a predominantly tribal village through a 12.5-kWp (kilowatt power) system for 117 beneficiary consumers. Each house now has 9-W (watt), CFLs (compact fluorescent lamps) against monthly payment of a minimal amount. There is a community water pumping facility for cultivation. Following the model, a central power station of 26-kWp capacity was set up at Kamalpur village at Sagardweep island in Sunderbans in 1996. Three-phase 400/230-V (volt) distribution lines were drawn to extend grid quality power to the consumers. The successful implementation of this unit was replicated in another village. Encouraged by this success, the endeavour to electrify nearly 55 villages in Sunderban islands through solar systems gained momentum with the involvement of the local people to utilize solar energy in manners that improve general economy and usher in welfare in many ways. As of now, 15 central solar power stations of capacity between 25 and 110 kW serving nearly 2500 consumers have come up in different islands. All the units are now running as regular off-grid power supply centres for 5–6 hours in the evening (a list is given in Table 1). A master plan already approved envisages electrification of inhabited islands through SPV, wind, biomass, or a combination of these through hybridization. The latest power plants incorporate extra capacity for power supply to tube wells for drinking water that comprises a control room with battery bank and



Table 1

Solar photovoltaic plants		
Name	Month/ Year of installation	Capacity (kWp)
Kamalpur	Feb/1996	25
Mrityunjay	Oct/1998	25
Khasmahal	May/1999	25
Gayenbazar	May/1999	25
Mahendra	Aug/1999	25
Natendrapur	Aug/2000	25
North Haradhanpur	Nov/2000	25
Mandirtala	Dec/2000	25
Parthapratim	March/2004	110
Indrapur	Nov/2004	110
Rakhalpur	Jun/2005	110
Koyalpara	Oct/2005	110
Dandpur	Jan/2006	55
Tushkahali	March/2006	55
Pathankhali	March/2006	55
Bondadna	April/2003	55
Baliara	March/2003	110
Biomass plants		
Gosaba		500
Chhoto Mullakhali		500
Hiramba Gopalpur		400

control panels, solar array with modules, and overhead distribution lines.

Biomass

Sunderban, as the name implies, is a vast forest area. Minor forestry products are suitable for producing gas in gasifier, and for running engine-generator set for distributive power supply. Three gasifier power plants have been commissioned having a total capacity of 1400 kW serving eight villages and 1200 consumers (details are given in Table I). The powerhouse consists of a wood processing unit, gasifiers, and engine-generator room with control panels and an overhead distribution system. Here, the plants usually run between 6 and 14 hours, and cater to day load also. To ensure the availability of biomass, 71 hectares of plantation has come up that would ensure captive supply of part of the feedstock at a cheaper price. More such biomass plants are in the pipeline according to the master plan. Biomass projects offer employment opportunities in raising plantation, harvesting, transportation,

storage, generation, and power distribution process. These projects deliver clean energy. Success story of wood-based biomass gasifiers is the nucleus of about 70 power plants totalling to 20-MW (megawatt) capacity in the main land, but based on rice husk. Because of diesel replacement estimated to worth nearly Rs 70 crore per year these units qualify for CDM benefit at the rate of 10 euro/tonne of carbon emission reduction valued at nearly 0.6 million euro.

Wind electric generation

Wind power potential in Sunderbans is estimated at 450 MW. Exploratory work is in progress. Till now, at two locations, the installed capacity stands at 1.45 MW. While at Frasergunj 1.25-MW output is fed to the grid, the capacity of 0.2 MW at Sagardweep island is unique to operate in tandem with diesel generating sets. Both these installations use highly technical operation process. As per the system design, while wind is available, the system will deliver power from WEG (wind electric generation), whereas under no-wind condition, it will operate from the DG set. Moreover, when wind is only partly available, proportionate demand will be shared between the WEG and DG set. A gasifier set is being added to the system so that in winter while wind velocity is poor, this unit can cater to the load and save diesel fuel.

Other renewable resources

The islands in Sunderban, in addition to off-grid power distribution, have nearly 50 000-nos of individual domestic solar lighting system of capacity varying between 35 W and 74 W that provide lights to scattered houses where distribution system from central power plants has not been extended. In addition there are about 2000 nos of biogas plants operating on cowdung, supplying both heat and light.

The total renewable energy power supply capacity in the islands is given below.

a	SPV	742 kW
b	Biomass	1400 kW
c	Wind	1450 kW
d	Wind-diesel hybrid	510 kW
e	Micro SPV units	32 kW
f	Total	4134 kW
g	Biogas units mostly 4 m ³	2000 nos.
h	Solar domestic lighting	50 000 nos.

About the place and people

The total area of Sunderbans is about 10 000 km² (square kilometres), and it has a population of four million. It has the world's largest mangrove forest and inter-tidal delta region. Of the two parts identifiable, one is linked with the main land, and the other has 102 islands out of which 54 are inhabited. Sagardweep is the largest (300 km²) with a population of nearly 0.2 million. The main source of livelihood is agricultural crops like paddy, chilli, betel leaves, and coconuts, besides fishing, tourism, forest wood, honey collection, and so on. The main energy sources are firewood, cow dung, and kerosene for cooking and lighting. Diesel and petrol are used for transport. The communication system is bad due to poor roads. Boats provide intra and inter island movements. Battery-operated radios are the only source of entertainment. Schools, hospitals, and government offices are not many in number. There is chronic shortage of power. Few private small DG (distribution generation) sets supply power at about Rs 25 per unit for shops in the market area. One diesel power station in Sagardweep owned by the government runs for short duration in the evening. The absence of power has been hindering economic growth. In such a situation, the availability of about 4100 kW power through renewable energy is a boon. To meet the expectation of people a master plan for large-scale implementation of SPV, wind, biomass, and their hybrid combinations has commenced and would be completed in three to five years.

Methodology and objective

The methodology adopted is based on discussion with consumers and other people to get their views on renewable energy and its contribution to socio-economic development. Education, poverty, per capita income, professional preference, unemployment, and so on were left out. The primary objective was to get their reaction on extension of power, affordability of charges, adequacy of service, impact on quality of living with induction of power to replace kerosene in domestic and commercial establishments, and problems encountered with a view to examine justifiability of setting up of more such WEG systems.

Operation, maintenance, and technology

Except for wind or wind-hybrid electric generation, O&M (operation and maintenance) of SPV and biomass systems is simple. In-plant training to local people for few weeks makes them fit to take up assignments. In case of wind and allied hybrid systems the training period has to be longer, and the education level should be higher. The technology in wind and allied hybrid systems is complicated whereas for others a basic knowledge of science is enough. Routine maintenance is done by the operational staff, but special repairs and maintenance have to be left to expertise services, normally outsourced.

