



Shri Vilas Muttemwar, Minister for New & Renewable Energy presenting the SESI Award for RE Financing Innovation to Shri Debashish Majumdar, Chairman and Managing Director, IREDA at the ICORE-2007 on 27 November 2007 at New Delhi. Also present is Dr. Rakesh Bakshi, President SESI.

IREDA Presented SESI Award

The International Congress on Renewable Energy (ICORE) - 2007 was held on 27-28 November, 2007 at Hotel The Grand, New Delhi.

On this occasion Shri Vilas Muttemwar, Minister, New & Renewable Energy said there is need to maximum development of domestic energy supply options in context of spiraling oil prices as well as need to diversify energy sources. Thus renewables remain very important to India's energy mix. He said that the ministry can take pride that the new & renewable energy sources - solar, wind, small hydro and bio-energy are making a significant contribution to the Nation's energy mix.

The Minister said that MNRE has embarked on a massive plan of driving home the benefits of renewable energy technologies in every possible manner. Today, renewable energy is not longer an alien word as it used to be for several years back. The change has not taken place overnight though and we must energise this further both under the fast blowing wind of the coastal areas and bright sunshine areas of the vast land areas.

On this occasion IREDA was presented the SESI Award for RE Financial Innovation for the year 2006-07. The award was presented by Shri Vilas Muttemwar, Minister, New & Renewable Energy to Shri Debashish Majumdar, Chairman & Managing Director, IREDA at a glittering function in the presence more than 500 delegates.



Shri Debashish Majumdar, Chairman & Managing Director, IREDA at the new manufacturing facility of Sudarshan Saur Shakti Pvt. Ltd. alongwith Shri K.S. Popli, Director (Technical), IREDA and Directors of the company. Inset at bottom left shows the new facility and Office block.

CMD, IREDA INAUGURATES SUDARSHAN SAUR SHAKTI'S NEW FACILITY

A new office block & new manufacturing facility of Sudarshan Saur Shakti Pvt. Ltd. was inaugurated by Shri. Debashish Majumdar, Chairman and Managing Director, IREDA on 23rd April 2008 in the presence of Shri K.S. Popli, Director (Technical), IREDA at Waluj, Maharashtra.

During 1997 - 98 the company started its own manufacturing set up at Waluj with the help of IREDA term loan finance of Rs.19.76 lakh. The firm was converted as a private limited company named Sudarshan Saur Shakti Pvt. Ltd. The excellent financial performance of the company earned it from IREDA as the best financial intermediary in the year 1997. In the year 2003-04 company entered in ETC business only. This decision proved a major milestone in the growth of the Company. Since then the company achieved a good growth & started expanding its market in different states of India.

The monthly production capacity of the company is 2000 sets of SWHS of different capacity of domestic solar water heating systems. The company has expanded its dealer network in many other states of India like Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, M.P. Gujarat, Punjab, Delhi etc.



IREDA Welcomes its New Independent Directors



Shri A. Prasad joined the Railways in 1963 after obtaining his Master's degree in Economics from Delhi School of Economics. In 1984 he was selected for assignments in different ministries of the central government. He served as Joint Secretary in the Department of Public Enterprises. He later served as Deputy Director General in the Department of Telecom. In 1995 he was promoted as Addl. Secretary and Financial Adviser in the Ministry of Steel and Mines. He was elevated as Member (Finance) and ex-officio Secretary in the Department of Telecom in 1997. During his tenure with the government he served as a member of boards of many companies. After his superannuation, he also served as Director, National Institute of Financial Management. He received recognition in 2002 from Railways Staff College, Vadodara as their "Distinguished Alumnus". He currently serves on the board of 3 other companies including Bharat Earth Movers Ltd., a public sector undertaking.



Dr. Raj Kishore Prasad, a reputed Water Resources Specialist has over 42 years of experience in the field of hydrological investigation, planning, design, construction and management of irrigation, drainage and flood control projects of surface and ground water sectors. After completing his Bachelor's Degree in Civil Engineering in 1965 from Patna University, he completed his M.Tech in Civil Engineering in 1972 from University of Roorkee and completed his Doctor of Philosophy from Indian Institute of Technology, Delhi. He has served in several distinguished positions in the government, including Chairman, Central Ground Water Board, Ministry of Water Resources. He is a Fellow of the Institution of Engineers



Prof Sadagopan is the founder Director of the International Institute of Information Technology, Bangalore a new generation Institute, promoted jointly by the Government of Karnataka and IT industry from September 1999. He has taught at two premier educational Institutes in India, namely, the Indian Institute of Technology, Kanpur, (IITK) during 1980 - 1995 and the Indian Institute of Management, Bangalore, (IIMB) during 1995-1999. He obtained his Bachelor's degree in Engineering from Madras University and his Master's and Doctoral degrees from Purdue University, USA. He is a Fellow of the IEE, UK, Computer Society of India and the Institution of Engineers (India). He currently serves on the board of 3 other companies including Bharat Electronics Ltd. & Neyveli Lignite Corporation Ltd., two public sector undertakings.

IREDA, its Chairman & Managing Director, Directors and Staff welcome the three new Independent Directors on its Board and look forward to their valuable contribution to the growth of the company



Future Direction of Renewable Energy Policy for India

Chittoor P. Krishnan¹ and P.C.Maithani²

In the Indian context, efforts to develop renewable energy technologies were initiated in a focused manner in early 1980s mainly due to the twin consideration of access to energy to its large population and energy security. In one way Indian commitment for development and utilization of renewable energy was much before the global surge for renewables in the wake of climate change and other related concerns. With rapid economic development that the country is witnessing the need to develop further renewables and also harness their potential to contribute to energy security as well as environmental objectives needs no further arguments. However, the Indian energy market has never been competitive and it is unlikely to be fully competitive in the near future. Investments in infrastructure and long-term subsidies for conventional energy along with the failure to internalize external costs and benefits, all act as obstacles to the advancement of renewable energy. Renewable energy is at the take-off stage and businesses, industry, government and consumers still have a number of issues to address before these technologies could make a real penetration. Policy instruments such as support funding, institutional finance, private investment, facilitation of international collaboration, removal of barriers to technology etc are key to bringing down costs and achieve market penetration. This apart, greater investment in research and development for renewable energy systems, both by the public and private sectors, is critical for long-term national enhanced energy and economic security. Although, there has been continued progress in bringing down the cost of renewable energy technologies but there is a further need to improve technology performance and provide coherent support for renewable energy technologies in ways that safeguard national interest and also provide global advantage. The present paper outlines some of the broad policy directions for accelerated development and application of renewable energy in the country.

INTRODUCTION

Ministry of New and Renewable Energy's (MNRE) policy for promotion of renewables broadly include: a) providing budgetary support for research, development and demonstration of technologies; b) facilitating institutional finance from various financial institutions; and c) promoting private investment through fiscal incentives, tax holidays, depreciation allowance and remunerative returns for power fed into the grid. The Electricity Act of 2003 has been a significant development in promoting renewables in the country, as it empowers State Electricity Regulatory Commissions (SERCs) to promote renewable energy and specify, for purchase of electricity from renewable energy sources, a percentage of the total consumption of electricity in the area of a distribution licence. Further, Ministry has initiated a process for linking incentives on renewable electricity with generation instead of the present system of providing them based on installed capacity. A scheme for providing generation linked incentive for solar electricity has already been announced.

However, with rapid developments are taking place across the world the policy framework has to be dynamic. The ultimate objective of the renewable energy policy framework is to significantly increase the share of renewable energy sources in India's energy mix. Such a framework should be ideally stable that has long-term mandatory targets with flexibility in target setting across sectors. There policy framework has to necessarily address various barriers.

Government of India is yet to announce a 'long-term' policy that takes into account development and dissemination of entire gamut of renewables. This apart, the policy should create a more level playing field for renewables and an assurance of a stable market. In view of the diversified nature of renewable energy technologies, it would be more appropriate if a combination of policies through correctly defined policy instruments is applied. However, the question remains of how to achieve these goals and what policy mechanisms need to be put in place to move towards the desired outcome. The policy suggestions here-in-under does not purport to offer straight-jacket mechanisms; it at best proposes some of the policy measures that are relevant and lead to better harnessing of renewables.

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INCENTIVE POLICIES

Before examining the incentive for renewables, let us see what makes them a fit case for financial support in one or another form:-

- a) facilitate sustainable development process as fossil fuels are finite and contributes to global warming;
- b) compensate for price distortions in the energy market, which prevent economically viable renewables from competing on equal footing with mainstream energy systems;
- c) compensate for the non-inclusion of external costs in the financial cost of production of mainstream energy systems;
- d) create minimum demand needed to motivate market to invest in an effective marketing and after-sales-service infrastructure for renewables;
- e) facilitate 'Learning curve' with a strong potential for technological progress as it would create the mass market demand which motivates.

Application-wise renewable energy can broadly be categorized in five distinct groups, viz, grid-interactive renewable power, decentralized & stand alone renewable electricity systems, heat energy for cooking purposes, process heat for domestic, industrial and commercial purposes, and liquid biofuels for transport applications. Except renewable power which is governed under the provisions of Electricity Act 2003 and related Electricity Policy and Electricity Tariff Policy, and have assured market in terms of existing and impending RPS by States, renewable systems for other applications are mainly linked either to annual targets of MNRE and availability of financial incentives. Technology can develop only when markets are projected. Longevity and predictability of policy support are important for overall market development.

A general principle of any sustainable renewable energy policy is that the project developer should be able to recover his project cost within a defined time-frame. Government could help by making clear to whom these costs will be disbursed or in other words the additional cost burden should be spread across all the citizens who benefit from the project, both from the energy as well as the environmental benefits. All types of economic incentives should be time limited through sunset clauses. In the present policy framework, incentives for renewable power are in various forms of tax benefits and capital subsidies. In line with the recommendations of the Energy Policy Committee (2006), phasing out the capital subsidies would help to move renewable power without annual budgetary support. An alternative mechanism for linking incentives to energy generated would spur the development process.

TRADABLE RENEWABLE ENERGY CERTIFICATES

Globally, two major and different compensation systems are used in order to promote generation of electricity from renewable energy sources: a) Feed-in Tariffs for priority access of renewable energy sources to the grid at guaranteed tariff for a specific and defined time period; b) Quota Obligation and/or green certificates in which government defines quota target and renewable certificates are traded at market price. Additional income is generated from certificate trading and prices for certificates are based on quota target and depend on market variation. Electricity Act 2003 provides for feed-in-tariffs and Renewable Portfolio Standards and many of the States have already announced feed-in tariff and quota for renewables. However, in the absence of a renewable energy trading system, effectiveness of the quota system is uncertain.

In the Indian context, the Electricity Act 2003 does not give any flexibility to create Renewable Portfolio Standards (RPS) or Quota for renewables. Introduction of tradable renewable energy certificates (REC) could overcome the existing gap that is hindering the application of quota for renewables and thereby create a vibrant



market. REC is being applied in many countries and its use is growing the world over. It provides flexibility to the electricity providers in meeting their RPS requirement. They can generate the necessary amount of renewable electricity themselves; they can purchase it from someone else; buy credits from other providers who have exceeded the standard or from the spot market (as is the case in developed country). They choose the option that is cheapest for them. The REC system if introduced at the national level would allow trading of green attributes separate from physical electricity, and would therefore remove geographical or physical limitations, such as resource availability and/or time scale such as seasonal availability or financial limitation associated with supply of renewable power. As such operationizing REC at the national level would be desirable for effectively meeting RPS commitments as enabled under the Electricity Act 2003. However, while doing so aspects relating to compatibility with the existing laws and development of a robust system for validating, registry, verification, transfer and tracking of RECs would need to be looked into. Eventually, REC market would be akin to stock markets, as is the case with carbon credits.

INTERNALIZATION OF ENVIRONMENTAL EXTERNALITIES

The principle of internalizing the environmental externalities of carbon emissions and other pollutants resulting from fossil fuel combustion is now globally accepted. Many countries have already started internalizing these costs in various ways. Such an action will result in rise of the cost of power generation based upon fossil fuel combustion and a relative improvement in the competitive position of an increasing range of renewable energy technologies. In other words, the removal of both direct and indirect subsidies to power generation technologies and the appropriate pricing of fossil fuels, to reflect the environmental damage created by their combustion, are essential policy strategies for stimulating the development of renewable energy technologies.

MANUFACTURING VOLUMES AND MARKET CREATION

In addition to focused and directed technology development, reduction in the cost of renewable energy facilities and products depends on development of market and creation of volumes. Any government policy should aim at creation of markets that best address the needs at the least economic cost. An increase in manufacturing volume for renewable technologies will result in substantial cost reduction. The level of the cost reduction varies with the type of technology and increased volume of equipment production results from increased market demand. The most effective policies that increase market demand are market-mandated policies and if properly designed and enforced these policies guarantee the demand for technologies that will generate the economies-of-scale in manufacturing needed to bring down costs.

Domestic manufacturing and reducing import dependence is important for a country like India, where market volumes exist and accordingly industry has the appetite and motivation for the same. However, it requires careful policy interventions and planning that allows for the steady increase of component manufacturing. Renewables are increasingly getting indigenous in India, and many a time import is an economic decision. Reduction in import depends on development of indigenous technology or technology transfer. Technology transfer generally includes a combination of gradual shifts in import tariffs, incentives for joint ventures, development of equipment standards and testing programme, and standardized criteria for competitive solicitation.

INSTITUTIONAL FINANCE

The annual investment of the renewable energy industry in the country has reached a level of over US \$ 5 billion. Over the coming years it is set to increase with increased levels of installations. To obtain the needed investment, renewable energy projects will have to compete with other conventional segments of the energy industry. Notably, there is striking difference between renewable projects and conventional investment projects



including those in the mainstream energy sector. In the Indian context, renewable energy programme is primarily private sector driven. The investment climate for renewables has now changed significantly from the initial years of the programme around two decades ago, when Indian Renewable Energy Development Agency (IREDA), a non-banking financing institution under MNRE was meeting a major portion of institutional finance needs.

Renewable energy projects are capital intensive and extremely sensitive to the structure and the conditions of capital cost financing. They often have insufficient data for prudent project analysis, due to lack of accurate reports on resource assessment at the project sites. Further, large segments of renewable energy technologies still have difficulties to find commercial financing sources. Traditional financiers and investors still view renewable energy as high risk and low return option. The barriers to finance include: a) many renewable energy projects are too small to attract commercial lenders; b) transaction cost is generally high; c) low returns with positive cash-flows coming first in the long run. In addition, the issues involved are different for the distinct types of technological applications, e.g., the off-grid projects generally require micro-finance while the larger grid connected projects require project finances. As such, structure of financial requirements and scale pose a challenge to investment in renewable energy.

An integral element of a project financial structuring is risk management. Linking renewable energy projects with carbon opportunities in the form of CDM projects is one of the new ways of improving project viability through carbon money while minimizing risks. With impending carbon-trading opportunities more and more banks have now started looking at renewable energy projects as a viable financial proposition.

Investment in renewables can be put in three categories. The first is where investments are financially attractive under sound, commercially viable policies. The second address promising new technologies that are not currently financially viable, but investment becomes viable with subsidies. The third category mainly relates

to the technologies at advanced research and development stage that could yield commercially viable results within medium term and in the short-term requires venture capital support.

A major area that needs attention is micro-credit for an off-grid renewable energy application where getting the finance is the real issue. Although a number of initiatives that cater to micro-finance needs in a specific area/region are already underway, there is an immediate need to develop a national framework, which ensures refinance to the national and regional banks against the loans given for renewable energy systems. There exists a precedence of NABARD refinancing banks for the loans given by them for biogas plants.

In a nutshell, innovative financing strategies would need to be developed/augmented for: a) micro credit or micro-lending; b) financing leasing programmes; c) venture capital financing; d) targeted project credits; and e) equity financing/ debt financing. Ideally, IREDA should take a lead and develop a diversified institutional finance management approach that takes into consideration future requirements and also involves mainstream financial institutions at all levels.

TECHNOLOGY SPECIFIC FUTURE DIRECTIONS

WIND ENERGY

At present the wind market, through a defined quota as well as returns through set tariffs, is assured. In the long term, as per the National Tariff Policy there would be competition within same renewable energy technology and subsequently with all renewable energy technologies. With improvement in technology for attaining higher conversion efficiencies for harnessing low wind regimes, identification of new wind sites including off-shore, continuous expansion of grid power electric installations and also increasingly economic viable potential it could be safely assumed that wind power systems will continue to be set up initially in 'Greenfield areas' and subsequently in old sites with new and higher efficiency systems for the next two decades or so, till new renewables offers more competitive solutions.



One of the limiting factors in the Indian wind market is captivity syndrome where manufacturers are having dual role of project development. As such a market segment of project developers is yet to be identified. An effective decoupling will have a positive impact in terms of project cost reduction, competition, better transparency and accountability.

SMALL HYDRO POWER

The logical policy aim should be to harness the existing small hydro power (SHP) potential in the shortest possible time frame. However, the present policies for SHP development are more regulatory in nature than being developmental. An approach that provides incentives for creation of SHP manufacturing and generating base at the small scale where manufacturer could double as developer would have far better results not only in terms of added capacity but also better functionality, utility and decentralized applications. Local capacity building and micro siting of systems which not only focuses on power generation capacity but also on mechanical application would be required to achieve the desired results. A step further would be to develop a mechanism that provides for the integration of all SHP systems to the national grid. This would result in better load management and generation of additional revenue stream to the local communities who own such power plants.

SOLAR PHOTOVOLTAICS

Solar energy for supplementing grid has recently found support of the Government. In December 2007, MNRE announced a scheme to provide financial assistance upto Rs. 12/kwh in case of SPV and Rs. 10/kwh in case of solar thermal power fed to the electricity grid. The scheme provides for setting up of a maximum capacity of 10 MW in each State and a maximum of 5 MW per developer. In the initial phase, incentives will be provided for 50 MW capacity. In view of rapid developments and future possibilities there is a need to put together experience in this segment and a policy instrument that provides for controlled dissemination. This would help in generating experience in solar power technologies development, thereby reducing costs by creating markets. Although,

rooftop solar systems and building integrated PV systems have been launched successfully in western countries, this involves a large number of generators to deal with and would call for interaction with numerous distribution companies, which may not be practical option in the Indian context to start with. Therefore, the present scheme is in right direction, however, in the longer run, roof top SPV systems would also need to be covered.

There exists a significant opportunity for stand-alone solar PV application which offers a viable option for household lighting in rural areas. As per the Census of India (2001), 83.12 million rural households in the country use kerosene as a primary source of lighting, despite having grid in most of these areas. Various studies indicate that on an average 2.0 litres kerosene oil is consumed per month per rural household, thus around 2000 million litres (in 2003-04 there was total consumption of around 10 million tonnes) of kerosene oil is being consumed for lighting purposes in the country. For 2004-05 average subsidy on Kerosene was Rs.8.78 per litre. Thus total subsidy for kerosene based lighting for 2004-05 would be Rs.18000 million (overall subsidy on kerosene in 2004-05 was over Rs.100,000 million) This subsidy is sufficient to cover around 45 million households with solar PV based home lighting systems by providing an one time subsidy of Rs.4000/system. Within two years entire rural population of the country using kerosene lighting systems could be covered instead of regular kerosene subsidy. This policy initiative on the other hand will create significant demand for SPV systems within the country resulting in additional industrial activities thus additional employment and economic activity.

SOLAR THERMAL POWER

Solar thermal power technologies offer interesting opportunities for India. These technologies can easily be adapted to Indian conditions and most components of solar thermal power plants could be produced indigenously. Success of efforts will depend on the extent of the impact of mitigation of initial investment cost, full recovery of operating costs, introduction of professional management, and accessibility of infrastructure and equipment support for operation and maintenance. In this process initial government support will be crucial.



BIOGAS

The strategic efforts may include adopting cluster approach in selected districts/blocks, based on biogas plant performance over the last two decades; addressing operational and technical glitches by reorienting the research machinery and by encouraging private sector investment in biogas research; investing in design research to make biogas suitable to different climatic conditions; develop models that take into account local problems like low temperature, less availability of water, alternate feeding material and proper feedstock mix; proper incentive scheme for batch-fed biogas systems, kitchen waste biogas plants and human excreta based biogas systems. The National Biogas and Manure Management Programme needs reorientation to accommodate developments in the sector and introduce new designs for speedy implementation. Re-assessment of biogas potential at district/block level for all possible biomass resources would help in increasing the coverage and outreach. Finally, the present approach of allocating token targets of around 1 plant in every 6 villages does not create an environment for proper institutional framework nor help in exploiting the potential in the foreseeable time frame. For the dissemination of this technology, volumes are of utmost importance as they are required for creation of effective operation, repair and maintenance services.

Another area that needs attention is participation of private entrepreneurs in setting up of biogas plants. This action needs to be developed that takes into consideration local and regional variations in terms of the biogas market. Parallel to this, it will also be required to develop a marketing strategy.

In addition to its cooking application, there is a potential of biogas generation in India to make it an alternate fuel for vehicular transport. Rural entrepreneurship for the effective utilization of local biomass resources for production of biogas not only for cooking purposes but also for motive power and transport purposes could open new business and employment opportunities in a decentralized manner that could translate into sustainable rural development.

BIOFUELS

At present, the prices of biofuels are not competitive when compared with fossil fuels. But increase in the crude oil prices and technological advancements being made in the biofuel production can make these 'green' fuels economically vie with fossil fuels in the near future. In order to diffuse bio-ethanol, it is necessary for government agencies to intervene in the related industries. Fuel standards and quality management systems are required to be arranged to make the fuel quality more reliable, and in addition stable supply systems need to be built. Further, bio-ethanol must have price competitiveness against sugar and gasoline.

At present, there is no coordinated programme for development of jatropha plantation in the country. No reliable data on production and productivity of jatropha is available. The economic viability of bio-diesel will depend largely on the seed yields, which show large variations. In addition, due to absence of data from block plantations, several yield estimates are based on extrapolation of yields obtained from individual plants or small demonstration plots. The main challenge is to create an organized market for bio-diesel in country.

HYDROGEN

In all likelihood, the energy shifts towards hydrogen is likely to be gradual. Hydrogen energy infrastructure would require a public policy framework for automotive and power generation purposes. The policy actions required may include development of codes and standards to support commercial activity; generate a critical mass in terms of resources, effort and competencies for "lighthouse" projects covering research, prototype development, technology demonstration, and commercialization leading to an application. In addition, creation of centres of excellence acting as focal points of critical research would be desirable.

INTEGRATION WITH NATIONAL DEVELOPMENT GOAL

Renewable energy cannot be developed and disseminated in isolation. It has to fulfill national



development obligations particularly in terms of access to energy services and contribution to overall energy security, by reducing demand of conventional fuels. Accordingly, the targets and measures for renewables should be in with the overall developmental priorities.

CONCLUSION

Renewable energy development is considered in India to be of great importance from the point of view of long-term energy supply security, environmental benefits and climate change mitigation. India, faced with twin challenges on energy and environmental fronts, has no option but to work towards increasing the role of renewables in the future energy systems. The challenges in hand are to increase the production volume for technology learning and for the cost reduction rate, which in turn affects the promotion policies. Larger application of renewable energy, than that of the present assessments, would depend on how rapidly the costs decline. Timely addressing of ambitious technical targets, i.e., performance and cost reduction would be an essential pre-condition to a substantially increased renewable share in the total energy mix.

The provisions of the Electricity Act 2003 have already given a major boost for promotion of the renewable energy sector in India. All major States have announced feed-in-tariff for renewable power and the recent growth of renewable power is attributed to stable regulatory policy framework. However, there are many unresolved issues and the Indian renewable energy programme is still hampered by a number of market distortions and institutional, financial, and economic barriers. Right policy strategies and initiatives can help in overcoming these barriers and accelerating the current gradual transition to renewable energy. Further, renewable energy policy instruments would be required to have a complete synergy with the national climate policy. Carbon finance and emissions trading are the longer-term incentives for developing renewable energy markets. Finally, renewable energy provides enormous benefits and can contribute significantly in the national energy mix at least economic, environmental and social costs. A shortened time frame in which it can be achieved will depend on long-term policy framework, institutional and government commitment and availability of adequate financial resources. □

The views expressed are personal to the Authors Future Direction of Renewable Energy Policy for India

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Hydrogen Production: Present Status and Prospects in the Indian Context

Dr. M.R. Nouni *

INTRODUCTION

Hydrogen was discovered in 1766 by Henry Cavendish who called it, "Inflammable Air". Hydrogen is the simplest and the most abundantly available element in the universe. It rarely exist as a gas on earth and is available only in combined form in water and many organic compounds such as natural gas, coal, petroleum, biomass etc. Therefore, hydrogen is produced from these feedstocks or primary energy sources through different energy intensive processes. In the context of energy systems, hydrogen is an energy carrier (a means of storing and transporting energy), similar to electricity rather than the fossil fuels that we extract from the earth's crust. Energy carriers like electricity and hydrogen are produced from primary energy sources using conversion technologies. It is a colourless and odourless combustible gas that is neither a greenhouse gas nor a local pollutant. In end-use, hydrogen is the cleanest of fuels. Its combustion in stationary and mobile applications produces pure water vapour and only oxide of nitrogen (NO_x) emissions. It is the ideal fuel for fuel cells, offering the potential for high electrical conversion efficiency and zero exhaust emissions.

GLOBAL AND INDIAN HYDROGEN PRODUCTION

Globally about 42 million metric tonne (MMT) i.e. 500 billion m^3 /year of hydrogen is produced annually mainly for captive use for producing fertilizers and by petroleum refineries for processing of low grade crude oils. This hydrogen is predominantly produced from fossil fuel feedstock and electrolysis of water as shown in Fig. 1 [1].

