eNREE

A quarterly electronic newsletter on renewable energy and environment

Vol. 5 • Issue 3 June–September 2008

Clean coal technology for green power

The need for primary energy sources is growing by the day. The global primary energy requirement has grown from 6700 MTOE (million tonnes of oil equivalent) to 10 200 MTOE over the last 25 years. There has been a very high positive growth in consumption of all kinds of primary energy sources, for example, oil, natural gas, nuclear energy, hydro electricity, and coal.

Is solar power competitive as stand-by resource

Solar power has been the victim of high capital cost. This is standing in the way of harnessing solar energy for the good of mankind as clean and pollution free alternative to replace conventional fuel. Going by the study, 1% solar irradiation on earth's surface is adequate to meet total world energy demand.

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Ministry of Environment and Forests, Government of India

Environmental Information System India

teri The Energy and Resources Institute

Clean coal technology for green power

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Introduction

The need for primary energy sources is growing by the day (Ghose 2002a). The global primary energy requirement has grown from 6700 MTOE (million tonnes of oil equivalent) to 10 200 MTOE over the last 25 years. There has been a very high positive growth in consumption of all kinds of primary energy sources, for example, oil, natural gas, nuclear energy, hydro electricity, and coal (Anon 1988). Coal enjoys the primary energy source status in the Asia–Pacific, which comprises the largest population and an economy that outperforms rest of the world in growth (Ghose 2004). The R/P (reserve-to-production) ratio with respect to major regions of the globe describes the life of different fossil fuels on earth on the basis of current level of production (Barney 1980). The fact remains that oil and gas have limited reserves to last 41 and 67 years, respectively, at current production levels. In contrast, the world coal reserves would last for about 190 years at the current production level.

It follows that due to limited oil and gas resources, countries all over the world will have to depend on coal in the near future for their primary energy requirement. Coal is widely available all over the world and is affordable. Its abundance, ease of storage, and transportation and wide distribution over the globe translates into a competitive international price. The world has a proven reserve of 880 trillion tonnes of coal including anthracite and bituminous coal. A major part of this reserve (838 trillion tonnes) is spread over three major regions namely, North America (254.4 trillion tonnes), Europe and Eurasia (287.1 trillion tonnes), and Asia–Pacific (297 trillion tonnes). The abundant reserves of coal, spread almost all over the globe, provide energy security. Due to its low price, easy availability, and transport ease, coal has become a popular choice as primary energy source in Asia–Pacific region, which accounts for the highest coal production and consumption in the world. However, the direct use of coal leads to environmental pollution.

Coal has always been treated as a not-so-clean fuel but it still is a major fuel for power generation in several countries of the world, such as Poland (94.7%), South Africa (92.2%), China (77.5%), Australia (76.9%), India (70%), Czech Republic (61.8%), Greece (60.4%), Denmark (55.1%), Germany (52.2%), USA (52.2%), and Indonesia (39.7%). The objective of this paper is to examine the promotion of clean coal technologies to meet the environmental challenges in the Indian context.

Coal as the prime energy source for India

India ranks sixth in the world in terms of energy demand accounting for 3.5% of the world's commercial energy demand (Ghose 2003a). With a GDP (gross domestic product) growth of 8% set for the Tenth Five-year Plan (2002–07), the energy demand has grown at 5.2%. Although this commercial energy consumption has grown rapidly over the last two decades, a large part of India's population does not have access to it (Ghose 2002b). At 479 kgoe (kilogram of oil equivalent), the per capita energy consumption is also low when compared to some of the other developing countries—like Thailand (1319 kgoe), Brazil (1051 kgoe), and China (907 kgoe). Primary commercial energy demand grew almost three-fold at an annual rate of 6% between 1981 and 2001 to reach 314.7 MTOE. India's incremental energy demand for the next decade is projected to be among the highest in the world, spurred by sustained economic growth, rise in income levels, and increased availability of goods and services. India's commercial energy demand is expected to grow even more rapidly than in the past as it goes down the reform path in order to raise standards of living.

The all-India installed capacity of electric power generation under utilities was 112 058.42 MW as on 31 March 2004 (consisting

of 77 968.53 MW of thermal, 29 500.23 MW of hydro, 2720 MW of nuclear, and 1869.66 MW of wind power). This has increased to 115 544.81 MW as on 31 January 2005, consisting of 80 201.45 MW of thermal, 30 135.23 MW of hydro, 2720 MW of nuclear, and 2488.13 of wind power. A capacity addition of 41 110 MW has been, targeted for the Tenth Plan. The projected requirement of commercial energy is estimated at about 412 MTOE and 554 MTOE, respectively, in 2007 and 2012 (Table 1). The commercial energy demand is estimated to grow at an average rate of 5.6% and 6.1%, respectively during the period 2002–07 and 2007–12. However, the demand may be less by 5% and 10% during 2006/07 and 2011/12, respectively due to increasing use of information technology and prevalence of e-commerce. This would mainly affect the demand of energy in the transport sector. Coal's share in the total energy demand remains highest at 46% from now till at least 2011/12.

Table 1 Estimated primary energy demand in India

		Demand (in original units)		*Demand* (MTOE)	
Primary	*Unit*	*2006/07*	*2011/12*	*2006/07*	*2011/12*
Coal	MT	460.50	620.00	190.00	254.93
Lignite	MT	57.79	81.54	15.51	22.05
Oil	MT	134.50	172.47	144.58	185.40
Natural gas	BCM	47.45	64.00	42.70	57.60
Hydro power	BkWh	148.08	215.66	12.73	18.54
Nuclear power	BkWh	23.15	54.74	6.04	14.16
Wind power	BkWh	4.00	11.62	0.35	1.00
Total commercial energy				411.91	553.68
Non-commercial energy				151.30	170.25
Total energy demand				563.21	723.93

MTOE – million tonnes of oil equivalent; MT – million tonnes; BCM – billion cubic metres; BkWh – billion kilowatt hour

*The coal demand figures are under review and revision

Source ASEAN-India Business Portal

In India, an area of about 22 400 km^2 (square kilometre) is estimated to cover coal deposits below the earth's surface. Out of this, 11 000 km^2 has been regionally explored so far for mining. Out of this, an area of 5500 km^2 has been explored in detail for actual mining operations. The geological coal reserves of the country are estimated at 245.7 billion tonnes as on January 2004. Out of this, proven reserves are 91.631 billion tonnes, 116.174 billion tonnes are indicated reserves, and 37.9 billion tonnes are inferred reserves (Anon 2004).

Globally, coal accounts for 26% of the primary energy consumption, whereas in India it has a share of 46%. With respect to power generation, the share of coal on a global basis is 36% and in the Indian context it is 65% (Anon 2004). Growth of the Indian economy would lead to growth in energy consumption. The dominant position of coal in energy consumption and electricity generation in the Indian context is, thus, likely to continue for decades together because of a very comfortable proven reserves position of coal vis-à-vis the increasingly depleting reserves of oil and natural gas. The WEO (World Energy Outlook) forecasts that India would face high demand of energy in future and coal alone can meet its needs.