Consumer services

Consumers are categorized into two divisions: domestic and commercial. Charges are based on service connection-cum-fixed initial security deposit that is in the range of Rs1000–1500. In addition, monthly charges between Rs 100 and Rs 150 are payable for a three-point supply, two CFL lamps, and a plug point for TV and other services having total connected load between 80 and 120 W. For shops depending upon load demand, the above charges differ. In case of biomass and wind-diesel power plants, consumers are charged on the basis of metered consumption. They are invariably involved in the initial planning, commissioning, and thereafter. They form cooperatives to take care of all commercial dealings for commissioned power plants. Their performance can be judged from realization of revenue to the extent of above 95%. Smart cards are being introduced for prepaid services, as also automatic tripping device to prevent drawal in excess of permissible limit. Working back, unit charges are between Rs 10 and Rs 14/ kWh for solar, whereas for others they are between Rs 6 and 8/kWh. This is higher than the energy charges under the grid system in the main land. However, there is a downward trend in the case of renewable energy contrary to year-on-year rise in case of conventional power.

Consumers' benefits and involvement

With the availability of CFL lamps, consumers have reduced kerosene purchase to the extent of 60% in households and by nearly 90% in shops.

Since the illumination level of CFLs is about 10 times higher than a kerosene lantern, this has been an immense help for working and studying in the evening. The greatest benefit is avoiding all hassles in the procurement of additional quantity of kerosene beyond public distribution quota. Markets and shops have attained a new look and attract customers in the evening. Hotels have come up to provide comforts. A number of new shops have also opened up. Hospitals and government offices are in a much better position to provide service to the people. Electricity has obviously contributed to the improved quality of life, and offers opportunity for socialization. In fact, there is a greater degree of awareness amongst people. The system is managed by the local energy cooperative organization, and thus, ensures full involvement of the people. These socio-economic welfare measures are sustainable.

Economics

A consumer on an average uses 12 litres of kerosene every month, which costs him Rs 120. Since full supply is not available from public distribution systems, he spends about Rs 180. With CFL lamps usage, this has gone down by 50%, and he saves about Rs 90. Although, paying an additional amount of Rs 10–50 every month for brighter lighting is tough for consumers to bear, with the hope for good living quality, the issue of affordability gets reduced. In case of shops and markets, with increased trading activities business is on the upswing. Shops no longer need to buy power at exorbitant rates in the market areas from private DG sets. Employment opportunities have also gone up. Hospitals are better equipped to store medicines, and drinking water is supplied by tubewells. This model is attracting more and more prospective consumers. Renewable energy has opened up new vistas in the developing economy by way of inviting investment, finding employment, and widening services.

Problems

In spite of many favourable factors, there are disadvantages also, which have to be addressed in the course of time. The present restricted timing for power supply should increase to serve

consumers for longer hours. Module capacity needs be increased for micro-irrigation. The quantum of supply should be increased in order to improve the economy and life style of people.

Future potential

Well-established technology, simple O&M, optimum resource availability in island areas, environmental sustainability, and a good management system are indications of the potential for setting up of these type of power plants all over the country. In the near future it is hoped that bigger units catering for higher demand and longer period of supply will come up to serve domestic and commercial consumers, small agriculture units, and tiny industries in remote areas. The country is yet to provide electricity to 12 50 000 remote villages. These resources are no doubt appropriate tools for this purpose.

Conclusion

Sustainable supply, affordable price, acceptability of system from the commercial point of view, local resources, and quantitative adequacy for the present are prime considerations for replicating the model not only in islands, but also in other remote parts of the country. The possibility of replicating the usage of the model should also be explored (1) for villages approachable by grid, (2) to improve voltage profile which is often worse at the tail end of distribution system, and most importantly, and (3) to harness nature's gift of wind power to mitigate deficit between demand and supply. With advances in technology, the price of renewable energy is falling while cost of conventional power is increasing. These ventures are being extended in a big way by the government through a master plan to cover all the inhabited islands as ideally suitable in remote areas.

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Wind energy development with special reference to India

Introduction

Wind as a source of electricity produces minimal quantities of GHGs (greenhouse gases), which has attracted governments to ambitious targets for wind energy in many parts of the world. Although, wind energy is generally developed in the industrialized world for environmental reasons, it has attractions in the developing world because it can be installed quickly in areas where electricity is urgently needed and establishing power grid is difficult.

In many instances it may be a cost-effective solution if fossil fuel sources are not readily available. In addition there are many applications for wind energy in remote regions, worldwide, either for supplementing diesel power (which tends to be expensive) or for supplying farms, homes, and other installations on an individual basis.

The technical feasibility of using wind as a source of power generation has now been established and wind energy has emerged in the near term as the most promising renewable energy technology for generating electricity. The growth in energy demand, the limitations of supply and increasing cost of fossil fuel generation, and environmental concerns make wind power a competitive option in countries that have a good wind resource base.

Global scenario

Over the last decade, significant progress has been made in harnessing wind for power generation in different parts of the world, particularly in China, Europe, India, and the US (United States). Wind power markets are concentrated in a few primary countries, with Germany, India, Italy, Spain, and the US leading expansion in the recent past. Several countries, including Russia and other transition countries like Brazil, China, Mexico, and South Africa, are now taking their first steps towards developing large-scale commercial markets for wind power generation.

Wind power has the potential to make a major contribution to the world's increasing energy

demand. The EWEA (European Wind Energy Association) projected that 180 GW (gigawatt) of wind energy could be generating 425 TWh (terrawatt hour) per annum by 2020. In the process it would save an annual 215 MT (million tonnes) of CO₂ (carbon dioxide) by 2020. *Wind Force 12*, a publication by the GWEC (Global Wind Energy Council), EWEA, and Greenpeace, shows that 12% of the world's electricity can be supplied by wind power in 2020 if political and policy changes are pursued, so that technical, economic, or resource limitations are minimized. In brief, the wind energy industry, by 2020, will develop into such a stage that it would fulfil the wind power demand in Europe as follows.

- Generation of enough electricity to satisfy 12% of the global demand
- Creation of over two million jobs
- Installed capacity of 1.2 million MW (megawatt) of wind power thereby generating 3000 TWh of electricity
- Annual investment value of more than 80 billion euros are required
- Annual saving of 1800 MT of CO₂

Interestingly, the wind power installations worldwide have crossed 50 000 MW in 2005. There is now a total capacity of about 36 650 MW in Europe, 7000 MW in the US, and 3740 MW in India. India now ranks fourth in the generation of wind power in the world after Germany, Spain, and the US. In 2005, the global wind power installation was 11 769 MW which represents a 43.4% increase in annual additions to the global market, up from 8207 MW in the previous year. The total value of new generating equipment installed was over 12 billion euros, or 14 billion dollars. The total installed wind power capacity now stands at 59 322 MW worldwide, an increase of 25% compared to 2004 (Table 1).

