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An approach to rural electrification

C R Bhattacharjee

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Waste-to-energy generation in India

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One of the adverse consequences of the process of rapid urbanization coupled with increased industrialization that our country is witnessing is discharging garbage and waste material in cities and towns of India. Unplanned and non-scientific methods for disposal of waste materials of diverse nature generated from domestic, agricultural, and industrial activities, has led to increasing pollution and environmental degradation, posing a considerable hazard to public health and local as well as global environment…

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An approach to rural electrification

C R Bhattacharjee
Consulting Engineer, 658, Lake Gardens, Kolkata – 700 045, e-mail: crbhatt@vsnl.com

RE (rural electrification) for lighting, water supply, irrigation, shops, tiny industries, telecommunication, radio, and TV is of no less significance than the corresponding urban demand where dazzling lights, air-conditioners, domestic-industrial-commercial gadgets, automation, and mechanization are consuming excessive power. At times, urban electrification appears as a luxury in a country where 26% of the population is below poverty line and 65% lives in villages. Here, 46% people are deprived of electricity and more than 80% are villagers. Leaving aside the pitfalls in nearly 85% of RE works already completed, there are nearly 100 000 green field villages still awaiting electrification. Out of this, 25 000 are in inaccessible areas where technical impediments on extension of grid supply call for harnessing of local renewable resources of energy in decentralized mode.

Electricity is an essential tool for a minimum standard of living paving the way to growth and good quality of life. Power supply being a service, is considered to have a commercial character having linkage with viability. This has not been viewed as a social obligation so far and at par with health, education, and water supply as commitment to the rural people. In fact without electricity food, shelter, housing, water supply, health, and education as fundamental rights are likely to be jeopardized. Electricity, whether in towns and cities or rural areas, stands foremost among all infrastructure facilities which in case of villages did not get due importance at least in implementation till recently.

Complications are there in RE because of scattered locations calling for long-distance distribution lines catering to very low load density and necessitating comparatively higher capital investment leading to non-remunerative return. O&M (operation and maintenance) for a quality service is difficult and can be attributed to the absence of a fair transport and telecommunication network. Villagers are incapacitated with low purchasing power and cannot afford to bear normal commercial tariff imposed on them. At many places power theft is common, inflicting losses on suppliers and giving rise to discouraging situations. Whatever be the dimension of the problems, it remains that 100% electrification in a democratic country dedicated to social welfare and economic development does not have any other option, but to complete RE within a time-bound framework. Thus, there is the declaration from the Government of India to achieve 100% RE by 2009 and coverage of all premises by 2012 as a national goal. For this, there is a provision of 90% in-built subsidy in capital investment proposal for RE with the remaining 10% to be arranged by state governments, undertakings, or institutions through loan or by other means. Existing un-electrified villages are in remote areas and offer stiff challenges to electrification. The future steps have to be cautious so that the earlier infamous episode of somehow reaching a village with scope for a single-phase connection for just fulfilling the definition of RE in a mechanical manner does not reoccur.

There are three issues confronting RE: (1) high capital investment compared to the expected revenue; (2) difficulties in maintaining long-distance lines for few consumers in rural areas subjected to bad road and telecommunication connectivity; and (3) inadequacy in the purchasing power of people to pay for the price of energy.

The first problem of mobilization of resources for capital investment has been resolved by the decision to finance 90% as subsidy. As such, payment of interest as recurring revenue charge also goes down with consequent a reduction in tariff. As regards the next issue on O&M of the supply system, it would be advisable to engage local youths, after training in technical and commercial aspects, in consultation with beneficiaries, preferably panchayats or consumer cooperatives in the village. This will infuse a sense of belonging and would lower down overhead charges of power suppliers. On electrification, the local economy will open up with shops, trading centres, tiny industries, irrigation, water supply, domestic electrification work, etc., absorbing more and more people.

On the third issue a close look at the villagers' use of kerosene in the absence of electricity for lights indicates—though demand varies widely—that it is valued on an average 125–150 rupees per family per month. Procurement, storage, handling, emission of soots, and poor illumination from kerosene lamps are unwanted compulsions thrust upon them who shall be glad to get rid of all these exercises as early as possible. With convenience attached to electricity like easy switching on and off, consumers will not hesitate to pay even 150 rupees per month towards electricity charges as replacement cost. However those living below the poverty line would require appropriate subsidy till they are raised to a self-supporting stage.

For energy conservation purpose and to be economical in the monthly payment of electricity bills with no compromise on quality of lighting, introduction of compact fluorescent lamp tubes of 9–15 W (watts) instead of conventional lights will restrict demand. Evening lights will be a boon for reading (especially for school-going children), for carrying out domestic work, or running small shops. A family would need 100 W of connected load for lighting, TV, and plug points that will limit monthly consumption to 20–30 units per month per family. Shops, industries, water supply, etc., will have, however, higher connected load and higher monthly charges. The total demand for rating of power supply source from grid line or renewable resources like solar, micro-hydel, wind, or biomass will fall within the range of 10–20 kilowatt per village inhabited by 50–100 families. The investment will depend upon distances from the existing grid set up. Usually any village more than 8–10 kilometre away from the grid will exhibit better economy in favour of renewable energy. A renewable resource is competitive with conventional power and ensures energy security in a village with flexibility for a connection with grid line at a later date. With the rising prices of fossil fuels and the greenhouse gas emissions from thermal plants threatening the civilization, there is no need to mention that renewable resources are gaining popularity as they deliver clean power that is free from pollution.

In the event of monthly charges being reasonable and services satisfactory, it will effect a big change in the outlook towards electric power and usher in 100% electrification of premises in rural areas to do away with hassles in the use of kerosene. Load density will rise and user charges will fall. Involving villagers through panchayats / consumer cooperatives to undertake power purchase in bulk and sell to consumers should work out in the form of mutual benefits to both the supplier and the consumers. Initial assistance to the institutions in addition to training youths as an integral part of the programme, should help in overcoming teething troubles, controlling power theft, and assuring payment to the supplier regularly.

The above model is highly successful in case of off-grid power supply through renewable energy resources implemented in Sunderbans, West Bengal, translated in practice by the West Bengal Renewable Energy Development Agency and now covers more than 50 villages where people are craving for more and more expansion. The most interesting part of this programme is that in a village it provides multiple benefits to children such as education, radio, and TV. Moreover, work can be carried out in the evening since shops in the markets are lighted up. Drinking water is available from deep tube wells. These are contributing factors in the generation of direct and tertiary employment.