Domestic coal demand and supply

At the end of the last plan in 2001/02, the actual coal consumption was 354.3 MT as against the original demand forecast of 412.2 MT. The shortfall in consumption has mainly been due to an over optimistic demand projection, slippages in addition of coal-based power capacity, low off-take by the cement sector, duty free import of coal against cement export, and slump in demand in the steel sector. The projected demand for final year of the current year (2006/07) has been assessed at 460.50 MT. This means a growth of about 109 MT during the current plan period as against about 60 MT during the previous two plan periods. The estimated capacity addition of coal-based power generation during the current plan period is

18 300 MW as against an actual capacity addition of about 7000 MW during the Ninth Plan. Tentative projections for coal demands for the terminal years of the Eleventh Plan (2011/12) and Twelfth Plan (2016/17) are 668 MT and 816 MT, respectively. The projected gap between demand and foreseeable domestic production capacities is on a rise (Table 2). It is an irony that despite having a plentiful reserve, India is not able to jack up coal production to meet its current and future demand.

Table 2 Demand–supply gap for the next plan periods*

Plan term year	*2006/07*	*2011/12*	*2016/17*	*2021/22*	*2024/25*
Estimated demand @ 8% growth	478	668	816	1063	1242
Domestic supply	432	617	772	967	1134
Gap (MT)	46	51	44	96	108

MT – million tonnes
*The figures are under review and may change

Clean coal technologies

Clean coal technologies have been put in four main categories, that is, pre-combustion clean coal technologies, during-combustion clean coal technologies, post-combustion clean coal technologies, and advanced clean coal technologies. Pre-combustion clean coal technologies include beneficiation of coal, desulphurization of coal, and blending or homogenization of coal. During-combustion clean coal technologies are fluidized bed combustion, staged combustion, low NO_x burners, boiler tuning for efficient and optimized combustion, super critical and ultra super critical boilers, and so on. These may include coal–water mixture combustion. Post-combustion clean coal technologies involve FGD (flue gas desulphurization), flue gas denitrogenation, catalytic reduction of NO_x, plasma reduction or selective catalytic reduction of NO_x, electrostatic precipitators, bag houses, cyclone and other scrubbers, and so onto arrest fly ash. Advanced clean coal technologies are IGCC (Integrated Gasification Combined Cycle) power generation, PFBC (pressurized fluidized bed combustion), IGCC – fuel cell power generation, ultra super critical boilers, and so on. However, there is a need to make these clean coal technologies economical and if possible more efficient and free of major engineering problems where these exist. Several clean coal technology projects are being undertaken world wide.

Since coal contains mineral matter (ash) and other impurities, the atomic H/C ratio of coal is not high; its calorific value is lower than that of oil and natural gas. Therefore, concerns about the pollution caused by the use of coal fuels are increasing. These include global warming, land degradation due to mining and fly ash disposal, and water pollution due to coal washing (Giri and Sharma 2004). There is also a need to add value to coal and thus to develop clean coal technologies further. Physical coal beneficiation techniques using oil agglomeration, froth flotation, and oleo flotation have to be integrated with chemical cleaning of coals (Sharma and Singh 1995). Chemical cleaning of coal using alkali–acid leaching under milder conditions may produce cleaner coal. Some research in this direction has been reported, where coal may be cleaned by using HF-HNO_3 cleaning (Steel and Partic 2003) and by using alkali–acid leaching (Sharma 2005). The thrust is for producing ultra clean coal, a nearly zero-ash coal, which may be used for the IGCC and for PFBC power generation without any problems of resorting to hot gas clean up. IGCC power generation through hydrogen generation for zero emission has been reported (Zock 2003). Co-combustion of coal with plastics, biomass, oil, water, biogas, organic wastes, natural gas, and so on can be practised for efficient power generation and adding value to coal.

Coal refineries

Since oil is refined to obtain different grades of fuels for use differently and efficiently in petroleum refineries, coal can also be refined in coal refineries to obtain different QGC (quality–grade–class) of fuels. There is a need to develop further clean coal technologies for the stepwise refining of coal to obtain different QGC products, as is practised for crude oil in petroleum refineries. Organo-refining of coal, that is,

stepwise solvent extraction of coal using different solvents such as NMP (N-methyl -2-pyrrolidone), AO (anthracene oil), MO (morpholine), EDA (ethylenediamine), QN (quinoline), LP (liquid paraffin), alkenes, phenols, DMF (dimethyl formamide), phenanthrene, and carbazole can produce different QGC products from coal (Pandey and Sharma 2002). Several combinations of solvents can be used for the stepwise refining of coal and the process has been termed as organo-refining of coal. This may lead to the production of two or three different QGC products from coal.

Some of the premium QGC products such as super clean coal having ultra low ash can be used for the production of graphite, carbon-nanotubes, and composites from coal. In fact, super clean coal or ultra clean coal can be used for more than 30 different uses including coking coal blends, carbon electrodes, reduction, nanocomposites, value-added chemicals, specialty chemicals conducting polymers, and engineering plastics. The RC (residual coal) obtained after the stepwise organo-refining of coal may be used for power generation. This coal (RC) may be beneficiated or chemically cleaned to obtain cleaner coal. The washability characteristics of the RC can also improve after the removal of some of the organic matter from the coal by solvent extraction (organo-refining). Liquefaction, gasification, and carbonization of RC may also produce different QGC products for use differently and even efficiently.

Modification of coal for added value

In fact, depolymerization of coal through phenolation may enhance the yield of super clean coal (having ultra low ash) through organo-refining of coal. The uses of coal derived from industrial solvents were made for these studies. In fact, coal can be chemically modified under ambient pressure and convenient conditions by reactions such as depolymerization by phenolation, co-polymerization, alkylation, reductive alkylation, reduction, alkaline degradation, and reductive depolymerization. Most of these processes involve atmospheric pressure operations at low temperature, as brute force high-pressure coal conversion processes have to be replaced by the convenient and cost-effective low to ambient pressure processes. Liquefaction of coal under mild atmospheric pressure conditions including solvent-refined coal processes also affords different QGC products. The unit processes employed in oil refineries may include, besides organo-refining, processes such as carbonization, hydro carbonization, gasification, liquefaction (hydrogenation), cracking, co-cracking, chemical leaching, and bio-refining.

The RC can also be utilized through co-combustion with plastics, biomass, vacuum residue, organic wastes, biogas, and so on to generate power by using efficient ultra super critical boilers. Co-processing of RC or original (untreated) coal with waste plastics, biomass, petroleum coke, vacuum residue, and so on may also lead to cleaner and efficient utilization of coal (Ahmaruzzaman and Sharma 2005) by PFBC, IGCC, or power generation techniques. Unit processes such as organo-refining, depolymerization, reduction, reductive alkylation, carbonization, hydro carbonization, hydro cracking, cracking, catalytic cracking, and gasification may form different reactor units in future coal refineries. The role of depolymerization and organo-refining and carbonization or gasification of RC (Anon 2006a) may be worth studies further for their role in future integrated coal refineries.