As per the recent data released by GWEC, the countries with the highest total installed capacity are Germany (18 428 MW), Spain (10 027 MW), the US (9149 MW), India (4430 MW), and Denmark (3122) (Figure 1). India has thereby overtaken Denmark as the fourth largest wind

Table 1 Cumulative installation (MW) in the wind power market

Country	Cumulative installation in end 2002 (MW)	Cumulative installation in end 2003 (MW)	Cumulative installation in end 2004 (MW)	Cumulative installation in end 2005 (MW)	Growth rate 2005/06 (%)	Contribution in world production (%)
Germany	11 968	14 612	16 620	18 428	10.87	31.0
Spain	5043	6420	8263	10 027	21.34	16.9
USA	4674	6361	6718	9149	36.18	15.4
India	1702	2125	3000	4430	47.66	7.5
Denmark	2880	3076	3083	3122	1.26	5.3
Italy	806	922	1261	1717	36.16	2.9
UK	570	759	889	1353	52.19	2.3
China	473	571	769	1267	64.75	2.1
Japan	486	761	991	1231	24.21	2.1
Netherlands	727	938	1081	1219	12.76	2.1
Top 10	29 329	36 545	42 735	51 936	21.53	87.6
World (Total)	32 037	40 301	47 912	59 322	12.81	100

Source Global Wind Energy Council, December 2005

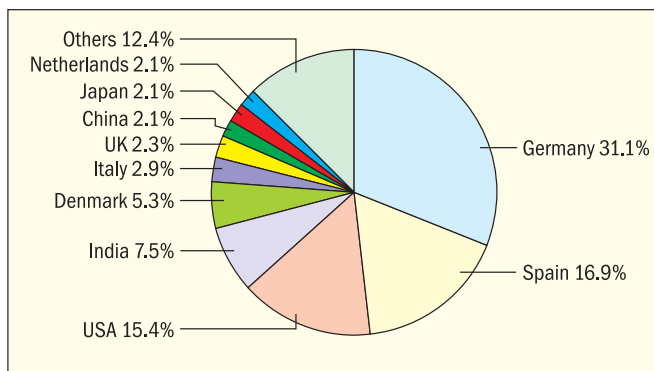


Figure 1 World wind power market share in 2005

Source Global Wind Energy Council 2005

market in the world. A number of other countries, including China, Italy, Japan, the Netherlands, Portugal, and the UK (United Kingdom) have reached the 1000-MW mark of installed capacity. In terms of new installed capacity in 2005, the US was clearly leading with 2431 MW, followed by Germany (1808 MW), Spain (1764 MW), India (1430 MW), Portugal (500 MW), and China (498 MW). This development shows that new players such as Portugal and China are gaining ground.

Europe is still leading the market with over 40 500 MW of installed capacity at the end of 2005, representing 69% of the global total. In 2005, the European wind capacity grew by 18%, providing nearly 3% of the EU's (European Union) electricity consumption in an average wind year.

Despite the continuing growth in Europe, the general trend shows that the sector is gradually becoming less reliant on a few key markets, and other regions are starting to catch up with Europe. The growth in the European market in 2005 only accounted for about half of the total new capacity, down from nearly three quarters in 2004.

Nearly a quarter of the new capacity was installed in North America, where the total capacity increased by 37% in 2005, gaining momentum in both Canada and the US. The US wind energy industry broke earlier annual records of installed capacity through installation of nearly 2500 MW.

Asia has also experienced a strong growth of over 49% in the installed wind power capacity with a total installation of over 7135 MW. In 2005, the continent accounted for 20% of the new installations. The strongest market here remains India with over 1430 MW of new installed capacity, which takes its total figure up to 4430 MW. The Chinese market has been boosted in anticipation of the country's new Renewable Energy Law, which came into force on 1 January 2006. As a result, nearly 500 MW of new capacity was installed in 2005, more than double the 2004 figure.

The Australian market nearly doubled in 2005 with 328 MW of new installed capacity, bringing the total up to 708 MW. The relatively young

African market saw a steady growth, with an installation figure double that of 2004. The main countries experiencing growth are Egypt (230 MW, up from 145 MW) and Morocco (64 MW, up from 54 MW).

The overall picture confirms that the right political framework is crucial to sustain the growth of wind power around the world, and to open new markets. Some 48 governments have already introduced laws and regulations to support the development of renewable energy, but this effort needs to be increased if the benefits of wind energy are to be reaped around the world.

Wind energy development in India

The wind power programme in India was initiated towards the end of the Sixth Plan, in 1983/84. The original impetus to develop wind energy in India came from the then Department of Non-conventional Energy Sources, now known as the MNES (Ministry of Non-conventional Energy Sources). Its purpose was to encourage a diversification of fuel sources away from the growing demand for coal, oil, and gas required to feed the country's rapid economic growth.

A market-oriented strategy was adopted right from its inception, which has led to the successful commercial development of the technology. The broad-based national programme includes wind resource assessment activities; research and development support; implementation of demonstration projects to create awareness and opening up of new sites; involvement of utilities and industry; development of infrastructure capability and capacity for manufacture, installation, operation, and maintenance of wind electric generators; and policy support.

Private investors and developers came forward to set up commercial wind power projects in different parts of the country during the late 1980s and early 1990s. In the 1990s, the importance of renewable energy sources as environmentally benign decentralized energy systems, especially for rural areas, was recognized by the government, and a new thrust was given to renewable energy efforts in the Eighth Five-year Plan. In 1992, MNES was restructured to provide a more coordinated approach towards policies, programmes, strategies, and institutions involved in the renewable energy programmes, and to provide market linkages for the commercialization

of RETs (renewable energy technologies). Thus, high priority was accorded to generation of grid quality power from wind energy, small hydropower, bio-energy, and solar energy. Secondly, rural energization was undertaken through enhanced use of different renewable energy devices.

Currently, a three-fold strategy has been pursued by the government for promotion of renewable energy sources through private sector involvement. These include the following.