The economy of villages has undergone a distinct change through this method of electrification. Consumers enjoy good quality power supply. The cost of power varies between 2.5 rupees and 7 rupees per unit depending on the mode of generation, which is acceptable since power supply has been instrumental in social benefits. The average monthly charge is within 150 rupees per family apart from the one time payment of security and connection charge of 1000 rupees. Unlike the grid system of supply where theft is not uncommon, it is surprising there is neither power theft nor any arrears in payment of dues.

Trained villagers are at the helm of the management working under cooperative set up. Power generation resources constitute solar, biomass, and wind–diesel hybrid sets. There is no reason why a similar type of management of consumers' services should not work at places where grid supply is not extendable.

There may be doubts about panchayats' interest and efficiency going by the fact that they are now being burdened with huge responsibilities in other administrative and developmental works. Hence, it may be necessary to form consumer cooperatives and involve them in RE works from the beginning of the preparation of the conceptual scheme for electrification. Arranging conducted tours to places where the schemes are in operation will add confidence-building measures to upcoming cooperatives. With the extension of power in rural areas, economic growth and social welfare are bound to follow along with a rise in purchasing power of the people, as has been experimented in remote areas in West Bengal.

It is imperative to provide villagers with capital subsidy for rural electrification as social commitment. In order to avoid recurring doling out of money even indirectly because of persistent poverty in a country having nearly 200 million households (80% being in villages), sharing power with local people can only resolve intricate problems. This is not only administrative actions alone but also through a cooperative approach with beneficiaries such that they develop a feeling of ownership for smooth operation and sustainable development.

Waste-to-energy generation in India

P K Bhattacharya
Associate Fellow, TERI, New Delhi, e-mail: pkbhatta@teri.res.in

Introduction

One of the adverse consequences of the process of rapid urbanization coupled with increased industrialization that our country is witnessing is discharging garbage and waste material in cities and towns of India. Unplanned and non-scientific methods for disposal of waste materials of diverse nature generated from domestic, agricultural, and industrial activities, has led to increasing pollution and environmental degradation, posing a considerable hazard to public health and local as well as global environment.

The National Programme on Energy Recovery from Urban and Industrial Wastes in India aims at promoting efficient and proven technologies for the treatment, processing, and disposal of wastes, not only as a means of improving the waste management practices in the country, but also for augmenting power generation. MSW (municipal solid waste) comprises mainly domestic refuse, with some commercial waste. A wide range of these waste materials can be used to recover energy.

Energy potential of wastes

Energy recovery is one aspect of the whole field of resource recovery from wastes. Energy recovery and resource generation are often integrated in municipal plants and an integrated approach to resource recovery has in some cases been a conscious plan. This dual approach applies to many of the compost plants, which now are also geared to producing a fuel fraction in various forms. There are many reasons for adopting an integrated approach, which include

- maximizing income from marketable products;
- reducing quantities of residue for disposal;
- obtaining maximum benefit from necessary separation processes; and
- reducing economic risks by providing flexibility through planning and designing to accommodate fluctuations in markets for different products.

However, the viability of integrated energy and resource recovery approach in MSW management will depend on the following local circumstances.

- Waste composition and characteristics;
- Market for products, fuel, and energy throughout the year;
- Alternative local disposal options; and
- Existing plant, equipment, facilities, and scope for adaptation.

In India, a large quality of waste is generated due to different human activities including domestic, industrial, and agricultural sources. The quantity of MSW from Class I cities alone is 30 MT (million tonnes) and that of liquid waste

Table 1 Quantity of urban, municipal, and industrial wastes	
Waste	*Estimated quantity*
Municipal solid waste	30 million tonnes/year
Municipal liquid waste	12 000 million litres/day
Distillery (243 units)	8057 kilolitres/day
Pressmud	9 million tonnes/year
Food and fruit processing wastes	4.5 million tonnes/years
Willow dust	30 000 tonnes/year
Dairy industry wastes	50–60 million litres/day
Paper and pulp industry wastes (300 mills)	$1.6 \times 10^3 m^3$/day
Tannery (2000 units)	52 500 m^3 waste water/day

Source TEDDY 2003/04

is about 4400 mm^3 (million cubic metres). The overall waste generation in the country has been presented in Table 1. Besides, an estimated 4400 mm^3 of liquid waste (Table 2) is generated every year in the urban areas of the country.

This estimation is based on the structured database prepared for 299 Class I cities and 36 Class II cities as part of the 'National Master Plan for Development of Waste-to-Energy in India' being taken up under UNDP (United Nations Development Programme)/GEF (Global Environment Facility)-assisted project. The study concluded that 17(6%) cities have generation rate in excess of 1000 TPD (tonnes per day), and 80 cities (26%) generate 150 to 1000 TPD. The balance 202 cities (68%) individually generate less than 150 TPD. The MSW generation ranges from 0.25 to 0.66 kg/person/day with an average of 0.45 kg/person/day. In addition, large quantities of solid and liquid wastes are generated by industries. Most of the wastes generated find their way into land and water bodies, without proper treatment, emitting gases like methane and carbon dioxide, resulting in bad odour, air and water pollution, as well as increase in the emission of GHGs (greenhouse gases). This problem can be significantly mitigated through the adoption of environment-friendly waste-to-energy technologies for treatment and processing wastes before disposal. It not only reduces the quantity of wastes, but also improves its quality to meet the required pollution control standards, besides generating substantial quantity of energy. Table 3 highlights the future potential of waste-to-energy power generation throughout India.

In recent years, technologies have been developed, which not only help in reducing the quantity of wastes but also generate substantial quantities of decentralized energy. The energy recovery potential (MWe) of different types of wastes from urban and industrial sectors in the country is shown in Figure 1.

Technology options

Energy recovery from wastes is not new; conventional incineration method has been in existence since many decades. However, countries are using more novel methods of heat recovery from wastes. The modern technologies include

Table 2 Estimated power generation potentials of urban liquid and solid wastes (2001/02)

Region	*Total liquid waste* (MLD)	*Energy potential* (MW)	*Total solid waste generated* (tonnes/day)	*Energy potential* (MW)
South	6000	49	22 955	299
North	7904	65	27 485	356
West	8920	71	30 893	396
East	6914	56	2565	306
Total	**29 738**	**241**	**104 898**	–