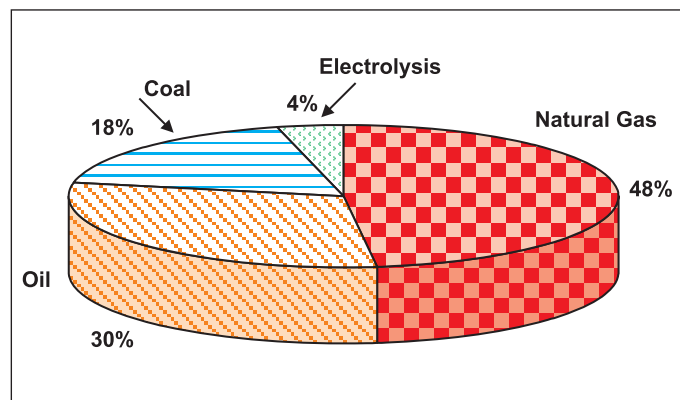


Fig.1 Feedstock wise global hydrogen production

Presently, hydrogen production in India is estimated to be 3.15 million metric tonne, of which 2.32 MMT is produced by fertilizer plants, 0.47 MMT is produced by petroleum refineries and 0.36 MMT by chlor-alkali industry as by-product hydrogen [2]. Some limited hydrogen is also produced through electrolysis. Hydrogen produced by fertilizer plants and refineries is for captive use. Hydrogen is also used by vegetable oil industry, chemical industry and for cooling of electric generators.

HYDROGEN PRODUCTION METHODS

Natural gas is most widely used for hydrogen production in view of its availability, ease of handling and its high hydrogen to carbon ratio. Natural gas can be converted to hydrogen by steam reforming. A number of other methods for hydrogen production using fossil fuels, biomass, electricity, solar and nuclear heat have either been developed or are under different stages of development world wide. Table-1 compares different hydrogen production methods in terms of energy efficiency, estimated cost of hydrogen production, current global status of technology and their advantages and disadvantages [2-6].

* Scientist-F Ministry of New and Renewable Energy

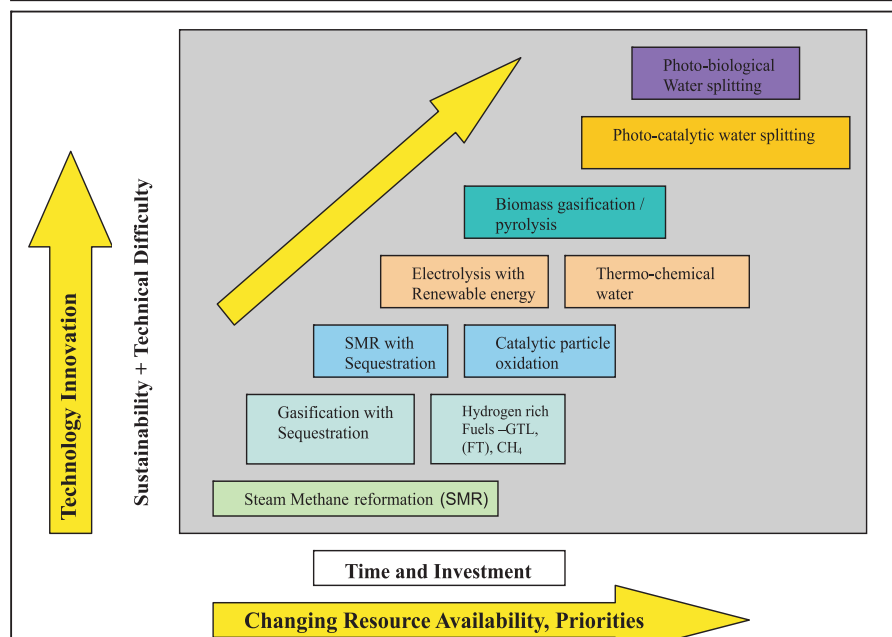


Fig. 2

Concerted R&D efforts for hydrogen production methods that are based on renewable energy methods and not dependent of fossil fuels are being made world over including in India. These methods for hydrogen production would be environmentally sustainable too. The roadmap depicted in Fig. 2, created by Miller and Penner [6] provides an overview of the likely evolution of hydrogen production technologies in the future for meeting the demand of hydrogen especially for automobiles.

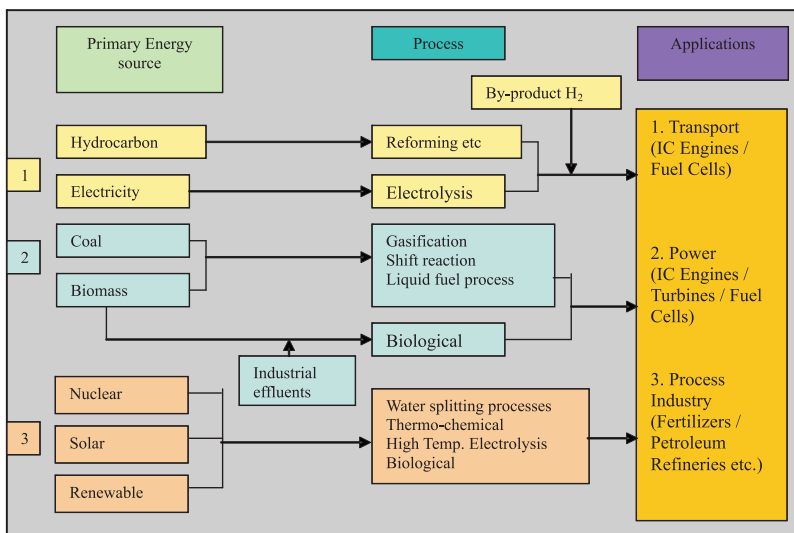
HYDROGEN DEMAND FOR TRANSPORT AND POWER GENERATION IN INDIA

National Hydrogen Energy Road Map was prepared under the guidance of the National Hydrogen Energy Board and was approved by it in 2006. The Road Map provides pathways for accelerated development different aspects of hydrogen energy in India. It envisages that there would be about one million hydrogen fuelled vehicles and aggregate power generating capacity of 1000 MW based on hydrogen in the country by 2020. For these applications, hydrogen production facilities with a total capacity of 1.1 MMT will have to

be set up in the country, involving huge investment. The Road Map projected a total investment of Rs. 24,000 crores for creating infrastructure for production, transportation and supply of hydrogen [2]. The transport sector is expected to create the main demand for hydrogen, though hydrogen based stationary power generation using fuel cells and internal combustion engines would also be another potential application that would require hydrogen.

In the Indian context, a schematic showing processes for production of hydrogen for meeting its requirement

for immediate supplies, medium and long-term supplies using different primary energy sources for transport sector, power generation and also for process industries like fertilizers and petroleum refining is shown in Fig. 3 [2]. Besides, hydrogen produced from SMR, by product hydrogen available from chlor alkali industry could be used for meeting requirement of hydrogen for vehicles.



- 1: For immediate requirement,
- 2: For medium and long term supplies, and
- 3: For supplies beyond 2017

Fig.3



HYDROGEN FUELLED VEHICLES

Application of Hydrogen as a fuel in internal combustion engine and fuel cells dates back to the 1920s. However, use of hydrogen in fuel cell based electrical power system for a significant application was made by General Electric for national Aerospace Agency (NASA) in Gemini and Apollo Space Capsules in early 1960s.

R&D for development of hydrogen fuelled vehicles is of relatively recent origin in India. Banaras Hindu University (BHU), Varanasi has modified petrol driven motorcycle to operate with hydrogen as fuel, which is stored in solid state metal hydride powder. The metal hydride is packed in suitably designed heat exchanger, which is placed under the seat of the rider. Heat from the exhaust of engine is used for releasing hydrogen from the hydride heat exchanger. Hydrogen is introduced in the engine through a specially designed valve. Presently 15 motorcycles are being demonstrated in the campus of the university. BHU has also modified petrol driven three wheeler to operate with hydrogen. Researchers at BHU are working on improving the performance the range of these vehicles. Hydrogen storage in metal hydrides is considered as safe but can store a limited amount of hydrogen (about 1.5 to 2.4 wt%) in a given mass of metal hydride. BHU is looking forward for commercialization of the hydrogen fuelled motorcycles and three wheelers through suitable industrial partners.

Some automobile manufacturers have also exhibited their hydrogen fuelled three wheelers in the Auto Expos. Some manufacturers have opted for gaseous hydrogen storage in high pressure cylinders. The trend world over is to use composite cylinders capable of storing gaseous hydrogen at 350 or 700 bars. Such composite cylinders are not presently being manufactured in India and are to be imported. Composite cylinders may also be useful in extending the range of CNG fuelled vehicles, which presently use stainless steel cylinders.

In India, we have acquired experience of handling CNG as fuel in vehicles by operating CNG fuelled vehicles in Delhi and Mumbai. The infrastructure for supply and

distribution of CNG exists in these cities and the network is likely to be expanded to suburbs of these cities and also other cities. Hydrogen when blended with CNG is found to reduce the NO_x emissions from the vehicles. Keeping in view the availability of CNG infrastructure in New Delhi and benefit of blending hydrogen with CNG, the Ministry of New and Renewable Energy supported a project to the Society of Indian Automobile Manufacturer (SIAM) to introduce hydrogen-CNG (H-CNG) fuel in select vehicles with a view to gain experience about production, storage and handling of hydrogen for transport applications. Five automobile companies and R&D Centre of Indian Oil Corporation are also participating in this project. Under this project the suitably modified selected vehicles would be run for 50,000 km each with H-CNG vehicle.

Some automobile companies are also engaged in development of Internal Combustion Engine (ICE) based as well as fuel cell based vehicles in India. Whereas fuel cell based vehicles are practically emission free, ICE based vehicles may cause some emission of NO_x . Therefore, from environment consideration hydrogen fuelled vehicles are considered to be green, provided hydrogen is produced from renewable sources of energy. This feature of hydrogen fuelled vehicles is the main reason for increasing interest in fuel cell vehicles world over. Although fuel cell vehicles are being demonstrated in some countries, the high cost and limited life of fuel cells are the main deterrent in large scale adoption of fuel cell vehicles by the customers. Hydrogen fuelled vehicles are likely to be available in India in the next two to three years time as a result of the efforts being made by the R&D organizations and automobile companies. In India, ICE vehicles are expected to be available earlier as compared to fuel cell vehicles due to familiarity of the manufacturers with ICE engine technology, possibility of using existing manufacturing facilities, lower cost and probability of rapid deployment of such hydrogen fuelled vehicles. Hydrogen fuelled ICE are expected to be marginally costly as compared to petrol based ICE. The efforts directed towards introduction of hydrogen fuelled vehicles in the country would bear positive results, provided a chain of hydrogen dispensing stations is also set up simultaneously in the country. Absence of infrastructure for production, supply and distribution of hydrogen is one of the major barriers in introduction of hydrogen fuelled vehicles world over.



HYDROGEN FUELLING STATIONS

For meeting the demand of hydrogen for automobiles, hydrogen fuelling stations are being set up in the different parts of the world. There are about 170 hydrogen fuelling stations that have been set up as on April, 2008 in different countries, of which 64 are in the USA, 26 in Germany and 24 in Japan. A total of 60 more hydrogen fuelling stations are under different stages of installation. Hydrogen fuelled vehicles are being demonstrated in different parts of the world to acquire experience and create awareness. As the number of hydrogen fuelled vehicles increase in the future, the number of hydrogen fuelling stations would also increase. In Japan alone, the projected hydrogen fuelled vehicles would be about 50 lakhs by 2020.

The first hydrogen fuelling station in India was set up by Indian Oil Corporation in its R&D Centre at Faridabad in Haryana (Fig.4). The second hydrogen fuelling station is under installation by Indian Oil Corporation at Lodi Road, New Delhi with partial financial support of the Ministry of New and Renewable Energy. It would be equipped with an electrolyser of 5 Nm³/hr capacity and associated facilities for compression and storage of hydrogen. This



Fig.4: Hydrogen Dispensing Station set up at R&D Centre of IOCL at Faridabad

dispensing station would be able to deliver neat hydrogen as well as blends of hydrogen and CNG. Indian Oil Corporation has plans of setting up two more hydrogen dispensing stations in New Delhi based on SMR process.

CONCLUSIONS

The greatest challenge to hydrogen production is its high cost of production vis-à-vis liquid and gaseous fossil fuels. The delivered cost of hydrogen has to be cost-competitive to fossil fuels. Considering the relative prices and maturity of hydrogen production processes, it is likely that SMR and coal gasification would be the choice of technologies in the transition to hydrogen economy. Water splitting processes, depending on the progresses in the technologies may replace the fossil fuel based processes in the years to come. With spiraling prices of crude in the international market during the last couple of years, the economic attractiveness of hydrogen as fuel, especially for automobiles would improve in coming years.

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Table 1: Comparison of Hydrogen Production Methods

| S. No. | Production Method | Energy Efficiency | Estimated Cost of Hydrogen (Rs./kg) | Current Global Status of Technology | Advantages | Disadvantages |
|---------------------------------------|--------------------------------------|-------------------|-------------------------------------|---|---|---|
| 1. Reformation of fossil fuels | | | | | | |
| a. | Steam Methane Reformation (SMR) | 70-83% | 25.67 | Commercially available for large capacities | <ul style="list-style-type: none"> - Proven technology - High efficiency - Economically most attractive - Ideal for centralized production | <ul style="list-style-type: none"> - Limited supply of methane on long term basis in India - Cannot be easily scaled down for distributed production - CO₂ by-product |
| b. | Thermal decomposition of natural gas | 70% | 102.4 - 136.4 | R&D | <ul style="list-style-type: none"> - Solar energy could be used - Suited for distributed production | <ul style="list-style-type: none"> - Limited supply of methane on long term basis in India |
| c. | Partial Oxidation | 70-80% | 43.17- 46.04 | Commercially available for large capacities | <ul style="list-style-type: none"> - Proven technology - Can be scaled down for distributed production - Economically reasonable - Process available for heavy residual oil and low value refinery products | <ul style="list-style-type: none"> - Limited supply of methane on long term basis in India - Lower efficiency as compared to SMR - CO₂ by-product |
| d. | Auto thermal reforming | 65-75% | 77.2 | Commercially available for large capacities | <ul style="list-style-type: none"> - Proven technology - Lower reactor costs and simplified reactor design compared to SMR | <ul style="list-style-type: none"> - Limited supply of methane on long term basis in India- Lower efficiency as compared to SMR- CO₂ by-product |
| e. | Gasification of coal | 63% | 57.51 | Commercially available for large capacities | <ul style="list-style-type: none"> - Proven technology - Economically attractive - Ideal for centralized production - Sufficient coal reserves in India | <ul style="list-style-type: none"> - Lower efficiency - CO₂ by-product |
| 2. Reformation of Biomass | | | | | | |
| a. | Gasification | 40-56% | 67.53 | Commercially available in medium size | <ul style="list-style-type: none"> - Renewable - Environmentally neutral | <ul style="list-style-type: none"> - Site specific and availability of biomass |
| b. | Pyrolysis | 56% | 50.4-87.6 | Commercially available in Medium size | <ul style="list-style-type: none"> - Renewable - Environmentally neutral | <ul style="list-style-type: none"> - Site specific and availability of biomass |
| 3. Electrolysis | | | | | | |
| a. | Conventional electrolyzers 25% | | 231.10 | Commercially available for small capacities | <ul style="list-style-type: none"> - Proven technology - Suited for distributed production | <ul style="list-style-type: none"> - Lower efficiency - Electricity price would determine cost of production |



| S. No. | Production Method | Energy Efficiency | Estimated Cost of Hydrogen (Rs./kg) | Current Global Status of Technology | Advantages | Disadvantages |
|---------------------------|-------------------------------------|-------------------|-------------------------------------|--|--|---|
| b. | PEM electrolyzers | - | - | Available in small capacities. In R&D stage in India | - Higher operational efficiency compared to conventional electrolyzers - Can operate at higher current densities and are therefore, compact - Potential to be used as "regenerative fuel cell" | - Significantly higher capital cost compared to conventional electrolyzers- Best suited to small plants |
| c. | High temperature steam electrolysis | 45-55% | 102.4 - 118.8 | In early stages of development | - Higher efficiency as compared to conventional electrolyzers | - High capital cost |
| 4. Water splitting | | | | | | |
| a. | Photobiological | 24% | 220.8 | In early stages of development | - Renewable | - Low efficiency and high capital cost of reactor |
| b. | Photocatalytic | 10-14% | 199.2 | In R&D | - Renewable | - Low efficiency and production rates- Expensive catalysts |
| c. | Photoelectrochemical | 10-12% | - | In early stages of development | - Renewable | - Low efficiency and production rates |
| d. | Thermochemical | 42-52% | 74.8 - 80.4 | In R&D | - Well suited for centralized production and emission free if nuclear and solar heat is used | - High capital costs - Material development poses challenges due to highly corrosive conditions |
| e. | Thermolysis | 20% | 153.2 - 204.4 | In early stages of development | - Renewable if solar heat is used | - High capital costs- Material development poses challenges |

Sources: [3-6]

The Sun radiates 1 PW (petawatt), or 1014 kWh, of energy every hour; only 3% of this energy is converted into wind energy and just 3% of this wind energy can meet the global power demand today



Solar Photo Voltaic Systems - Current Status, Promotional Measures and New Developments

M.Kumaravel *

INTRODUCTION

Solar Photo Voltaics (known by SPV or simply PV) is the technology, wherein a PV Cell converts the sunlight directly into electricity. A PV module has a group of interconnected PV cells, to provide a required voltage, current and power levels and is a basic building block of any PV system. Advantages of PV are modular, reliable, long life, non-polluting and requiring only minimal maintenance. They can be designed in different capacities, i.e. from a small lighting system of a few watt capacity to a large plant of tens of MW capacity size. PV is one of the potential Renewable Energy sources and its applications are multiplying rapidly in urban as well as in rural areas and now the PV industry is poised for a dramatic growth. Due to its inherent merits and other factors such as technological advances, continuous down trend in prices and fast depletion of fossil fuel sources, PV is being looked at as a viable alternative option in generation of electrical power. Also, its increased use is consistent with the global environmental issues. Cost reduction due to size scale-ups as well as the different green financing mechanisms are expected to enhance the number as well as the installation capacities, which would help to bring down the PV price further so as to compete with fossil fuels in the years to come. Even today, in fact in certain pockets of areas, PV is cost effective, even when other forms of electricity are available. PV Systems may be mainly classified into two categories viz (i) Stand-alone or often known as off-grid (ii) Grid connected.

PV Systems are configurable in many ways, depending on the inclusion of battery backup or not, grid support, or combination with other energy sources making it a hybrid version. They can be installed in the land, over the building roofs or as an integral part of building. Though

PV is now a matured technology, to ensure reliable and trouble free PV systems, still certain remedial measures may have to be undertaken. The problem free and reliable PV systems alone, will help to enhance the confidence level in PV users, so as to have positive multiplicity effect amongst new potential PV users. This will also help to accelerate the PV market, widen the applications, adopt the new technologies or products in PV applications and will also make headway towards the quality installation of multi-Mega watt size PV installations in the country.

PV SYSTEMS

Stand-alone or off-grid Systems: They are quiet independent of any utility and it is self contained including all the stages of any power plant such as generation, control, storage (if any), power conditioning (if any), protection devices and distribution of the power to the load. These systems are usually categorised into three types, depending on whether they use battery storage and/or auxiliary power source. The potential applications are lighting, water pumping, telecommunications, information services, highway signs, rural electrification, vaccine refrigeration and cathodic protection. The first type is PV-Direct where it powers the load directly and does not use any battery. Examples are water pumping and ventilation fans. Some form of power conditioning may still be required to operate the load properly and to maximise the PV output. The second type is PV with battery backup. This has got storage that allows the load to be powered when the PV array cannot supply the power directly (e.g during night and cloudy periods of low insolation). This is the common type of PV system as it suits wide range of applications worldwide. The third type is called PV-Hybrid, wherein addition to PV, an auxiliary source, usually a diesel generator or wind turbine is used. This type generally uses battery bank and is much preferable for powering the critical loads.

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Grid Connected Systems: There are many methods to connect the output of PV system to electrical utility or grid. These are usually classified into two types i.e. central power plants of large (MW) capacity and distributed power systems of smaller (a few kW to a few tens of kW) capacity. The purpose of the central plants could be for bulk power generation, transmission and distribution support or demand side management. The purpose of distributed PV systems is to reduce the peak demand at those sites or buildings where the systems are installed.

SYSTEM COMPONENTS

In a photovoltaic system, besides the PV module, there are many other subsystems and all these are grouped under Balance Of System (BOS) components. Again, these are classified as mechanical BOS or electrical BOS components.

PHOTO VOLTAIC CELLS AND MODULES

Most of the commercially available PV modules are made of monocrystalline, polycrystalline or amorphous silicon cells. While conventional monocrystalline cells have an efficiency of 13 to 16% and polycrystalline cells have about 12 to 14%, higher efficiencies (about 18%) are realized by using specially improved monocrystalline cells. Amorphous silicon is the least efficient (around 10%) when it is new, and after exposure to sun, will further decrease to stabilize over a period of time. There are many technologies, that are being developed, with the objectives of increasing the cell efficiency, reducing the size, increasing the module reliability as well as decreasing the cost of production. PV module consists of series connected cells and series parallel combination of the modules provide panels and subarrays to deliver more and more power at higher system voltages.

PV ARRAY SUPPORT STRUCTURE

As mentioned earlier, this comes under Mechanical BOS. A PV array is usually mounted in a fixed position at an appropriate tilt angle (on a building or a separate structure), facing towards the equator (i.e. towards the south in our country) so as to maximize its performance.

The main advantage of this fixed structure is that it minimises human intervention, but it limits the performance. As an improvement, a manual tilt adjustment of the array (on a seasonal basis, for instance) has got the flexibility and the array output is maximized during each season. The ways of improving the performance are by array trackers and by the use of concentrators or reflectors.

BATTERY

The applications requiring electrical power at night or during the periods of low isolation need an energy storage. Most of the stand-alone systems require storage mediums and usually they are rechargeable batteries. Widely used types in PV systems are lead-acid and nickel-cadmium. Lead-acid batteries are most commonly used. Nickel-cadmium batteries have some technical advantages over lead-acid and are preferred in some applications. However, they are more expensive. Lead-acid batteries are divided into two categories: Open units (often referred to as 'vented') and sealed units (also known as 'valve-regulated'). In the case of open units, batteries when overcharged produce oxygen and hydrogen and there is a consequential loss of water, which is made up from time to time. In the case of sealed batteries under proper operating conditions, this loss is minimum, does not need the addition of water and hence these are branded as 'Maintenance Free' batteries. As the water cannot be added to these batteries after they are overcharged, if there is any mishandling, valve will let the battery vent leading to a permanent water loss.

Other characteristics, such as the plate construction and type of the electrolyte, make some batteries more appropriate under certain operating conditions. For instance, solar powered telecommunication systems have battery banks to provide back up power. Their duty cycle involves infrequent and relatively light discharges compared to the batteries used under heavy duty cycle conditions. Also, variations in irradiance levels at a given site and load profile would influence the selection of the right type. Because batteries are designed to suit a particular duty cycle, it is important that the correct type



of battery is selected and sized depending upon the duty cycle for a given application. It is cautioned that the automotive batteries are not recommended for PV applications.

SYSTEM/CHARGE CONTROLLER

All stand-alone PV systems normally require some form of control. The complexity of the control function depends on the user requirements, the type of system and the type of other auxiliary sources included. In simple systems, charge controllers interface the PV array with the battery and the battery with the load while the inverter interfaces the battery with the AC load. However, in the case of hybrid systems, energy management can become more complex in order to improve the overall efficiency of the system. Charge controller is the heart of the PV system in stand-alone system with battery storage. Its main function is to manage the use of the battery by disconnecting the PV array when the battery is sufficiently charged and disconnecting the load to protect the battery from over-discharging. A number of configurations (series, shunt, and in combination with pulse width modulation operation) are available. Technical specifications and selection of charge controller depend on the technical specifications of PV module, battery and load.

INVERTER

PV array or battery provides only DC output and hence an inverter (which converts DC into AC) is required to supply power to AC loads. They are categorized as stand-alone or grid connected inverter. Stand-alone inverter is classified, depending on the output waveform i.e square, quasi sine or pure sine. Different models available are from simple square wave to microcontroller based sine wave inverters. Total Harmonic Distortion (THD) in the output of inverters play a major role. This is in the order of 1 to 5% in the case of sine wave inverters and as high as 45% in the case of non-sine wave inverters. Quasi sine wave inverters will power many electrical appliances; but not all and the list of appliances incompatible to quasi sine wave is long. This is why the appliances that operate from quasi sine wave would perform better, if powered from sine wave power source. Water pumps driven by AC

motor fed from sine wave inverter would deliver about 30% more quantity of water compared to that fed from quasi sine wave type. Also, most electric motors, computer power supplies and domestic appliances will run smoother and cooler when fed from sine wave inverters. If the cost is not a criteria, sine wave inverter is the best choice, as every appliance is designed to operate from utility, which is a sine wave power source. Grid connected inverters are different from the stand-alone inverters for the reasons that (i) the power is not fed from the battery but from the PV array directly and (ii) the amplitude and frequency of the output are the same as that of the grid or utility. Also, the amplitude and frequency of these inverters have to follow the variations in utility or grid to which they are connected.