- Providing budgetary resources by government for demonstration projects
- Extending institutional finance from IREDA (Indian Renewable Energy Development Agency) and other financial institutions for commercially viable projects, with private sector participation; and external assistance from international and bilateral agencies
- Promoting private investment through fiscal incentives, tax holidays, depreciation allowance, facilities for wheeling and banking of power for the grid and the remunerative returns for the power provided to the grid

The current policy environment has been instrumental in creating one of the largest and most diverse renewable energy programmes in the world, with a broad technological base and large human capacity.

Wind power potential in India

The wind power potential of India as per the revised estimates of MNES has been assessed at about 45 000 MW. The technical potential is estimated about 13 000 MW, assuming 20% grid penetration, which will go up with the augmentation of the grid capacity in the windy states. The state-wise gross and technical potential assessment is given in Table 3.

Out of the total Indian wind power potential of 45 195 MW, about 12 875 MW capacity has already been installed. Potential windy locations have been identified in the flat coastal terrains in the Andaman and Nicobar Islands, Gujarat, Kerala, Lakshadweep, Maharashtra, Orissa, and Tamil Nadu. Favourable sites have also been identified in some inland locations of Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan, Uttaranchal, and West Bengal. Figure 2 shows installation of the wind power plants in major states.

Table 3 Estimated state-wise wind power potential in India

State	Gross potential (MW)
Andhra Pradesh	8275
Gujarat	9675
Karnataka	6620
Kerala	875
Madhya Pradesh	5500
Maharashtra	3650
Orissa	1700
Rajasthan	5400
Tamil Nadu	3050
West Bengal	450
Total	45 195

Source Ministry of Non-conventional Energy Sources, New Delhi

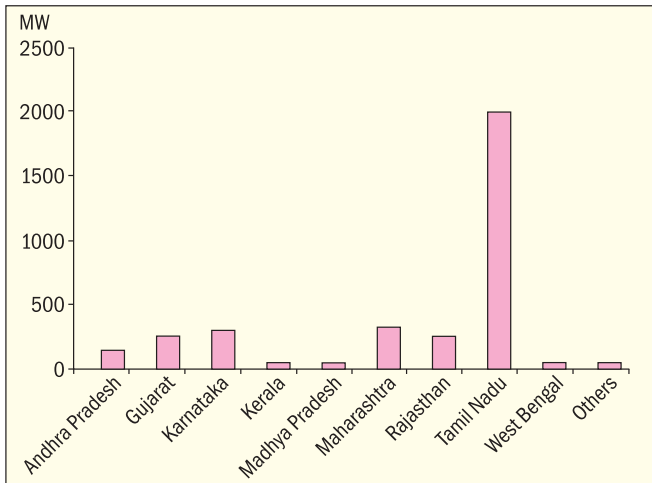


Figure 2 State-wise wind power installation (April 2005)

Source Directory: India Wind Power 2005

Conclusion

India's wind energy sector registered impressive growth and expansion during 2005/06. The total installed capacity stood at 4430 MW in December 2005, an increase of more than 47% over the previous year. India now occupies an enviable position as the wind leader in Asia, and has maintained its world ranking as the fourth largest producer of wind energy in the world.

The growth witnessed during 2004 was also the highest ever in a single year, a massive 45% increase over the previous year.

Even so, given the country's vast potential, progress could be further accelerated. With the change in government policy focus, the wind energy sector is witnessing a progressive trend (Figure 3).

According to preliminary information received from various sources, the installed capacity of wind power in India is likely to cross 5200 MW by March 2006. This means a capacity addition of more than 1600 MW during the financial year 2005/06.

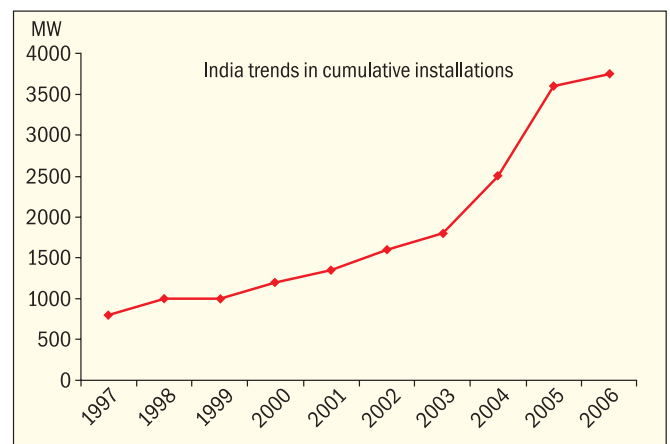


Figure 3 Cumulative wind energy installed capacity
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Abstracts on renewable energy

Jebaraj S and Iniyar S. 2006. A review of energy models. *Renewable and Sustainable Energy Reviews* 10(4): 281-311
Department of Mechanical Engineering, Bharath Institute of Science and Technology, Chennai – 600 073, India

Energy is a vital input for social and economic development of any nation. With increasing agricultural and industrial activities in the country, the demand for energy is also increasing. Formulation of an energy model will help in the proper allocation of widely available renewable energy sources such as solar, wind, bio-energy, and small hydropower in meeting the future energy demand in India. During the last decade several new concepts of energy planning and management such as decentralized planning, energy conservation through improved technologies, waste recycling, integrated energy planning, introduction of renewable energy

sources, and energy forecasting have emerged. In this paper an attempt has been made to understand, and review the various emerging issues related to energy modelling. Different types of models such as the energy-planning model, energy supply-demand model, forecasting model, renewable energy model, emission reduction model, and optimization model have been reviewed and presented. Also, models based on neural network and fuzzy theory have been reviewed and discussed. The review paper on energy modelling will help the energy planners, researchers, and policy-makers. (6 figures, 9 tables, 32 references)

Pohekar S D and Ramachandran M. 2006. Multi-criteria evaluation of cooking devices with special reference to utility of parabolic solar cooker in India. *Energy: the International Journal* 31(8-9): 1215-1227
CREED (Centre for Renewable Energy and Environment Development), BITS (Birla Institute of Technology and Science) Pilani – 333 031, India

Multi-criteria decision-making is an emerging technique for evaluation and policy formulation for renewable energy technology promotion. In this paper, the case of the PSC (parabolic solar cooker), which is a relatively recent innovation, is evaluated with respect to eight prevalent domestic cooking devices in India. Thirty different criteria categorized under technical, economic, environmental, social, behavioural, and commercial aspects are considered for the evaluation based on the additive MAUT (Multi Attribute Utility Theory) model. A survey of

various decision-making groups and user preferences for domestic cooking devices in India is used to formulate the evaluation matrix. Expert opinion is collected to devise the utility functions. On the basis of user preferences and expert opinion, it is found that the LPG (liquefied petroleum gas) stove has the highest utility, followed by the kerosene stove, SBC (solar box cooker) and PSC, respectively. Sensitivity analyses are carried out to identify the areas of improvement for the widespread use of PSC. (4 figures, 3 tables, 22 references)