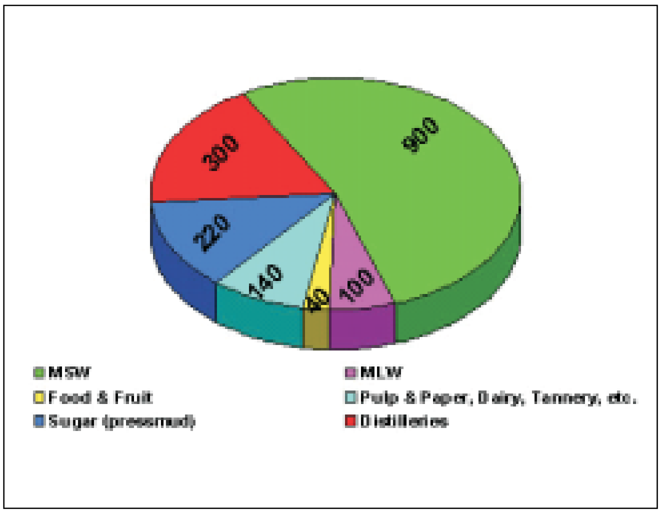
Source TEDDY 2003/04

Table 3 Total estimated power generation potential

Year	*Liquid waste quantity* (MLD)	*Power potential* (MW)	*Solid waste quantity* (MTD)	*Power potential* (MW)
2002	12 305	229.5	86 224	1461.2
2007	14 151	264.0	130 928	2266.5
2012	16 523	308.2	189 986	3276.5
2017	19 543	364.6	265 834	4565.8

Source http://www.indiawteplan.com

Figure 1 Energy-recovery potential



Source Dhussa and Varshney (2000)

- biological processes including landfill gas utilization, engineered anaerobic digestion systems for methane generation, hydrolysis, and fermentation processes;
- refuse-derived fuels;
- pyrolysis or gasification; and
- fluidized bed combustion.

These technologies produce gaseous, liquid, or solid fuel offering a more refined energy source than raw refuse through various levels of processing. Some of the technologies use basic processes, which are decades old in other applications (for example, gasification), others borrow from more recent developments (for example, palletizers from the animal feed preparation industry), while some are at a more early stage of development (for example, hydrolysis).

Most of the conversion technologies involve two-basis process stages: waste preparation and energy extraction. The waste preparation stage involves upgrading the raw refuse product into a more acceptable and valuable resource by reducing the moisture content, incombustibles, improving physical handling characteristics, and extracting material for direct sales. With the exception of direct methane recovery from landfills and some pyrolysis and gasification processes, the refuse in the conversion technology undergoes more stages of shredding, pulverization, screening, and magnetic separation prior to energy extraction. The energy extraction stage involves either the direct combustion of the solid fuel or using modern combustion systems such as fluidized bed systems, or chemical or biological conversion of the solid raw materials into a more refined high energy density gaseous or liquid fuel for example, pyrolysis (Parker and Roberts 1985).

National waste-to-energy programme

Having identified 'energy recovery from wastes' as one of the thrust areas, the MNES (Ministry of Non-conventional Energy Sources) has been implementing two programmes aimed at the promotion of projects for recovery of energy from urban and industrial wastes.

- National programme on energy recovery from urban, municipal, and industrial wastes
- UNDP/GEF-assisted project entitled, 'Development of high-rate biomethanation processes as a means of reducing greenhouse gases emission'.

The NBB (National Bio-Energy Board), MNES, Government of India, has retained MWH to prepare a NMP (National Master Plan) for waste-to-energy. The NMP is an integral part of the UNDP/GEF-assisted biomethanation project and this effort will lead to setting up of several large waste-to-energy demonstration projects in different areas on a variety of waste streams.

The NMP focuses on cost-effective treatment, stabilization of urban and industrial wastes with optimal bio-energy recovery, and efficient power production for 299 Class I cities and selected Class II cities throughout India. It incorporates a wide array of liquid and solid waste collection, treatment including high-rate biomethanation, energy recovery, and disposal. The development and implementation of NMP is based on long-term cost benefits and several tangible and intangible benefits including environmental pollution control, socio-economic effects, and reduction in the emission of GHGs. Biomethanation of organic wastes would enable India to make its contribution in protecting the global and local environment.

A waste-to-energy programme as envisioned under the NMP not only provides a solution to environmental pollution problems, but also maximizes energy recovery from waste in a cost-effective and proven manner. This NMP incorporates a wide array of bio-solids collection, treatment including high-rate biomethanation, energy recovery, and bio-solids disposal and utilization technologies that are applicable to the Indian community, and conditions and support ongoing adaptation to meet implementation needs. The NMP equally emphasizes on the project funding from national and international resources, implementation, operation, and maintenance issues.

The ministry, under the National programme on energy recovery from urban, municipal, and industrial wastes, provides financial assistance and interest subsidy for the setting up of projects along with incentives to local bodies, nodal agencies, and state electricity boards to promote and disseminate information on waste utilization. Projects with a total capacity of 41.5 MW (megawatt) have been commissioned since the start of the programme. However, the Tenth and Eleventh Five-year Plans envisioned a brighter picture for energy recovery (Table 4).

Details of waste-to-energy projects installed in India are given in Table 5. During the Ninth Plan period, the target was to install waste-to-energy projects of a total of 42 MW capacity. However, the achievement till December 2001 was about 17.08 MW. The Tenth Plan target for this sector is 80 MW.

Recent developments

Backed by the government's favourable policy and incentives, and also for protecting the environment, several waste-to-energy projects are presently underway. Although most of these projects are financed under the MNES' waste-to-energy programme, a few these – from private companies – have also started (Box 1).

Table 4 Future waste-to-energy potential

	Power generation potential (megawatt)			
	Tenth Plan period (2007)		*Eleventh Plan period* (2012)	
Sector	*Liquid waste*	*Solid waste*	*Liquid waste*	*Solid waste*
Dairy	34	–	43	–
Distillery	503	–	629	–
Maize starch	10	35	13	44
Paper	58	–	72	–
Poultry farms	–	65	–	81
Sugar	59	303	74	379
Tapioca starch	11	3	14	4
Cattle farms	–	–	–	–
Leather tanneries	–	–	–	–
Pharmaceutical	–	–	–	–
Slaughter houses	–	–	–	–

Source http://www.indiawteplan.com

Table 5 Installation of waste-to-energy projects

Year	*Energy projects* (MW)
1996/97	2.75
1997/98	2.00
1999/2000	8.40
2000/01	1.00
2001/02	10.00

Source TEDDY 2003/04

Box 1 Waste-to-energy project developments

Projects

- A project for generation of 2.75 MW (megawatt) power from rice husk has been set up at Gowthami Oil Solvents Ltd, Tanukku, Andhra Pradesh.
- A project for generation of 1 MW power from biogas produced through distilleries pent wash has been set up at K M Sugar Mills (Distillery), Faizabad, Uttar Pradesh.
- A project for generation of 2 MW power from biogas produced through distillery effluent has been set up at Kanoria Chemicals and Industries Ltd, Ankleshwar, Gujarat.
- A project for generation of 2.7 MW power from biogas produced through distillery spent wash has been set up at Som Distilleries, Raisen, Madhya Pradesh
- A project for generation of 1 MW power from biogas produced through distillery spent wash has been set up at Sugar Works, Belgaum, Karnataka. This project

Continued...