QUALITY AND RELIABILITY ISSUES

Most of the quality and reliability issues of PV systems are due to malfunctioning, intermittent or marginal behaviour of the BOS components. Within the BOS components, most of the failures are related to batteries in the case of stand-alone systems and inverters in the case of grid connected systems. PV has got a life span of 20 to 30 years, but due to the BOS related problems, PV does not its due credential, and thereby reduces the confidence level of the end user of PV. Thus, one may have to understand that 'PV failed' means, often it does not refer to the PV modules, but refers only to the BOS components. It is a fact that a significant fraction of the PV systems or plants that have been installed, whether standalone or grid connected do not deliver the energy to their rated value due to marginal failures, minor or major breakdowns. Hence, to sustain the quality of PV Systems, besides improving the efficiency and quality of PV modules, more determined efforts need to be focused towards to ensure the quality and reliability of these BOS components. The quality and reliability issues could be classified as relating to (i) system design or system sizing (ii) system integration (iii) wiring and installation (iv) inspection and maintenance.

System failures and poor reliability are a result of two categories of problems. First category is related to



non-conformance of Quality Standards. This is applicable to PV Systems and it covers right from the selection of the components used in each subsystem to the interconnections between the different subsystems of a system or plant. Second category refers to non-conformance of certified 'System Installers' and it covers the non-involvement of right type of skilled manpower in maintenance and inspection.

REMEDIAL AND PROMOTIONAL MEASURES

To ensure the quality of PV systems with trouble free operation and to promote the PV industry following measures may have to be taken up or accelerated:

TESTING AND CERTIFICATION OF PV SUB-SYSTEMS

Batteries and Charge Controllers: Currently, batteries used in most of the Photovoltaic Systems do not get tested for its acceptance in PV applications and hence resulting poor performance, shortened battery life and frequent system breakdowns. Next to the battery, the charge controller is likely to have problems and failures in stand-alone systems. The problems are attributed to (i) the selection of particular type and charging algorithm used for the given load requirements and (ii) controller settings. Acceptance testing of batteries and charge controllers together will help to improve the performance, reliability and life of the stand-alone PV Systems.

Inverter Testing: Inverter is another important subsystem used both in the case of stand-alone system and in grid connected systems. Technical requirements and specifications will vary depending on the PV applications and the load requirements of the clients. There is a tendency to use any type of inverter commonly or readily available in the market, without considering its suitability by the way of acceptance testing for PV applications. Hence testing and bench marking activities may provide a standardized methods for evaluation of stand-alone inverters, reassure the state utilities/grids that grid connected inverters will be of the quality ones and will not therefore interfere with their operation and be free from so called 'Islanding' problems. Therefore,

besides the existing certification facilities for PV modules, the certification facilities for these BOS components need to be strengthened. Further, considering the prevailing utility power conditions at any given site, maximum performance expected from the upcoming large number of grid connected PV Plants in the country would depend on the stringent testing procedures with special emphasis on 'Islanding' aspects and safety requirements to which the inverters would be subjected to. For carrying out the Testing and Certification of the above mentioned products, networking the sub-system manufacturers (charge controllers, batteries and inverters), PV Standards developers, PV System Integrators, PV industries and coordinated efforts through a well established system would make the process simpler.

PV STANDARDS

An important issue concerning the poor reliability of the PV systems is the lack of Standards. There is a need for the Standards to address the issues specific to PV because PV systems are unique in their characteristics and they are: (i) unlike conventional grid/utility, PV systems don't have inherently high fault current levels (ii) PV is usually installed in the exterior of buildings or structures (iii) output is not easily turned off and is dependent on solar insolation of variable in nature (iv) grid connected PV is a form of distributed generation, generally integrated to the grid via inverter and these systems are different from conventional electromechanical generator systems. PV Standards will help to ensure the quality and safety aspects in installation and operation of PV systems. Needless to say that the lack of the PV Standards will bring in the reliability problems, leading to more system failures and hampering the growth of PV. Whereas the well developed Standards will help to eliminate the inferior products or installation practices, build customer confidence, reduce costs and further help to enhance the PV market. There are several International Standards including IEEE for design and hardware installation of stand-alone or grid connected PV system. These Standards cover various aspects such as installation of PV Modules, cable types and selection, ampacity requirements, temperature considerations,



voltage ratings, BOS wiring, battery wiring, battery to inverter wiring, blocking diodes, bypass diodes, disconnect devices, their location and ratings, grounding requirements, surge and transient suppression, load centre, power qualities, protection features and safety regulations. The areas covered mainly, by the Standards are quality of power supply and safety aspects. Again these could be classified under (i) DC Side Issues, (ii) Grid Connect Issues in the case of grid connected PV system and (iii) Safety Issues.

DC Side Issues: These are: (i) Protection of human from electric shock covering insulation type, fuses, grounding, warning signs, equipment mounting and site accessibility (ii) Wiring practices covering operating temperature rating, environment protection, and insulation (iii) Protection of equipment and surroundings from fire hazards due to equipment failures due to overload, short circuit and over voltage (iv) Installation of equipment and components i.e terminals, junction boxes, switch gear on DC side like circuit breakers, fuses and disconnect switches.

Grid Connect Issues: These include quality of power supply covering harmonics, flicker, over voltage from direct / indirect lightning, transient overvoltage in grid, DC injection, EMC - EMI, reverse power flows, short circuit capacity of the inverter, auto reconnect after trip and AC side disconnect switch.

Safety Issues: In DC side, this has to be in the area of safety of installation with respect to contact with dangerous voltage levels, which includes warning signs, limiting access, insulation and grounding. In the area of grid interface, the most difficult problem concerns about islanding and it needs more attention to carefully test and select the inverters for protection from islanding.

As a part of development of these PV Standards, the existing Standards may be modified / revised and adopted to the extent possible to suit Indian conditions or otherwise they may have to be freshly developed in some cases, Also, as PV is proving to be a rapidly developing industry, Standards must be developed cautiously so as not to hamper the growth of PV. Coordinated efforts from MNRE,

BIS, the representatives of manufacturing industries of PV modules, batteries, charge controllers, inverters, lamps for PV applications, PV system integrators, electrical utilities, electrical testing laboratories and R & D organisations as well as academic institutions may be required to develop the Standards in a phased manner. Further, there is a need to create an awareness on the importance/relevance of these Standards, and prepare the working level draft documents for necessary review and approval by the suitable body.

MAN POWER DEVELOPMENT

Trouble free PV Systems are possible, only if following are fulfilled i.e. (i) Quality System (ii) Quality installation (iii) Easy Maintainability and Reliability and (iv) Assured Performance. If one carefully looks at each one of these, these are influenced by (i) quality aspects and critical selection of components and subsystems (ii) manufacturing, assembly, testing and certification of subsystems and system integration (iii) standardization of test procedures, installation practices and inspection procedures (iv) maintenance and trouble shooting of the subsystems (v) technical competency of the manpower involved in each of the above activities. The quality of manpower is the key factor in achieving the first four, and hence there is a need to produce quality manpower by organizing the training programs and workshops in the respective areas of PV.

Training Programs: Technical Institutions, depending on their strength and expertise, can play a significant role in a number of ways to achieve these. Following may be considered for developing the required Manpower: (i) Revamping of curriculum and introduction of SPV in the courses offered in Engineering Colleges, Polytechnics and Industrial Training Institutes (ii) Training Programs for Development of PV practitioners (iii) Accreditation of PV Training Laboratories and (iv) Certification of PV Practitioners like PV Installers, PV Inspectors and Field Service Personnel at different levels.

Workshops / Seminars: Well designed Workshops / Seminars on PV Failure Analysis may be organized by taking several case studies. The problems relating to BOS, system



design or sizing, wiring, installation, operation and maintenance may be taken up for detailed presentations and discussions. Such an approach would be more useful to identify the root cause of the problems and take suitable remedial measures for restoring the operation of the systems/plants.

PV SYSTEM RELIABILITY DATABASE

As Indian PV industry is growing with many upcoming MW size PV Power Plants, it is high time to establish the product wise (i.e. Solar lantern, Water Pumping System, Street Lighting System, Home Lighting System, PV Power Plants of Stand-alone as well as grid connected) reliability data base for each State/region. This database may be built to retrieve the information such as capacity ratings, performance, reliability, cost, supplier/installer and end user. While the performance data may include daily or monthly energy production data, reliability information may include the system/plant failures, type and duration of the failures and reasons for the same. This database, if established not only will be useful to validate the over all designs of PV systems / plants but would also help to take corrective actions for restoring them and to know the healthiness of the systems installed in the country.

NEW TECHNOLOGIES AND PRODUCTS

PV CELLS AND MODULES

Over 90% of commercial PV cell production now is made from crystalline silicon and the rest belong to different types of thin film technologies. Due to shortage of silicon and for using the potential of this material fully, several research organizations and PV industries are working intensively on different technologies that would result lower and lower silicon usage, less energy for processing and higher efficiency cells. In parallel, many research groups are concentrating on the alternate materials to silicon.

As a result of these ongoing R & D activities, PV cells of different technologies with higher efficiencies and/or lower prices are expected to be available in future. Typical ones are: thin film CIGS, thin film silicon, ultra thin

crystalline silicon solar cells, dye sensitized solar Cells (DSSC), silver cells, organic thin film solar cells, multi junction cells, Vertical Multi Junction (VMJ) cells, CNT (Carbon Nano Tube) cells and CNT 3D cells. Further, flexible PV Modules using DSSC, known under brand names such as power plastics may be available commercially for 'PV Roof' and building integration applications.

Referring to the PV Modules, technical advancements and built-in electronics now allow the integration of small size high quality micro inverters along with PV Modules, often known as 'AC Modules', thus increasing the reliability of the systems. With master state control capability, several AC Modules may be paralleled to get a PV panel/array of the required wattage ratings.

PV/T FLAT COLLECTOR AND CONCENTRATING PHOTO VOLTAIC (CPV) SYSTEMS

As on now, the cost of PV electricity is 3 to 5 times higher than the cost of electricity from fossil fuels. This is due to the use of excessive cost of silicon material, and lower or efficiency of PV cells. One of the methods of solving the first problem is by concentration: i.e. collecting solar radiation with a mirror or lens, and concentrating it to a small target where only a small area is needed. Several types of concentrating systems are available with varying sizes and levels of concentration. The other problem is regarding the conversion efficiency. Most of the PV cells convert 10-20% of the incident radiation to electricity, while the more sophisticated (and very expensive) VMJ cells reach around 40% efficiency. Most of the collected solar energy is then rejected as heat into atmosphere. Efficient approach is to capture this rejected heat as well, and use it as an additional energy product. Photovoltaic/Thermal (PV/T) flat collector is the result of this approach, but provides heat at a relatively low temperature (40-60°C), which may be suitable only for domestic water heating. A large fraction of energy requirements of most of the buildings is for thermal (i.e. air-conditioning) and this may not be possible by low-temperature heat. Whereas, Concentrating Photo Voltaic (CPV) systems can achieve a synergy that meets both these requirements. CPV systems can greatly reduce the area of the cells and they can operate at higher



temperatures than that of flat collector PV/T type. The extracted heat is therefore suitable for a wide range of applications such as heating, air-conditioning, steam production or desalination. Therefore, CPVT system can provide electricity, heating, cooling, and in addition in some cases steam or fresh water from desalinated seawater.

ENERGY STORAGE DEVICES

Besides the Lead Acid and Ni Cd batteries, Nickel Metal Hydride (Ni MH), Lithium Ion, and Lithium Polymer batteries will find their increased use in PV applications when their prices come down, due to inherent merits of each of technologies. For example, Ni MH is best suited to the applications where high corrosion stability and long life time are the key factors. Fuel Cell is another fast developing technology and will be commercially available for PV applications as PV-Fuel Cell Hybrid systems.

Supercapacitors: Like batteries, these are energy storage devices and are almost ideal capacitors, with low Equivalent Series Resistance (ESR) and very low leakage current. Energy is stored via charge separation at electrode-electrolyte interface. They are now receiving great attention in low PV power applications due to higher power density, ability to withstand hundreds of thousands of charge/discharge cycles without significant degradation in performance, capacity to provide quick bursts of energy and long life of 10 to 20 years. In some cases, arrangement of supercapacitors in parallel with conventional batteries would effectively meet transient/surge power as well as steady power requirements.

Flywheel Batteries: These are also known as 'Mechanical Batteries'. They store the energy kinetically, instead of as chemical energy. It stores the energy kinetically through magnetically levitated flywheel rotor assembly. As kinetic energy is roughly equal to mass times the square of the velocity of the flywheel, doubling the velocity of the wheel would quadruple the energy storage capacity. New generation series of these batteries are more efficient by replacing mechanical bearings through magnetic bearings and spinning of the flywheels, made of carbon fibre/composite materials, inside the vacuum

through sophisticated electronics controls / drives. The main advantages of these batteries are: (i) high energy density (ii) almost zero power losses (iii) long life of 15 to 20 years (iv) higher reliability (v) minimal heat generation and (vi) absence of chemical and safety hazards and hence true environmental friendly. There would be a good demand in future for this type of batteries in PV applications, though they are expensive as on now.

NEW GENERATION CHARGE CONTROLLERS

New generation sophisticated charge controllers will offer options such as periodic equalization of the batteries, temperature compensation for varying environmental temperature and multipower source management capability (e.g. PV-wind-diesel hybrid). Auxiliary load diversion during peak sun hours when the battery bank under full charge condition, energy monitoring with remote access via modem and advanced weather prediction so as to modify the load configuration as well as and charge/discharge profile of the batteries are the advanced features that these controllers would offer in future.

MAXIMUM POWER POINT TRACKERS (MPPT)

The orientation of an array can be continuously optimized with mechanical devices called trackers, so as to get the maximum annual energy yield. These systems can track the sun in different ways, by changing the tilt angle, the azimuth or a combination of the both. An Electronic MPPT is a subsystem that operates the PV array at that voltage that provides the maximum power and then converts this voltage to a level as required by the battery or the load. This allows the use of a maximum energy from the PV array and this may be integrated either as a function of the charge controller or the inverter.

NEW GENERATION GRID CONNECTED INVERTERS

Some of the sophisticated inverters may often integrate many control functions, including the bi-directional models in which AC (i.e. utility mains) can be rectified into DC to charge the batteries. In the case of new generation inverters, one may have to look at their



salient features i.e. multi-string operation (which would allow to wake up one after another with increasing level of irradiance), master-slave arrangement, sleep mode of operation and wakeup algorithms, suitability for parallel operation, reduced THD levels, built-in DC and AC surge protection, integrated data acquisition system, meaning of efficiency notation including weighted efficiency, enhanced efficiency even at partial load conditions, DC injection into grid, standard protection against over temperature, protection against failure of critical components, redundancy in islanding protection and built-in diagnostics.

BUILDING INTEGRATED PHOTO VOLTAICS (BIPV) SYSTEMS

As the energy consumption in buildings is a significant percentage of total energy consumption in the country, now there is a growing interest to meet at least a part of this demand from BIPV. With all the advantages and promise of continued cost reductions, there is a large potential for BIPV systems. These could be either stand-alone or grid connected, replacing the conventional building materials and labour, thus further reducing the installed cost of the PV. Many BIPV systems are integrated roof type because these have the highest solar exposure and hence the output power, having more value at that site. Following are the requirements of BIPV: (i) Good architectural design (ii) Suitable PV system, fitting the building design with aesthetics (iii) Colour of PV cells to match the surroundings (iv) Good roof design and (v) Mountability and dimensions of the PV system. More BIPV specific products like flexible PV membranes, PV/Thermal Hybrid Systems, AC PV Modules, Architectural PV Glazings, Power Roof and PV powered Electrochromic Windows would be commercially available in future. Unlike that of outdoor applications, these products will be designed to allow direct sun light to pass through the modules into the buildings to generate electrical power as well as passive solar heating in the space adjoining the PV Modules. Quality aspects of these BIPV systems may fall under three categories namely (i) building related (ii) architecture related and (iii) PV related. Besides the standard PV modules, the use of custom made PV modules, PV cells of different colours, innovative designs of

different profiles/mountings and standardized mountings are foreseen. Also, system may evolve such that BIPV product will undergo for Type Approval and independent Acceptance Tests. Further, development of BIPV products with CE labeling would make the jobs of the architects simpler in getting the approval for their use as part of the building. Again to ensure the reliability and safety of the installations, it may become mandatory to get the BIPV systems installed by the certified PV installers.

PV ROOF TOP SYSTEMS

Recent development and emerging market is 'Roof-Top systems', in which PV cells are being incorporated into roofing materials. System cost may be further reduced in this way by offsetting against the cost of the building roof due to advancements in technologies of PV modules as well as inverters, and improvements in quality of the electrical power provided by the electrical utilities. Small Roof Top systems of standalone type and utility connected with two way (net) metering are expected to become more popular. Suitable incentive schemes as practiced in other countries, if implemented by our Government, would help to accelerate the growth of this segment of PV market in the country.

'PLUG AND PLAY' TYPE PV SYSTEM IN KIT FORMS

There are attempts being made to manufacture the BOS like charge controllers and inverters with terminal compatibility such that these items are interchangeable from one make to another. If this proceeds, in cooperation with PV subsystem manufacturers, if a Standard Common Bus Structure (like in any PC) is designed for interconnection of the subsystems, it may be possible to manufacture any PV system, for example, a Solar Home Power System it may then allow universal exchange compatibility of the PV subsystems. Then, the opportunity for manufacturing 'Plug and Play' type PV systems in Kit form, as in the case of PCs may become reality. This development along with PV Roof Tops with two way metering, integration of mini CPV systems to provide electrical power as well as heat power and fuel cell storage system would meet the most of energy requirements of a typical home and this day is not too far.



LARGE SCALE GRID CONNECTED PV POWER PLANTS

As a result of MNRE's strong initiatives, it is foreseen that a large number of large scale PV Power Plants (of 1 MWp, to 5 MWp capacity) will come up in near future in most parts of the country. No doubt that the design of these plants will be technically evaluated for performance, safety and reliability of inverters under Indian grid conditions. In due course, installation of large scale MW size PV Power plants for desalination of seawater for obtaining fresh water may become reality and this would help to solve the twin problems of 'Energy Crisis' as well as 'Water Crisis'. These plants, when they are replicated would help to expand the PV Market and to bring down the price of PV further.

Remote monitoring of the plants' performance: The above mentioned PV Power Plants will normally have remote monitoring feature. Continuous monitoring of the performance of the plants including day to day energy yields and healthiness of various sub systems from a central location would help to update the centrally located PV System Reliability Database.

CONCLUSION

Though PV is matured technology, due to certain quality issues associated with BOS and installation practices, probability of PV encountered with system failures are significant. The prices of both PV and BOS components are decreasing, following a trend of expanding PV market, improved technology and increased production. New generation PV modules of higher efficiencies and lower cost, quality BOS components and advanced energy storage devices would help to further expand the PV applications and hence the market. As a result of these and due to various proactive measures taken by the MNRE now, Large scale PV power plants, Distributed PV systems, PV Roof Tops, Solar Home Power Systems and BIPV Systems are expected to increase in large number in the years to come. Hence, this is the high time that remedial and promotional measures as suggested here taken as appropriate to the need for achieving reliable PV systems and this would help to promote the use of PV energy to a reasonable extent to meet a significant part of our energy requirements in the country in the coming decades. □



**IREDA CMD
Attends
Inauguration
of 500th
branch of
South Indian
Bank Ltd. at
New Delhi.**

Shri Debashish Majumdar CMD, IREDA addressing at the inaugural function of the 500th branch of South Indian Bank Ltd. at New Delhi in the presence of Smt. Shiela Dikshit, Hon'ble Chief Minister of Delhi and Dr. V.K. Garg, CMD, PFC Ltd.



Solar PV : The way forward

*K Subramanya **

The solar photovoltaic technology is fairly well established and is now being widely used the world over. The conversion of sunlight into electricity is not just a fascinating science but also a ray of hope for this energy-starved world. As we are increasingly debating about the depletion of natural resources of our planet, the search is on for an enduring energy source that could dramatically reduce our reliance on natural sources of fuel. Bio Gas, Wind, Tidal energy, Fuel Cells are a few of the non-conventional areas where significant research is currently on to find a sustainable energy alternative. And solar photovoltaics is a prominent field where significant efforts and monies are being invested to tap into the biggest energy source of our galaxy.

The global PV scenario is pointing towards a stupendous growth. Solar PV presently accounts for less than 0.5% of global energy situation and a recent report suggests this would grow at a CAGR greater than 40% in the next 5 years. Countries such as Germany, Spain, Japan and USA account for more than 90% of consumption of solar modules. An optimistic scenario suggests that by 2015, the global PV business size would be US\$ 350 billion. Even if the industry continues to be dogged by the availability of Silicon, it's not difficult to predict that PV industry is poised for its biggest growth phase.

The population of India continues to grow thereby increasing the gap between energy supply and demand, skewing it unfavourably. In order to meet the growing energy demand of the country, India will have to double its capacity of energy generation that calls for an investment of more than Rs.13,000 billion. The per capita electricity consumption of India is 600 KWh / year while the global average is 2,400 KWh / year. It is 13,000 KWh / year for the USA. A cursory look at the above numbers reveals a yawning gap in the energy scenario in India and

the rest of the world. The accumulated losses of the State Electricity Boards are in excess of Rs.280 billion. The transmission and distribution losses exceed 30%.

But the very lack of infrastructure presents a great opportunity for solar PV. India has an abundant solar resource with more than 300 days of sunshine every year. This is equal to over 5,000 trillion kWh/year. Though theoretical, India's entire energy requirements can be met just out of solar energy. Solar photovoltaic technology can be an answer to address many a energy related risk that India is currently subjected to.

Over 125,000 villages are yet to be electrified and many of them are so remote that there's little chance for grid electricity to reach them. Solar PV would be an ideal alternative as it can be commissioned even in the remotest corners of our country. Solar PV systems incur negligible operating costs and need little maintenance. Since the power generated closer to the point of utilisation, the entire costs of transmission and distribution are done away with. What's more, the PV modules have a life of 25 years guaranteeing efficiency and reliability.

Solar PV can help in generation of local employment and rural population, including women can take up additional activities of income generation. PV can help rural children go back to school helping improve the literacy of the country.

On the technology front too, solar PV is poised to achieve significant improvements. The efficiency of solar cells under mass production is expected to reach 20% - 21% in future. In addition, the advancements in manufacturing processes would enable processing of 150 micron wafers. These improvements, apart from increasing the manufacturing yield would also result in bringing down the cost of solar cells. Considerable work is also on to combine the lower cost Metallurgical grade silicon with the expensive Semiconductor grade silicon to

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produce low cost cells with a small compromise in efficiency. Such reductions in cost coupled with very negligible operational costs would make solar PV solutions extremely competitive with other forms of alternative energy and making it ideal for mass applications

Unarguably, PV technology is a winner and most ideal for our country. However, to make this technology a ground-level success, the role of the policy makers will be paramount. Clear, user-friendly policies and financial incentives targeting both the users and manufacturers would go a long way in spurring growth of the industry. The European countries have had very clear policies for embracing renewable energy, including solar energy. All we need to do is to draw from their experience and replicate those policies that are suitable to our needs. And if our country's energy scenario has to be improved, such actions are required immediately.

Though there are many programs and initiatives that could be implemented, following are some of the suggestions that must be accorded priority. A few of these suggestions when implemented would certainly catapult PV industry in India on the growth track.

- * To begin with a clear and vivid vision needs to be set out for renewable energy sources, including solar PV. The vision should articulate the position and role of PV in driving Indian economy for at least next 25 years.
- * Grid-connect solar PV to be accorded top priority as this represents the advanced technology of PV and is widely adopted worldwide.
- * Solar hybrid systems such as Solar-Wind bring a combination of energy resources into a working model thereby compensating the drawbacks of individual systems. Such systems need to be encouraged with distinct policies as they can also bring down the total cost of ownership.
- * Compulsory solar lighting in all commercial buildings, including government offices.
- * To clearly have distinguishing policies for the urban

and rural markets. The rural markets represent the need for basic energy while the urban markets are a representation of convenience, status, green culture, etc.

- * The subsidy programs must be reconsidered and reoriented to take into account the latest energy situation. Subsidies for non conventional sources would help mitigate the energy crisis that is impending to explode.
- * Extending a mix of capital subsidy, micro credits and crop-linked payback scheme for solar PV systems in rural areas. Special focus also is required for solar water pumps as irrigation represents the most important need of the agricultural community.
- * To provide a mix of capital subsidy and generation subsidy for solar power plants that would encourage private investment and also venture capitalists. Examples of solar water heaters are worthwhile remembering here. Some state governments have extended capital subsidy on solar water heaters (Delhi extends a subsidy of Rs.6,000 per water heater) and a few like Karnataka extend a subsidy on monthly electricity bills. But the impact is quite significant as solar water heaters have achieved good penetration and gained consumer acceptance.
- * Availability of subsidised finance to Corporates, Institutes and domestic users would certainly give a fillip to PV business. Though such schemes are already in place through certain banks, they are unable to make an impact. A wider, far-reaching scheme that would reach out through nationalised and private banks, Financial Institutions, DCCBs and other Grameena banks can transform the PV industry, a consumer goods industry.
- * A relief in Income tax or Property tax to users of PV products and systems.

In addition, it is very important to have clear targets in order to transform the vision and policies into a measurable system. The targets would exert pressure at



all levels of the policy chain and lead to implementation and performance. Though not exhaustive, some of the important targets for solar PV could be

- Of the total energy mix, the renewable energy share to be aimed at 25%. Within the Renewable energy mix, solar PV to be 25%
- To quickly aim for a Gigawatt scale - both in production and deployment
- 5% of all Petrol bunks to run on solar PV

While the policies and targets are forward looking, It is also important to mention here that there have been some important policy decisions announced in the recent past that will positively impact the solar PV industry in near future. Grid-connect solar systems are at the centre of many a discussion today ever since the government recently announced a support policy subsidising 80% of generating costs when electricity is fed back into the grid. Such a policy would encourage Corporates and Industries to set up Megawatt PV power plants and enable them to

manage their energy requirements more efficiently. Though set out in the right direction, the policy needs a bigger scale to make a significant impact as the incentive is restricted to only 50 MW. In the context of making renewable energy contribute to at least 25% of India's energy requirements, an incentive for 50 MW is insignificant.