Jain D. 2006. Modelling of solar passive techniques for roof cooling in arid regions. *Building and Environment* 41(3): 277-287
Central Institute of Post Harvest Engineering and Technology, Punjab Agricultural University Campus, Ludhiana – 141 001, India

Thermal models are presented for the typical methods of passive cooling of roof in the arid region of Rajasthan, India. The periodic analyses for hourly variation of roof cooling are presented for bare roof, insulation beneath the roof, evaporative cooling above the roof, and roof pond with movable insulation system. Calculations were carried out for a typical summer day of May for Jodhpur (India). The models have been tested with the published

experimental data of roof temperature. The predicted values of roof temperature obtained from the proposed models exhibited good agreement with the coefficient of correlation ranging from 0.94 to 0.96 and standard error 1.76-2.80. The water depth (0.05 m) of the roof pond with movable insulation is appropriate for better comfort condition in arid region. (6 figures, 2 tables, 16 references)

Thankappan S, Midmore P, and Jenkins T. 2006. **Conserving energy in smallholder agriculture: a multi-objective programming case study of north-west India.** *Ecological Economics* 56(2): 190-208
Centre for Business Relationships, Accountability, Sustainability, and Society, Cardiff University, CF10 3AT, UK

In semi-arid conditions in north-west India, smallholder agriculture has made increasing use of subsidized mechanization and energy inputs to reduce short-term risks. However, detrimental environmental consequences have occurred, such as rapidly falling water table. Besides, energy-intensive production is threatened by the prospect of increasing scarcity and expense of energy supplies, especially as urban demands are forecast to grow rapidly. This paper describes the energy flows through four subsystems of smallholder agricultural villages: the crop system; non-crop land uses; livestock systems; and households. It employs a multi-objective programming model to demonstrate choices available for net solar energy

capture or financial surpluses. Applied to three villages selected to represent major settlement types in the Saurashtra region of Gujarat, the results demonstrate that both energy conservation and financial performance can be improved. Although these results need further experimentation qualifying because of the reductionist, linear character of the model used, they do provide important insights into the cultural role of mechanization and the influence of traditional agricultural practices. They also underline the need for local energy conservation strategies as part of an overall approach to improved self-determination in progress towards rural sustainability. (5 figures, 7 tables, 45 references)

Azam M M, Waris A, and Nahar N M. 2005. **Prospects and potential of fatty acid methyl esters of some non-traditional seed oils for use as bio-diesel in India.** *Biomass and Bioenergy* 29(4): 293-302
Central Arid Zone Research Institute, Jodhpur - 342 003, India

Fatty acid profiles of seed oils of 75 plant species having 30% or more fixed oil in their seed/kernel were examined. SN (saponification number), IV (iodine value), and CN (cetane number) of fatty acid methyl esters of oils were empirically determined. They varied from 169.2 to 312.5, 4.8 to 212, and 20.56 to 67.47, respectively. Fatty acid compositions, IV, and CN were used to predict the quality of fatty acid methyl esters of oil for use as bio-diesel. Fatty acid methyl ester of oils of 26

species including *Azadirachta indica*, *Calophyllum inophyllum*, *Jatropha curcas*, and *Pongamia pinnata* were found most suitable for use as bio-diesel. They meet the major specifications of bio-diesel standards of the US (United States), Germany, and European standard organizations. The fatty acid methyl esters of another 11 species meet the specification of bio-diesel standard of the US only. These selected plants have great potential for producing bio-diesel. (2 tables, 28 references)

Purohit P and Kandpal T C. 2005. **Renewable energy technologies for irrigation water pumping in India: projected levels of dissemination, energy delivery, and investment requirements using available diffusion models.** *Renewable and Sustainable Energy Reviews* 9(6): 592-607
Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi - 110 016, India

In this paper an attempt has been made to study the past diffusion trends of four renewable energy technologies for irrigation water pumping in India namely, solar photovoltaic pumps, windmill pumps, and biogas/producer gas-driven dual-fuel engine pumps. The paper presented results to project their future dissemination levels. The

likely contribution of the renewable energy options considered in the study to the projected energy demand for irrigation water pumping in India has been estimated. Estimates of the associated investment requirements taking into account the learning effect have also been presented. (4 figures, 7 tables, 25 references)

Ghosh D, Sagar A D, and Kishore V V N. 2006. **Scaling up biomass gasifier use: an application-specific approach.** *Energy Policy* 34(13): 1566-1582

TERI School of Advanced Studies, Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi – 110 003

Biomass energy accounts for about 11% of the global primary energy supply, and it is estimated that about two billion people worldwide depend on biomass for their energy needs. Therefore, the utilization of biomass in a clean and efficient manner to deliver modern energy services to the world's poor remains an imperative for the development community. Although significant efforts have been directed towards developing and deploying biomass gasifiers in many countries, scaling up their dissemination remains an elusive goal. Based on an examination of biomass gasifier development, demonstration, and deployment efforts in India, this article identifies a number of barriers that have hindered widespread

deployment of biomass gasifier-based energy systems. It also suggests a possible approach for moving forward, which involves a focus on specific application areas that satisfy a set of criteria that are critical to deployment of biomass gasifiers, and then tailoring the scaling up strategy to the characteristics of the user groups for that application. The technical, financial, economic, and institutional analysis conducted by authors suggests an initial focus on four categories of applications – small and medium enterprises, the informal sector, biomass-processing industries, and some rural areas – may be particularly feasible and fruitful. (4 figures, 7 tables, 24 references)

Purohit P, Tripathi A K, and Kandpal T C. 2006. **Energetics of coal substitution by briquettes of agricultural residues.** *Energy: the international journal* 31(8-9): 1321-1331

Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi – 110 016, India

The suitability of using biomass briquettes to substitute coal is debatable, as substantial amount of energy is required for briquetting of biomass. In the present work, an attempt has been made to evaluate the energetic viability of briquetting of agricultural residues compared with the energy embodied in coal in India. The results revealed that briquetting of agricultural residues is not

found to be an energetically viable option even for locations at a distance of about 1500 km from the coal pithead, even if the briquetting unit is located very close to the place of availability of the agricultural residues. A need for transportation of agricultural residues further pushes this critical distance upwards. (4 figures, 3 tables, 23 references)

Nouni M R, Mullick S C, and Kandpal T C*. 2006. **Techno-economics of micro-hydro projects for decentralized power supply in remote locations in India.** *Energy Policy* 34(10): 1161-1174