Most of the techniques of physical beneficiation of coal are already being commercially exploited. Future techniques such as oil agglomeration and froth flotation may be integrated with bio-depyritization by using patented processes. The flow schemes of beneficiation of coals may be developed further. The rejects may be fired in FBCs (fluidized bed combustors). The success of coal blending or homogenization may be dictated by the developments in the technology of solid–solid mixing such as blending in beds, strata, skewed chevron, windrow, chevron-windrow, chevron, blending in silos, and blending on moving belts.

The US DOE has recently reported (Anon 2006b) an updated status of the DOE commercial-scale demonstration of CCTs (clean coal technologies). These demonstrations involved billions of dollars—USDOE funding and funding from the participating commercial organizations on cost sharing basis (that is, federal government, other public institutions, technology suppliers,

and users). These were performed under the CCTDP (Clean Coal Technology Demonstration Programme), PPII (Power Plant Improvement Initiative), and CCPI (Clean Coal Power Initiative). The CCT research development and demonstration programmes contribute to achieving the DOE strategic goal, including the President's Coal Research Initiative, Future Gen Initiative, Global Climate Change Initiative, Hydrogen Fuel Initiative, and CSI (Clear Skies Initiative). The programme further addresses the requirements of the CAIR (Clean Air Interstate Rule) and the CAMR (Clean Air Mercury Rule).

The CCTDP focused on reducing SO_2 (sulphur dioxide) and NOx (nitrous oxide) emissions and on advanced turbines, gas separation membranes, fuel cells, new gasification processes, carbon sequestration, hydrogen production, and other advanced energy system technologies. These include low NOx burners staging combustion, oxygen-enhanced combustion, and selective catalytic and non-catalytic NOx reduction (Anon 2006c). Mercury control technologies use sorbents and oxidizing agents and wet-FGD scrubbers. ESP and fabric-filter dust collectors were used to control even PM 2.5. Advanced power systems include IGCC–fuel cell power generation and CFB (circulating fluidized bed combustors) using low-grade coals and waste materials. The new advanced systems being developed are hybrid systems integrating IGCC and CFB technologies and advanced combustion using O_2 instead of air or chemical looping to effect the equivalent of combustion. The other endeavour includes upgrading goal by removing ash to obtain clean fuels. The work on conversion of coal to liquid fuels, chemicals, or hydrogen is also being undertaken. Under industrial applications, direct coal use for substitution of coal in place of coke for coke making and for oil or natural gas in energy production are being undertaken. Work on the utilization of fly ash in cement and in abandoned coal waste piles is in progress. A large number of projects have been successfully completed.

Conclusion

Though conventional fossil fuels, which provide primary energy, are limited, coal will maintain its dominance in the international energy scenario because of its huge reserves that will last for two centuries. Due to environmental concerns, various other energy options including renewables are being tried globally but they have failed to provide bulk energy at a competitive cost. Thus, there is a need to refine coal, and coal refineries need to be set up to obtain different QGC products fractions from coal. Carbon nanotubes, composites, graphite, and so on can be obtained from the super clean coal or ultra clean coal. After organo-refining, coal can be further refined by washing or chemical cleaning. The RC may be subjected to co-processing, that is, co-combustion or gasification, co-cracking (co-carbonization) or liquefaction along with biomass, vacuum residue, plastics, organic wastes, and so on to obtain further different QGC products fractions for efficient utilization. There may be a need for further research work to develop the process of coal refineries involving multi-step coal conversion, refining, and utilization.

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Is solar power competitive as stand-by resource

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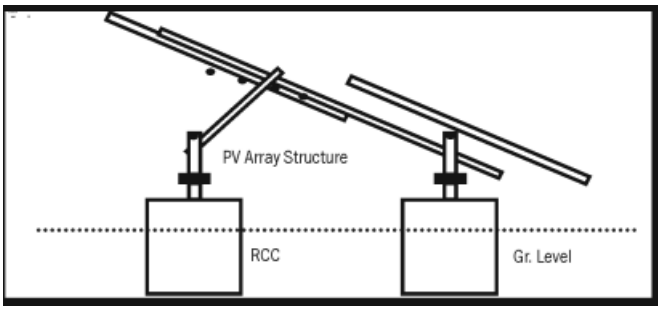
Solar power has been the victim of high capital cost. This is standing in the way of harnessing solar energy for the good of mankind as clean and pollution free alternative to replace conventional fuel. Going by the study, 1% solar irradiation on earth's surface is adequate to meet total world energy demand. However, despite high cost, financial packages devised to implement SPV (solar photovoltaic) and recent introduction of encouraging feed-in-tariff in India will be a big boost to SPV power. Also, on a micro-scale solar power could be competitive to stand-by diesel power. Moreover, even both being equal, SPV qualify for the credit of being a renewable resource.

Diesel engines are common as stand-by for power plants during the load shedding. For an hour or two in a day, DG (diesel generators) are preferred with advantages of instantaneously pressing into service on load shedding and stopping while grid supply resumes, in multi-storey apartments, commercial houses and industries. It is in great demand for service during grid failure to run pumps, air-conditioners, lifts, few lights and fans as emergent measure. Further, in case of DG, low capital investment, less space occupancy, and ready availability in the market are advantageous. On the negative side, the sets develop sounds at high volume, are untidy in operation and maintenance, and guzzle diesel fuel. In India, fuel supply relies on import of crude from international market, procurement of which is a serious concern due to continuous price rise. However, most adverse effect of DG is that it releases greenhouse gas thus polluting the environment. Further, operation and maintenance cost is high with need for replacement of spare parts at regular intervals. Also, the machines undergo de-rating with carbon deposition inside causing a technical snag.

A recent assessment reveals that load shedding in a year does not exceed 750 hours or an average of about 2 hours a day. For arguments sake, let us consider 1000 hours in a year can be reckoned as period of load shedding, which means DG sets would remain idle for most part of the year and also during the entire life cycle of the equipment. On this premise, it is clear that the investments made on DG sets are grossly under-utilized, since minimum daily running of the sets should be 8 hours or about 3000 hours annually. In

ascertaining cost per unit, it is observed, small running hours of DG sets push up the running cost per unit to the proximity to actual energy cost of SPV.

SPV power on the other hand is virtually maintenance free. With sun shining in India for about 10 hours in 300 days or more in a year and high irradiation could offer a viable alternative to DG set.



Solar panel

SPV power generation does not require fuel support or arduous maintenance. Besides, it delivers eco-friendly power supply and with battery back-up SPV power generation can be made available during cloudy days also or to supply power on demand at the time of load shedding. Moreover, as per the new regulations introduced in many states, in order to encourage use of green power excess, power generated as a continuous process from SPV systems during the day may be fed to the grid against payment. Standby solar power above 200-kW will be eligible for tariff on export to grid at Rs 15/unit (payment from utility and balance to be compensated by the Government of India). Small SPV units can be installed at the rooftop and avoid space constraints. Rooftop schemes in Japan, USA and Germany are making substantial contribution to the grid in terms of national policy to fight global warming and reduce peak demand in the day.