Box 1 Waste-to-energy project developments (*Continued*)

is based on indigenously available biogas gensets and H_2S removal technology.

- A biomethanation plant of 25 m^3 (cubic metres) biogas per day capacity based on sewage has been set up at Regional Research Laboratory, Bhubaneshwar, Orissa.
- A biomethanation plant of 10 000 m^3 biogas per day capacity utilizing black liquor from paper industry has been installed at Satia Paper Mills, Muktsar, Punjab.
- A biomethanation plant of 3000 m^3 biogas per day capacity utilizing liquid abattoir waste has been installed at Al Kabeer Exports Ltd, Medak, Andhra Pradesh.
- A biomethanation plant for treatment of 5 TPD (tonnes per day) tannery flesh and sludge from tannery effluent plant has been set up at Tanners Cooperative, Mehlvisharam, Tamil Nadu as a demonstration unit under the UNDP/ GEF-assisted project.
- The first phase of a project for production of 105 TPD fuel pellets from garbage of Hyderabad city has been installed and second phase of the same capacity is under installation. The pellets produced from this project would be used as industrial fuel initially and for generation of power ultimately.
- A project for generation of 8000 m^3 biogas per day from waste from a starch and glucose-manufacturing unit Vensa Biotek Ltd, Samalkot, Andhra Pradesh has been installed.
- Work has commenced on the setting up of a plant for generation of 4 MW power through biomethanation of MSW (municipal solid waste) in Nagpur, Maharashtra.
- The execution of a 30 TPD biomethanation plant utilizing solid waste of a slaughterhouse of Al Kabeer Exports Ltd, at Medak, Andhra Pradesh has commenced.
- A project for generation of 1.2 MW power from poultry droppings at Namakkal in Tamil Nadu is being installed as a demonstration project.
- A few projects for recovery of energy from urban and industrial wastes with aggregate capacity of about 25 MWe have been developed and are expected to mature during next year.
- A detailed project report has been prepared for setting up a 1 MW power plant based on animal manure in Punjab. The execution of this project is expected to begin soon.
- PCF (Prototype Carbon Fund), the World Bank, promotes projects that achieve greenhouse gas reduction. The project is based on SWERF (Solid Waste and Energy Recycling Facility) technology to generate power from MSW and located at Perungudi landfill site in Chennai, Tamil Nadu, India. It will process 600 TPD of MSW collected by the Corporation of Chennai and delivered at the site. The processed waste will be used to produce 14.85 MW using a gas-based power generation unit for supply to the TNEB (Tamil Nadu Electricity Board) grid.
- Energy Developments Ltd, an Australian company, submitted a proposal to the Tamil Nadu Pollution Control Board to set up the resource incineration plant in Chennai. The company proposes to produce 14.85 MW of electricity using 600 metric tonnes of MSW per day given by the Chennai Corporation. It plans to sell it to the TNEB at a cost of 3.87 rupees per unit.

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England: Elsevier Applied Science Publishers Ltd. 217pp.

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New Delhi: TERI. 486 pp.

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http://www.mnes.nic.in, last accessed on 10 July 2005

Current research on renewable energy and environment

* 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*

Using the past diffusion trends of four RETs (renewable energy technologies) for irrigation water pumping in India (SPV [solar photovoltaics] pumps, windmill pumps, and biogas/producer gas-driven dual fuel engine pumps), results of an attempt to project their future dissemination levels, have been presented in this study. 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)

* Muneer T, Asif M, and Munawwar S. 2005. **Sustainable production of solar electricity with particular reference to the Indian economy.** *Renewable and Sustainable Energy Reviews* **9**(5): 444–473
**School of Engineering, Napier University, 10 Colinton Road, Edinburgh, Scotland EH10 5DT, UK*

Fossil fuels, presently contributing to 80% of the world primary energy, are having enormous impacts on the environment. A secure, environmentally benign, and accessible supply of energy is thus very crucial for the sustainability of modern societies. There is an urgent need for a quicker switchover of energy systems from conventional to renewables so that the present and projected world energy demand can be met. Coupled with hydrogen as an energy carrier, solar energy has a high potential to become the fuel of the future. The present study is aimed at exploring such potential for India in 2025. SPV is a potential technology for meeting India's future energy demand. The present work proposes solar hydrogen-based energy network to meet the future energy demand for the major cities of India in a sustainable way. In the proposed energy network, SPV-produced electricity would be utilized to meet the energy demand during day hours. Besides, the electricity generated through solar energy (that is produced in excess), would be stored in the form of hydrogen, and utilized during nocturnal hours and prolonged overcast conditions. A modular approach has been adopted for the proposed energy network to meet the year-2025 demand of six major cities of India. Present as well as projected cost scenarios for 2025 have been provided for all the proposed technologies to evaluate the economical viability of the energy network under study. Based on the futuristic trends, it is foreseen that by the year 2025, PV electricity would be more economical than fossil fuel electricity. (18 figures; 8 tables; 48 references)

* Pohekara S D, Kumara D, and Ramachandrana M. 2005. **Dissemination of cooking energy alternatives in India: a review.** *Renewable and Sustainable Energy Reviews* **9**(4): 379–393
**CREED (Center for Renewable Energy and Environment Development), Mechanical Engineering Group, BITS (Birla Institute of Technology and Science), Pilani – 333 031, India*

Energy requirements for cooking account for 36% of total primary energy consumption in India. The rural and urban populations depend mainly on non-commercial fuels to meet their energy needs. It is observed that India follows an income-based ladder starting with fuelwood and ending with sophisticated fuels like LPG (liquefied petroleum gas) and electricity. This paper discusses cooking energy dissemination in the country with an objective of understanding the underlying socio-economic factors governing the utilization of various fuels/energy carriers in cooking. The diffusion of renewable energy devices is observed to be far below their estimated potential. Policy interventions required for better dissemination of renewable energy-based devices are also discussed in this paper. (8 figures; 5 tables; 41 references)

* Ramachandra T V and Shruthi B V. 2005. **Wind energy potential mapping in Karnataka, India, using GIS.** *Energy Conversion and Management* **46**(9-10): 1561–1578
**Centre for Sustainable Technology, Indian Institute of Science, Bangalore – 560 012, India*