The solar PV technology has evolved over time and today is able to meet even the most complex energy requirements. It is easy to use and offers convenience like never before. From domestic energy requirements to community requirements, from corporate offices to industrial needs, from road safety applications to green buildings solar PV has demonstrated its performance successfully. It can be commissioned in the remotest parts of our country and yet function reliably. With a little help from policy makers, this technology is all set to change the way we energise our lives.

The future is bright and shining for Solar Photovoltaic technology. □

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Corporate Governance

The National Common Minimum Programme (NCMP) of Government of India envisages a strong and effective public sector and pledges to devolve managerial and commercial autonomy to successful profit making companies operating in a competitive environment. The NCMP, inter alia, also provides that Public Sector Companies will be encouraged to enter capital markets to raise resources and offer new investment avenues to retail investors. Keeping in view the fact that large public funds have been invested in Central Public Sector Enterprises (CPSEs), there is a need for greater public accountability on the part of the CPSEs' managements regarding discharging of their duties and responsibilities. Also, as ethics and probity need to be maintained in the functioning of CPSEs, good Corporate Governance practices are required to be built into the management systems of CPSEs.

The Government of India has considered the above issues and approved the Guidelines on Corporate Governance for CPSEs. The Ministry of Heavy Industries and Public Enterprises, Department of Public Enterprises have formulated the guidelines through a consultation process with various stakeholders and keeping in view the relevant laws, rules and instructions. These guidelines cover issues like composition of Board of Directors setting up of Audit Committee, role and powers of Audit Committees, issues relating to subsidiary companies, disclosure, accounting standards, risk management, compliance and schedule of implementation etc. Implementation of these guidelines would protect the interests of shareholders and other stakeholders. The compliance with these guidelines requires to be reflected in the Directors' report, Annual Report and Chairman Speech in the Annual General Meeting.

IREDA is committed to follow the best practice of principles of good corporate governance. The Board lays strong emphasis on transparency, professionalism, accountability and integrity.

IREDA has taken following initiatives for implementation of corporate governance:

A : **BOARD OF DIRECTORS** :

- Composition of Board of Directors is in line with the DPE guidelines and provisions of Companies Act, 1956;

B : **AUDIT COMMITTEE:**

- IREDA has in place its Audit Committee in terms of provisions of Companies Act. The terms of the Audit Committee are as under :
 - (a) To appoint Internal Auditors and fix payment of fees.
 - (b) To discuss the scope of work of the Internal Auditors and review / modify the same.
 - (c) To discuss with the Auditors periodically about the internal control system, progress of the work and compliance/action taken by IREDA.
 - (d) To discuss the observations of the Statutory Auditors, Internal Auditors, action taken by IREDA and review the same.
 - (e) To review the half-yearly and annual financial statements before submission to the Board.
 - (f) To review the Internal Audit Reports and action taken/compliance report thereon, internal control systems and all matters of financial management having direct impact on the functioning of the Company.
 - (g) To review the Company's financial and risk management policy.
 - (h) To investigate into the matters referred to the Committee by the Board.



C : CODE OF BUSINESS CONDUCT AND ETHICS FOR BOARD MEMBERS AND SENIOR MANAGEMENT PERSONNEL:

- * IREDA has notified its Code of Business Conduct and Ethics for Board Members and Senior Management Personnel. The said Code is in line with the model Code of Conduct framed by DPE.
- * The object of this Code is to enhance ethical and transparent process in managing the affairs of the Company. The Code is in alignment with Company's vision and values to achieve the mission and objectives and aims at enhancing ethical and transparent process in managing the affairs of the Company.
- * Code of Conduct is hosted on the website of IREDA.
- * The Board members and Senior Management Personnel have submitted the compliance to the Code of Conduct for 2007-08.
- * Appropriate Disclosure on the same in the Annual Report for the year 2007-08 shall be reflected in the Directors' Report and Chairman's Speech.

D: COMPLIANCE AS PER RESERVE BANK OF INDIA GUIDELINES:

IREDA has put in place and disseminated the Fair Practices Code and Know Your Customer (KYC) policy on the website of IREDA for information of the general public as per RBI requirement. Briefly these guidelines are as under:

FAIR PRACTICES CODE:

- * Financing Guidelines for loan assistance of different types of projects contain details about rate of interest, repayment period, moratorium, minimum promoters' contribution, eligibility criteria for loan assistance, various incentives offered by the Govt., registration fee, front end fee, securities for the loan, disbursement procedure, concessions etc. and other conditions affecting the interest of the borrowers.

- * Prescribed form alongwith clear cut details about documents/information required for availing loan from IREDA.
- * Acknowledgement and verification of loan applications.
- * Validity of loan application.
- * Processing of loan applications.
- * Loan appraisal and terms & conditions.
- * Signing of loan documents.
- * Disbursement of loans including changes in the terms and conditions.
- * Monitoring and evaluation.
- * Notice before taking decision to recall/acceleration of payment.
- * Release of securities on repayment of loan and interest.
- * General :
 - Non-interference in the affairs of the borrowers except seeking information/document required for IREDA loan related queries.
 - No discrimination on the grounds of sex, caste, region and religion etc.
 - Convening of joint meetings/discussions to sort out the issues arisen.
 - Demand notices are sent twice in advance before the end of every quarter.
 - No harassment of borrowers in the recovery process which is pursued through ordinary course of business following due process of law.



GRIEVANCES REDRESSAL MECHANISM (GRM):

IREDA is having Grievance Redressal Mechanism containing procedure for settlement of grievances of customers of IREDA and to adopt measures as would result in timely settlement of grievances of IREDA's customers within the frame work of the policies, rules and procedures of the Company. IREDA is making endeavours to achieve and maintain a fair and cordial relationship between IREDA and its customers.

IREDA is having a Grievance Redressal Committee (GRC). The GRC meets once in a month to sort out the complaints etc. of the Customers of IREDA. The reports on redressal of the grievances are submitted to the appropriate authorities viz. CMD/Board of Directors on periodical basis.

'KNOW YOUR CUSTOMER' (KYC) POLICY

- ANTI MONEY LAUNDERING STANDARDS:

IREDA is having KYC Policy to prevent IREDA being used intentionally or unintentionally, by criminal elements for money laundering activities. KYC Policy enables IREDA to know/ understand the customers and their financial dealings better and manage the risks prudently.

As per RBI's guidelines on KYC policies, IREDA confirms the following key elements :

- * Customer Acceptance Policy.
- * Customer Identification Procedures.
- * Monitoring of Transactions
- * Risk Management.

IREDA has also appointed Shri S.K. Bhargava, Deputy General Manager (FS) & Company Secretary as **Principal Officer** in terms of requirements of RBI.

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Biofuels – Opportunities and Challenges

Sachin Chugh & Dr. Anurag A. Gupta *

Given an opportunity to bet on the World's Heavyweight Crown, who would you put your money on – Petroleum or Alternate Fuels? The prediction is going to send ripples in our thoughts as the former is an established player in the field and the later with bright possibilities establishing a foothold.

Transport sector, in particular, depends on oil for 98% of its powering source. That degree of dependence would be a worry, whatever the situation may be. It is of double concern given that oil is one of the fossil fuel of which global supplies are the lowest. There may be many options which may provide solutions to this problem; but today, biofuels are just about the only large-scale option available to diversify fuel sources in the transport sector.

But over the years, the fossil fuels have dictated terms of their own. The competition was not there and the crowning was natural. Today, these fuels form the backbone of each and every economy of the world. A blink without these fuels can stop the earth from spinning. Along its journey, this powerhouse has forgotten to complement the environment. The rise of about 0.7 degrees in temperature over the last century clearly demonstrates this dormant truth. Atmospheric CO₂ is now around 40% higher than before the industrial revolution. The Arctic and Antarctica may be the Earth's climate early warning system—feeling the heat first—but we know it does not end there.

Ocean circulation, the key driver of regional and global weather systems, is inextricably linked with melting and freezing processes in and around the poles. Water resources are already under strain. The hydrological cycle across the world is predicted to become more intense, both with the disturbed distribution of annual average rainfall as well as periods of drought. Coastal infrastructure, tourist activity, onshore explorations are

at risk. Large scale emigration from coastal zones is expected due to submergence of coastal-lines after sea levels have risen. This will create large numbers of environmental refugees especially from low-lying delta regions.

Also, with the term 'fossil', millions of years are associated. This period includes the time for deposition, chemical change and formation. With the current supply not able to compliment the demand, the exploration activities at the identified sites are emptying the bucket without any time to replenish. Moreover, the deteriorating health (quality) of crude is posing challenges to change the refining process. The changing product mix, environmental regulations and quality up-gradation are other areas where the defender can loose some strikes.

The greenhouse gas emissions in transport are growing fast. On present trends, transport will account for more than 60% of the increase in carbon dioxide emissions between 2005 and 2020; it is essential for these trends to be reversed. Therefore, the champion despite its powerful impact is being made to run for its survival.

The challenger on the other side is determined and geared up to enumerate the exuberance of youth. The infant is multi-faceted and the competition will be healthy only if the concentrated efforts of all the sources are applied. As far as the bio-fuels are concerned, the options do include ethanol and biodiesel. The application of these energy resources to overcome the mighty champ demands targeted approach from the decision makers and the government.

Ethanol has its own history and is driving the wheels in various countries for the past century. Oil companies in India marketed 5% ethanol gasoline blend during the pilot project in three locations - Miraj/Hazarwadi and Manmad/Panewadi in Maharashtra and Bareilly/Aanola in Uttar Pradesh. During the course of the pilot project, some

* Indian Oil Corporation Limited, Research & Development Centre, Faridabad – 121 007



problems related to compatibility of needle valve and float of the carburetor, carburetor overflow were encountered by some two-wheelers. These problems were resolved by incorporating suitable corrosion inhibitor and metal deactivator.

On the success of these pilot plants, the commercial production and marketing of ethanol-blended gasoline started in January 2003, when the government launched a program to mandate the blending of 5 percent ethanol in gasoline in nine states (out of a total of 29) and four union territories (UT) (out of a total of 6). The program foresaw an ethanol supply of 320 to 350 million liters from the domestic sugar industry (mostly mills with distilleries) to the oil companies.

But soon the ground realities in combination with the disproportionate relationship between demand and supply swelled from bubble to balloon. The country which was 4th major supplier of ethanol faced its deficiency owing to its great demand due to 5% blending in gasoline. Sugar production declined sharply in marketing year (MY) 2003/04, resulting in a severe shortage of molasses and a consequent increase in alcohol and ethanol prices. The government was forced to remove the mandatory supply condition, and introduced new pricing conditions on the use of ethanol for blending purposes in October 2004. The resurgence of the sugar industry in 2005 did see the fulfillment of the targets in the selected regions but for competing in the ring, the production has to complement the growth of the automobiles.

Prior to launching the ethanol in the market, complete trial testings were conducted to establish the effect of blends of ethanol in gasoline on engine fuel economy and exhaust emissions especially NO_x, hydrocarbons, CO, and other air toxics. With addition of ethanol in gasoline, it was observed that CO reduces due to the presence of oxygen atom in the fuel. Exhaust emissions of hydrocarbons may increase or decrease, depending on factors such as engine or product design and the overall fuel properties. However, NO_x emissions from conventional products and vehicles generally increase since enleanment creates conditions which increase NO_x. The degree of increase of NO_x, however, is a complex

function of engine design and other operating conditions. For sophisticated closed-loop operation, NO_x emission increases can be small, but for less sophisticated open-loop engines, increase in NO_x emission can be dramatic. India has about 300 distilleries, with a production capacity of about 3.2 billion liters of rectified spirits (alcohol) per year. The government's ethanol policy has led to 120 distilleries modifying their plants to include ethanol production, and these have a total capacity of over 1.2 billion liters per year. As per the figures available the motor vehicle growth in India is going to hover around 10-12% for the coming years and gasoline demand expected to increase at 5-8%. Therefore the sustainability has to complement the growth of vehicles besides adhering to the quality norms.

If the strategic thinkers are planning to launch 10% ethanol programme in India, the requirement of ethanol will be about 1500 million litres per annum. For this, the production capacities need to be enhanced by expanding the molasses based ethanol plants, and by setting up sugarcane juice-based production facilities. This poses an exciting challenge to the existing players in the market and survival of the fittest. Breakthrough technologies in production of ethanol have to be evolved. Fermentation technology is commercially established but the process design involving simultaneous utilization of different resources needs to be explored. Azeotropic distillation, molecular membrane dehydration and cellulose based ethanol technologies are in infant stage and R&D studies may be focused on developing these packages and for converting biomass to ethanol. Once this dosage is complete, indisputably ethanol is going to give stiff competition to gasoline.

In India, diesel has larger share than in other countries for transport purposes. Consumption of diesel is expected to rise at an annual 5.6% rate. Domestic supply can presently satisfy 22% of demand and dependence on crude oil imports (>18 billion \$/a) is increasing. There is a growing demand gap between production and consumption. Biodiesel however doesn't need any introduction. With the diesel consumption scaling new heights and controlling about 70% of the fuel matrix, the concentration on this alternative of diesel is absolutely imperative.



Biodiesel can be made after transesterification from virgin or used vegetable oils (both edible and non-edible). It is meant to be produced in India mainly from *Jatropha curcas* and, to a lesser extent, from other non-edible virgin oils (in particular *Pongamia pinnata*). *Jatropha* cultivation requires largely an unproductive land located in poverty-stricken, watershed areas and degraded forests. To accomplish this, the National Biodiesel Mission is being implemented in a phased manner. Phase I consisting of a Demonstration Project with an investment of Rs. 1500 crore (\$300 million) on 400,000 ha land. As a follow up of the Demonstration Project, Phase II consists of a self sustaining expansion of the programme leading to production of Biodiesel required in the year 2011-12. Expected outputs from 400,000 ha are meant to be 0.5 Million tonnes of bio-diesel, compost from the press cake, and generation of employment for the poor. Most of the states governments are taking steps to promote *Jatropha Curcas* and *Pongamia Pinatta*.

In Chhattisgarh, the government planted 80 million saplings of *jatropha*, a source of bio-fuel in 2005, as the state attempts to tap non-conventional energy sources. Andhra Pradesh has also taken the lead in *Jatropha* Plantation. The state government has set up a separate department for bringing into productive use the 728,000 hectare cultivable wasteland for *Jatropha* plantation to produce bio-diesel. The state government is drawing up a roadmap, which will see the involvement of oil majors to make the state one of the biggest producer of bio-diesel. It is planning to bring between 4 and 5 million acres of land in seven to eight districts under biodiesel plantations and ensure that micro-irrigation is used in a big way in these areas.

The Government of India may announce a modified biofuel policy during this year. The changes would be incorporated to dispel any doubts in the minds of farmers and other stake holders about the new initiatives. The ministry for new and renewable energy has suggested setting up of a national biofuel development board and formulation of the national biofuel policy for the promotion of biofuel as an alternate source of energy.

The new policy may propose minimum support prices (MSPs) for farmers engaged in the production of bio-fuel crops like *jatropha*, *karanja* seeds and oil-bearing materials. The rural development ministry, meanwhile,

had demanded a gross budgetary support of Rs 1,340 crore to support *jatropha* cultivation in 400,000 hectare of wasteland over a period of five years. The new policy envisages the replacement of 10% of the petroleum products requirement of the country with biofuels by 2012.

In line with the demand of the diesel a comprehensive shift to biodiesel may not be possible at this juncture. As the figures indicate that the requirement of the biodiesel is going to be 13.38 million tonnes if 20% blend is promoted. It has been observed that over a period of time the relative pace has shrunk and the country where the rate of growth of real estate and infrastructure market is following the geometric progression, there is a need to visualize and develop coherent techniques to meet the expectations from biodiesel. The supply chain model including the cultivation, extraction and production of biodiesel has to be strengthened to make it an economically viable alternative.

Second generation biofuel technologies have to be developed because first generation biofuel manufacturing has certain limitations. First generation biofuel processes are useful, but limited: there is a threshold above which they cannot produce enough biofuel without threatening food supplies and biodiversity. They are not cost competitive with existing fossil fuels such as oil, and some of them produce only limited greenhouse gas emissions savings. The new technologies include the production of Bio-DME, Fischer-Tropsch, BioHydrogen diesel, Biomethanol and Mixed Alcohols through syngas. Surely there is enough room for existence for biodiesel and the intermingling of technologies with strategies & policies could energize it to give healthy fight for capturing the crown.

These Alternate Energy options would help in rejuvenating the rural economy of India by giving employment opportunities to millions of poor and land less farmers. The support of all stakeholders, including energy companies, technology vendors, government organizations, opinion-leaders and academia, is required to channelize the dormant benefits which these extenders possess and to ensure the successful deployment and acceptance of these sustainable biofuels.

Are you betting on the Alternate fuels?



Gold Standard CDM: Recognising and Enhancing social and Environmental Sustainability in CDM Projects Through Global Recognition

Thilotham R Kolanu¹, Jasmine Hyman², & Caitlin Spark³

INTRODUCTION

Clean Development Mechanisms (CDM) is an arrangement under Kyoto protocol which is instrumental in transferring low cost GHG emission reductions from developing countries to developed countries. This mechanism allows entities in developing countries to implement projects that result in reduction of green house gas emission and to sell the quantified/certified emission reduction to industrialized countries which have targets to reduce GHG emissions owing their higher per capita GHG emissions. This mechanism is beneficial for both the party involved as developed countries are enabled in meeting their emission reduction targets by paying less as comparable of buying the same from other developed countries. The developing countries also benefit from such projects as they get the opportunity to generate additional revenue by selling GHG emission reductions on top of the benefits of implementing the CDM projects. In addition, such projects make a contribution towards sustainable development (SD) in their own country.

CDM IN INDIA

India acceded to the Kyoto Protocol in August 2002 and one of the objectives of acceding was to fulfill prerequisites for implementation of Clean Development Mechanism (hereinafter referred to as CDM) projects, in accordance with national sustainable priorities (CDM

India). A variety of CDM projects have been implemented in India which include renewable-like biomass, small hydro, wind, biogas etc; energy efficiency projects in a variety of manufacturing industries, such as cement, thermal power plants, and steel and aluminium. In 2005 India registered its first CDM project. Total number of CERs issued to date in India is 31,918,274 tonnes of CO₂ and the expected average number of CERs is estimated to be 27,604,123 tonnes of CO₂ annually. Sector wise and state wise 300 CDM projects have been registered in India (as January 3rd 2008). A snapshot of CDM projects registered in India is presented in Table-1, by sector and region.

CDM AND SUSTAINABILITY A CRITICAL REVIEW

Although CDM is part of the emerging carbon market and aims to achieve sustainable development in developing countries and cost effective reduction of green house gases, there are uncertainties regarding whether CDM Projects are additional and help to achieve global sustainable development.. There is little proper guidance with regards to the correct interpretation of the concept of additionality (WWF). First interpretation could be the lower emission than in the non-project scenario and second interpretation is that the project would not have occurred without the CDM. The first is a baseline issue whereas the second screens out business as usual projects. Both are necessary to ensure climate effectiveness. Unfortunately the 2nd is not explicitly dealt within the rules and there is currently no indication from the CDM Executive Board that project developers will be obliged to show that their projects would not have happened without the CDM. Sustainable development of the host country which should have been the central feature of the projects is treated as an optional extra. K.H.Olsen's

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Table-1: Sector wise & State wise CDM Projects Registered in India

| Sector | No. of Registered CDM Projects | State | No. of Registered CDM Projects |
|--|--------------------------------|-----------------------------|--------------------------------|
| Biomass | 66 | Chattisgarh | 31 |
| Hydro | 35 | Rajasthan | 27 |
| Wind | 46 | Andhra Pradesh | 41 |
| Solar | 1 | Uttar Pradesh | 29 |
| Co-generation - Bagasse | 19 | Uttaranchal | 2 |
| Co-generation - Biomass | 11 | Haryana | 2 |
| Biogas | 1 | Himachal Pradesh | 12 |
| Cement - blending | 16 | Goa | 2 |
| Cement - usage of alternate fuels | 3 | Gujarat | 23 |
| Waste heat recovery | 42 | Karnataka | 38 |
| Fuel Switch | 12 | Jharkhand | 1 |
| Methane Recovery | 9 | Maharashtra | 31 |
| HFCs | 4 | Orissa | 9 |
| Natural Gas grid connected power plant | 4 | Punjab | 18 |
| Others energy efficiency projects | 30 | Tamilnadu | 32 |
| | | Madhya Pradesh | 8 |
| | | Pondicherry | 2 |
| | | West Bengal | 15 |
| | | Projects in Multiple States | 26 |
| Total | 299 | Total | 325 |

(2005), extensive review of literature on CDM's contribution to sustainable development including poverty alleviation, reveals that the CDM does not significantly contribute towards sustainable development. CDM is expected to deliver sustainable development benefits including investments, technology transfer and contribution to poverty alleviation. It is mandatory for CDM projects to result in emission reductions which are real, measurable, long term and additional to any that would otherwise have occurred. Inclusions of a wide range of unsustainable projects types including fossil fuel technologies, large hydro and potentially large scale monoculture plantation forestry crowds out smaller investments in sustainable energy and efficiency projects (WWF). Moreover, when it comes to practical and concrete assessments of sustainability impacts of CDM projects there is no single, authoritative and universally accepted approach or methodology applicable to any CDM project regardless of project type and location (K.H. Olsen 2005). Prerogatives of all designated national authorities (DNAs) to confirm whether a CDM project achieves socio-economic sustainability or not lead to variance of sustainable development indicators, as different host

countries prioritize their individual development criteria. Even different stakeholders priorities are at variance with regards to aspects of sustainable development (Brown & Corbera 2003; Kim 2003). Moreover, in CDM project provisions for stakeholder consultation and public participation are inadequate. Stakeholder consultations are not considered seriously and there is no requirement that project documentation be available in language familiar to stakeholders (WWF). At times the competitive buyer countries tend to attract host countries to invest in projects by giving incentives to set low sustainability standards (Sutter 2003). Recently it has been found that SD criteria are not clearly defined by DNAs (Brown, Adger et al 2003) which reopens the question of who should assure the sustainability of CDM projects and how. In this context many studies have been carried out to assess the sustainability impact of CDM projects using different criteria and indicators.

GS CDM: A RESPONSE TO LOW QUALITY CDM

The above problems threaten the credibility of the CDM and undermine its potential to deliver the benefits



it is capable of. In addition, these issues create risks for all actors in the carbon market: heightened political risks for project developers, reputation risk affecting investors, particularly those concerned with corporate social responsibility and environmental reputation, little assistance for host countries working towards sustainable solutions and future and public doubts over the credibility of emission reduction projects (WWF). To explicitly address these problems and to provide a standard and rate CDM projects, WWF International has taken the lead in conceptualizing The Gold Standard (GS). Initiated by WWF, SSN, and Helio International The Gold Standard for CDM/JI projects was launched in 2003 after a wide-ranging stakeholder consultation with carbon market experts, environmental organizations, business and government representatives. In 2005 GS became a non profit foundation under Swiss Law and is funded by public and private donors worldwide. GS is the only independent best practice benchmark for carbon emission reduction projects widely endorsed by the environmental community. The Gold Standard label and methodology offer a widely recognizable brand for carbon reduction projects, allowing GS projects to fetch premium prices and reputation benefits. It is a yardstick for evaluating the quality of the project and a practical guide for the project developers who are committed to the environmental integrity of their investments.

ORGANIZATIONAL STRUCTURE

The GS Technical Advisory Committee (TAC) is a group of carbon market experts who consult on emission reduction projects and provide technical support for the Foundation's Board and the GS Management team. Its mandate includes assessment of potential GS projects to ensure the credibility of the validation and verification process and maintain the credibility of the label.

CRITERIA THAT DISTINGUISH GS CDM PROJECTS DIFFERENT FROM NORMAL CDM PROJECTS

Gold Standard is composed of set of quality control criteria based on following three screening processes. These are:

1. Project Type Screen: The project must be a renewable energy or energy efficiency project type.
2. Additionality and Baseline Issues: It must go above and beyond a "business as usual" scenario and must prove additionality according to the UNFCCC's additionality test.
3. Sustainable Development Screen: The project must promote sustainable development.

Project Type Screen

GS projects belong exclusively to the domain of renewable energy and energy efficiency technologies because they carry inherently low environmental risks and lessen human reliance upon fossil fuels. The GS methodology was explicitly designed to facilitate a shift from a fossil fuel based energy intensive economy to an economy based on renewable . Other projects, such as gas flaring or carbon sequestration, while potentially beneficial to the environment in the short term, don't change the fundamental relationship to the ways humans use and produce energy. fossil fuel consumption in the long term (CDM Gold Standards). GS certification is reserved for projects that maximize long-term environmental betterment.

Additionality Issues and the Baseline Scenario

GS projects look beyond business as usual scenario. Normally, for a conventional CDM project it is not mandatory to follow the UNFCCC' additionality tool which provides a step by step method for showing that a project goes beyond a "business as usual" scenario: Gold Standard projects require application of the UNFCCC's additionality tool. The project must result in measurable emission reductions that are verified by UN accredited third-party auditors. , The UNFCCC additionality tool provides clarity and transparency and sets a minimum standard allowing for comparison between credits. A GS CDM project must also demonstrate that no similar projects in terms of technology, fuel, size, site and process have been commercially implemented, without carbon finance, in the region in the previous 5 years (WWF).