A comparative analysis between the DG set and SPV power generation is worked out (Table 1) as per the available market price considering a life span of 25 years.

It can be surmised from the competitive study between stand-by DG sets and SPV, cost of the later is cheaper or may be at close proximity.

Table 1 Comparative analysis of a DG set and SPV power generation

Items	*Diesel power*	*SPV power*
Capacity	25 kW**	20 kW
Unit Gen (kWhr)	500 000*	750 000
Capital cost	8 125 000	6 000 000
Equity 20%	162 500	1 200 000
Loan – 10 years repayment	650 000	4 800 000
Interest rate 12% for DG^ 8% for SPV		
Interest Life cycle	390 000	1 920 000
O&M@	875 000	750 000
Loan repayment	6 500 000	4 800 000
POL#	52 500 000	–
Total Ex.	7 165 000	7 470 000
Sale of SPV to grid ^^ (750 000–500 000 = 250 000) units x Rs 4.5	(-) 1 125 000	
Cost of SPV energy	6365000	
Per unit energy cost	Rs 14.337 P	Rs 12.73 P+

** DG sets de-rates fast as such next higher size is shown
* DG set generates 20 000 units a year, SPV-30 000 units which may be 42000 in Rajasthan.
^ Normal rate for DG and special for SPV
@ DG @ 7% with spares and staff, SPV @ 0.5%, both on capital cost yearly
# Fuel cost is of diesel @ Rs 35/ litre.
& SPV power will be sold to the grid at normal rate at which power is purchased.
+ Cost gets further reduced by Rs 0.60–0.80 p/unit with CDM benefit claimed.
^^ Grid power will be continuous generation and surplus is counted in excess of units consumed during load shedding.

It promotes pollution-free energy in the context of threats on global warming. To encourage SPV against the trend for stand-by DG sets, government has to create awareness, declare incentives. Also, building rules should be amended suitably for in-built SPV emergency supply. Further, it is necessary that government could take adequate steps to draft policies and aware people about advantages of BIPV units incorporated in the roof, since it will reduce cost and provide better comforts. This will give a totally new twist to the conception of stand by power.

Current research on renewable energy and development

Sharma R C, Bisht Y, Sharma R, Singh D. 2008. **Gharats (watermills): indigenous device for sustainable development of renewable hydro-energy in Uttarakhand Himalayas.** *Renewable Energy* **33**(10): 2199–2206
Department of Environmental Sciences, H N B Garhwal University, Srinagar (Garhwal), India

The Himalayas have a rich ancient tradition of tapping hydroenergy from the hill streams and rivers with the help of *gharats* (watermills). This paper discusses the energy consumption pattern of hill communities living in the buffer zone of the Nanda Devi Biosphere Reserve, a world heritage site located in Garhwal Himalayas, India. The current status of *gharats*, the factors responsible for the neglect of this renewable energy device, and the initiatives taken for their upgradation have been highlighted. Field- and policy-level opportunities and constraints associated with promotion of hydro-energy in the study area by upgrading traditional watermills are analysed and suitable options for removing impediments are suggested. (5 figures, 4 tables, 10 references)

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Department of Electrical Engineering, Indian Institute of Technology Roorkee, Roorkee – 247 667, Uttaranchal, India

In India, wind power generation has gained more attention and acceptability compared to other renewable energy technologies. New technological developments in wind power design have contributed towards significant advances in wind energy penetration and optimum power.
The yearly percentage increase in wind energy installation is highest for India and now ranks fourth in the world with an installed capacity of 6018 MW (megawatt). This paper reviews the development of wind energy in India and five potential Indian states. The future growth pattern and time period to achieve the technical wind potential are also predicted and analysed.
(8 figures, 6 tables, 16 references)

Singh M C, Garg S N, and Singh R. 2008. **Different glazing systems and their impact on human thermal comfort: Indian scenario.** *Building and Environment* **43**(10): 1596–1602
Centre for Energy Studies, Indian Institute of Technology, Hauz Khas, New Delhi – 110 016, India

In this paper, 15 different glazing systems ranging from 3-mm single-glazed clear glass to double-glazed with low-e and solar control coating, have been analysed in terms of their human thermal comfort impact. Thermal comfort is measured in terms of PMV (predicted mean vote) and PPD (predicted percentage of dissatisfied). This study encompasses all the six climatic zones of India. By using OPTICS 5.0 and WINDOW 5.0, U-values, solar heat gain coefficient, inside glazing surface temperatures, and inside solar radiation have been computed. Depending upon different climatic zones, six sets of different design conditions, in terms of ambient temperatures, solar radiation, and wind velocity, have been chosen. Typical values of metabolic rate and clothing insulation taken are 1.2 met and 0.5 clo for summer and 1.0 met and 1.0 clo for winter, respectively. The inside room air velocity is taken as 0.15 m/s round the year. It is found that for cold station, all glazings except solar control glazings, ensure thermal comfort and total PPD is less than 10% (PMV 0.5). For warm and hot climates, solar control glazings are thermally suitable. (2 figures, 8 tables, 13 references)

Vishnu G, Palanisamy S, and Joseph K. 2008. **Assessment of field-scale zero liquid discharge treatment systems for recovery of water and salt from textile effluents**. *Journal of Cleaner Production* **16**(10): 1081–1089
Centre for Environmental Studies, College of Engineering, Anna University, Guindy, Chennai – 600 025, Tamil Nadu, India

In this study, treatment systems consisting of physico-chemical treatment, biological treatment, ozonation, reverse osmosis system, nano-filtration system, multiple effect evaporator, crystallizer, and solar evaporation pans set up by three dyeing units in Tirupur, India, were assessed. The composite samples were analysed for colour, pH, TSS, TDS, chlorides, sulphates, COD, total iron, silica, SDI, LSI, and total hardness. The results indicated that the physico-chemical treatment alone is inadequate to achieve the feed water quality norms for spiral wound RO membranes. It is recommended that the primary treatment may incorporate biological treatment and ultra-filtration to reduce COD and SDI in the feed water. Water recovery by reverse osmosis and salt recovery using nano-filter were 87% and 71%, respectively. It was also found that there is substantial direct profit in recovering water using reverse osmosis and sodium chloride in solution using nano-filtration as compared to the recovery of Na_2SO_4. The study also revealed that high-quality water could be produced by treatment system, incorporating membrane technology at affordable costs and recycled back into the process in the textile dyeing industry. (4 figures, 8 tables, 16 references)

Shukla A, Tiwari G N, and Sodha M S. 2008. **Experimental study of effect of an inner thermal curtain in evaporative cooling system of a cascade greenhouse**. *Solar Energy* **82**(1): 61–72
Center for Energy Studies, Indian Institute of Technology, Hauz Khas, New Delhi – 110 016, India