Wind energy is one of the fastest developing clean energy source technologies across the globe when compared with fossil fuels, which pollute the lower layer of the atmosphere. It has the advantage of being harnessed on a local basis for application in rural and remote areas. In order to tap the potential of wind energy sources, there is a need to assess the availability of the resources spatially. Mapping potential sites for tapping wind energy in Karnataka is the focus of this study. The study employs GIS (geographical information system) to map the wind energy resources of Karnataka and analyse their variability considering spatial and seasonal aspects. Taking these into account, the present status of the potential is assessed and maps of locations suitable for tapping wind energy have been prepared. A spatial database with data of wind velocities has been developed and used for evaluation of the theoretical potential through continuous monitoring and mapping of the wind resources. The study shows that the average wind velocity in Karnataka varies from 0.85 m/s (metres per second) in Bagalkote to 8.28 m/s in Chikkodi during the monsoon season. Chikkodi, in Belgaum district, has high wind velocity from May to September with a peak value of 9.18 m/s in July. Agro-climatic zone-wise analysis shows that the northern dry zone and the central dry zone are ideal for harvesting wind energy for regional economic development. (12 figures; 5 tables; 14 references)

* Fernandez E, Saini R P, and Devadas V. 2005. **Relative inequality in energy resource consumption: a case of Kanvashram village, Pauri Garhwal district, Uttaranchal, India.** *Renewable Energy* **30**(5): 763–772
**Electrical Engineering Department, Indian Institute of Technology, Roorkee – 247 667, India*

Energy planning for rural areas is beneficial for locally available renewable resources since it can cater to the energy needs of the population even better. The first step in the implementation of an energy planning exercise is to understand the energy consumption and utilization habits of the population being served. A frequent assessment of the levels of inequality in the consumption of various resources is necessary as this provides the rural planner with an understanding of the future trends and thus forearms him with strategic alternatives to combat any future energy resource crisis that the trends seem to imply. In the present paper, an attempt is made to assess the level of energy resource consumption inequality in a typical hilly rural Indian village. The Gini Coefficient of Inequality, a measure of inequality in the field of Econometrics has been applied for this assessment. The population is segregated into different categories based on their income levels and certain socio-economic criteria, which are also felt to exercise an influence on the consumption levels of energy. The results of the analysis are then discussed in the light of the findings. (9 figures; 1 table; 15 references)

Mukhopadhyay K. 2004. **An assessment of a biomass gasification-based power plant in the Sunderbans.** *Biomass and Bioenergy* **27**(3): 253–264
Center for Development and Environment Policy, Indian Institute of Management Kolkata, Joka, D H Road, Kolkata – 700 104, India

The energy requirement in India is steadily increasing and this requirement is met both by commercial and renewable energy sources. The objective of the present study is to evaluate the socio-economic and environmental impact of the BGBPP (biomass gasification-based power plant)

in Chottomollakhali islands of Sunderbans set up by the WBREDA (West Bengal Renewable Energy Development Authority). Four villages of Chottomollakhali island are benefited with electricity from the power plant, which serves 225 consumers comprising household, commercial, and industrial sectors. A simple cost–benefit analysis has been used to estimate the impact of the BGBPP. The findings of the study indicate that BGBPP has made a very positive impact on the life of the villagers of Chottomollakhali island. This has led to increased economic activities and more profitable turnover for the commercial consumers and has also improved the quality of life for the household sector. There is a willingness to pay higher prices for 24-hour power supply. From the cost–benefit analysis it has been found that the benefit–cost ratio, internal rate of return, and pay back period of the project are 1.68, 19%, and 7 years, respectively. (2 figures; 11 tables; 8 references)

* Dasa P, Sreelathab T, and Ganesh A. 2004. **Bio-oil from pyrolysis of cashewnut shell-characterization and related properties.** *Biomass and Bioenergy* **27**(3): 265–275
**Energy Systems Engineering, Indian Institute of Technology Bombay, Mumbai – 400 076, India*

Biomass in the form of CNS (cashewnut shell) represents a renewable and abundant source of energy in India. CNS was pyrolysed in a fixed-bed pyrolysis reactor under vacuum. The CNS on heating upto 175 °C produced dark brown oil (oil CO1), which was extracted, and the CNS, after the removal of oil CO1, was pyrolysed under vacuum. The pyrolysis vapours were condensed to get a combustible oil fraction (oil CO2) as well as a non-combustible aqueous fraction. The detailed chemical compositional analysis of both the oils as well as aqueous fractions was carried out by various techniques like liquid column chromatography 1HNMR, 13CNMR, FTIR, and GC-MS. The CNS oils (CO1 and CO2) were found to be a renewable natural resource of unsaturated phenols with long linear chains and marked absence of anacardic acid. The oils were completely miscible in diesel and were found to be less corrosive towards copper and stainless steel, and thus promise to be a potential fuel. (8 figures; 5 tables; 9 references)

* Reddy S and Painuly J P. 2004. **Diffusion of renewable energy technologies: barriers and stakeholders' perspectives.** *Renewable Energy* **29**(9): 1431–1447
Indira Gandhi Institute of Development Research, Goregaon (E), Mumbai – 400 065, India

This paper presents the results of a survey administered to households, personnel belonging to industry and commercial establishments, and policy experts with the objective of eliciting their views on the barriers to the diffusion of RETs (renewable energy technologies). Taking the state of Maharashtra, India, as a case study, the paper develops a systematic classification of barriers to the adoption of RETs (economic, technological, market, and institutional) and ranks them based on the perceptions of various stakeholders. The results provide evidence of how the consumers receive RET information and make decisions using their limited analytical capabilities. The analysis is used to enhance the knowledge by introducing ideas based on behavioural theory. Not only do these help in understanding the consumer perspective but also in developing policy interventions. The aim is to define each barrier and describe its mode of influence that will help in developing policy measures for the removal of each barrier. (1 figure; 7 tables; 11 references)

* Kroeze C, Vlasblomb J, Gupta J, Boudrid C, Blokb K. 2004. **The power sector in China and India: greenhouse gas emissions reduction potential and scenarios for 1990–2020.** *Energy Policy* **32** (1): 55–76
Environmental Systems Analysis Group, Wageningen University, P O Box 8080, 6700 DD, Wageningen, The Netherlands