GS projects Ensure Sustainable Development

Unlike conventional CDM projects, Gold Standard CDM projects prioritize contribution to sustainable development. The GS methodology employs a set of SD indicators that ensure a net positive environmental impact and require a series of stakeholders consultation meetings. It ensures that the project makes a three fold contribution to sustainable development; First, additional environmental criteria, in addition to an EIA when necessary, are taken into consideration at all levels from local to global. Second, local populations are invited to participate in the project design and their concerns or comments documented in the project monitoring plan. Third, economic and technological development as stipulated by the project types eligible, permits the introduction of new technologies into region and helps to stimulate new market economy. Only projects with an overall positive impact on the environment, on neighbouring communities and on local economy are eligible for Gold Standard CDM certification. Unlike conventional CDM projects the GS projects go through two stakeholder consultations, one at initial stage during the design phase of the project and the other at a later date, before the project is submitted for validation. All relevant local stakeholders from the local community and all regional GS supporter NGO's should be invited to participate in the initial stakeholder consultation - this process is designed to promote transparency and ensure credibility. It encourages members of the local population to participate in the socio economic development of their region and contribute to global climate change mitigation. The second stakeholder consultation takes place before GS validation and must demonstrate that stakeholder concerns have been addressed and incorporated into the project design. Essentially, the GS consultations require project developers to actively engage relevant stakeholders and to substantiate their response to the participatory process.

GS FOR VOLUNTARY OFFSETS

With the rules and procedures for Voluntary Offsets (GS VER) the Gold Standard offers the world's only

independent quality standard for generating high-quality verified emission reductions (VERs) within the voluntary market. VERs are used for offsetting emissions of companies, events and individuals.

To ascertain high quality offsets contributing to local and global sustainable development and real, additional emission reductions, the GS VER builds on the criteria applied for GS CDM projects. The main differences are as follows:

- ✱ Simplified guidelines for 'micro-projects delivering less than 5,000 tonnes of emissions annually and lowered validation costs.
- ✱ Broader eligibility of host countries
- ✱ Lower requirements on the use of official development assistance (ODA)
- ✱ Border scope of eligible baseline methodologies and ability to develop new methodologies.
- ✱ No need for formal host country approval

Validation and registration to the GS and verification follow the general principles of CDM. A Gold Standard registry is allows for unambiguous identification of credits used to back offsets.

GS CDM PREMIUM QUALITY AND BRANDING

As mentioned earlier GS projects mark premium quality carbon credits. The premium that a Gold standard projects gets for its credits is some times 50 to 100 per cent more than normal CER price. GS brings more certainty to the carbon market. Using the Gold Standard, project developers can profit from a fair priced niche market. In the voluntary market, GS voluntary credits are independently validated, clearly additional and promises sustainable development benefits in a renewable energy economy. GS is the safest investment in the voluntary market. GS has established an excellent reputation and very high standards in the CDM and JI markets. The reliability stems from GS's adherence to the UNFCCC



additionality tool and best practice methodology and makes GS a safe choice for the voluntary market. The GS has a clearly defined process with steps for project design, validation, verification and administration of issued credits which ensures that a GS voluntary credit is a tradable product in an otherwise illiquid market.

The GS foundation has recently expanded its terms to include local experts who work as part time GS consultants.

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www.wwf.or.jp/activity/climate/lib/kyotoprotocol
<http://cdmindia.nic.in>, <http://cdmgoldstanard.org>

0.75 MW MALIGIRI SHP



Name of the Company : M/s. Venika Green Power Pvt. Ltd.
 Project Location : Mandya -Taluk, Mandya-District, Karnataka
 Load Factor : 57 %
 Design Head : 4.63 M
 Design Discharge : 20.01 Cumecs
 Number of Units : 1
 Installed Capacity : 0.75 MW

Date of Commissioning : 02/10/2007

5.00 MW BRAHMGANGA SHP



Name of the Company : M/s. Harisons Hydrel Construction Company Pvt. Ltd
 Project Location : Manikaran- Village, Kullu- District, Himachal Pradesh
 Capacity factor : 79 %
 Design Head : 229.3 M
 Design Discharge : 2.52 Cumecs
 Number of Units : 2
 Installed Capacity : 5.00 MW

Date of Commissioning : 29/03/2008



Energy Efficiency vs Small Scale Renewables

Climate Change is the biggest challenge facing the world today. Civilization has developed in what is now recognized and an unusually stable climatic period. We may be about to change all that. The climate change when initially responding to changes in greenhouse gases does so in a fairly predictable manner, and the consequences of this alone will be devastating. More abrupt changes are however possible when the climate system changes state i.e ocean circulation patterns change. The climate system has been described as a drunk: leave it alone and it is likely to gently wobble around but push it and you increase the likelihood that it will collapse. We are performing this experiment by releasing vast quantities of greenhouse gases, preeminent of which is carbon dioxide. The harder we push and the more sudden the jolt, the more likely the climate system is to change dramatically. Many people think we should stop pushing!

Governments have responsibility to act, but so do individuals, what can we do? Many things: restrict the distance we travel, use energy efficient cars, and, importantly, reduce use of fossil fuel derived energy for running our homes.

In the domestic setting is it more cost effective to reduce energy usage or produce your own green energy? Unfortunately this question doesn't have a simple answer.

Case A When the 'domestic setting' is a yet to be built house there is great potential to save all the energy associated with heating. However the cost of several renewable energies is also reduced at this stage.

Case B When the 'domestic setting' is an already built house built up to modern building regulation standards the opportunities for energy efficiency improvements are significant but poor when compared to the opportunities for renewables.

Case C When the 'domestic setting' is an old house with little in the way of insulation there are often several cheap energy efficiency measures which are worth looking at.

CASE A: THE DETAILS

The physical structure of a house has an impact on two main energy requirements, energy for heating (or cooling) spaces and energy for lighting. Energy for heat is by far the most significant of these requirements in most situations.

- * In order to keep a property at a suitable temperature the design should consider the proportion of windows on the northern and the southern side of the building, it is advisable to glaze the southern side with 70% of the total glazing when in a cold environment. This maximises 'solar gain' and minimises energy losses.
- * In hot areas it may be worthwhile considering 'thermal mass' i.e rock/concrete as a significant structural element in living areas. Thermal mass stores heat but also takes a long time to warm up: during the night the living areas have time to cool down so during the day much of the heat in the air is removed warming up the mass again. If any of you have ever been in a castle before then you will know they tend to remain just cool, roughly the same temperature at mid day as at mid night.
- * More traditional methods of insulation have two important factors: thermal conductivity and air tightness. In new houses both of these are important but air-tightness is a particular feature of top-end eco-homes. Reducing the number of air changes per hour down to very low levels has enabled the design of buildings that need no heating or only very occasional heating, even as far north as Norway and Sweden! One of the best ways to achieve this air tightness is through use of structurally integrated panels (SIP). This building method involves using a layer of insulating material sandwiched between two pieces of composite board and allows very tight sealing of these components to give a more or less air tight 3D jigsaw. These buildings if done correctly actually need a ventilation system to be included to remove stale air! This ventilation system can be fitted with a heat exchanger so that



around 75% of the warmth in outgoing air is used to heats the incoming air.

- ✱ Preventing the usual types of heat loss through thermal conduction is relatively inexpensive whatever system of building is used. There are a wide variety of alternative insulation techniques such as using straw bales, wool or recycled news paper. All of these materials however require careful consideration and their use requires consideration at an early stage of the design process. In the UK the traditional form of insulation is mineral wool, increasingly a layer of sprayed cellulose is used, this having similar thermal properties. These materials if applied to sufficient depth (>300 mm for a low carbon home) do provide a good level on insulation, this thickness insulation is however not possible in all areas of buildings. Several high performance alternatives exist, including foil backed PU, which can be used at a thickness of 100 mm to give the same insulating properties as 250 mm mineral wool. Particular attention has to be paid to dormer windows which are often poorly insulated due to the lack of space. A specific warning should be given with regards multi-foil insulation (typically 20 mm thick with numerous layer of foil) don't use it! The national physical laboratory just revealed its performance is about a quarter what is claimed! Use foil faced PU instead.
- ✱ The main types of renewables which can be installed at reduced cost during the construction phase are photovoltaics (PV) and ground heat. The reduced cost of installing PV is due to the fact that PV tiles can be used instead of regular tiles or slates. For this reason there is some gain from PVs as you need less regular building materials. Ground heat (as apposed to geothermal) is an increasingly common way of getting cool but not cold water out of the ground. During the winter at mid latitudes water used in households has to be heated from around 0 degrees Celsius up to usable temperature. Ground heat utilises the fact that below about 1m in depth the ground is at a just about constant temperature all year round and therefore water has to be heated less. This system needs quite a bit of room and installation under the floor of buildings is ideal.

CASE B: THE DETAILS

Modifications of buildings are expensive. Alterations, therefore, must have significant advantages over the status quo for them to be viable when compared to micro-generation. The main modifications which can be easily carried out on new buildings are 1. The fitting of a condensing boiler. 2. Draught proofing 3. Increased loft insulation and 4. Improved glazing (particularly softwood argon filled low-emissive glass double glazing).

Because of the limitations of affordable modifications in this case we will take this opportunity to give a rough guide to micro-generation. The suitability of these power sources varies enormously with site but one or other of them will be practical for most sites.

- ✱ Solar Panels (provide hot water). The average UK emits around 5 tonnes of CO₂ per year. Of this around 27% is due to heating water. A typical solar panel system may aim to provide 60-70% of this hot water requirement. 100% of the hot water requirements in the summer but no more than about 25% in the winter. Carbon reduction is therefore 5 tonnes x 0.27 x 0.65, giving an annual saving of around 0.9 tonnes of carbon a year. The price of solar heating varies but is typically in the range of GBP 2500-3500. In the UK grants of GBP 400 are available for these systems so the cost to the consumer is from GBP 2100. Solar is currently the most affordable small scale renewable. In Spain it has just become compulsory to install solar panels on all new buildings, the carbon saving produced by this plan will be huge, bearing in mind the hundreds of thousands of new homes built each year.
- ✱ Small Scale Wind (feeds directly into power supply, or used to heat water). Wind turbines intended for domestic use typically have a maximum rated value of 0.6 kW to 1.5 kW. The average UK home uses 3300 kWh electricity a year (and a greater amount of gas for heating needs). Over a year these systems will generally generate as little as 800 kWh and as much as 2500 kWh, these values may however be radically improved upon given an ideal location. Wind power on the west coast of Scotland for example is likely to be by far the most affordable small scale renewable. The small units are designed to feed directly in to the power supply of the



house, they provide the base load and less electricity is drawn from the grid. Larger units often have an optional heating element so the all the energy captured is utilised even if more energy is produced than immediately required by the household. Costs are fairly high, but significant grants are available.

- * Photovoltaic (PV) is a new and still rapidly developing technology which faces significant economic problems in the UK but which has great potential in warm climates. A typical installation would consist of two modules and produce a maximum of 2 kW of power. A 2 kWp system in the UK will produce at least 1500 kWhr (about half the average household consumption) and would save around 0.65Kg of carbon dioxide emissions a year. In the lifetime of a solar cell (at least 25 years) the saving would be more than 16 tonnes of carbon, from around 37,500 kWhr of electricity. Factors currently encouraging the uptake of PV include government grants of around GBP 3500 per kWp of installed capacity and the dramatic increases of oil prices. Like large scale wind which has reduced its prices per kWhr dramatically since the 1980s it is expected that innovation and market scaling will cut prices drastically in the long term.

CASE C: THE DETAILS

In old houses with poor insulation, and, of a design which does not consider energy needs, the gains that can be made from energy efficiency and renewables are largest of all. The cheapest gains are likely to come from improvements in energy efficiency but investment in renewables is also required to reduce the carbon footprint of these buildings to sustainable levels.

- * Energy efficiency of households can be improved by changing the appliances and heating systems being used. Use of A rated white goods and energy efficient light bulbs are the first steps to be taken.
- * More significant investment and savings can be made by using an A rated condensing boiler.
- * In terms of reducing the requirement for heating the two biggest and least expensive gains can be made by increasing loft insulation and adding insulation to cavity walls. There are numerous types of cavity wall insulation

that can be applied without major disruption to the house. Injected resins and foam beads are commonly used.

- * Many old houses are single glazed and good quality double glazing achieves a U-Value of around 1.4 to 1.6 which compares favourably to 5.0 for single glazing. Secondary glazing, when appropriately fitted can be a cheaper option that results in similar improvements in energy efficiency.
- * Somewhat surprisingly one of the best value investments in old housing stock is the purchase of a good central heating system which is easy to use and programmable. Being able to set individual rooms at the desired temperature and at the desired times has been found to reduce the total amount of heating used drastically.
- * Finally a bit of simple DIY is often very useful, draught stripping and other improvements to air tightness can make an enormous difference to old houses.

As an example of what can be achieved Kirklees Metropolitan Council managed to upgrade 19 houses built in 1946 to a SAP (Standards Assessment Procedure) rating of 76 from 35 by simply installing a well insulated and efficient heating system with 3-4 square meters of solar panels. This resulted in average yearly savings of 1.4 tonnes of carbon dioxide.

To conclude: there are many renewable energy options and they tend to be locations specific. Basic improvements in energy efficiency of old housing should however be the first consideration.

The reason for bothering is Climate Change, many of the measures will have long terms of payback but increases in comfort levels are also important. According to the latest science we each have about half a tonne of carbon dioxide to emit a year! The earth can remove around 3 billion tones from the atmosphere and there are six billion people on the planet and rising.

So the message is get on to it, your bit of renewables and energy efficiency measures will be needed (if you still want your TV/PC/washing machine/DVD player/dish washer etc...)

Source: <http://climatechangeaction.blogspot.com/2005/09/energy-efficiency-vs-small-scale.html>

पृथ्वी पर ऊर्जा का कोई विकल्प मौजूद नहीं है

लेकिन वैकल्पिक ऊर्जा मौजूद है

इरेडा वैकल्पिक ऊर्जा के द्वारा

दीर्घकालिक विकास हेतु

प्रतिबद्ध है



इरेडा की विशेषताएँ

- न्यूनतम वार्षिक ब्याज दर **7.5%**
- **10 वर्ष** तक की वापसी अदायगी अवधि
- संस्थापित परियोजनाएँ भी योग्य हैं*

स्वच्छ और उज्ज्वल भविष्य के लिए इरेडा में अपनी संकल्पना एवं परियोजना प्रस्तुत कीजिए और उसके लिए वित्त प्राप्त कीजिए।

अक्षय ऊर्जा से देश विकास
गाँव-गाँव बिजली, घर-घर प्रकाश



भारतीय अक्षय ऊर्जा विकास संस्था सीमित

(भारत सरकार का प्रतिष्ठान)

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भारत में जैव-ईंधन का परिदृश्य

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पृष्ठभूमि

भारत की अर्थव्यवस्था तेजी से विकसित हो रही है और उसी के साथ ऊर्जा की मांग भी बढ़ रही है। ऊर्जा की मांग की दृष्टि से विश्व में भारत का छठा स्थान है। अगले दो दशकों में अर्थव्यवस्था की वृद्धि 7-8 प्रतिशत तक पहुंच जाने की संभावना है। भारत के पास कोयला के पर्याप्त भंडार हैं, लेकिन तेल और गैस की कमी के कारण पेट्रोलियम की लगभग 72 प्रतिशत जरूरत बाहर से आयात करके पूरी करनी पड़ती है।

पूरे विश्व में पेट्रोलियम की वार्षिक आवश्यकता 17,000 एमएमटी (मिलियन मीट्रिक टन) है, जबकि भारत की 120 एमएमटी कूती गई है। तेल और प्राकृतिक गैस का घरेलू उत्पादन सन् 2006-07 में 340 लाख टन के आसपास था। अतः मांग और पूर्ति का अंतर आयात से ही पाटा जा सकता है। सन् 2004-05 में 22.6 अरब डालर (लगभग 1,01,963 करोड़ रुपये) का तेल मंगाया गया था, जो सन् 2005-06 में बढ़कर 34.1 अरब डालर (लगभग 1,50,557 करोड़) तक पहुंच गया। 2006-07 में यह आंकड़ा 43.3 अरब डालर (लगभग 1,90,000 करोड़ रु.) तक पहुंच गया था। इस तरह हर साल पहले से औसतन कोई ढाई गुना अधिक पूंजी खर्च करनी पड़ रही है।

इसमें अक्षय-ऊर्जा के साधन अपनाने से कमी की जा सकती है, जैसे कि जैव-ईंधन के उपयोग से। जैव-ईंधन के दो स्रोत – इथेनोल और बायोडीजल पर सारी दुनिया का ध्यान गया है। इनको अपनाने से पर्यावरण के क्षरण की समस्या घटेगी, आयात में कटौती होगी, ऊर्जा-सुरक्षा, ग्रामीण रोजगार तथा कृषि-अर्थव्यवस्था बढ़ेगी। तेल पर हमारी निर्भरता भी कम होती जाएगी।

बायोईथेनोल

कम परमाणु-भार, अधिक ऑक्सीजन अंश, अधिक दहन-दक्षता, गैर-जहरीला और प्रदूषण-रहित प्रभाव के कारण इथाइल अलकोहल (यानी इथेनोल) सम्पूर्ण जैव-ईंधन माना जा

रहा है। यह शर्करा और मण्ड सामग्री से बनाया जाता है। जब वाहनों में इथेनोल को ईंधन के रूप में अपनाया जाता है तो ऑक्सीजन के रूप में टैट्राइथाइल लैड का इस्तेमाल नहीं करना होता। इससे सल्फर डाइऑक्साइड, नाइट्रोऑक्साइड तथा कणमय सामग्री का उत्सर्जन नहीं होता। इससे हाइड्रोकार्बनों का जो उत्सर्जन होता है, वह कैंसरजनक नहीं होते और कार्बन डाइऑक्साइड पेट्रोल की तुलना में 57: कम पैदा होती है।

ब्राजील में इथेनोल शर्करा से, अमरीका में अनाजों से, यूरोप में सुगरबीट (चीनी चुकंदर) से और भारत में शीरे से बनाया जाता है। ब्राजील अपने 20: वाहनों में शत प्रतिशत इथेनोल तथा बाकी वाहनों में गैसोलीन में 25: इथेनोल मिश्रित करके इस्तेमाल करता है। आस्ट्रेलिया गैसोलीन में 10: इथेनोल मिलाता है, यूरोप 15: और स्वीडन 5:।

भारत में बायोईथेनोल तरह-तरह की कच्ची सामग्री से बनाया जाता है। उदाहरण के लिए मिठास वाले पौधों – गन्ना, चीनी चुकंदर, मीठी ज्वार, फलों के छीजन, महुआ के फूल इत्यादि से; मण्डयुक्त पौधों और धान्यों से – आलू, शकरकंद, कसावा (टेपिओका), चावल, मोटे अनाज, मक्का आदि से और सेल्यूलोजयुक्त बायोमास से, जैसे कि शीरा, गन्ने के छीजन, गन्ने के अगोलों तथा फसलों के छीजन से।

बायोडीजल

बायोडीजल पर्यावरण-हितैषी ईंधन है। इसमें सल्फर कतई नहीं होती, कोई एरोमैटिक यौगिक नहीं होते और ऑक्सीजन (10:) अंतर्निहित होती है। यह वसा-अम्ल का एस्टर होता है – इथाइल या मिथाइल। बायोडीजल के भंडारण और वितरण के लिए अलग से किसी बुनियादी ढांचे की जरूरत नहीं पड़ती और वर्तमान टंकियां, टैंक तथा पेट्रोल-पंपों में ही इसका भंडारण और वितरण हो सकता है। इसका इस्तेमाल करना, लाना-ले जाना, उठाना-रखना पूरी तरह सुरक्षित है। डीजल के अपेक्षा इसके लैश पॉइंट अधिक होते हैं। डीजल में बायोडीजल मिलाने से गैर-जले हाइड्रोकार्बन का अंश कम होता है। वाहनों में इसको इस्तेमाल करने से उनके उत्सर्जनों में कार्बन मोनो ऑक्साइड और कणमय सामग्री बेहद घट जाती है। पिछले एक दशक में दुनियाभर में बायोडीजल का उपयोग बढ़ा है। यूरोप, जर्मनी, फ्रांस और

* निदेशक (पी), राष्ट्रीय तिलहन और वनस्पति तेल विकास बोर्ड (कृषि मंत्रालय), गुडगांव, हरियाणा, इरेडा न्यूज, अक्टू-दिस.2006 के अंक में पृष्ठ 5-12 का संक्षिप्त हिंदी रूपांतर



आस्ट्रेलिया ने बायोडीजल का उपयोग बढ़ाने के बड़े आकर्षक कार्यक्रम बनाए हैं। अमरीका, कनाडा, मलेशिया, थाइलैंड, फिलिपीन्स, घाना, दक्षिण अफ्रीका, चीन, जाम्बिया और अन्य अनेक देश भी इस क्षेत्र में आगे बढ़ रहे हैं और भारत भी इनसे पीछे नहीं है।

बायोडीजल को खाद्य और अखाद्य दोनों तरह के वनस्पति तेलों से बनाया जाता है। यह पशुजात चिकनाई से भी बनाया जाता है। पेट्रो-डीजल की तरह कम्प्रेशन इग्नीशन इंजनों में बायोडीजल भी उतना ही कारगर है और प्रदूषण नगण्य पैदा करता है। डीजल में बायोडीजल किसी भी अनुपात में मिलाया जा सकता है। इसको तेल देने वाले पेड़ों जैसे करंज, रतनजोत (जैट्रोफा), होहोबा और नीम आदि से बनाया जा सकता है। इन सबके बीजों से तेल निकलता है।

राष्ट्रीय जैवईंधन-नीति

केन्द्रीय नई और नवीकरणीय ऊर्जा मंत्रालय (एमएनआरई) ने राष्ट्रीय जैवईंधन नीति बनाई है। इस नीति में गन्ना, मीठी ज्वार, कसावा, मक्का, तिलहनी वृक्षों (रतनजोत, करंज आदि) को जैवईंधन पैदा करने के लिए शामिल किया गया है। इस नीति में एक 'नेशनल बायोयूअल्स डेवलपमेंट बोर्ड' की स्थापना करने का भी प्रस्ताव है। यह राष्ट्रीय जैवईंधन विकास बोर्ड पेट्रोल और डीजल की तरह बायोडीजल के उपयोग का भी एक मार्ग सुझाएगा, जिस पर बढ़कर बायोडीजल को आगे बढ़ाया जा सके और मार्ग की सारी बाधाएं दूर की जा सकें। इसमें 2012 तक 5: तथा 2017 तक 10: बायोडीजल को पेट्रोल व डीजल में मिलाने का लक्ष्य रखा गया है, जिसमें कुछ परिवर्तन किए जाने की आशा है।

जैवईंधन के लाभ

बायोईथेनोल का उपयोग करने से कार्बन मोनोऑक्साइड हाइड्रोकार्बन के उत्सर्जनों में 35 से 50: की कटौती की जा सकती है। यह सामान्य ईंधनों की तरह ही वाहनों को गति प्रदान करता है। इंजन ज्यादा गर्म नहीं होता और सहज ढंग से चलता है। 20: तक मिश्रण करने पर इंजन या कार्बुरेटर में किसी बदलाव की जरूरत नहीं होती। पेट्रोल की तुलना में बायोईथेनोल से कार्बन डाइऑक्साइड का उत्सर्जन 57 प्रतिशत कम होता है। इससे सल्फर डाइऑक्साइड, नाइट्रो-ऑक्साइड, कणमय सामग्री इतनी कम निकलती है कि वह कैंसरजनक नहीं होती। गैसोलीन में ईथेनोल मिलाना हर तरह से निरापद है। इसमें ऊर्जा का अंश गैसोलीन से कम होता है। यह अपने ही देश में बनाया जा

सकता है और 20: तक मिश्रण व्यापारिक दृष्टि से उपयोगी और लाभप्रद सिद्ध हुआ है।

बायोडीजल के लाभ

इसके उपयोग से डीजल की तुलना में कणमय सामग्री 30 प्रतिशत कम पैदा होती है। इसी तरह इसमें से हाइड्रोकार्बन 93: कम निकलते हैं। नाइट्रोजन ऑक्साइड काफी कम किए जा सकते हैं। पोली-साइक्लिक एरोमेटिक हाइड्रोकार्बन (पीएएच) और नाइट्रेट यौगिक भी 75 से 80: कम पैदा होते हैं। डीजल की बजाय इससे 50: कम धुंहासा (धुंआ + कुहासा + स्मॉग या धुंहासा) पैदा होता है, क्योंकि हाइड्रोकार्बन भी कम पैदा होते हैं। इसी प्रकार जहरीली कार्बन मोनोऑक्साइड भी डीजल से 50: कम पैदा होती है। कार्बन डाइऑक्साइड भी डीजल से 78: कम पैदा होती है। इसका धुंआ अपने आप खत्म हो जाता है और जहरीला नहीं होता। इसकी खपत डीजल की तरह ही की जा सकती है। इसमें लैश पॉइंट अधिक होते हैं। यह आसानी से नवीकरण के काबिल है। सही ढंग से जलता है और देश में ही पैदा किया जा सकता है।

बायोईथेनोल के उत्पादन में भारत सरकार की पहल

सन् 2003 में ही भारत सरकार ने 9 प्रमुख गन्ना-उत्पादक राज्यों और 4 केन्द्रशासित प्रदेशों में 5 प्रतिशत ईथेनोल मिश्रित पेट्रोल (ईबीपी) की स्कीम शुरू कर दी थी। इससे पहले सन् 2001 में अप्रैल-जून में तीन अग्रगामी परियोजनाओं में परीक्षण किए गए थे - दो महाराष्ट्र में और एक उत्तर प्रदेश में। लेकिन ईथेनोल पैदा करने के लिए आवश्यक कच्ची सामग्री उपलब्ध नहीं हो पाई। अब भी चीनी मिलों से सीमित मात्रा में उपलब्ध शीरे से ही ईथेनोल बनाया जा रहा है। यों तो दुनिया के किसी भी देश से पहले सन् 1940 के बाद के दशक के शुरू में ही भारत में ईथेनोल का कार्यक्रम शुरू किया गया था, क्योंकि विश्व युद्ध के दौरान वाहनों का परंपरागत ईंधन वांछित मात्रा में उपलब्ध नहीं था।