In this paper, experimental study has been carried out in a cascade greenhouse with inner thermal curtain to see the effect of thermal curtain. A thermal model has also been developed to predict the air temperature in a cascade greenhouse. The fan-pad system has been used for evaporative cooling and an inner thermal curtain has been used to divide the greenhouse in two zones. Statistical analysis has been carried out to validate the agreement of experimental observations with predicted values. The values of the root mean square per cent deviation and coefficient of correlation has been found to be 9%, 0.90; 5%, 0.95; and 7%, 0.97 for April, May, and June in case of evaporative cooling without curtain in greenhouse-2. The degree of freedom for the experimental work is 10. It was found that the use of evaporative cooling with a thermal curtain reduces the temperature of greenhouse by 5 °C and 8 °C in the second zone of greenhouse-1 and 2 in comparison to the greenhouse without curtain. (5 figures, 3 tables, 26 references)

Gupta A K, Karar K, Ayoob S, John K. 2008. **Spatio-temporal characteristics of gaseous and particulate pollutants in an urban region of Kolkata, India**. *Atmospheric Research* **87**(2): 103-115
Environmental Engineering Division, Department of Civil Engineering, Indian Institute of Technology, Kharagpur – 721 302, India

This study deals with air quality monitoring in an urban region of Kolkata, consisting of residential, commercial, and industrial sites having high population density and pollution. Concentrations of ambient SO_2 (sulphur dioxide), NO_2, (nitrogen dioxide), NH_3 (ammonia), and PM_{10} (particulate matter with a 50% efficiency cut-off at 10 µm [micrometre]) were measured. The meteorological parameters (wind speed, wind direction, rainfall, temperature, and relative humidity) were collected simultaneously from the Indian Meteorological Department, Kolkata. The daily average concentrations of SO_2, NO_2, NH_3, and PM_{10} were observed at the residential, commercial, and industrial sites. Winter concentrations of ambient SO_2, NO_2, NH_3, and PM_{10} were observed to be higher irrespective of the monitoring sites and duration of sampling, suggesting longer residence times of these pollutants in the atmosphere during winter due

to stagnant conditions and low mixing heights. The SO_2/NO_2 ratios at the residential, commercial, and industrial sites were found to be 0.38, 0.42, and 0.43, respectively. These low SO_2/NO_2 ratios are indicative of major emissions from mobile sources within the city. Spearman's rank correlation analysis showed an inverse relationship between the measured gaseous and particulate pollutant concentrations with the observed wind speed, rainfall, temperature, and relative humidity. The data analysed using varimax-rotated principal component analysis show that local emissions dominate the concentration of SO_2, NO_2, NH_3, and PM_{10}. The major sources of emissions affecting this urban area include mobile sources along with contributions from industrial sources, coal-fired power plants, and domestic heating. (6 figures, 4 tables, 27 references)

Pandey S K, Tripathi B D, and Mishra V K. 2008. **Dust deposition in a sub-tropical opencast coalmine area, India**. *Journal of Environmental Management* **86**(1): 132–138
Pollution Ecology Research Laboratory, Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi – 221 005, India

This paper provides baseline information about the total annual dust fall, and its constituents and seasonal variation, from a sub-tropical opencast coalmine area in Bina, India. Dust samples were collected from five sampling sites for two years and analysed for water-soluble and -insoluble matter. Two-way ANOVA indicated significant variations in dust fall at different sites, over the months and in their interactions. The dust deposition rate was highest during summer, followed by winter, and lowest in the rainy season. Maximum dust fall was observed near the coal handling plant followed by the receiving pit of the coal handling plant, near the main sub-station, and nearby residential areas. An inverse and significant relation was observed between dust fall and precipitation. The study has shown that the main residential areas are experiencing higher levels of dust fall which makes them unsuitable for living. The authors therefore suggested that residential areas should be moved farther away from the mining area in the opposite direction of prevalent winds. (6 figures, 37 references)

Gupta R and Garg V K. 2008. Stabilization of primary sewage sludge during vermi-composting. *Journal of Hazardous Materials* **153**(3): 1023–1030
Department of Environmental Science and Engineering, Guru Jambheshwar University of Science and Technology, Hisar – 125 001, Haryana, India

The aim of the present study was to investigate the ability of an epigeic earthworm *Eisenia foetida* to transform PSS (primary sewage sludge) amended with cow dung into value added product. Two approaches investigated in the study were: (1) evaluation of vermin-stabilization of PSS and CD mixtures after 15 weeks in terms of fertilizer quality of the products and (2) growth and reproduction of *Eisenia foetida* up to 11 weeks in different vermin-reactors. In all the PSS and cow dung mixtures, a decrease in pH, TOC, and C:N ratio, but increase in EC, TKN, TK, and TP, was recorded. The heavy metals' content in the vermi-composts was higher than initial mixtures. Maximum worm biomass was attained in 10% PSS + 90% cow dung mixture while, the worm growth rate was highest in 30% PSS + 70% cow dung feed mixture. It was inferred from the study that addition of 30%–40% of PSS with CD had no adverse effect on the fertilizer value of the vermin-compost as well as growth of *Eisenia foetida*. The results indicated that PSS could be converted into good quality manure by vermi-composting if mixed in appropriate ratio (30%–40%) with cow dung. (5 figures, 6 tables, 48 references)

Kumar S S, Pitchandi K, and Natarajan E. 2008. **Modelling and simulation of down draft wood gasifier**. *Journal of Applied Sciences* **8**(2): 271–279
Department of Mechanical Engineering, College of Engineering, Anna University, Chennai – 400 025, India

The conversion of biomass by gasification into a fuel suitable for use in a gas engine increases greatly the potential usefulness of biomass as a renewable resource. Hence, there is huge expectation from the user industry for its application. For a country like India with its vast agricultural residues, there is a large requirement for an efficient power generation system. The critical operating parameters that affect the gasifier performance are wood diameter, air temperature, moisture content throat angle, and throat diameter of fixed gasifier geometry. In the present study, a mathematical model was developed to characterize the gasification performance of a typical biomass downdraft gasifier and the validated model is used to simulate the parametric study. The study revealed that performance of each of the parameters of the gasifier is satisfactory. (3 figures, 5 tables, 16 references)

Karki S, Mann M D, and Salehfar H. 2008. **Environmental implications of renewable distributed generation technologies in rural electrification**. *Energy Sources* **3**(2): 186–195
School of Engineering, University of North Dakota, Grand Forks, ND, United States

Customer choices and competition have led electric utilities to undergo major regulatory and technological changes while the power sector reform continues. A part of this change also originates from the rapid emergence of viable small-scale DG (distributed generation) sources that are highly competitive with grid-delivered electricity in the isolated areas. In this article, the cost-effectiveness of renewable DG sources (that is, photovoltaics, small-scale wind turbines, and biomass gasifiers) were assessed and compared with centralized generation for the case of a rural and isolated island in the western state of India. The hybrid optimization model for electric renewables (HOMER), developed and provided by the US NREL (National Renewable Energy Laboratory) was used for the purpose. The model identifies a least cost set of various DG and centralized grid capacities and ranks them based on a life cycle cost. The adoption of DG technologies (especially wind and biomass gasifiers) provides useful options with significant CO_2 emission mitigation potential when operated under net-metering scheme. (6 figures, 5 tables, 12 references)