Due to rapid growth of economy, the emissions of GHGs (greenhouse gases) from China and India are expected to increase in the coming two decades. The objectives of this study are two-fold: (1) to quantify the technical potential of various options to reduce emissions of GHGs from the

electricity sector in China and India in the year 2020 and (2) to evaluate a BAU (business-as-usual) scenario plus a number of BPT (best practice technology) scenarios for emission reduction of GHGs from electricity production in China and India up to the year 2020. Options to reduce emissions include end use efficiency improvement, fuel switches, and efficiency improvement of the existing and new power plants. For China, the authors calculated that the individual options analysed have technical potentials to reduce 2020 emissions ranging from 1% to 43% (relative to 2020 unabated emissions) and for India from 4% to 45%. Reducing electricity losses during transmission and distribution would reduce emissions by seven per cent (China) and six per cent (India), and increase electrical efficiency of power plants by nine per cent in both the countries. The reduction options differ with respect to their feasibility. In the BAU scenario, emissions increase considerably between 1990 and 2020. The authors presented results for three BPT scenarios, which reflect the combined technical potential of selected options to reduce emissions. The calculations indicated that all three scenarios have a potential to reduce emissions to about half the 2020 BAU level. The authors concluded that end use efficiency improvement could be one of the most effective ways to reduce emissions, particularly in combination with fuel switches. (7 figures; 5 tables; 34 references)

Gangopadhyaya S, Ramaswamia B, and Wadhwa W. 2005. **Reducing subsidies on household fuels in India: how will it affect the poor?** *Energy Policy* **33**(18): 2326–2336
India Development Foundation, Gurgaon – 122 015, India

Kerosene and LPG are widely used in households in India for lighting and cooking. These fuels have historically been subsidized. As part of the restructuring of the energy sector, the government is committed to limiting these subsidies. This paper examines the impact of reducing energy subsidies on the welfare of the poor. The paper uses data from nationally representative surveys of over 100 000 households. The paper concludes that the case for reducing LPG subsidies is strong. Although the kerosene subsidy is an inefficient means of subsidizing fuel use by the poor, reduction in it will need to be supported by other policies that would limit the adverse impacts. (19 tables; 10 references)

Bhargava A, Khanna R N, Bhargava S K, Kumar S. 2004. **Exposure risk to carcinogenic polycyclic aromatic hydrocarbons in indoor air during biomass combustion whilst cooking in rural India.** *Atmospheric Environment* **38**(28): 4761–4767
Industrial Toxicology Research Centre, P O Box 80, MG Marg, Lucknow – 226 001, India

In India, a vast majority of rural households burn unprocessed biomass indoors in conventionally homemade clay-stoves, called *chulha* (stove), which results in the generation of a variety of airborne products along with PAH (polycyclic aromatic hydrocarbons) in an uncontrolled manner. The authors report the concentrations and profile of carcinogenic PAHs, co-sampled with respirable suspended particulate matter, in rural indoors during burning of biomass vis-à-vis LPG as the energy source. The seasonal variation has also been studied. Sampling was done in the breathing zone and in the surrounding areas concurrent with cooking on *chulha*. PAHs were extracted in methylene chloride and analysed over HPLC (high performance liquid chromatography) after column clean up on silica gel. The authors' study revealed that the concentrations of carcinogenic PAHs were fairly high in the breathing zone and in the surrounding areas while cooking over *chulha* in rural India. PAH concentrations increased substantially during biomass combustion. Concentrations were high during CDC (clean diesel combustion) and low during LPG combustion or the non-cooking period. Concentrations of total PAHs were greater in winter as compared to summer and greatest in the breathing zone with di-benz(a,h)anthracene, benzo(k)-fluoranthene, —chrysene contributed maximum. Maximum concentrations of indoor-air benzo(a) pyrene (>1.5 g/m^3) were found in the breathing zone in winter. The daily exposure to high concentrations of carcinogenic PAHs in indoor-air environment while cooking food could be impacting for chronic pulmonary illnesses in rural Indian women. (1 figure; 5 tables; 33 references)

Aggarwala R K and Chandel S S. 2004. **Review of improved cookstoves programme in western Himalayan state of India.** *Biomass and Bioenergy* **27** (2): 131–144

Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan – 173 230, Himachal Pradesh, India

The status of the NPIC (National Programme on Improved Cookstoves) in Himachal Pradesh, the Western Himalayan Indian state, is presented in this paper. The lessons learnt from the success and failures in the implementation of the programme are highlighted. The research and development efforts of the Technology Back Up Centre of NPIC, in developing energy-efficient space-heating metal stoves for high-altitude regions of the state are described. The feedback survey indicates that these improved stoves based on traditional stove designs are more acceptable to people. The study shows that NPIC needs to continue with new vigour in the ecologically fragile Himalayan region for the protection of forests and health of women. A new approach for the implementation of NPIC is outlined which includes a massive awareness campaign about the harmful impact of smoke emissions, improved ventilated kitchen designs, and introduction of alternate cooking and space-heating technologies including passive solar house technology for space heating in extremely cold climates. (6 figures; 9 tables; 7 references)

Kishore V V N, Bhandari P, and Gupta P. 2004. **Biomass energy technologies for rural infrastructure and village power: opportunities and challenges in the context of global climate change concerns.** *Energy Policy* **32** (6): 801–810

The Energy and Resources Institute, Darbari Seth Block, I H C Complex, Lodhi Road, New Delhi – 110 003, India

The potential and role of biomass resources in developing countries for addressing global climate change concerns is highlighted using India as a case study. Promotion of technologies, which use biomass more efficiently, is seen as a key strategy to integrate the concerns of both the developing and developed countries. The role of various biomass technologies for improving rural infrastructure and village power is discussed in detail. A vision for establishing and running a chain of rural energy service companies, operating with a basket of devices and technologies, under the general provisions of clean development mechanisms, is examined for commercialization and mainstreaming of biomass technologies which have achieved reasonable levels of maturity. (3 figures; 4 tables; 16 references)

* Ghosal M K, Tiwari G N, Das D K, Pandey K P. 2005. **Modelling and comparative thermal performance of ground air collector and earth air heat exchanger for heating of greenhouse.** *Energy and Buildings* **37** (6): 613-621

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

In this paper, the potential of using the stored thermal energy of ground for space heating has been investigated with the help of two buried pipe systems, that is, ground air collector and earth air heat exchanger, integrated with the greenhouse located in the premises of Indian Institute of Technology Delhi, New Delhi, India. The total length of the buried pipes in both the arrangements was kept same for making a comparative study. A complete numerical model has been developed to predict and compare their thermal performance for choosing a suitable heating method in the composite climate of India. The model was validated against clear and sunny days. The performance of these two arrangements was compared in terms of thermal load levelling and total heating potential. Temperatures of greenhouse air with ground air collector were observed to be 2–3 °C higher than those with earth air heat exchanger. The temperature fluctuations of greenhouse air were also less when operated with ground air collector as compared to earth air heat exchanger. Predicted and computed values of greenhouse air temperatures in both the systems exhibited fair agreement. Finally the ground air collector was chosen as a suitable option for heating of the greenhouse in the above climate. (6 figures; 1 table; 15 references)