अब एक राष्ट्रीय ईथेनोल नीति शुरू की गई है, जिसमें 5 प्रतिशत मिश्रण ही फिलहाल स्वीकृत किया गया है। इसके लिए हर साल 5000 लाख लिटर ईथेनोल की जरूरत पड़ेगी। अगर 10: मिश्रण किया गया तो 12000 लाख लिटर और यदि 20: मिश्रण किया गया तो 10,000 लाख लिटर ईथेनोल की आवश्यकता होगी।



दिसंबर 2001 में तत्कालीन पेट्रोलियम और प्राकृतिक गैस मंत्री ने भारत की संसद में इथेनोल के मिश्रण का कार्यक्रम दो चरणों में शुरू करने की घोषणा की थी। अगस्त 2002 में इसके लिए भारतीय गजट में घोषणा की गई। इसके तहत 1 जनवरी 2003 तक 9 राज्यों और 4 केन्द्र शासित प्रदेशों में 5: इथेनोल का पेट्रोल में मिश्रण अनिवार्य कर दिया गया था।

बायोडीजल का विकास

योजना आयोग ने एक राष्ट्रीय बायोडीजल मिशन शुरू किया, जिसके अंतर्गत भारत का 25 लाख हैक्टर क्षेत्र बायोडीजल के विकास-क्षेत्र में शामिल किया जाना है। इससे 5: बायोडीजल के मिश्रण का देश का लक्ष्य पूरा किया जा सकेगा। इसके तहत पेट्रोलियम तथा प्राकृतिक गैस मंत्रालय (एमएनपीजी) ने 1 जनवरी 2006 से 12 राज्यों में स्थित सरकारी पेट्रोल पम्पों में 25 रुपये प्रति लिटर की दर से बायोडीजल मिश्रित डीजल/पेट्रोल बेचना शुरू करना था। लेकिन इतनी कम कीमत पर कंपनियों बायोडीजल प्राप्त नहीं कर पाईं।

सन् 2011-12 तक भारत सरकार ने 20: पेट्रो-डीजल की जगह बायोडीजल के इस्तेमाल का लक्ष्य रखा है। इसके लिए 111 लाख 90 हजार हैक्टर में रतनजोत लगाने का लक्ष्य रखा गया, ताकि 133 लाख 80 हजार टन बायोडीजल बनाया जा सके। सन् 2006-07 में वार्षिक लक्ष्य 1240 लाख टन बायोडीजल का रखा गया। सन् 2006-07 में कच्चे तेल और प्राकृतिक गैस का घरेलू उत्पादन 339 लाख 70 हजार टन के स्तर पर जारी रखा गया। मांग और पूर्ति में 900 लाख टन की खाई आयात या जैवईंधन से भरने की बात सोची गई।

दसवीं योजना (2002-07) में उठाए गए कदम

यूँ तो पूरे देश में जैट्रोफा करकास (श्रंजतवर्ची बनतबें) यानी रतनजोत और पोंगामिया पिनाटा (च्वदहंउपं चपददंजं) यानी करंज उगता है, लेकिन छितरा हुआ; और पुराने लगे हुए पेड़ हैं, जिनमें बीज कम पैदा होते हैं और बीजों में तेलांश भी कम होता है। सरकार ने सर्वेक्षण करके इन परंपरागत रूप से उगाए गए पेड़ों में से अधिक उत्पादकता और तेलांश वाले पेड़ छांटे हैं। इनके बीज इकट्ठे करके अनेक कृषि विश्वविद्यालयों को दिए गए हैं, ताकि वे इनका संवर्धन कर सकें। 21 राज्यों में इनके आधार पर 10,000 हैक्टर से अधिक क्षेत्र में रतनजोत और करंज के पेड़ उगाए गए हैं

‘वृक्ष-आधारित तिलहनों का एकीकृत विकास’ नामक यह स्कीम दसवीं पंचवर्षीय योजना में शुरू की गई। इसके अंतर्गत रतनजोत, होहोबा, महुआ, नीम, करंज, जंगली खुबानी, च्यूरा, कोंकम, सिमारौबा, तुंग आदि तिलहनी वृक्षों की वर्तमान संभावनाओं का उपयोग किया जाएगा और भविष्य के लिए इनकी बेहतर किस्मों का चयन करके उत्पादन-क्षमता बढ़ाई जाएगी। इनके उद्यान लगाने के अलावा छांटे गए श्रेष्ठ वृक्षों को उगाने के लिए उनकी पौध तैयार करने के लिए नर्सरियां बनाई जा रही हैं, किसानों को प्रशिक्षण देने के लिए प्रशिक्षक तैयार किए गए हैं, साथ ही अनुसंधान और विकास, जन-जागरण तथा प्रसार के कार्यक्रम चलाए गए हैं ऋण तथा सब्सिडी की व्यवस्था भी की गई है। खरीद केन्द्र, प्रसंस्करण-इकाइयां तथा उनके लिए आवश्यक उपकरणों का भी प्रबंध किया गया है।

सन् 2005-06 के दौरान तिलहनी वृक्षों की श्रेष्ठ पौध के जो आदर्श उद्यान लगाए गए उनमें से लगभग 10,000 हैक्टर में केवल रतनजोत के पौधे हैं। 21 राज्यों में स्थित आदर्श उद्यानों से 25 लाख हैक्टर में लगाने लायक पौध सामग्री मिल जाएगी। यह पौध-सामग्री सन् 2008-09 से उपलब्ध होने लगेगी। छत्तीसगढ़, गुजरात, गोआ, हरयाणा, झारखण्ड, मध्य प्रदेश, उत्तर प्रदेश तथा पश्चिम बंगाल में लगभग 750 हैक्टर में करंज के आदर्श उद्यान तथा 369 हैक्टर में नीम के आदर्श उद्यान बनाए गए हैं। इसी प्रकार महुआ, सिमारौबा और जंगली खुबानी की पौध 1500 हैक्टर में लगाई गई है। इसी प्रकार के प्रयास ऑइलपाम और अरंडी के लिए भी किए जाने चाहिए।

अनुसंधान और विकास के कार्यक्रम

‘रतनजोत और करंज के राष्ट्रीय नेटवर्क’ तथा ‘जंगली खुबानी और च्यूरा के राष्ट्रीय नेटवर्क’ बनाकर कृषि विश्वविद्यालयों तथा आईसीएआर, सीएसआईआर, आईसीएमआरई (इंडियन कौंसिल ऑफ फॉरेस्ट्री रिसर्च एण्ड एजुकेशन), टेरी (द एनर्जी एण्ड रिसोर्सिज इन्स्टीट्यूट) और नई दिल्ली के आइ आइ टी को इनसे जोड़ा गया है। ये श्रेष्ठ किस्मों का चयन करेंगे, बीजों के संसाधनों का आकलन करके उनका भंडारण करेंगे तथा किस्मों को सुधारने के साथ ही अलग-अलग कृषि-जलवायु में उगाने के कार्यक्रम चलाएंगे। इसमें श्रेष्ठ किस्मों के पेड़ों की पौध तैयार करके आदर्श उद्यान और नर्सरी बनाना तथा बड़ी संख्या में पौध तैयार करना भी शामिल है। अनेक महत्वपूर्ण तिलहनी वृक्षों का तेल निकालने के बाद जहरीली खली मिलती है और उसको विषमुक्त करने के उपाय खोजकर उसके उपयोग भी सोचे जाएंगे। इस बारे में सभी राज्यों में प्रशिक्षण-कार्यक्रम भी चलाए जाएंगे।



रतनजोत

रतनजोत की सुधरी पौध कहां-कहां उगाई जा सकती है, इसके लिए 31 सहभागी केन्द्रों ने 21 राज्यों के 140 से अधिक जिलों का सर्वेक्षण किया। कम से कम पांच साल की उम्र के पेड़ों की जांच की गई और उनकी लंबाई, मोटाई, प्रति पौधा बीज-उत्पादन की दर, फूल आने और फल तथा बीज बनने के समय और मात्रा के आंकड़े भी इकट्ठे किए गए। 100 बीजों का भार भी ज्ञात किया गया, ताकि अधिक वजनी बीज इकट्ठे किए जा सकें। रोगों और कीटव्याधियों का पता लगाकर उनकी रोकथाम के उपाय भी खोजे गए। चुने हुए पेड़ों में बीजों में तेल का अनुपात 28 से 48: पाया गया और 100 बीजों का वजन 20.7 से 77.1 ग्राम तक पाया गया। 20 किस्मों का चयन करके बेहतर किस्मों की पौध उगाई गई। बीज-भार, मोटाई, लंबाई आदि के बारे में काफी विविधता पाई गई। किस्में सुधारने के लिए अंतरजातीय, अंतःजातीय संकरण, उत्परिवर्तन, आणविक विधियों से पैकेज बनाने के लिए भी परीक्षण किए जा रहे हैं। नर्सरी के लिए फरवरी का महीना और रोपने के लिए जुलाई-अगस्त के महीने उपयुक्त पाए गए। रोपण की आदर्श तकनीकें तय करने के साथ ही पौध से जड़ निकालने के लिए हार्मोन-उपचार भी तय किए गए। टेरी की प्रयोगशालाओं में तेल का अनुपात ज्ञात करने के लिए बीजों का 500 नमूनों का विश्लेषण किया गया। राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो में देश भर से चयनित रतनजोत के 300 श्रेष्ठ वृक्षों के बीज परिरक्षित किए गए हैं। रतनजोत -30 से. तापमान नहीं सह सकता। लेकिन फरवरी में तापमान बढ़ने पर बीज अंकुरित हो गए। जिन क्षेत्रों में वार्षिक वर्षा 500 से 1200 मिलीमीटर तक होती है, वहीं रतनजोत की बढ़वार अच्छी हुई और उपज भी अर्थक्षम थी। रतनजोत और करंज दोनों ही 9.5 तक पीएच हो और मिट्टी कम से कम दो फुट गहरी हो, ऐसी जमीनों में उगाए जा सकते हैं।

करंज

आंध्र प्रदेश, तमिल नाडु, छत्तीसगढ़, मध्य प्रदेश, महाराष्ट्र, उत्तर प्रदेश, राजस्थान और कर्नाटक आदि राज्यों के 10 सहभागी केन्द्रों में करंज उगाने योग्य क्षेत्र और उच्च श्रेणी के वृक्ष छांटे गए। देश के 120 जिलों में 432 वृक्ष चुने गए। 21 चुने गए पेड़ों की संतति का मूल्यांकन किया गया। बीजों का अंकुरण-प्रतिशत, पौधे की लंबाई तथा जमीन के पास तने का घेरा आदि नापे गए। फलीदार वृक्षों, पौधों, सब्जियों तथा हरी खाद वाली फसलों के साथ करंज की मिश्रित कृषि वानिकी के परीक्षण किए गए। कलमों से जड़ निकालने के हार्मोनों का उपयोग आजमाया गया

जैसे कि आइबीए और एनएए। बसंत के मौसम में 52.9: अंकुरण हुआ जो अधिकतम था। अधिकतम लंबी जड़ें 15.7 सें.मी. तक बढ़ीं। जड़ें निकालने में आइबीए की 3000 पीपीएम मात्रा से 52.9: जड़ें फूटीं, जो अधिकतम अनुपात था। 20-25 सें.मी. की कलम को 800 पीपीएम आइबीए तथा 800 पीपीएम एनएए लगाकर बोन से सबसे अच्छे नतीजे मिले। करंज के बीजों के 117 नमूनों में 35: से अधिक तेल मिला। कुल 323 नमूनों का परीक्षण किया गया जिनमें औसतन तेलांश 20-25: था। टेरी ने बीजों के 240 नमूनों को तेलांश के लिए जांचा। बेहतर खूबियों वाले पेड़ों के बीजों के 47 नमूने एनबीपीजीआर के जीन बैंक में संरक्षित किए गए।

प्रौद्योगिकी-प्रसार

गांवों में उत्पादकों को प्रशिक्षण देने के लिए प्रशिक्षकों के प्रशिक्षण के 18 और किसानों के प्रशिक्षण के 58 कार्यक्रम चलाए गए। सन् 2005-06 में तिलहनी वृक्षों के बीज इकट्ठे करने का प्रशिक्षण 5800 प्रक्षेत्र-कर्मियों को तथा बीजों और कलमों से पौधे उगाने की कृषि-विधियों का प्रशिक्षण 900 प्रक्षेत्र-कर्मियों को दिया गया।

ईथेनोल की आवश्यकता का आकलन

सन् 2006-07 से 2011-12 के बीच प्रति वर्ष ईथेनोल की आवश्यकता के बारे में वार्षिक आकलन किए गए। यह नीचे सारणी में बताया गया है :

ईथेनोल बनाने के लिए शीरा सबसे सस्ता पड़ता है। भारत में हर साल 78 लाख 20 हजार टन शीरा पैदा होता है। इसका 70 प्रतिशत देश भर में 300 डिस्टिलरी इस्तेमाल करती हैं। इन

सारणी 1: वर्षानुसार पेट्रोल तथा ईथेनोल की आवश्यकता का आकलन

| वर्ष | पेट्रोल (एमएमटी) | 5% ईथेनोल (एमएमटी) | 10% ईथेनोल (एमएमटी) | 20% ईथेनोल (एमएमटी) |
|---------|------------------|--------------------|---------------------|---------------------|
| 2007-08 | 11.00 | 0.55 | 1.10 | 2.20 |
| 2008-09 | 12.50 | 0.62 | 1.25 | 2.50 |
| 2009-10 | 14.50 | 0.72 | 1.45 | 2.90 |
| 2010-11 | 16.50 | 0.82 | 1.65 | 3.30 |
| 2011-12 | 18.15 | 0.90 | 1.80 | 3.60 |



सारणी 2: फसलवार ईथेनोल उत्पादन की संभावना

| फसल | ईथेनोल-उत्पादन (लिटर/टन) | ईथेनोल-उत्पादन (टन/है.) | ईथेनोल-उत्पादन (लिटर/है.) |
|-------------|-----------------------------|----------------------------|------------------------------|
| गन्ने का रस | 70 | 42 | 2940 |
| शीरा | 245 | 1.68 | 412 |
| मीठी ज्वार | 60 | 45 | 2700 |
| शकरकंद | 125 | 25 | 3125 |
| कसावा | 180 | 25 | 4500 |
| चीनी चुकंदर | 110 | 35 | 3850 |
| मक्का | 360 | 4 | 1440 |
| टालू | 110 | 16 | 1760 |

आसवनशालाओं की स्थापित क्षमता 28250 लाख लिटर प्रतिवर्ष है और वे 12000 लिटर प्रतिवर्ष उत्पादन करती हैं। शीरे की उपलब्धता कम होने के कारण ये डिस्टिलरियां पूरी क्षमता का उपयोग नहीं कर पातीं। भारत में गन्ना इसकी आवश्यकता से अधिक पैदा किया जाता है। 5 प्रतिशत ईथेनोल-मिश्रण के लिए गन्ने की पैदावार का 4: और 10: के लिए 8: ईथेनोल पैदा करने के लिए कच्चे माल के रूप में इस्तेमाल किया जा सकता है। इस तरह सीधे गन्ने के रस से ईथेनोल बनाना सस्ता पड़ेगा। आगे सारणी में फसलवार ईथेनोल-उत्पादन की संभावना बताई गई है:

इसके लिए गन्ना 5: ईथेनोल के लिए 40,000 हैक्टर में 10: के लिए 80,000 हैक्टर में और 20: के लिए 160,000 हैक्टर में उगाना होगा। इसी प्रकार मीठी ज्वार क्रमशः 20,000, 40,000 और 80,000 हैक्टर में उगानी होगी। शकरकंद भी इतने ही क्षेत्र में उगानी होगी। कसावा क्रमशः 30 हजार, 60 हजार और 120,000 हैक्टर में उगाना होगा। चीनी चुकंदर 15 हजार, 30 हजार और 60 हजार हैक्टर में उगानी होगी। मक्का 22000, 44000 और 88000 हैक्टर में उगानी होगी। इस तरह इन सभी फसलों का कुल क्षेत्र क्रमशः 147000 हैक्टर, तथा 588000 हैक्टर बैठता है।

बायोडीजल

इस समय भारत में 20 प्रतिशत वाहन पेट्रोल से और 80 प्रतिशत डीजल से चलते हैं। शुरू में 10: ईथेनोल और 20: बायोडीजल इंजनों में बिना किसी बदलाव के मिलाया जा सकता है। यह आकलित किया गया है 5:, 10: और 20: बायोडीजल के

मिश्रण के लिए क्रमशः 2.62 एमएमटी, 5.23 एमएमटी और 10.47 एमएमटी बायोडीजल की जरूरत होगी। यह सन् 2006-07 में 52.33 एमएमटी की मांग के अनुसार कूती गई।

फसलों के अनुसार रतनजोत से बायोडीजल 5: मिश्रण प्राप्त करने के लिए 17 लाख हैक्टर में, 10: के लिए 34 लाख हैक्टर में और 20: के लिए 68 लाख हैक्टर में उगाना पड़ेगा। इससे क्रमशः 17, 34 और 68 लाख मीट्रिक टन बायोडीजल मिलेगा। इसी तरह करंज 5, 10 और 20 लाख हैक्टर में उगाकर क्रमशः 2.50, 5.00, 10.00 लाख मीट्रिक टन बायोडीजल मिलेगा। ऑइलपाम के लिए ये आंकड़े 1, 2, 4 लाख प्रति हैक्टर और 4, 8, 16 लाख मीट्रिक टन हैं। अरंडी के 4, 8, 16 लाख हैक्टर क्षेत्र से क्रमशः 1.80, 3.60 और 7.20 लाख मीट्रिक टन बायोडीजल मिलेगा। अन्य तिलहनी वृक्षों के लिए ये आंकड़े 5, 10, 20 और 1.50, 3.00, 6.00 हैं। इस तरह कुल 32, 64, 128 लाख हैक्टर में लगे तिलहनी पेड़ों के बीजों से 5:, 10: और 20: मिश्रण-दर पर क्रमशः 26.8 लाख मीट्रिक टन, 53.6 और 107.2 लाख मीट्रिक टन बायोडीजल मिल सकेगा।

इन हरे ईंधनों - ईथेनोल और बायोडीजल को अपनाने से 60 से 80 लाख बेरोजगारों को रोजगार मिलेगा। अनुसंधान और विकास के ठोस प्रयासों से उत्पादकता बढ़ाकर अधिक पैदावार और अधिक रोजगार मिल सकता है। सबसे बड़ी बात यह है कि तेल और गैस के लिए विदेशों पर हमारी निर्भरता कम होगी और विदेशी मुद्रा की बचत होगी। इन फसलों से ईंधन के अलावा चारे, दाने और भोजन की जरूरतों के एक बड़े हिस्से की भी पूर्ति की जा सकेगी।

(अनुवादक : गीता शर्मा)

बिजली की खपत में बचत
करने के लिए अक्षय ऊर्जा
उत्पाद प्रयोग में लाएं।

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48 MW Cogeneration Project of M/s. Dwarikesh Sugar Industries Limited Commissioned



project is already registered with UNFCCC for generation of (Carbon emission reduction) CER units is a matter of pride and bears adequate testimony of the environment friendly nature of the project. Power purchase agreements (PPA) are already executed with UPPCL for supply of power from these units for the next 20 years. Registration of these projects with UNFCCC will help enable the Company to sell CER units and in the process earn handsome revenues. The commencement of these projects would not only have lot of socio-economic benefits but also employment generation in the region.

IREDA sanctioned a term loan of Rs. 6830 lakhs to M/s Dwarikesh Sugar Industries Ltd. for setting up of 2x24 MW Baggase based cogeneration projects at their 7500 TCD sugar mills at Dwarikeshpuram and Dwarikesh Dham in the state of Uttar Pradesh. The above projects were a part of the company's expansion programme which envisaged setting up a Greenfield sugar project of 7500 TCD with 36 MW co-generation (24 MW for export to state grid) at Dwarikesh Dham, Tehsil Faridpur, District Bareilly and expansion of cogeneration capacity by 24 MW at one of its existing unit at Dwarikesh Puram, Tehsil Dhampur, District Bijnor in the state of Uttar Pradesh. The entire project was executed in 15 months from the date of conceptualization. The cogeneration projects are successfully synchronized with UPPCL grid in the month of Feb 2008.

The project is co-financed by Punjab National Bank, the Industrial Development Bank of India (IDBI) and Sugar Development Fund(SDF). Govt. of India, New Delhi. The

The company has three sugar plants with a combined capacity to crush 21,500 tons of sugarcane everyday, cogeneration facility to export 56 megawatts of power every hour (after meeting captive power requirement of nearly 30 megawatts) and a distillery to distill 30 KL of Industrial alcohol/ ethanol everyday. The company is a listed company and its shares are listed at BSE, NSE and Luxemburg stock exchange.





MITCON Celebrates its Silver Jubilee

MITCON Consultancy Services Ltd., celebrated its Silver Jubilee at MITCON Institute of Management, Balewadi on Saturday the 5th of January, 2008 in the August presence of Hon'ble Minister Shri Ashokrao Chavan, Department of Industries, Mining, Cultural Affairs & Protocol, Government of Maharashtra. Dr. Narendra Jadhav, Vice Chancellor University of Pune and Mr. H.K. Mittal, Advisor, DST, Govt. of India, New Delhi were the guests of honour on the occasion. Shri B. Venkateshvara Rao, General, Manager (DCCS), IREDA attended the Silver Jubilee function of MITCON. □



Shri Ashokrao Chavan, Hon'ble Minister, Department of Industries, Mining, Cultural Affairs & Protocol, Government of Maharashtra presenting a souvenir to Shri B. Venkateshvara Rao, GM (DCCS), IREDA at the Silver Jubilee function of MITCON at Pune.

North East India Energy Summit 2008 at Guwahati, Assam

The North East India Energy Summit 2008 was held at Guwahati on March 29, 2008. The Summit was organized jointly by India Energy Forum and Assam Energy Development Agency and was inaugurated by Shri V. Subramanian, Secretary, MNRE.

The Summit was divided into four technical sessions as follows:

- I - Implementing Renewable Energy Power Projects in North Eastern India.
- II - Coal bed Methane
- III - Various Options of Conventional Energy Sources in NE
- IV - Various Options of Non-Conventional & Renewable Energy Sources & CDM

Presentations during the above Technical Sessions were also made by various officials representing Assam Energy

Regulatory Commission, UNDP, Coal Group, IEF, Oil India, Consultants, Tata BP Solar India, Price Waterhouse Cooper, American Supplemental Fuel & Environmental Solutions, USA etc.

In the Summit, two presentations were made by Shri K.P. Philip, DM (TS), IREDA on behalf of IREDA, one on IREDA's Financing Mechanism of Renewable Energy Projects and the other on Small & Micro Hydro Power Generation – Potential Investment Opportunity.

Senior dignitaries who attended the Summit were Shri S.C. Tripathi, Former Secretary, Petroleum, Shri A.K. Barua, Director, AEDA, Shri B.C. Bora, Former CMD, ONGC and OIL, Vice President, IEF, Shri P.S. Bami, President, IEF, Shri Ashok Dasgupta, Convenor, Eastern India Chapter, IEF, Shri Amarjit Singh, Secretary General, IEF. □



IREDA, PTC India Financial Services and PTC India Ltd. Join Hands for Meeting Debt, Equity and Off-take Requirement of Renewable Energy Projects

India Ltd. (PTC) have entered into a Memorandum of Understanding (MOU) to provide a range of offerings including project structuring, project advisory, off-take arrangement and funding through both equity and debt for renewable energy projects to meet the growing energy needs for sustained long term growth of the renewable energy sector in India.

The MOU was signed by Shri Debashish Majumdar, Chairman and Managing Director on behalf of IREDA, Shri Deepak Amitabh, Director on behalf of PFS and by Shri Arun Bhalla EVP on behalf of PTC on 8th April, 2008 at New Delhi in the presence of Shri V. Subramanian, Secretary, MNRE and Shri T.N. Thakur, CMD, PTC.

The MOU brings to a single platform the inherent strengths and competencies of IREDA in providing debt for the development of renewable energy projects, PTC for off-take & marketing of power and PFS for equity participation. The coming together of the three, shall provide complete financial solutions to the entire value chain in renewable energy projects. As per the MOU, the three parties have agreed to cooperate and share all relevant information for facilitating financing of renewable energy, energy efficiency & conservation and medium and large hydro projects for their mutual



benefit, while providing a single window to promoters to meet their equity, debt and power off-take & marketing requirements. Each of the three parties would treat the other as a preferred partner. IREDA, in all renewable power projects where PTC is a off-taker and/or PFS is a stakeholder, will offer the best possible terms (including lower rate of interest) for financing. Similarly, PTC and/or PFS in all renewable power project where they act as a off-taker or as a investor, will recommend the project to IREDA for financing.

The MOU, valid for a period of three years, would lead to providing complete financial solutions to the renewable energy value chain, leading to early financial closure and act as a catalyst in the speedy development of renewable energy in the country. □



IREDA & PFC join hands for joint financing Renewable Energy Projects



Indian Renewable Energy Development Agency Limited (IREDA) and Power Finance Corporation Limited (PFC) have entered into a Memorandum of Understanding (MoU) to facilitate financing of renewable energy, energy efficiency and conservation to meet the growing energy needs and for sustained long term growth of the renewable energy sector in India.