Singh J, Panesar B S, and Sharma S K. 2008. **Energy potential through agricultural biomass using geographical information system: a case study of Punjab**. *Biomass and Bioenergy* **32**(4): 301–307
Mechanical Engineering Department, SLIET Longowal, Punjab – 148 106, India

Agricultural biomass has immense potential for power production in an Indian state like Punjab. But agricultural biomass is spatially scattered. The spatial distribution of this resource and the associate costs of collection and transportation are major bottlenecks for the success of biomass energy conversion facilities. Biomass, being scattered and loose, has huge collection and transportation costs, which can be reduced by properly planning and locating the biomass collection centres for biomass-based power plants. Before planning the collection centres, it is necessary to evaluate the biomass, energy and collection cost of biomass in the field. In this paper, an attempt has been made to evaluate the spatial potential of biomass with GIS (geographical information system) and a mathematical model for collection of biomass in the field has been developed. The total amount of unused agricultural biomass is about 13.73 MT/year. The total power generation capacity from unused biomass is approximately 900 MW. The collection cost in the field up to the carrier unit is $3.90 per tonne. (3 figures, 5 tables, 18 references)

Barnwal P and Tiwari A. 2008. **Design, construction, and testing of hybrid photovoltaic integrated greenhouse dryer**. *International Journal of Agricultural Research* **3**(2): 110–120

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

In this study, a hybrid PV (photovoltaic) integrated greenhouse (roof-type even span) dryer has been designed and constructed at Solar Energy Park, IIT, New Delhi. The testing of the proposed hybrid dryer (without load) has been carried out by using the thermal loss efficiency factor. The dryer has a floor area of 2.50 × 2.60 m with 1.80-m central height and 1.05-m side-wall height from ground. The roof has a slope of 30 degrees. Two PV modules (glass to glass) were used in its construction for thermal heating of greenhouse environment and to provide electrical power to operate a DC fan under forced mode condition. The experiments have been conducted under natural and forced mode operation without load. It has been observed that the direct thermal loss efficiency under forced mode is higher than that expected for crop drying. The coefficient of diffusion under natural mode has also been determined. (3 figures, 7 tables, 20 references)

Technological developments

SunCatcher™

A US-based renewable energy company is developing equipment for utility-scale renewable energy power plants and distributed electrical generating systems 'SunCatcher'. Its most remarkable achievement is the recent contract with Southern California Edison to install a 500-MW (megawatt) plant that is expected to cover 4500 acres of land with 20 000 large, dish-shaped mirrors and open in 2009. It is a 25-kW (kilowatt) solar power system that has been designed to automatically track the sun. Each dish unit consists of 82 mirrors formed in a dish shape to focus the light to an intense beam. The solar dish generates electricity by focusing the sun's rays onto a receiver, which transmits the heat energy to a cycle engine. The engine is a sealed system filled with hydrogen. As the gas heats and cools, its pressure rises and falls. The change in pressure drives the pistons inside the engine, producing mechanical power, which in turn drives a generator and produces up to 25 kW of electricity per system.
http://stirlingenergy.com, last accessed on 23 June 2008

Low-cost energy-efficient solar panel

Researchers at Colorado State University, USA has developed a method for manufacturing low-cost, high-efficiency solar panels, bringing solar electricity to approximately the same cost as traditional grid electricity. These unique PV (photovoltaic) modules are produced using CdTe (cadmium telluride) thin-film technology in which a simple semiconductor film stack is deposited on a TCO (transparent conducting oxide) coated sheet of glass in conjunction with a back metal contact. An encapsulant layer binds the thin-film-coated front glass with a tempered back glass creating an environmentally sealed module. High throughput, low waste, and high yield in manufacturing makes the technology even more attractive to consumers. The mass production of these panels is expected to commence by the beginning of 2009. The technology will significantly reduce the cost of generating solar electricity. The panels are expected to cost the consumer as little as $2 per watt, which is roughly half as much as what present solar panels cost.
http://www.avasolar.com, last accessed on 23 June 2008

Trash-fed generator

The US Army is testing two prototype generators in Iraq that run on garbage, rather than diesel fuel. The TGER (Tactical Garbage to Energy Refinery) was co-developed with Purdue University. TGER uses a variety of technologies to fuel a standard 60-kW (kilowatt) electrical generator. People put trash into a chute and then the wet waste – like food slop – is separated from

the rest. The cardboard, plastic, and other dry trash are crushed and pelletized. Those pellets are then put into a gasifier, which heats them until they turn into synthetic gas—fuel for the generator. Developers found that the relatively low-grade fuel from the trash over-heated the generators and maximized the output at about 40 kW. It created a system to convert the sugar-rich wet wastes into a form of ethanol. The wet waste is treated with enzymes and then fermented into hydrous ethanol—a mix of 85% pure ethanol and water. That ethanol is blended in with the synthetic gas, which boosts the generator's output to 55 kW. Compared to an incinerator, TGER is far more efficient at converting garbage to usable energy as TGER runs at 90% efficiency. Moreover, it significantly cuts down on the amount of garbage that needs to be trucked around.

New system aims to efficiently convert biomass to ethanol

Increasing supplies of renewable energy and using more energy-efficient technologies must continue to play an indispensable role in reducing greenhouse gas emissions and meeting the rapidly growing demand for energy. IOWA State University researcher's system of thermo-chemical and catalytic technologies efficiently produces ethanol from plant biomass. The system work as plant biomass such as corn stalks and switchgrass would be broken down by fast pyrolysis, a process that uses heat at 900 °F in the absence of oxygen to convert biomass in to a bio-oil. The bio-oil would be gasified with steam and/or oxygen at 1100 °F–1500 °F to produce a synthesis gas, a mixture of carbon monoxide and short-chain hydrocarbon gases. The hydrogen and carbon monoxide in the synthesis gas would be reacted with a nanotechnology-based catalyst to produce ethanol fuel.
http://mnes.nic.in/akshayurja/contents.htm, last accessed on 20 June 2008

Biomass-based coal makes coal plants renewable and clean

A renewable energy company has produced a coal equivalent from 100% biomass sources. The pellets do not produce smoke, are odourless, and produce virtually no pollution; yet they have the same BTU content as coal, and are available at a lower price, when all the costs of coal are factored in. The pellets were specifically designed for coal-burning power plants to immediately reduce their CO_2 and GHG (greenhouse gas) emissions. It is a renewable alternative fuel to coal, and is CO_2 and greenhouse gas neutral. This clean coal can be either co-fired with coal or totally replace coal at any coal-fired power plant worldwide, without any retrofitting, loss of productivity, or service to customer. It is a pound per pound replacement for coal. It is the most compatible biomass fuel to burn with coal.
http://peswiki.com/index.php/, last accessed on 11 June 2008