**Centre for Energy Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi – 110 016, India*

In this paper, results of a techno-economic feasibility evaluation of few MHP (micro-hydropower) projects being planned and implemented for decentralized power supply for remote locations in India are presented. The capital cost of such projects including cost of power evacuation and distribution system, cost per unit of rated capacity, and relative cost of different sub-systems of MHP projects in the

capacity range of 10–100 kW have been analysed. Unit cost of delivered electricity for these MHP projects has been estimated. Measures of financial performance for one of the MHP projects have also been determined. Breakeven values for useful life, plant load factor, and unit cost of electricity to the user have also been estimated for the same project. (11 figures, 3 tables, 13 references)

Markard J and Truffer B. 2006. **The promotional impacts of green power products on renewable energy sources: direct and indirect eco-effects.** *Energy Policy* 34(3): 306–321

CIRUS (Centre for Innovation Research in the Utility Sector), Swiss Federal Institute for Environmental Science and Technology (EAWAG), CH-6047 Kastanienbaum, Switzerland

Green power products may be seen as a means of fostering renewable energy sources because they create and channel consumer demand for environmentally sound power generation. In the present paper, the authors provide an encompassing review of the ecological consequences of green electricity products. The authors examine the direct eco-effects by comparing five European countries in their endeavour to increase electricity generation from renewable energy. The results show that the impact of green power on increasing renewable generation capacity is rather limited. In a second

step, they analysed the contribution of green power in stimulating eco-oriented learning. It turns out that green power has particular potential in facilitating simultaneous learning processes involving power producers, traders, suppliers, and consumers. The authors therefore, conclude that green electricity can be a crucial complement to governmental energy policies in the mid term. A precondition for reaping this potential is the careful policy design to create synergies in the interaction of regulatory support schemes and the green power market. (1 figure, 4 tables, 27 references)

Ramesohl S and Merten F. 2006. **Energy system aspects of hydrogen as an alternative fuel in transport.** *Energy Policy* 34(11): 1251–1259

Wuppertal Institute for Climate Environment Energy, Research Group 'Future Energy and Mobility Structures', P O Box 100 480, 42004 Wuppertal, Germany

Considering the enormous ecological impacts and economic importance of the transport sector, the introduction of alternative fuels together with drastic energy efficiency gains, will be a key to sustainable mobility. However, the future role of alternative fuels cannot be examined from the isolated perspective of the transport sector. Interactions with the energy system as a whole have to be taken into account. With emphasis on hydrogen as a transport fuel for private passenger cars, this paper discusses the energy systems

impacts of various scenarios introducing hydrogen-fuelled vehicles in Germany. It identifies clear restrictions to an enhanced growth of clean hydrogen production from RES (renewable energy sources). Furthermore, it points at system interdependencies that call for a priority use of RES electricity in stationary applications. Whereas hydrogen can play an increasing role in transport after 2030, the most important challenge is to exploit short–mid-term potentials of boosting car efficiency. (3 figures, 5 tables, 15 references)

Bhattacharyya S C. 2006. **Renewable energies and the poor: niche or nexus?** *Energy Policy* 34(6): 659–663

CEPMLP (Centre for Energy, Petroleum, and Mineral Law and Policy), University of Dundee, Dundee DD1 4HN, Scotland, UK

Renewable energy is considered as an essential element of any strategy for sustainable energy development. The poor in the developing world without access to modern energies are regarded as a major market for renewable energy. This paper attempts to analyse whether such a niche is

backed by any economic logic, and whether renewable energy and the poor nexus could be a strategy for success. The paper suggests that contrary to the common belief, the economic logic behind the niche is unsound, and that the nexus is not a recipe for success. (5 references)

Several factors have led to growing interest in a hydrogen energy economy, especially for transportation. A successful transition to a major role for hydrogen will require much greater cost-effectiveness, fuelling infrastructure, consumer acceptance, and a strategy for its basis in renewable energy feedstocks. Despite modest attention to the need for a sustainable hydrogen energy system in several countries, in most cases in the short to mid term hydrogen will be produced from fossil fuels. This paper surveys the global status of hydrogen energy R&D (research and development) and public policy, along with the likely energy mix for making it. The current

state of hydrogen energy R&D among auto, energy, and fuel-cell companies is also briefly reviewed. Just two major auto companies and two nations have specific targets and timetables for hydrogen fuel cells or vehicle production, although the EU (European Union) also has an aggressive, less specific strategy. Iceland and Brazil are the only nations where renewable energy feedstocks are envisioned as the major or sole future source of hydrogen. None of these plans, however, are very certain. Thus, serious questions about the sustainability of a hydrogen economy can be raised. (4 tables, 60 references)

Technology news

Tide machines may be major power sources

Norwegian firm, Statkraft, has proposed creating underwater tide-harnessing machines to provide up to three per cent of the EU's (European Union) electricity. The floating machines – about 130 feet long by 50 feet wide – use tidal water movements to turn submerged turbines. The low-visibility tide machines also have a lesser environmental impact compared with the nearly 400 feet high windmills already in operation in the UK (United Kingdom) and Norway. Statkraft estimates the technology eventually could supply up to 100 terawatts of power for the EU, with Germany, the UK, and the Netherlands already interested in the project.

<http://www.physorg.com>, last accessed on 2 June 2006

New thermo photovoltaic materials could replace alternators in cars and save fuel

A TPV (thermo photovoltaic) generator burns fuel to heat a material that emits light (labelled 'radiator'). The light is then filtered and converted into electricity in PV cells. Researchers at MIT (Massachusetts Institute of Technology) are developing new technology for converting heat into light and then into electricity that could eventually save fuel in vehicles by replacing

less-efficient alternators. The technology, called thermo photovoltaics, uses gasoline to heat a light-emitting material, in this case tungsten. A PV cell then converts the light into electricity. But until now, the light emitters for the PV produced inefficient and very costly systems. The researchers modified the surface structure of the light emitter, etching into it nano-sized pits to tune the wavelengths of light emitted to precisely those a PV cell can convert most efficiently into electricity. They further refined the device with the use of filters that allow the desired wavelengths of light to pass through to the PV cells, but reflect other wavelengths back to the light emitter. The reflected light carries energy that helps keep the emitter hot, reducing the amount of fuel needed. In addition to replacing the alternator with a TPV module, the technology could be part of an air-conditioning system for vehicles, researchers said.