The MoU, signed by Mr. Debashish Majumdar, Chairman and Managing Director on behalf of IREDA and Mr. Shyam Wadhera, Director (Projects) on behalf of PFC, was inked yesterday 25th March 2008 at New Delhi.

The MoU brings on to one platform the inherent strengths and competencies of both the public sector enterprises engaged in providing funds for the development of the power sector. Both parties have agreed to cooperate for facilitating financing of renewable energy, energy efficiency and conservation and medium

and large hydro projects for their mutual benefit, while providing a single window to promoters and entities for consortium financing to achieve speedy financial closure.

The current MoU, valid for a period of two years, would lead to a system of common security, interest rates along with sharing of data/information while maintaining confidentiality. □

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IREDA's Officer Attended Conference on "Centralized Solar for Electric Generation in USA".

IREDA has sponsored **Mr. B.V. Rao, General Manager (PTS)** to attend the two days conference on **Centralized Solar for Electric Generation** organized by **Electric Utility Consultants In (EUCI)** at **Denver, USA** from **13th - 14th February '08** and to visit **National Renewable Energy Laboratory (NREL), USA**. The conference is mainly to address various issues related to megawatt **Centralized Solar Power (CSP) Generation** as indicated below:

- * Status of the technologies
- * Performance requirements.
- * Power purchase agreements
- * Selling RECs vs. selling energy
- * Load matching and storage
- * Siting and transmission
- * Virtual systems
- * How solar differs from wind.

During the conference, various eminent speakers from, R & D, manufacturing companies, Utilities and Consultants made presentation on different topics, covering the latest technical developments related to Solar PV and Thermal Power Plants design and operation of large scale Solar Power Plant, case studies on existing Centralized megawatt Solar Power Plants, policies related to financing large units and incentive mechanism and innovative finance including Government policies, legal framework etc.

It was very much interactive program wherein the participants are from different fields such as policy planners, scientists, project developers, Financial Institutions, Commercial Banks, legal institutions, equipment suppliers etc.

In the entire program and interactions, various issues were discussed on promotion of large scale Centralized Solar Power Plants using both Solar PV and Thermal Technologies, design of the systems and their operation, financing and economics of the Power Plants, policy framework in USA and future challenges to develop large scale plants in different locations and the technological developments in different countries with respect to materials science and manufacturing capabilities etc.

The conference is very much useful in exchange of information and also to understand the changes that are required in the present policy framework in promotion of large scale Centralized Solar Power Plants in India.

Various experts, technology providers and project promoters have given in sight on the critical issues such as choice of technology, selection of site, policy framework, financing and incentive mechanism etc. to be considered while designing the Power Plants and also various operational issues in order to maximize the efficiency of the Power Generation Units and also improve Power Generation Capacity.

The present policy framework related to tax breaks / incentives available in USA are very much relevant for Indian conditions also and it may be worthwhile



considering to provide similar facilities with appropriate changes for the Indian Promoters in taking up large scale commercialization of Solar Power Technologies. The project developers and technology experts have shown their keen interest in establishing such Power Plants in India in collaboration with Indian partners.

Mr. B.V. Rao, General Manager (PTS) has also visited National Renewable Energy Laboratory(NREL) to discuss on the technological developments in Solar PV and Solar Thermal Power Generation.

During the discussion, it was explained by the Scientists at NREL on the status of current Solar Thermal & Solar PV /Thermal technologies and future developments and also highlighted the specific design features of Power Plants which are to be commissioned in the near future using advanced PV technologies.

Solar Thermal Power using trough technology is getting more commercialized and shortly 64 MW power

plant is going to be commissioned in Nevada, where fuel oil is used as backup source.

It has been provided with 6 hr storage facility also where the plant load factor is expected to be nearly 23-34 %. In case of Solar Power Technology, large capacity plants of each 100-200 MW capacity are planned to be executed in next 2-3 years in USA.

CSP technologies are getting commercialized by providing suitable incentives from US Federal and State Govts.. High efficiency Solar PV cells (up to 37% multi junction) are under laboratory testing and expected to be available in the commercial market in next few years.

It was informed that the power generation cost though Central Solar Power is expected to be around 5-7 cents per Kwh by 2020 which is very much comparable with conventional power generation. □

IREDA & Export-Import Bank of United States join hands for improving infrastructure for India

Indian Renewable Energy Development Agency Limited (IREDA) and Export-Import Bank of United States of America (Ex-Im Bank) have entered into a Memorandum of Understanding (MoU) to facilitate IREDA receiving a Special Delegated Line of Credit (SDLC) from Ex-Im Bank under its newly created India Infrastructure Facility to support the purchase of US goods and services to be incorporated in infrastructure projects in India including renewable energy technologies.

The MoU was signed by Mr. Debashish Majumdar, Chairman and Managing Director on behalf of IREDA and

Mr. James H. Lambright, Chairman on behalf of Export-Import Bank of the United States on 14th May 2008 at New Delhi.

The MoU shall make available a SDLC of upto US\$ 50 Million to be used by IREDA to support renewable energy technologies. The key elements of the SDLC includes access to Ex-Im Bank's medium and long term guarantee, direct dollar loans and establishment of a new marketing tool for both Ex-Im Bank and IREDA thereby assisting in meeting its goals with respect to development of renewable energy in the country. □



Renewable Energy in the Global Context

The book entitled 'Renewable Energy in the Global Context' authored by Dr. Maithani has seven chapters including introduction, renewable energy technologies: present status and future projections, renewable energy policies, EU Germany, USA, Japan and China, renewable energy in India, renewable energy and environment, strategy for renewable energy development in India and renewable energy policy directions.

It covers the global energy scenario including energy demand and supply, policies to promote renewable energy in developed countries and developing countries like India and China, financing infrastructure and the roles played by the World Bank and Global Environment Facilities. Detailed status and future projections of the matured renewable energy technologies such as solar photovoltaics, solar thermal energy systems, wind energy, and bio-energy have been made. Emerging and future renewable energy technologies such as bio-fuels, bio-diesel, ethanol, wind energy and hydrogen energy finds due importance.

The growth of RE sector through various enabling mechanisms and laws enacted in the USA, European Union Countries, Japan, China and India to promote renewable energy technologies in meeting the energy requirements in centralized and decentralized modes have been placed in the correct perspective.

Maithani enunciates the Indian energy sector, the role of fossil fuel in meeting the energy demands of the commercial, industrial and domestic sectors. In India non-commercial energy also plays a very important role in meeting the energy requirements of both urban and rural poor.

Maithani in his book highlights also brings out the various energy projects and the policies required for

meeting the energy requirements upto 2031-32. Main recommendations of the Integrated Energy Policy document has also been taken note of particularly with regard to new and renewable energy sources such as solar, wind, small hydro, biomass, biofuels, biogas, hydrogen, ocean energy, geothermal, etc. Implications of the National Electricity Policy and Tariff Policy on the growth of electricity production from renewable sources have also been covered in the book.

Maithani covers in great detail the strategy for the development of renewable energy to meet a substantial portion of the energy requirements in the country. It also defines the future directions for carrying out the research and development in the different sectors such as photovoltaics, wind, biomass, biofuel, hydrogen, etc. In order to meet the energy requirement of people and improve their living standards the renewable can play a very important role for which Central and State Governments should clearly define the policies and strategy. Policy directions for matured renewable energy systems have also been clearly brought out.

I strongly recommend all those who deal with the energy planning and policy and want to promote renewable energy in the country to read this book as it contains information about the policy measures adopted in different developed countries to promote renewable energy systems including wind power, solar energy, biomass, geothermal, etc. The book also provides information about the futuristic technologies such as hydrogen, fuel cells, biofuels, etc. The book could well serve as a reference book for initiating research and development activities in the renewable energy systems and devices.

Reviewed by **Dr. Ahmar Raza**
Director, MNRE



Biodiesel Fuels New Green Power Plant

Safe Renewables Corporation (SRC), a producer and marketer of biodiesel for transportation fuel and power generation, has begun supplying fuel for what the company says is the nation's first, 100% biodiesel-powered electricity generating turbine plant.

Located on a portion of SRC's 250-acre property in Conroe, Texas, the plant, owned and operated by Biofuels Power Corporation, can produce up to 10 megawatts (MW) of electricity at any given time for delivery direct to the grid.

According to Jeff Kissell, Safe Renewables Chairman, President and CEO, "It is comparable to the horsepower of a car engine."

Biodiesel is a clean burning, environmentally friendly alternative fuel made from oils derived from farm crops

and animal fats. SRC will supply up to one million gallons per month of pure biodiesel (B100) for the plant. The feedstock will primarily be poultry fat, sourced from large poultry processing operations in Texas, making the electricity produced by the plant an indigenous, renewable Texas product.

"The new operation is particularly appropriate in the Texas market where an estimated 3,000 megawatts of new power generation will be required in coming years.

It is becoming increasingly difficult to use traditional power-generating fuels, such as coal, due to harmful emissions," Kissel noted. "Biodiesel produces low levels of emissions in power generating applications."

■ **Source:** <http://www.renewableenergyworld.com/rea/news/story?id=50268>

Creating a 21st Century Grid

In 1957, as Eisenhower began his second term as U.S. President, the first satellite launched into orbit and the first commercial nuclear reactor came online, electrical workers all over the country were installing the world's most advanced transmission and distribution (T&D) system. Today, much of that T&D system installed 50 years ago remains in place, holding together a patchwork grid for ever-expanding electricity markets.

Now in 2007 - the age of the internet, personal digital media and distributed energy - the grid has failed to keep pace with the rapidly changing technological landscape. While most industries rely on technologies that have been invented or updated in the last few years, the electricity delivery industry uses technologies that have more or less stayed the same for 100 years.

There's a common idiom that goes, "if it ain't broke don't fix it." While the grid in the U.S. is hardly broken, it is beginning to deteriorate rapidly in some places, and it will need some serious repairs in order to meet the

growing demand for electricity in general and distributed renewable electricity specifically.

"We need to see a very substantial transformation of the system," says David Meyer, Senior Policy Advisor in the Office of Electricity Delivery and Energy Reliability at the U.S. Department of Energy (DOE). "We're outgrowing it in many parts of the nation. It's certainly not the high-capacity, integrated and smart system that we need."

The current grid is a stiff arrangement of one-way transmission lines, centralized generation facilities and aging substations. The recent emergence of large amounts of renewable electricity in markets around the country are creating new challenges for both the transmission and distribution sectors.

On the transmission side, the issue is whether there are enough lines to bring renewable energy onto the grid. Because many of the abundant renewable resources are



far away from load centers, additional lines must be built to bring wind, solar and geothermal energies to market. If plans to construct lines are not on the table, developers will be hesitant to build large projects in these rural areas.

“This is what we call the ‘chicken and egg’ problem,” says Meyer. “It’s difficult to develop new generation without being certain that the transmission capacity is there or will be there. No one wants to be out front taking an undue portion of the risk.”

As planners look to build more of those lines, they may have some emerging technologies to consider; particularly High Voltage Direct Current (HVDC) and wires based on nanotechnology.

HVDC transmission is certainly not a new concept – but it’s gaining ground in the U.S. as renewable electricity will have to be transported further distances with higher efficiency in the future.

The other technology still in the research and development phase is the “armchair quantum wire” made from tubes of carbon 1,00,000 times thinner than a human hair, called carbon nanotubes. When these nanotubes are made into a larger wire, they can conduct electricity far more efficiently and over far greater distances than the copper wires used today.

A leading researcher of carbon nanotubes, Dr. Wade Adams of the Richard E. Smalley Institute for Nanoscale Science and Technology, says that these nanotube wires can theoretically conduct 100 million amps of current over thousands of miles without much loss in efficiency. Today’s wires conduct around 2,000 amps of current over hundreds of miles, with about 6 to 8% of the electricity lost in the form of heat.

According to Adams, these armchair quantum wires will also be one sixth the weight of current wires and so strong that they won’t need support mechanisms.

That means new transmission lines would be less conspicuous, and perhaps not as controversial to communities and interest groups concerned about their impact on the landscape.

“That enables us to carry, say, electrical power from vast solar farms in the desert to the Northeast, or maybe from wind farms in Montana or North Dakota down to Florida - and in fact, even from continent to continent,” says Adams.

Of course, transmission lines made from carbon nanotubes are about 10-15 years away from commercialization. But if brought to scale, these new lines could transform how the nation, and indeed the world, transmits large amounts of renewable electricity.

The distribution sector, which is made up of facilities that lower voltage for ordinary consumption, faces a different set of issues. One of the biggest challenges for distribution is the emergence of smaller renewable energy generators, which can sometimes cause issues with metering and load flow. This is where the “smart” grid system comes in.

In order to better control electricity entering the grid at the local level, interactive control devices, monitoring networks, energy storage facilities and demand response systems will need to be implemented.

As distributed generation becomes more widespread and local communities start generating their own power, the grid must adapt in order to handle a steady two-way flow of electricity.

“You have to think much more distributed than centralized, you have to solve the problem of storing energy, and it has to be much more like an internet system than the current grid is today in order to be effective,” says Adams.

These upgrades of the T&D infrastructure won’t be cheap and they won’t happen quickly. According to the Electric Power Research Institute, a California-based energy think tank, the cost of upgrading the grid with “smart” technologies could be \$100 billion.

Some analysts have put the figure at around \$150 billion. While utilities and other developers would pay



for much of the upgrade, ratepayers and taxpayers would also be responsible for the bill.

However, the economic impact associated with a failed grid could rival the price of an upgrade. For example, the 2003 Northeast blackout caused an estimated \$6 billion in direct and indirect economic losses over only a few days.

According to the North American Reliability Corporation's 2007 Long-term Reliability Assessment of the North American Grid released last month, transmission capacity continues to lag behind demand and will need to increase by more than 10% over the next 10 years to meet the needs of the U.S. electricity markets, especially as more states integrate renewables into their energy portfolios.

The report also recognizes the imminent need to develop reliable storage capacity to better manage demand.

So in 2007, as we use the grid in ways it was not originally designed for, the energy community is looking for new ways to maintain the T&D infrastructure so that it doesn't just meet market needs, but reacts to them.

"There's a lot of awareness of the benefits associated with this kind of change. While we won't see the change overnight, I am very optimistic that we can implement these new technologies and make the grid far more sophisticated," says DOE's Meyer.

Source: <http://www.renewableenergyworld.com/rea/news/story?id=50519>

Deep Vision: Big Energy from Way, Way Down

Today, typical geothermal wells are about 2.5 km in depth, produce steam at about 300 degrees Celsius and generate about 4-7 megawatts (MW) of electricity. In Iceland, a project is underway to drill almost twice that deep and potentially produce almost ten times that much energy.

The Iceland Deep Drilling Project (IDDP) is being run by the IDDP consortium, which is essentially made up of the three leading Icelandic power companies, Hitaveita Sudurnesja Ltd., Landsvirkjun, Orkuveita Reykjavikur,

together with Orkustofnun (National Energy Authority) and Alcoa Inc.

The main objective of the IDDP is to investigate whether it is even economically feasible to produce energy and chemicals from geothermal systems at supercritical conditions.

In order to determine the economic feasibility the companies must drill to depths of 4 to 5 km in order to reach temperatures of 400-600°C (750 - 1,100°F). It is estimated that producing steam from a well penetrating a reservoir hotter than 450°C – at a rate of 0.67 cubic meters (24 cubic feet) per second could be enough to generate 40-50 MW of electricity. If this proves correct, it could lead to a major step forward in the development of high-temperature geothermal resources worldwide.

Two UC Davis geologists, Peter Schiffman and Robert Zierenberg, along with professors from UC Riverside, Stanford, and University of Oregon are part of the project.

The scientists plan to study the chemistry that occurs at high pressures and temperatures at these great depths.



A typical geothermal drilling rig is shown above.
Photo Credit: Robert Zierenberg, UC Davis



The images above show two geothermal wells.
Photo Credit: Robert Zierenberg, UC Davis

“We hope to understand the process of heat transfer when water reacts with hot volcanic rocks and how that changes the chemistry of fluids circulating at depth,” Zierenberg said. “We know very little about materials under these conditions.”

Currently Iceland generates more than half of its electrical power from geothermal energy. Hot water and steam from boreholes can be used to run turbines for electricity or directly to heat homes and businesses. Iceland meets the rest of its electricity needs from hydroelectric power, and imports fossil fuels only for transportation.

The U.S. has lots of potential for geothermal energy generation, Zierenberg said. There are several plants in California, including the Geysers region in the north and at Mammoth Lakes. According to Zierenberg, although its share of energy generation in the state is small, the Geysers is the largest geothermal field in the world. There are also numerous abandoned oil and gas boreholes around



Geysers on an Icelandic farm.
Photo Credit: Robert Zierenberg, UC Davis

the country – including in the Central Valley – that could potentially access hot water that could be used for space heating.

That would, however, require something of a cultural change. In Iceland, geothermal heating is used at a community level: hot water is pumped up and circulated around a town or neighborhood. Americans are more accustomed to individual power delivery, Zierenberg said.

The team expects to begin drilling in the summer of 2008.

Source: <http://www.renewableenergyworld.com/rea/news/story?id=50526>

Merrill Lynch Introduces Biofuels Indices

This week, Merrill Lynch introduced two indices designed to offer investors exposure to the fast-growing biofuels market with greater liquidity, transparency and efficiency than financial instruments currently available: The MLCX Biofuels Index and the MLCX Biofuels Plus Index.

Until now, investors seeking to profit from rapid expansion in the ethanol and biodiesel industries typically recurred to traditional agricultural commodity indices or futures. Such instruments are vulnerable to very negative

roll returns, or negative carry, due to the storage dynamics of the underlying agricultural commodity markets. Merrill Lynch’s new indices use a rolling mechanism to spread the buying and selling process over 15 days. The MLCX Biofuels Index offers exposure specifically to biofuels. The MLCX Biofuels Plus Index offers exposure to biofuels and conventional fossil fuels.

“Our indices have been carefully designed to mitigate the negative roll returns inherent to many agricultural



commodities markets,” said Francisco Blanch, Head of Global Commodity Research at Merrill Lynch. “They also offer additional returns by overweighting crops that produce the most energy in biofuel production, notably sugar and soybeans.”

The MLCX Biofuels Index weights commodities according to production levels and calorific potential, in order to reflect their economic value. It contains seven commodities commonly used as biofuels feedstock: sugar, corn, soybeans, barley, rapeseed, canola and soybean oil. The MLCX Biofuels Plus Index adds gasoline and diesel to the commodities in the MLCX Biofuels Index. The MLCX Biofuels Plus Index reflects how current technology and infrastructure is more geared to blending biofuels with conventional fossil fuels than to offering a pure biofuel alternative.

Merrill Lynch expects demand for agricultural commodities to grow in the long term, thanks in part to legislation. E.U. directives adopted in 2003 aim to derive 5.75% of total transport fuel consumption from biofuels by 2010 and up to 20% by 2020. The U.S. Renewable Fuel Standard Program requires that at least 7.5 billion gallons of renewable fuel be blended into vehicle fuel by 2012.

Slow progress in finding more efficient ways to produce biofuels means that the demand will have to be met by a massive expansion in supply, increasing competition for cropland, labor and water. This could drive up the price of biofuels related crops as well as other crops such as wheat, rice and coffee.

Source: [www.Renewable Energy Access.com](http://www.RenewableEnergyAccess.com) October 4, 2007

Carbon-neutral Hydrogen on the Horizon

Hydrogen as an everyday, environmentally friendly fuel source may be closer than we think, say Penn State researchers.

“The energy focus is currently on ethanol as a fuel, but economical ethanol from cellulose is 10 years down the road,” says Bruce E. Logan, the Kappe professor of environmental engineering. “First you need to break cellulose down to sugars and then bacteria can convert them to ethanol.”

Logan and Shaoan Cheng, research associate, have recently demonstrated a method based on microbial fuel cells to convert cellulose and other biodegradable organic materials directly into hydrogen.

The researchers used naturally occurring bacteria in a microbial electrolysis cell with acetic acid – the acid found in vinegar. Acetic acid also is the predominant acid produced by fermentation of glucose or cellulose. The anode was granulated graphite, the cathode was carbon with a platinum catalyst, and they used an off-the-shelf anion exchange membrane. The bacteria consume the acetic acid and release electrons and

protons creating up to 0.3 volts. When more than 0.2 volts are added from an outside source, hydrogen gas bubbles up from the liquid.

“This process produces 288 percent more energy in hydrogen than the electrical energy that is added to the process,” says Logan.

Water hydrolysis, a standard method for producing hydrogen, is only 50 to 70 percent efficient. Even if the microbial electrolysis cell process is set up to bleed off some of the hydrogen to produce the added energy boost needed to sustain hydrogen production, the process still creates 144 percent more available energy than the electrical energy used to produce it.

For those who think that a hydrogen economy is far in the future, Logan suggests that hydrogen produced from cellulose and other renewable organic materials could be blended with natural gas for use in natural gas vehicles.

“We drive a lot of vehicles on natural gas already. Natural gas is essentially methane,” says Logan. “Methane burns fairly cleanly, but if we add hydrogen, it burns even



more cleanly and works fine in existing natural gas combustion vehicles.”

The range of efficiencies of hydrogen production based on electrical energy and energy in a variety of organic substances is between 63 and 82 percent. Both lactic acid and acetic acid achieve 82 percent, while untreated cellulose is 63 percent efficient. Glucose is 64 percent efficient.

Another potential use for microbial-electrolysis-cell produced hydrogen is in fertilizer manufacture. Currently fertilizer is produced in large factories and trucked to

farms. With microbial electrolysis cells, very large farms or farm cooperatives could produce hydrogen from wood chips and then through a common process, use the nitrogen in the air to produce ammonia or nitric acid. Both of these are used directly as fertilizer or the ammonia could be used to make ammonium nitrate, sulfate or phosphate.

The researchers have filed for a patent on this work. Air Products and Chemicals, Inc. and the National Science Foundation supported this work.

Source: <http://www.renewableenergyworld.com/renews/story?id=50630>

Examining the World’s Potential to Produce Biodiesel

What do the countries of Thailand, Uruguay and Ghana have in common? They all could become leading producers of biodiesel, says a study from the University of Wisconsin-Madison Nelson Institute for Environmental Studies.

“We’re not suggesting that all exported vegetable oil should be converted into biodiesel, because that would fundamentally upset the food supply. We’re looking at this more from each individual country’s perspective: They’re already exporting one thing, could they be exporting something else?” says Tracey Holloway, Researcher, University of Wisconsin-Madison

The ease of manufacturing biodiesel from vegetable oils and animal fats has made it one of the most promising, near-term alternatives to fossil fuels.

Seeking to understand which nations are best positioned today to enter the burgeoning biodiesel market, researchers Matt Johnston and Tracey Holloway of the Nelson Institute’s Center for Sustainability and the Global Environment (SAGE) ranked 226 countries according to their potential to make large volumes of biodiesel at low cost.

Scheduled for inclusion in the Oct. 24 journal *Environmental Science and Technology*, the analysis uncovered many of the usual suspects, including the



United States, a top soybean grower; and Brazil, already a major biodiesel producer. The Netherlands, Germany, Belgium and Spain also cracked the top ten in overall volume potential.

But the researchers say the study’s true motivation was to identify developing countries that already export significant amounts of vegetable oil for profit, but may not have considered refining it into biodiesel. By exporting biodiesel—a higher value commodity—these countries could improve their trade balances, says Johnston, or use the fuel to offset their own energy needs.

“A lot of these countries don’t have any petroleum resources and so they’re having to import petroleum,”



he says. "At the same time, they're exporting vegetable oil that they could be turning into biodiesel and using domestically."

Overall, the study ranked Malaysia, Thailand, Colombia, Uruguay and Ghana as the developing nations most likely to attract biodiesel investment, not only because of their strong agricultural industries, but also due to their relative safety and stability, lack of debt, among other economic factors.

Johnston emphasizes, however, that the set of criteria he and Holloway used is just one among many. "As long as they're profitable and have large volumes of vegetable oils, all the countries on our list—even if they aren't on our top ten list—they could do this," he says.

The idea for the analysis first struck Johnston on a visit to a remote island of Fiji, where people rely primarily on petroleum diesel to run generators for electricity. Transported in by boat, the fuel cost the equivalent of \$20 per gallon. Meanwhile, the islanders were growing coconuts and processing them into oil that sold for 50 cents a liter.

"The price disparity was just incredible," says Johnston, "and it prompted me to think about where else in the world countries might have this biofuels potential, but not necessarily realize it."

At the same time, many agencies—chief among them the United Nations - have raised concerns about the biofuel industry's possible impact on the world's poor, as vegetable oils, now used for food, are increasingly diverted to fuel production. Rampant growth of biofuels could also negatively affect the environment; a soaring demand for palm oil, for example, has already led to deforestation in Southeast Asia.

By highlighting the places in the world where biodiesel development will likely happen, Johnston and Holloway hope their analysis will help people foresee these problems and make plans to mitigate them.

"We're not saying, 'There's all this potential out there, go get it,'" says Johnston. "Instead, we're looking at which vegetable oil feed stocks are most likely to be affected and which countries will most likely be doing this at a large-scale. That way, we can anticipate some of the impacts, as opposed to having to react after the fact."

Of all the vegetable oils and animal fats examined in the study, soybean and palm oil were by far the most common. In fact, the world's top five soybean and palm oil producers—Malaysia, Indonesia, Argentina, the United States and Brazil—accounted for 80 percent of the potential global biodiesel production, the researchers found.