Bagasse power turns sweet option for sugar units

The bagasse-based co-generation option, which started as a cost-saving measure by sugar companies when the industry was reeling under margin pressure a few years ago, is fast turning into a money-spinning option. Co-generation is the concept of producing two forms of energy from one fuel, of which one is heat and the other may be electricity or mechanical energy. Sugar producers across the country, who are fast shifting to bagasse-based generation option to meet captive power needs, are increasingly exporting surplus to the grid from their plants and claiming CDM (Clean Development Mechanism) benefits in return. Among manufacturers exploiting the co-generation option, DSCL (DCM Shriram Consolidated Ltd) is ramping up its bagasse-based generation and exporting surplus power to the tune of 27.5 MW to the UPPCL (Uttar Pradesh Power Corporation Ltd) and getting CDM benefits in return. Sri Chamundeswari Sugars is building a 26-MW co-generation plant at its factory in Karnataka, of which 18 MW will be an exportable surplus to the state-owned utilities. The Deoband Bagasse Cogeneration Power project is exporting surplus electricity to the tune of around 20 MW to UPPCL.
The Hindu Business Line, 26 May 2008

China auto maker to develop hydrous ethanol engines

One of China's largest auto makers recently completed its initial research of using hydrous ethanol in automobiles. The new technology could produce combustible gas, mainly hydrogen, from

hydrous ethanol that contained 65% ethanol. The present ethanol-fuelled vehicles needed pure ethanol blended with gas. Experts said that producing 65% ethanol could save up to 60% of energy compared with producing the same amount of pure ethanol, as dehydration was energy consuming. The use of hydrous ethanol, unlike some synthetic fuels that required adapted engines, only needed an additional device to be fixed on present engines. Thus, it was more likely to be accepted by consumers.
http://www.chinadaily.com.cn, last accessed on 23 May 2008

New nano-composite material could increase solar cell efficiency

In the race to make solar cells cheaper and more efficient, many researchers and start-up companies are betting on new designs that exploit nanostructures—materials engineered on the scale of a billionth of a meter. Using nanotechnology, researchers at the University of California, Santa Cruz, experimented and controlled how a material generates, captures, transports, and stores free electrons—properties that are important for the conversion of sunlight into electricity. Two nanotech methods for engineering solar cell materials have shown particular promise. One uses thin films of metal oxide nanoparticles, such as titanium dioxide, doped with other elements, such as nitrogen. Another strategy employs quantum dots – nanosize crystals – that strongly absorb visible light. These tiny semiconductors inject electrons into a metal oxide film, or 'sensitize' it, to increase solar energy conversion. Both doping and quantum dot sensitization extend the visible light absorption of the metal oxide materials. Combining these two approaches appears to yield better solar cell materials than either one alone does.
http://www.renewableenergyaccess.com, last accessed on 23 May 2008

New source for biofuels discovered

A newly created microbe 'cyanobacteria' produces cellulose along with glucose and sucrose that can be turned into ethanol and other biofuels, report scientists from the University of Texas, Austin, USA. Normally, huge expenses are incurred in making cellulosic ethanol and biofuels using enzymes and mechanical methods. However, the cyanobacteria usage escapes these expensive processes. The new cyanobacteria use sunlight as an energy source to produce a relatively pure, gel-like form of cellulose that can be broken down easily into glucose. Glucose, cellulose, and sucrose can be continually harvested without harming or destroying the cyanobacteria (harvesting cellulose and sugars from true algae or crops, like corn and sugar cane, requires killing the organisms and using enzymes and mechanical methods to extract the sugars). The scientists say the microbe could provide a significant portion of the nation's transportation fuel if production can be scaled up.
http://www.renewableenergyworld.com, last accessed on 5 May 2008

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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Web updates

Alternative energy forum

http://www.alternative-energy-news.info/forums
The forum discusses clean and alternative energy technologies and sustainable living solutions. It covers news on energy, biofuels, environment, hydrogen, solar, transportation, and wind energy technologies. This forum is also for discussions relating to hydrogen energy and fuel cell technologies.

Geo-Heat Centre

http://geoheat.oit.edu/
The Geo-Heat Centre developed information through firsthand experience with hundreds of projects and through extensive research. The United States Department of Energy supports the centre's activities. The centre provides free technological information to consultants, developers, potential users, and the general public on geothermal energy systems—both direct use and ground source heat pumps.

Geothermal Resources Council

http://www.geothermal.org/
The GRC (Geothermal Resources Council) develops educational functions on a variety of topics that are critical to geothermal development. The GRC convenes special meetings, workshops, and conferences on a broad range of topics pertaining to geothermal exploration and development. The site holds collection of articles, news, events, links, and other publications available for members.

BC Sustainable Energy Association

http://www.bcsea.org/
The BC Sustainable Energy Association is a non-profit society of citizens, professionals, and practitioners committed to promoting the understanding, development and adoption of sustainable energy, energy efficiency, and conservation in British Columbia. It works to realize a future where all of BC's energy comes from clean, renewable sources. The website contains a rich collection of publications; policy briefs; and media resources on climate change, sustainable energy, energy efficiency, transport and education.

The Alternative Technology Association

http://www.ata.org.au/
The ATA (Alternative Technology Association) is Australia's leading not-for-profit organization, promoting sustainable technology and practice in order to protect environment. The website hosts a collection of publications, events, news, and project-specific information. ATA regularly organizes workshop to familiarize its members for sustainable energy development.

Centre for Alternative Technology

http://www.cat.org.uk/
CAT (Centre for Alternative Technology) is a solution-driven organization, offering practical solutions to environmental problems. Its key areas of work are renewable energy, environmental building, and energy efficiency. The centre offers consultancy services, runs educational courses, and offers related information on the site. The site also hosts publications, news, and discussion forums.

Energy Refuge

http://www.energyrefuge.com/
EnergyRefuge.com is an alternative energy news site on areas including solar, wind, energy, ethanol, oil, environment, fuel, and hybrids. It provides current energy alternative trends and related articles. This site consists of a searchable news and article database. The site also offers energy saving tips.

CirKits – Alternative Energy Websites

http://www.cirkits.com/solar/solarlinks.html
CirKits.com provides a rich collection of references of useful links to alternative energy suppliers and resources. The major categories covered include solar, PV, wind, bio-diesel, energy efficiency, energy conservation, hybrid, transportation, and many more.

Hybrid vehicles

http://www.hybrid-vehicles.net
Hybrid vehicles website host a wide range of hybrid car resources with reviews and insight information. Major areas covered in this website include cars, SUVs, trucks, minivans, buses, trains, and watercraft.