<http://www.technologyreview.com>, last accessed on 1 June 2006

Turning corn fibre into ethanol

Iowa State University researchers have successfully convert corn fibre, that is typically used for animal feed, into ethanol. The innovative

process could boost ethanol production by about four per cent or 160 million gallons a year. By nature, corn fibre, like all lignocellulose, forms the structure of a plant's cell walls. During the process, the researchers could develop a mold, which produces enzymes that break down corn fibre into the simple sugars that are fermented into ethanol. So far, the researchers have demonstrated that they have a process that can convert corn fibre – a byproduct of the wet milling process that produces corn syrup – into fuel-grade ethanol on a very small scale. With additional research, at least double the amount of ethanol is expected from the process.

<http://www.iastate.edu>, last accessed on 31 May 2006

Cheaper and smaller inverters for solar panels

A student got Britain's Top Younger Scientists, Engineers, and Technologists award as part of UK National Science Week 2006 Annual Presentations for 'Modular Photovoltaic Systems for Embedded Generation'. The focus of the research is on the development of new electronic systems for efficient power conversion, in particular the problem of efficiently converting solar generated power so that it can be continuously fed into the standard domestic AC electricity supply. The energy output from solar panels changes continuously as the level of light varies during the day. To maintain high efficiency when the power output from the solar panels is low is particularly challenging. Most solar installations, which are connected to the grid, need to be at least of 1 kW (kilowatt) capacity to ensure that the overall system efficiency can be maintained even in low sunlight conditions. This research is aimed at breaking the limit while maintaining high efficiency, to allow much smaller solar installations of about 100 W, requiring much smaller capital investment, to be connected to the electricity grid. Previous devices would need at least five solar panels to work whereas this technology only requires one. The reduced size, easy connectivity, and integrated conversion unit allow these solar panels to be plugged into a standard power socket in a domestic building. Instead of drawing power from the socket, power will be fed into the system.

<http://www.physorg.com>, 29 March 2006

New solar technology centre to promote South-South cooperation

UNIDO (United Nations Industrial Development Organization) inaugurated the new International Center for the Promotion and Transfer of Solar Energy Technology, China. The centre will strengthen solar technology exchange and enhance international cooperation among developing countries through training programmes and seminars. Construction of new facilities will begin this spring and is expected to take two years, funded with an initial investment of 300 000 dollars from UNIDO. The Chinese government is also set to invest 150 million RMB (roughly \$18.5 million) for acquisition of the land, infrastructure construction, and R&D (research and development) endeavours.

<http://www.worldwatch.org>, 28 March 2006

Complete Solar Roof technology offers power and heat

The 'Complete Solar Roof', a technology developed by Solarcentury of England offers an alternative to conventional roofing products by combining solar electric and solar thermal in a tile that is installed like a conventional roofing tile. The two technologies are integrated to generate both power and heat from sunlight. In this technology, the tiles are sit flush with the building's roof structure.

<http://www.renewableenergyaccess.com>, 27 March 2006

Renewable power in remote places

The MBS (mobile power station) by SkyBuilt offers 1.5 to 150 kW of solar and wind power as well as power generated through other sources in a shipping container-sized unit that can be trucked or air-dropped to remote areas. The standard steel freight container stabilizes the unit, and solar panels and wind turbines can be directly attached to it. The design is modular, and SkyBuilt will configure the MPS with any desired combination of solar panels, wind turbines, batteries, and generators. The MPS can accommodate most commercially available components. In April 2006, the MPS was selected by the New Energy Congress as a top-20 clean energy technology product.

<http://www.renewableenergyaccess.com/rea/news/home>, 5 May 2006

Plant to generate eight-megawatt power from waste

The waste-to-energy plant at Mandur near Hoskote will be ready to take about 1000 tonnes of Bangalore city's 2200 tonnes of daily garbage from August 2006. After completion, the plant, work on which is under progress, will be able to generate eight MW (megawatt) of power. The BMP (Bangalore Mahanagar Palika) has entrusted the project to set up a scientific landfill, a processing plant, and a power plant to Srinivasa

Gayatri Resource Recovery Ltd on a 'build-operate-transfer' basis for 33 years. Of the 135 acres of land allotted by the state government for landfill, the facility to process waste and generate power out of it is coming up on 25 acres. BMP will get a two per cent equity share in the project by the company as per the agreement signed. This will enable BMP to purchase power produced at the plant at a later date, which can be used for streetlights.

The Hindu, 24 February 2006

Internet resources

American Council for Renewable Energy

<http://www.acore.org/>

Founded in November 2001, ACORE (American Council On Renewable Energy) works to bring all forms of renewable energy into the mainstream of America's economy and lifestyle. The website hosts news, reports, directories, events, and network information for wider information dissemination to its members.

International Solar Cities Initiative

<http://www.solarcity.org/>

The International Solar Cities Initiative is a partnership between city governments and researchers to address climate change, energy policy, and urban designs based on renewable energy sources. The website is a rich collection of research papers, reports, conference related information, bibliographies, visual resources, links to related websites, and directory of key personnel.

European Renewable Energy Research Centres

<http://www.eurec.be/>

EUREC (European Renewable Energy Research Centres) is a network of about 40 research centres throughout Europe for renewable energy technology, industry support, and policy. Complete descriptions of each centre, including contact information is available from EUREC. The website is a rich collection of resources on papers, reports, news, other publications, projects, links to websites, and members' directory.

World Council on Renewable Energy

<http://www.wcre.org/>

The WCRE (World Council on Renewable Energy) is a globally operating independent organization, free of the vested interests of the present global energy system, and works as the global voice for renewable energy. It has multiple regional councils established around the world to address policy, finance, education, and other topics. The website hosts reports, conference documents, events, and links to other associated organizations.

European Small Hydropower Association

<http://www.esha.be/>

ESHA (European Small Hydropower Association) is a non-profit international association representing the SHP (small hydropower) sector. The association was founded in 1989 as an initiative of the European Commission. ESHA serves to create a platform for actors in the field of SHP (from national associations to research institutions and industry) to represent their interests at the European level. The website is a rich collection of reports, news, conference documents, research papers, publications, and links to other sites.

Database of State Incentives for Renewable Energy

<http://www.dsireusa.org/>

DSIRE (Database of State Incentives for Renewable Energy) is a comprehensive source

of information on state, local, utility, and selected federal incentives that promote renewable energy. The searchable database covers information like tax incentives for solar electric and other renewables, vehicles running on alternative fuels, and energy conservation. The database is a graphical presentation of data, tables, and other information.

China Renewable Energy Information Network

<http://www.newenergy.org.cn/english/index.asp>

This network in the field of new and renewable energy covers information on solar, wind, biomass, geothermal, ocean, hydrogen, and small hydro renewable energy resources. The site is a collection of news, technology, publications, documents, and glossary of terms. It also hosts a bulletin board on the field.