Srinivasan S. 2005. **Solar home systems: offering credit and ensuring recovery.** *Refocus* 6(1): 38–41

This review revealed the conclusion of numerous studies that provision of credit would contribute to widespread deployment of SHS (solar home systems) among populations otherwise deprived of the access to modern electricity services. Paradoxically, offering credit also represents a significant source of risk to the creditors, given the nature of the product and the specifics of the market. The author suggested that pre-payment systems could offer a way out of this impasse and programme designers could do well to pay greater attention to the development, testing, and deployment of such systems. (8 references)

Technological developments

Shift all hydel projects to MNES, says house panel

The Parliamentary Standing Committee on Energy has recommended a complete shift of all hydroelectric power projects from the jurisdiction of the Ministry of Power to the MNES (Ministry of Non-conventional Energy Sources). The committee's recommendations stem from the fact that the MNES has now got the requisite skill, strength, and capabilities to install, operate, and maintain even mega hydel power projects. Within a short time, MNES, the committee said, had been able to achieve a capacity of 1693.94 MW (megawatt) out of the total hydel power potential of 15 000 MW.

The Hindu, 24 April 2005

India looks towards bio-diesel for energy

Spiralling crude oil prices and increasing dependence on its imports, from 70.7% in 2003/04 to an estimated 85% in 2200, is pushing 'energy insecure' India to look for alternative techniques. One of them could be the bio-diesel extracted through the seeds of *Jatropha curcas* plant that can be grown extensively on wastelands available with the village panchayats. In a first of its kind effort, the petroleum minister, Mr Mani Shankar Aiyar who also holds charge of the panchayati raj ministry, is looking to synergize the efforts of both the ministries to make strong initiatives in starting mass production of bio-diesel. The two ministries would be jointly seeking the advice of parliamentary consultative committees on initiatives in alternative fuels.

The Asian Age, 24 April 2005

Five bio-diesel trains on track soon

In a path-breaking effort towards attaining energy security, Indian Railways will start running five trains on bio-diesel from Lucknow. These trains will have a 10% mix of bio-diesel derived from *J. curcas* and other oil-producing plants with the usual diesel. 'The Research Designs and Standards Organization of Indian Railways based in Lucknow would be seeing the effects of bio-diesel's durability on locomotive engines for a year. Afterwards, it would decide to go in for more percentage and trains. If the projections of the petroleum ministry and the Planning Commission get translated, India would attain a 20% mix of bio-diesel in all diesel-run vehicles that will not only bring down the high dependability on crude oil import and create better environment but also create 11 million jobs in the rural area.

The Asian Age, 4 May 2005

Bio-fuel boost from mobile refinery

A mobile refinery has been built by Cambridge University, England, so that farmers can turn rapeseed oil into bio-diesel to sell to fuel retailers. The refinery, the first in the world that can continuously produce bio-diesel from cooking oil, is expected to dramatically increase the availability of bio-diesel. It will be demonstrated for the first time at the Clean Energy Technology Show in London. Currently bio-diesel is produced in large tanks, which have cooking oil and chemicals mixed together. The tanks have to be emptied after each batch—an expensive process. There is potential for a large market for farmers with a European directive insisting that this year two per cent of all road transport should be powered by bio-fuels and this should reach 5.75% by 2010.

The Hindu, 7 May 2005

Husk power

While almost all the rice mills in West Bengal have to depend on sales of bran to keep themselves going, Kolkata-based NPG Rice Mills Pvt. Ltd is using a new technology to cut costs in the milling process. When rice husk is burnt to generate heat, carbon monoxide is generated and this can be used at a certain pressure to move electric generators. The Union Ministry of Renewable Energy is offering huge incentives for the promotion of this technology. For NPG, sales of bran are an extra source of income. The company uses technology to cut the cost of production as well as purchases. While rice mills traditionally use diesel to fire their boilers, NPG uses the husk of paddy. About six kilogram of husk worth three rupees gives the energy equivalent of one litre of diesel. On this front alone, the savings are considerable.

The Financial Express, 8 May 2005

Microbes found to produce miniature electrical wires

Researchers at the University of Massachusetts, Amherst, have discovered a tiny biological structure that is highly electrically conductive. This breakthrough helps describe how microorganisms can clean up groundwater and produce electricity from renewable resources. It may also have applications in the emerging field of nanotechnology, which develops advanced materials and devices in extremely small dimensions. Researchers found that the conductive structures, known as 'microbial nanowires', are produced by a novel microorganism known as Geobacter. The nanowires are incredibly fine, only 3-5 nanometres in width (20 000 times finer than a human hair), but quite durable and more than a thousand times long as they are wide. Geobacter can live in the absence of oxygen because of its ability to transfer electrons outside the cell onto iron minerals, which are natural constituents of most soils. The conductive pili that Geobacter produces are required for further miniaturization of electronic devices in the industry. Manufacturing nanowires from more traditional materials such as metals, silica, or carbon is difficult and expensive. Another interesting implication of this research is that it suggests a mechanism for microbes to share energy in a mini-power grid.

Details available at < *http://www.eurekalert.org*>, last accessed on 22 June 2005

G-8 leaders' cars to use eco-fuel made from straw

The Canadian car-maker Iogen Corporation claimed that their cars will run on a blend that contains a fuel made from straw, which it says can help in the battle against climate change. Ottawa-based Iogen uses enzymes to produce cellulose ethanol from straw or other agricultural waste, while conventional ethanol, widely used in the Brazil, Canada, and the United States, is made from corn or sugar. The cars will be powered by a mixture of 95% gasoline and 5% cellulose ethanol—the maximum that European engines can handle. Regular vehicles in the United States can run on a 10% ethanol blend. Even five percent of cellulose ethanol cuts carbon dioxide emissions by five g/km (grams per kilometre) (0.6 miles) driven, from a European average of 163 g/km. The European Union wants to cut the average to 140 g/km by 2008.

Details available at<*http://www.planetark.com*>, 23 June 2005

Web updates

Energy efficiency and Renewable Energy Network

http://www.eren.doe.gov/

The website of EREN (Energy efficiency and Renewable Energy Network), United States Department of Energy provides information on energy efficiency and renewable energy programmes and offices, news, events, and hot topics and links to the best clean energy websites. Consultation facility with energy experts about energy efficiency and renewable energy technologies is also available. The website presently holds 600 links and over 80 000 documents.