India at a glance

Table 1 Installed (all India) power generation capacity by category (up to December 2007)

Power generation sources	*Capacity* (MW)
Hydro	34 681
Nuclear	4 120
Renewable energy	10 855
Coal	74 752
Gas	14 692
Oil	1 202
Total	**140 302**

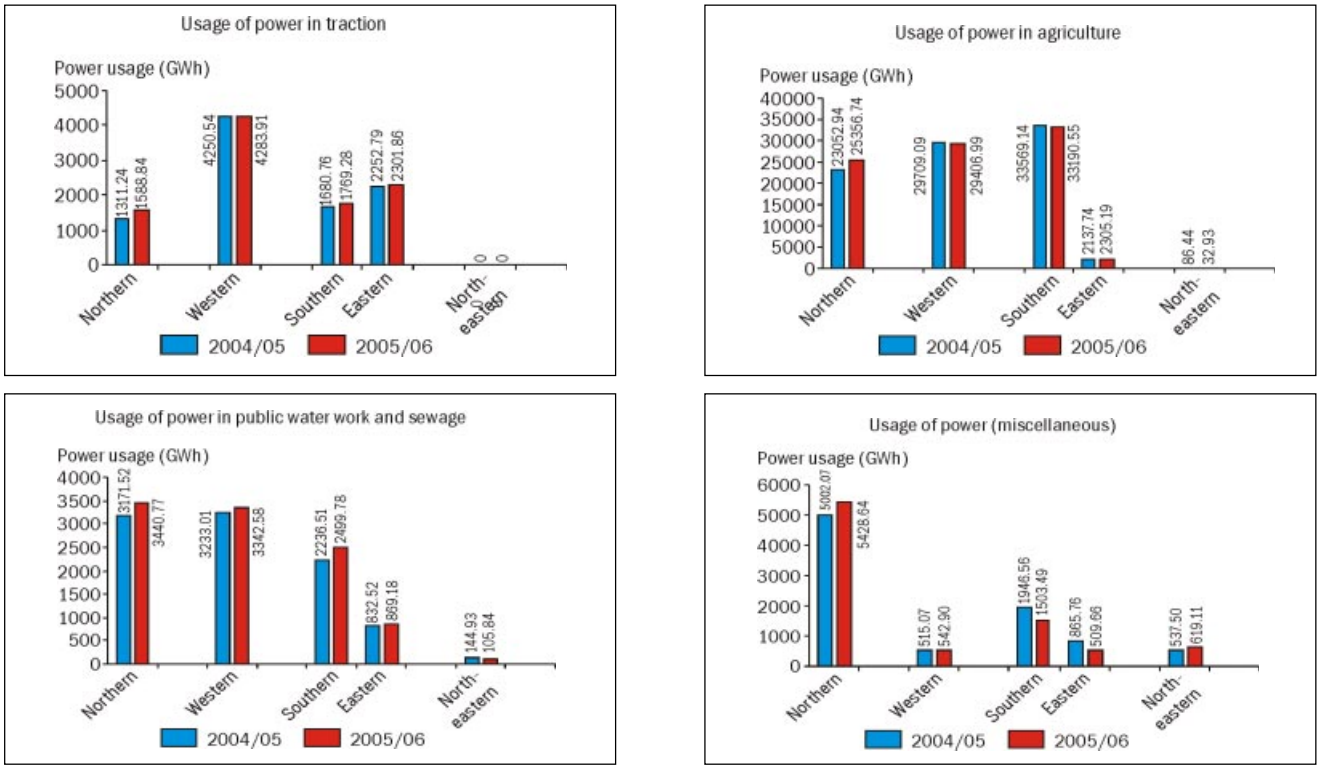
Source Ministry of Power (2008)

Table 2 Consumption of household fuels (Consumption of fuels on per capita basis in 30 days during 1993/94 and 2004/05)

Fuel types	*Year*					
	1993/94		*1999/2000*		*2004/05*	
	Rural	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
Firewood and chips (kg)	17.27	6.09	17.70	5.34	21.44	6.29
LPG (kg)	0.04	0.88	0.14	1.31	0.22	1.60
Kerosene (litre)	0.68	1.42	0.82	1.34	0.62	0.62
Electricity (kWh)	2.27	9.67	4.54	20.89	5.67	19.96

Source NSS Report No.509

Use of power by region (by category)



Source All India Electricity Statistics, CEA

Forthcoming events

19–25 July 2008, Glasgow
Scotland, **United Kingdom**

10th World Renewable Energy Congress
Prof. Ali Sayigh
World Renewable Energy Congress / Network
P O Box 362, Brighton BN2 1YH, United Kingdom
Tel. +44 (0) 1273 625643
Fax +44 (0)1273 625768
E-mail asayigh@netcomuk.co.uk
Web http://www.wrenuk.co.uk

10–12 August 2008
Karachi, **Pakistan**

Energy for Sustainable Development
Abdul Waheed Bhutto
Dawood College of Engineering & Technology
M A Jinnah Road, Karachi – 74800, Pakistan
Tel. +92 21 9230 307, +92 21 9231 195–8
Fax +92 21 9230 710
E-mail principal@dcet.edu.pk
Web http://www.dawoodcollege.edu.pk/conference.html

14–15 August 2008
Kuala Lumpur, **Malaysia**

Clean Energy & Power Generation 2008
Priscilla Ng
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Singapore 068909
Tel. +65 6324 9733
Fax +65 6225 4070
E-mail info@availcorp.com
Web http://www.availcorp.com/english/events_list.php?eventsid=142&backurl=upcomingevents_list.php

16–17 September 2008
Warwickshire, **England**

Waste 2008
Waste 2008 Conference Office
Attenborough House
Browns Lane Business Park
Stanton-on-the-Worlds, Nottingham NG12 5BL
Tel. +44 (0) 115 937 1058
Fax +44 (0) 115 937 1100
E-mail info@waste2008.com
Web http://www.waste2008.com

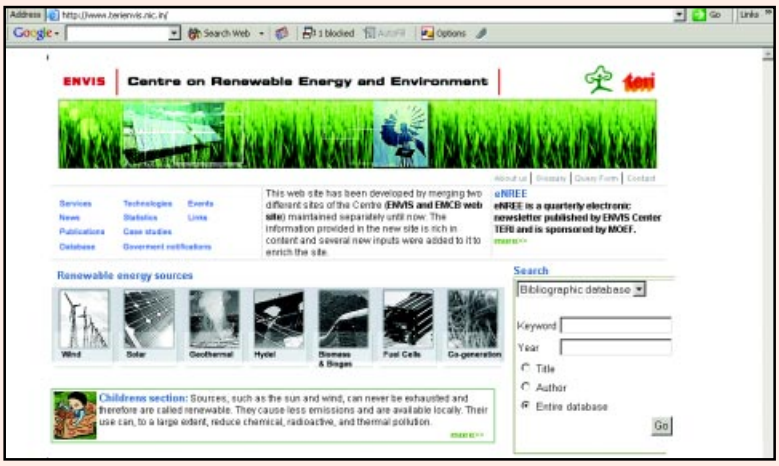
27–30 September 2008
Changzhou, **China**

The 10th China Solar PV Conference & Exhibition
Mr Liu Wenliang
Conference Secretary
Changzhou Trina solar Co., Ltd
No 2,Tianhe Road, Electronic Park, New District, Changzhou
Jiangsu, China – 213 031
Tel. 0519 8517 6050, 138 6129 8671
Fax 0519 8517 6053
E-mail wenliang.liu@trinasolar.com, lwlwfm@126.com
Web http://www.chinasolarpv.com

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.



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

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'.

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