Forthcoming events

19–25 August 2006
Florence, **Italy**

World Renewable Energy Congress IX and Exhibition

Prof. Ali Sayigh, WREN, P O Box 362, Brighton BN2 1YH, UK
Tel. +44 (0)1273 625 643 • *Fax* +44(0)1273 625 768
E-mail asayigh@netcomuk • *Web* www.wrenuk.co.uk

19–20 July 2006
Kuala Lumpur, **Malaysia**

Alternative Energy Forum 2006: fuelling and driving the energy needs of the future

Prakash Ramajillu, Conference Production Manager, Conferences and Training, Marcus Evans, CP 21 Suite 2101, Level 21 Central Plaza, 34 Jalan Sultan Ismail, 50250 Kuala Lumpur
Tel. +603 2723 6631 • *Fax* +603 2723 6711
Web www.marcusevans.com

17–19 July 2006
Tallinn, **Estonia**

The Sustainable City 2006: fourth international conference on urban regeneration and sustainability

Katie Banham, Conference Secretariat, The Sustainable City 2006 Wessex Institute of Technology, Ashurst Lodge, Ashurst Southampton, SO40 7AA, UK
Tel. +44 (0) 238 029 3223 • *Fax* +44 (0) 238 029 2853
E-mail kbanham@wessex.ac.uk
Web www.wessex.ac.uk/conferences/2006

6–9 July 2006
Bangkok, **Thailand**

Renewable Energy Asia 2006

Jantira Pongsatiwittaya, Sales Manager, CMP Media (Thailand) Corporation Ltd, 41 Lertpanya Buildings, 8th Floor, Soi Sri Ayuthaya 12, Sri Ayuthaya Road, Phyathai Rajathewee, Bangkok 10400 Thailand
Tel. +66 2 642 6911/8 • *Fax* +66 2 642 6919/20
E-mail [yantira@cmphailand.com](mailto:jantira@cmphailand.com) • *Web* www.cmphailand.com

27–28 June 2006
San Diego, California, **USA**

Photovoltaics Summit 2006

Libby Sass, Conference Producer, Intertech PIRA, 19 Northbrook Drive, Portland, Maine 04105, USA
Tel. + (207) 781-9601/9800 • *Fax* + (207) 781 2150
E-mail lsass@intertechusa.com

21–22 June 2006
London, **UK**

Third Renewable Energy Finance Forum

Euromoney Energy Events, Nestor House, Playhouse Yard
London EC4V 5EX
Tel. +44 (0)20 7779 8103 • *Fax* +44 (0)20 7779 8946
E mail energyevents@euromoneyplc.com

15–16 June 2006
Hong Kong

Renewable Energy Finance Asia

281 Gloucester Road, Causeway Bay, Hong Kong
Tel. + 44 207 900 1853 • *E-mail* info@greenpowerconferences.com
Web www.biofuelsmarkets.com or www.greenpowerconferences.com

13–16 June 2006
Lyon, **France**

16th World Hydrogen Energy Conference

AFH2, Stephanie Paysant, 28, rue Saint Dominique
F – 75007
Paris
Tel. +33 (0)1 53 59 02 11 • *Fax* +33 (0)1 45 55 40 33
E-mail info@afh2.org • *Web* www.whec2006.com

24–25 May 2006
Aberdeen, **UK**

All-Energy 2006: the renewables show in the Energy City

Conference Secretariat, All-Energy, 34 Ellerker Gardens, Richmond
Surrey TW10 6AA, UK
Tel. +44 (0) 20 8241 1912 • *Fax* +44 (0) 20 8940 6211
E-mail info@all-energy.co.uk • *Web* <http://www.all-energy.co.uk>

eNREE invites contributions

eNREE is meant for ENVIS members and all stakeholders interested in advancing, promoting, and sharing the knowledge in renewable energy and environment in India and abroad. We sincerely welcome your help in enriching this newsletter by sending us articles, case studies, etc. and also welcome feedback on the contents of the newsletter to help us make it more informative and rich in content.

Please send in your contributions to

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ENVIS Centre on Renewable Energy and Environment

A knowledge gateway

To work towards saving the environment by understanding its myriad facets, the ENVIS (Environmental Information System) network was established under the MoEF (Ministry of Environment and Forests), Government of India, in December 1982. The objective was clear and urgent: work towards bridging the data gaps by developing an environmental information system that will help disseminate information to decision-makers, scientists, and other stakeholders.

The ministry selected certain institutions/organizations, universities, academic/research bodies in state governments, corporate houses, and NGOs as ENVIS centres, based on their excellence in research activities. Each centre would work on a specialized subject from the vast expanse of environmental studies available.

TERI became the host to the ENVIS Centre on Renewable Energy and Environment in July 1984. The mandate for the TERI centre is to collect, collate, store, retrieve, and disseminate information on renewable energy and environment as well as to support and promote research and development. The Institute has also hosted the EMCB (Environment Management Capacity Building) Node on Renewable Energy and Environment since 2000/01, a sub-component of ENVIS that aims to build capacity through the development and maintenance of a web site that serves as an information clearing house.

This new-look, revamped website has helped achieve just what the centre set out to do display a world of information at a glance. TERI's ENVIS Centre and the EMCB Node have been actively engaged in resource generation, data collection, problem recognition and provision of solutions, capacity building, and information dissemination. Rich in content that is constantly updated, the site



<http://www.terienvis.nic.in>

does an impressive job of plugging information gaps that existed in the renewable energy and environmental sectors. Besides, it draws the attention of the Indian scientific community, a fact that becomes evident from the hundreds of technical queries received through the website.

Here's a snapshot of some of the main features of the site.

- Regular sections – news, events, statistics, etc. – provide updates on the environmental impact of power, renewable energy, transport, pollution control technologies, hazardous waste management, and other related subjects spanning local and national boundaries.
- Recently developed renewable energy technologies and case studies are added attractions.
- Review articles from the Centre's premier publication *TIDEE (TERI's Information Digest on Energy and environment)* enrich the knowledge base of the scientific community by providing information on the latest developments in energy and environment.
- *eNREE (E-Newsletter on Renewable Energy and Environment)*, a quarterly, non-priced, electronic newsletter (also uploaded on the site) highlights recent issues in the sector.
- The search function for the bibliographic database and the directory of experts can further be screened through categories such as title, author, etc. The online bibliographic database includes bibliographic records of selected fields from 1991 onwards, covering over 11 000 records. The centre is also building up an exhaustive Directory of Experts on Renewable Energy and Environment.
- The colourful and lively children's section, *Edugreen*, lives up to its tag line—'making environmental learning fun for the young'.