World Energy Efficiency Association

http://www.weea.org/

The WEEA (World Energy Efficiency Association) assists developing countries in accessing information on energy efficiency; serves as a clearinghouse for information on energy efficiency programmes, technologies, and measures; disseminates this information worldwide; and publicizes international cooperation efforts in energy efficiency. The website hosts publications including occasional paper series, international directory of institutions and individuals, reports, and news. The site provides links to energy efficiency sites on the Web and also hosts an energy efficiency bulletin board service.

The global network in environment and technology

www.gnet.org/

This site provides market information, technology, business and government news, business directory, links, and calendar of events. It also hosts a technology, news, and government centre for information dissemination. The site maintains a database on environmental technology information.

Business Council for Sustainable Energy

http://www.bcse.org/

The BCSE (Business Council for Sustainable Energy) was created to advocate policies to promote the economic, environmental, and security goals in natural gas, energy efficiency, electric utility, and renewable energy industries. The website provides information on efficient, economic, and environmentally sound technologies, such as fuel cells, solar power, cogeneration, wind power, and natural gas combined-cycle systems. Besides it also hosts information on financing, project reports, consultancy, publications, and related links.

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

Mr P K Bhattacharya
Editor
TERI, Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003, India

Tel. 2468 2100 or 2468 2111
Fax 2468 2144, 2468 2145
India + 91 • Delhi (0)11
E-mail pkbhatta@teri.res.in

INFORSE

http://www.inforse.dk
INFORSE (International Network for Sustainable Energy) is a worldwide network of 200 non-governmental organizations in more than 60 countries. It influences global strategies and actions in order to enable and stimulate sustainable energy development world wide. The website provides a comprehensive information source on sustainable energy news, network activities, publications, and links to other information sources.

Sustainable Energy and Economy Network

http://www.seen.org/
SEEN (Sustainable Energy and Economy Network), a project of the Institute for Policy Studies (Washington, DC) and the Transnational Institute (Amsterdam), works in partnership with citizens groups globally on environment and development issues with a particular focus on climate change, energy, economic issues, etc., for global sustainable development. The website includes SEEN reports, news, events, statistics, and links to other websites.

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20–21 September 2005 Kings College Cambridge, **UK**

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Prof. Timothy M Swanson, Department of Economics
University College London,
Gower Street, London WC1E 6BT, United Kingdom

Tel. (020) 7-679-5831 • (020) 7-6016-2772
E-mail tim.swanson@ucl.ac.uk • *Website* www.bioecon.ucl.ac.uk

21–24 September 2005 Nagpur, **India**

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Confederation of Indian Industry, Plot No 249-F, Sector 18
Udyog Vihar, Phase IV, Gurgaon – 122 015, Haryana, India

Tel. +91 0124 501 4060–67 • *Fax* 0124 501 4057/501 4538
E-mail shruti.bhatia@ciionline.org • *Website* www.ciionline.org

22–25 September 2005 Fairground Augsburg, **Germany**

RENEXPO 2005: International Trade Fair and Conference for Renewable Energy and Energy Efficiency
Postfach 1565, 72705 Reutlingen, Deutschland, Germany

Tel. 49 (0) 71 21-30 16-0 • *Fax* + 49 (0) 71 21-30 16-100
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3–6 October 2005 Suctec City, **Singapore**

WHTC (World Hydrogen Technology Convention) 2005
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Rex House, Singapore 229832

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E-mail eventmanager@whtc2005.com • *Website* www.whtc2005.com

4–6 October 2005 Westminster, London, **UK**	**Ninth Grove Fuel Cell Symposium** Gill Heaton, Grove Fuel Cell Conference Secretariat, Hillside Cottages, Wheatley Road, Islip, Oxford OX5 2TF, United Kingdom *Tel.* +44 (0) 1865 373 625 • *Fax* +44 (0) 1865 375 855 *E-mail* grovefuelcell@elsevier.com • *Website* www.grovefuelcell.com/
6–7 October 2005 Berlin, **Germany**	**Fourth European Conference on Green Power Marketing 2005** Green Power Marketing GmbH, Weberstrasse 10, 8004 Zurich, Switzerland *Tel.* +41 44 296 87 09 • *Fax* +41 44 296 87 02 *Website* www.greenpowermarketing.org
13–15 October 2005, Shanghai, **China**	**15th International Photovoltaic Science and Engineering Conference** Worldwide Exhibitions Service, Room 801, Block B, No 580 Nanjing (W) Road, Nanzheng Building, Shanghai, 200 041, China *Tel.* +86 21-5234 0653 • *Fax* +86 21-5234 0649 *E-mail* srexpo@sh-wes.com
15–21 October 2005 Brighton, **UK**	**WREN International Seminars: renewable energy, policy, security, electricity, sustainable transport, water resources management, and the environment** Prof. Ali Sayigh, WREN, P O Box 362, Brighton BN2 1YH, United Kingdom *Tel.* +44 (0) 1273 625 643 • *Fax* +44 (0) 1273 625 768 *E-mail* asayigh@netcomuk.co.uk • *Website* www.wren.co.uk
2–5 November 2005 Melbourne, **Australia**	**Fourth World Wind Energy Conference** Stefan Gs'nger, Secretary-General, World Wind Energy Association, WWEA Head Office, Charles-de-Gaulle-Street 5 53113 Bonn, Germany *Tel.* +49-228-369 40-80 • *Fax* +49-228-369 40-84 *E-mail* sg@wwindea.org • *Website* www.wwindea.org; www.wwec2005.com
9–11 November 2005 Mumbai, **India**	**Power India 2005 : International Exhibition and Conference** V K Pandit, Convener, Indiatech Foundation B-702 Dheeraj Heritage Residency Shastri Nagar, Linking Road Extn Santa Cruz (W), Mumbai – 400 054 *Tel.* 022 2660 5550 • *Fax* 022 2660 3992 *E-mail* itf@india-tech.com • *Website* www.india-tech.com
14–18 November 2005 Palm Springs, California **USA**	**2005 Fuel Cell Seminar** Fuel Cell Seminar Headquarters, C/o Courtesy Associates, 2025 M Street Suite 800, Washington, DC 20036 *Tel.* +202 973-8671 • *Fax* +202 331-0111 *E-mail* fuelcell@courtesyassoc.com • *Website* www.fuelcellseminar.com/
22–25 November 2005 Zaragoza, **Spain**	**Second EHEC (European Hydrogen Energy Conference) 2005** European Hydrogen Association Avenue Marcel Thiry 204 B-1200 Bruxelles, Belgium *E-mail* info@ehec.info. • *Website* www.ehec.info

ENVIS Centre on Renewable Energy and Environment

A knowledge gateway

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

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 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'.

▪ **Editor** P K Bhattacharya ▪ **Assistant Editor** Ambika Shankar