Based on current export volumes of vegetable oil from 119 countries, Johnston also estimated that a grand total of 51 billion liters of biodiesel could be produced annually—enough to meet roughly 4-5 percent of the world's existing demand for petroleum diesel. Yet, although interesting, these numbers aren't the main point.

"We're not suggesting that all exported vegetable oil should be converted into biodiesel, because that would fundamentally upset the food supply," says Holloway. "We're looking at this more from each individual country's perspective: They're already exporting one thing, could they be exporting something else?"

Because the study employed data from online, public sources—primarily the Food and Agriculture Organization of the United Nations Statistics Division—Holloway points out that any country could repeat the calculations or do its own analysis of the biodiesel opportunity. And she and Johnston hope they will.

"I'd love to see some of these development opportunities come to fruition for some of these countries," Johnston says.

Madeline Fisher is a staff writer at the University of Wisconsin-Madison.

Source: <http://www.renewableenergyworld.com/rea/news/story?id=50328>



If Corn is King of Biofuels, Tropical Maize May Be Emperor

When University of Illinois crop scientist Fred Below began growing tropical maize, the form of corn grown in the tropics, he was looking for novel genes for the utilization of nitrogen fertilizer and was hoping to discover information that could be useful to American corn producers.

Now, however, it appears that maize itself may prove to be the ultimate U.S. biofuels crop. Early research results show that tropical maize, when grown in the Midwest, requires few crop inputs such as nitrogen fertilizer, chiefly because it does not produce any ears.

It also is easier for farmers to integrate into their current operations than some other dedicated energy crops because it can be easily rotated with corn or soybeans, and can be planted, cultivated and harvested with the same equipment U.S. farmers already have.

Finally, tropical maize stalks are believed to require less processing than corn grain, corn stover, switchgrass, *Miscanthus giganteus* and the scores of other plants now being studied for biofuel production.

What it does produce, straight from the field with no processing, is 25 percent or more sugar—mostly sucrose, fructose and glucose.

“Corn is a short-day plant, so when we grow tropical maize here in the Midwest the long summer days delay flowering, which causes the plant to grow very tall and produce few or no ears,” says Below. Without ears, these plants concentrate sugars in their stalks, he adds. Those sugars could have a dramatic affect on Midwestern production of ethanol and other biofuels.

According to Below, “Midwestern-grown tropical maize easily grows 14 or 15 feet tall compared to the 7-1/2 feet height that is average for conventional hybrid corn. It is all in these tall stalks,” Below explains. “In our early trials,

we are finding that these plants build up to a level of 25 percent or higher of sugar in their stalks. This differs from conventional corn and other crops being grown for biofuels in that the starch found in corn grain and the cellulose in switchgrass, corn stover and other biofuel crops must be treated with enzymes to convert them into sugars that can be then fermented into alcohols such as ethanol.

Storing simple sugars also is more cost-effective for the plant, because it takes a lot of energy to make the complex starches, proteins, and oils present in corn grain. This energy savings per plant could result in more total energy per acre with tropical maize, since it produces no grain.

“In terms of biofuel production, tropical maize could be considered the ‘Sugarcane of the Midwest,’” Below said. “The tropical maize we’re growing here at the University of Illinois is very lush, very tall, and very full of sugar.”

He added that his early trials also show that tropical maize requires much less nitrogen fertilizer than conventional corn, and that the stalks actually accumulate more sugar when less nitrogen is available. Nitrogen fertilizer is one of major costs of growing corn.

He explained that sugarcane used in Brazil to make ethanol is desirable for the same reason: it produces lots of sugar without a high requirement for nitrogen fertilizer, and this sugar can be fermented to alcohol without the middle steps required by high-starch and cellulosic crops. But sugarcane can’t be grown in the Midwest.

The tall stalks of tropical maize are so full of sugar that producers growing it for biofuel production will be able to supply a raw material at least one step closer to being turned into fuel than are ears of corn.

“And growing tropical maize doesn’t break the



farmers' rotation. You can grow tropical maize for one year and then go back to conventional corn or soybeans in subsequent years," Below said. "Miscanthus, on the other hand, is thought to need a three-year growth cycle between initial planting and harvest and then your land is in Miscanthus. To return to planting corn or soybean necessitates removing the Miscanthus rhizomes."

Below is studying tropical maize along with doctoral candidate Mike Vincent and postdoctoral research associate Matias Ruffo, and in conjunction with University of Illinois Associate Professor Stephen Moose.

This latest discovery of high sugar yields from tropical maize became apparent through cooperative work between Below and Moose to characterize genetic variation in response to nitrogen fertilizers.

Currently supported by the National Science Foundation,

these studies are a key element to developing maize hybrids with improved nitrogen use efficiency.

Both Below and Moose are members of Illinois Maize Breeding and Genetics Laboratory, which has a long history of conducting research that identifies new uses for the maize crop.

Moose now directs one of the longest-running plant genetics experiments in the world, in which more than a century of selective breeding has been applied to alter carbon and nitrogen accumulation in the maize plant.

Continued collaboration between Below and Moose will investigate whether materials from these long term selection experiments will further enhance sugar yields from tropical maize.

Source: <http://www.renewableenergyworld.com/rea/news/story?id=50329>

Understanding Financing Structures in the Wind Industry

There have been a number of financing structures developed in recent years to help fund the rapid expansion of the wind power industry in the United States. A new report from the Lawrence Berkeley National Laboratory released last month examines these financing options to provide a better understanding of how these complex structures work.

These structures feature varying combinations of equity capital from project developers and third-party tax-oriented investors, and in some cases commercial debt.

While their origins stem from variations in the financial capacity and business objectives of wind project developers, as well as the risk tolerances and objectives of equity and debt providers, each structure is, at its core, designed to manage project risk and allocate Federal tax incentives to those entities that can use them most efficiently.

The report begins with a contextual discussion of recent trends in the financing of utility-scale wind projects in the United States.

Next, the report describes in both visual and textual detail the seven principal financing structures through which most utility-scale wind projects (excluding utility-owned projects) have been financed from 1999 to the present. These structures include simple balance-sheet finance, several varieties of all-equity partnership "flip" structures, and a pair of leveraged structures.

Finally, using a simplified pro forma financial model and market-based assumptions about the cost of equity and debt capital under each structure, the report analyzes the impact of these seven structures on the levelized cost of energy from a generic wind project.

Source: <http://www.renewableenergyworld.com/rea/news/infocus/story?id=50188>



Low-cost Solar Thermal Plants at Heart of Algerian-German Research Push

The development of a new generation of large-scale, low-cost solar thermal power plants is the focus of a joint research agreement signed between Algeria and Germany.

Researchers will be sharing data and expertise to speed up the market introduction of large-scale solar thermal plants. The plants could supply up to 200 megawatts (MW) of electricity and desalinate water for 50,000 people.

Electricity from solar thermal plants could cost as little as •0.04/kilowatt hour (kWh) [US \$0.06/kWh] by 2015 to 2020, Bernhard Milow from the German Aerospace Center (DLR) said. And using solar thermal power to desalinate seawater could cost the same.

“The technology and science is all there. It’s just a question of transferring that knowledge to those who have the sunshine and optimizing the technology to make it competitive,” Milow said.

Electricity from solar thermal plants currently costs •0.20 to 0.30/kWh [US \$0.31 to 0.47/kWh], depending on the location of the plant and the amount of sunshine it receives. But with improvements in the performance of plants and better sites, solar thermal electricity could soon be cheaper than coal, and so generate huge amounts of reliable, clean electricity in hot desert regions, Milow said. Even factoring in high steel prices and other costs, a kWh of electricity could still be as low as •0.06-0.07/kWh [US \$0.09-0.11/kWh] if the power plants are in prime locations, Milow said.

By 2050, he estimated that 10 - 25 percent of Europe’s electricity needs could be supplied by North African solar thermal plants.

The agreement between the DLR in Germany and the New Energy Algeria (NEAL) in Algeria will allow German researchers access to data from the 150 MW hybrid solar-

gas plant at Hassi R’mel, 420 kilometers south of Algiers. The plant is due to go into operation in 2009 and has a 25 MW solar energy capacity with a parabola trough design. The DLR researchers will look at ways of optimizing the design and manufacture of the component parts and the efficiency of the collectors and absorbers.

Another area for research will be thermal storage technology. “The DLR has 30 years of experience in solar thermal power technology while Algeria has the right sites for these plants, and has committed itself developing the technology for its own use and for export to Europe, so we can help each other out,” Milow said.

Algeria has introduced a feed-in tariff for electricity from solar thermal plants to boost the use of the technology, and NEAL plans to build pure solar thermal plants without gas as soon as the technology allows it. The typical solar thermal plant of the future could be as large 200 MW and supply electricity to 250,000 people and fresh water to 50,000 people.

In fact, solar thermal desalination plants could turn as much as 100,000 m³ / day of sea water into fresh, clean water – and so help boost agriculture and secure





the supply of drinking water in a region increasingly hit by drought. According to a German study, there is already a shortfall of 50 billion cubic meters of fresh water in the region and that shortfall is set to grow to 150 billion by 2050. Algeria is particularly rich in sites suitable for solar thermal desalination plants.

The DLR has identified the best locations for plants using satellite images to encourage investment. "80 percent of the finance for solar thermal projects will come from private investors who will be looking for the best return. That means finding places where there are as few clouds as possible," said Milow.

The DLR has used weather data going back for decades to identify locations with the most sunshine. An average of 2200 kWh of solar radiation falls on each square meter of Algeria with 2650 kWh falling on the Sahara desert region; this compares to just 1000 kWh falling on a square meter in Germany. One study estimated that solar energy harnessed just from Algeria could supply 60 times the electricity needs of Europe.

To transport the electricity to Europe, a 1,875 mile high voltage direct current cable is to be built between Algeria and Germany, running through Sardinia, Italy and Switzerland.

"Getting permission from all these countries to build this cable could slow down the project for years because of all the red tape. But the cable will be able to carry electricity to Europe with only about a 10 percent loss," Milow said. He said small quantities of electricity could be imported into Germany as early as 2010.

The DLR is also carrying out parallel research on a pilot 1.5 MW solar tower power plant in Julich in northern Germany.

"We need to do research on several solar thermal technologies to find the best one," Milow said.

He said that the same model could be used in Australia for electricity and water desalination.

"Plants in Australia could even supply enough fresh water to ensure good, reliable harvests in key crop growing areas that have seen yields drop dramatically because of drought. Israel already successfully uses desalinated water for agriculture, so it has been shown to work in practice," said Milow.

The southern states of America could also expand their solar thermal plants and eventually export electricity to the northern states, Milow said. Solar thermal power plants have been in commercial use in southern California since 1985. Last year, the 64 MW parabola trough Nevada Solar One plant went into operation.

In Spain, 10 new solar thermal plants are being planned. Spain, which introduced a 25-year guaranteed feed-in tariff of •0.26/kWh [US \$0.40/kWh] for solar thermal electricity, is building Europe's two biggest parabola trough solar power plants, Andasol I and II, in Andalusia. The 11 MW PS10 solar power tower has also started operating close to Seville in southern Spain.

New plants are also being planned in Abu Dhabi, Egypt, Iran, Israel, Mexico, and Morocco. Milow said Morocco and the Red Sea region could also tap wind power in addition to the sunshine to generate clean energy.

"Energy in the future will come from many different sources, including biomass and geothermal, but solar thermal power plants can definitely play a big part when they become cost competitive," he said.

Looking into the future, networks of decentralized and overlapping renewable energy technologies complemented by irrigation networks and water desalination plants could power economies – and large-scale solar thermal power plants could be playing a key role in the energy supply of many regions.

Jane Burgermeister is a RenewableEnergyWorld.com European Correspondent based in Austria.

Source: <http://www.renewableenergyworld.com/rea/news/story?id=51889>



Five Trends to Watch in the Renewable Energy Industry

Growth in the renewable energy industry is set to reach more than US \$250 billion by the year 2017 with the electric car, sustainable cities, non-U.S.-based energy firms, geothermal energy and the greening of the shipping industry helping to lead the way. That's the prediction made by Clean Edge in its Clean Energy Trends 2008 report released on Wednesday.

The report's co-authors Joel Makower, Ron Pernick and Clint Wilder spotlighted the biofuels, wind power, solar photovoltaic (PV) and fuel cell markets as the benchmark segments for the renewable energy industry as a whole. Worldwide in 2007 the biofuels market reached US \$25.4 billion, 40 percent of which came from the U.S., the wind market rose to US \$30.1 billion. The market for solar PV grew to US \$20.3 billion and the emerging fuel cell market, still dominated by R&D, totaled US \$1.5 billion in revenue in 2007. Watch for more on the report from Ron Pernick on RenewableEnergyWorld.com in two weeks.

The report put the spotlight on five trends to watch as renewable energy industry surges ahead. The first was the new structure taking shape in the electric vehicle market where startups are taking center stage. In a presentation about the trends, Joel Makeower said that there are currently 200 U.S. companies working, in some way, shape or form, on bringing the electric car to market.

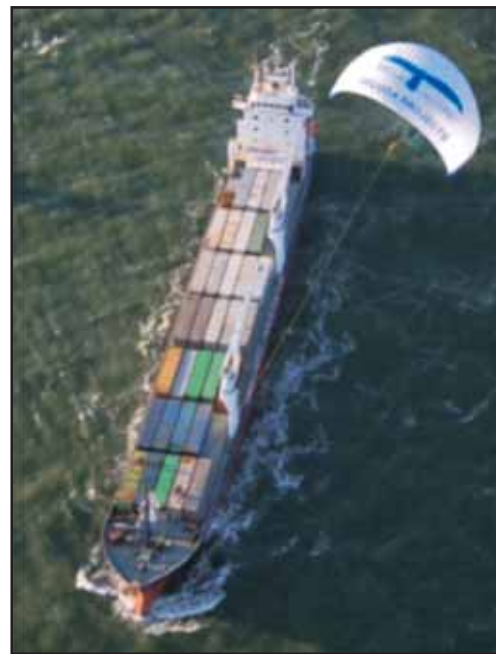
According to the report, "the new generation of green vehicles may not be driven by Detroit or its Euro or Asian counterparts. A growing line of start-ups is rendering moot the question of 'Who killed the electric car?' While the global car companies go through years-long retooling to create plug-in hybrids, electric cars, and other alt-fuel vehicles, these start-ups are beating the big guys to market, delivering greener cars to a waiting public."

These startups include Scandanavian company Think, Tesla, Project Better Place/Renault-Nissan in Israel, Eliica from Japan, Miles and ZAP in the U.S., REVA in India, ZENN in Canda, Spark in China and Venturi in France.

The second trend to watch according to Clean Edge is the movement toward sustainable cities, including the new Masdar City in Abu Dhabi a city that plans, by 2016, to serve a population 50,000 individuals and 1,500 businesses all powered by solar energy. Another emerging eco-city is Dongtan, on Chongming Island near Shanghai, which plans to serve 20,000 people by 2010 and be powered completely by renewables, mostly wind and biomass. The report also points to major efforts being made around the world to "green" established cities.

Third in the series of trends is the growing presence of overseas companies in the U.S. wind energy market, a trend that will continue to grow according to the Clean Edge report as the dollar remains relatively weak and the demand for wind in the U.S. continues to grow.

Geothermal energy's return to the main stage is the fourth trend to watch. According to the report, "geothermal is the only clean-energy resource besides hydroelectric that provides baseload power 24 hours a



Sky Sails kite technology is one of Clean Edge's five renewable energy trends to watch



day, and with average plant uptime of 98 percent, it does so even more reliably than nuclear or coal-fired power plants, both of which require more downtime for maintenance.”

The co-authors noted that three of California’s largest investor-owned utilities, PG&E, Southern California Edison, and San Diego Gas & Electric, within the past year have announced new geothermal plans. This comes as no surprise as average geothermal electric costs are between 4-7 cents per kilowatt-hour.

And finally, the fifth trend is a building movement to make shipping by sea more environmentally friendly. Driven more by the major shippers worldwide (the presenters mentioned IKEA, Home Depot, and Toyota), than the shipping companies themselves, the idea is to lessen the negative impact that cargo ships currently put on the environment. In the report, the co-authors point

out that cargo ships account for more than 4 percent of the global carbon dioxide emissions, double the emissions of aviation, according to a study commissioned by the UN’s International Maritime Organization.

Companies that are developing technologies to propel ships without greenhouse gas emissions are gaining ground. Kite for Sail, KiteShip and Sky Sails, all of whom are working on designing kites that, when combined with better navigation tools and software will allow large ships to use the wind for propulsion.

The report said that “given that shipping emissions, left unchecked, are forecast to grow 30 percent from current levels by 2020, such technologies could be a breath of fresh air.”

■ Source: <http://www.renewableenergyworld.com/rea/news/story?id=51825>

Scaling Up Solar in India

At the moment India has an installed capacity of only about 3 megawatts (MW) of grid-tied solar electricity, but Moser Baer PV (MBPV) has plans to change that.

The company, a relatively new entrant in the solar photovoltaic (PV) market, has recently announced a series of new initiatives. These include setting up India’s largest grid-connected solar farm in the sunshine abundant state of Rajasthan, and increasing production capacities. MBPV announced that it had partnered with the Rajasthan Renewable Energy Corporation (RREC) to set up a solar farm of 1-5 MW capacity in the state. At US \$4.5 million per MW, the total investment for this farm will be US \$25 million.

Mr. Ravi Khanna, CEO of MBPV said, “As per our MOU [memorandum of understanding] signed with the Rajasthan government back in Nov 2007, we are committed to continue working on the solar farm in Rajasthan. And for this, we are in the process of tying up the investors/partners for this project. Moser Baer will be providing the complete turn-key solution for this farm.”

The company is awaiting the announcement of suitable tariffs for its sale of electricity to the state utility. It has other initiatives currently in the discussion phases with other states and investors. “In fact, there is so much interest today from potential investors in solar farms that we are tying them in MOUs that our module capacities and order books are properly planned out,” Khanna said.

Rajasthan already generates about 10% of its electricity from non-conventional private units. According to a press release issued by MBPV, “Rajasthan offers significant opportunities for renewable energy projects and also has large natural resources conducive for setting up such non-conventional energy projects in the state.”

India’s economy is growing fast, nearing a double-digit growth rate. To fuel this growth, more commercial-use electricity is needed in addition to meeting residential demand. India has supply shortages in both residential and commercial electricity, including peak time supply. Solar electricity may help fill this demand gap, especially in peak time demand. Many of India’s remote villages are



not connected with electricity grid, and solar offers a solution for this, along with other local small scale renewable electricity generation technologies. The government of India has announced subsidy plans of US \$750/KW for installed capacity of residential or commercial use, with a maximum of US \$1,250/household. For community and institutional use the subsidy is higher, at US \$1,250/KW. The government has also announced feed-in-tariffs of up to US \$0.30 per unit (KWh). This is up to 75% of the generation costs of PV, which range between US \$0.38 to \$0.75 per unit.

Commenting on policy support for PV, Khanna said, "We believe the recent policy announcement is a very positive and welcome step by the Indian government. Though we will continue to work with them to make it a real success, there is no doubt that once a few MWs are installed in India, we can see the beginning of a much wider growth for the PV industry. Already, we are seeing the spiraling effects of this with many state governments like Punjab, Rajasthan, West Bengal, etc. getting in the process to formalize solar tariffs."

India has abundant solar resources, receiving about 3000 hours of sunshine every year, and has a potential of about 20 MW per sq km, according to energy researcher Mr. Shirish Garud at The Energy and Resources Institute (TERI) in New Delhi. However, the high price of PV electricity remains an issue. With higher volumes and economies of scale the prices are expected to come down as the market expands in the next few years. "We expect the per unit price to drop to US \$0.12 to \$0.15 in the next 3 years. Also, as we have big plans for thin films as well, we don't expect any delays in this target at least for Moser Baer. We also have a considerable focus on reducing BOS (Invertors, Structures, etc.) parts cost which will help us achieve our target," said Moser Baer's Khanna.

PV-based electricity is expected to remain a very small share of total electricity generated in India in the near future. Therefore, even with higher costs it is not expected to add much to the averaged price of electricity. "It may add only about US 1/40 cent to averaged cost of electricity in the short-term. It is important that we invest in solar now, and the costs will come down as the technology and market develops in the future. It is very good option to develop for the future," Garud said.

Moser Baer PV is fueled by the enthusiasm for PV. It is planning to expand its plant in NOIDA near New Delhi, and planning a new plant near Chennai. The major expansion will be in thin-film capacity going from the present 40 MW to 600 MW by 2010, with a total investment of US \$1.5 billion. An immediate doubling of crystalline silicon cell capacity from 40 MW to 80 MW is expected by the end of March 2008. The company has also invested in solar technology R&D through stakes in three U.S.-based companies: Stion, Solaria and SolFocus. MBPV hopes to benefit from R&D by these firms in concentration technology and nanotechnology to increase PV output and reduce the of size of PV producing units.

The growing global market for PV, which is expected to generate revenues of up to 16 billion by 2012 by some estimates, is what MBPV is banking on. Most of the demand for MBPV is expected to come from the U.S. and the EU but MBPV's expectations for Indian market are also high, 1,000-2,000 MW by 2010. PV offers many potential applications in India. According to Garud, "The telecom industry has used it [PV] to power relay systems and telephone exchanges in rural areas. Railways have used it for remote applications, signaling and for operating unmanned gates," he said

Use in telecom towers is another potential application. Dr Bharat Bhargava, a Director in India's Ministry of New and Renewable Energy said that in India, "Solar makes possible stand-alone, distributed and decentralized electricity available to rural, remote, difficult areas and unmanned applications. The rule of thumb today is that where reliability and unmanned operation are important – for example, telecom etc – solar offers the best solutions." With the flexibility of PV in generating electricity from milliwatt to megawatt it offers a wide range of applications. Moser Baer PV focuses primarily on large scale modules and commercial applications. However, solar lamps and other consumer applications of PV are a large potential market in India, especially in underpowered rural areas and high-tech uses like personal and business computing.

Source: <http://www.renewableenergyworld.com/rea/news/story?id=51685>



Renewables 2007 Global Status Report: Perceptions and Realities

In 2007, more than \$100 billion was invested in new renewable energy capacity, manufacturing plants, and research and development – a true global milestone. Yet perceptions lag behind the reality of renewable energy because change has been so rapid in recent years. This report captures that reality and provides an overview of the status of renewable energy worldwide in 2007. The report covers trends in markets, investments, industries, policies, and rural (off-grid) renewable energy. (By design, the report does not provide analysis, discuss current issues, or forecast the future.) Many of the trends reflect increasing significance relative to conventional energy.

Renewable electricity generation capacity reached an estimated 240 gigawatts (GW) worldwide in 2007, an increase of 50 percent over 2004. Renewables represent 5 percent of global power capacity and 3.4 percent of global power generation. (Figures exclude large hydropower, which itself was 15 percent of global power generation.)

Renewable energy generated as much **electric power** worldwide in 2006 as one-quarter of the world's nuclear power plants, not counting large hydropower. (And more than nuclear counting large hydropower.)

The largest component of renewables generation capacity is **wind power**, which grew by 28 percent worldwide in 2007 to reach an estimated 95 GW. Annual capacity additions increased even more: 40 percent higher in 2007 compared to 2006.

The fastest growing energy technology in the world is **grid-connected solar photovoltaics (PV)**, with 50 percent annual increases in cumulative installed capacity in both 2006 and 2007, to an estimated 7.7 GW. This translates into 1.5 million homes with rooftop solar PV feeding into the grid worldwide.

Rooftop **solar heat collectors** provide hot water to nearly 50 million households worldwide, and space heating to a growing number of homes. Existing solar hot water/

heating capacity increased by 19 percent in 2006 to reach 105 gigawatts-thermal (GWth) globally.

Biomass and geothermal energy are commonly employed for both power and heating, with recent increases in a number of countries, including uses for district heating. More than 2 million groundsource heat pumps are used in 30 countries for building heating and cooling.

Production of **biofuels** (ethanol and biodiesel) exceeded an estimated 53 billion liters in 2007, up 43 percent from 2005. Ethanol production in 2007 represented about 4 percent of the 1,300 billion liters of gasoline consumed globally. Annual biodiesel production increased by more than 50 percent in 2006.

Renewable energy, especially small hydropower, biomass, and solar PV, provides electricity, heat, motive power, and water pumping for tens of millions of people in rural areas of developing countries, serving agriculture, small industry, homes, schools, and community needs. Twenty-five million households cook and light their homes with biogas, and 2.5 million households use solar lighting systems.

Developing countries as a group have more than 40 percent of existing renewable power capacity, more than 70 percent of existing solar hot water capacity, and 45 percent of biofuels production.

Including all these markets, an estimated \$71 billion was invested in new renewable power and heating capacity worldwide in 2007 (excluding large hydropower), of which 47 percent was for wind power and 30 percent was for solar PV. Investment in large hydropower was an additional \$15-20 billion. Investment flows became more diversified and mainstreamed during 2006/2007, including those from major commercial and investment banks, venture capital and private equity investors, multilateral and bilateral development organizations, and smaller local financiers.



The renewable energy industry saw many new companies, huge increases in company valuations, and many initial public offerings. Just counting the 140 highest-valued publicly traded renewable energy companies yields a combined market capitalization of over \$100 billion. Companies also broadened expansion into emerging markets. Major industry growth is occurring in a number of emerging commercial technologies, including thin-film solar PV, concentrating solar thermal power generation, and advanced/second generation biofuels (with first-ever commercial plants completed in 2007 or under construction). Jobs worldwide from renewable energy manufacturing, operations, and maintenance exceeded 2.4 million in 2006, including some 1.1 million for biofuels production.

Policy targets for renewable energy exist in at least 66 countries worldwide, including all 27 European Union countries, 29 U.S. states (and D.C.), and 9 Canadian provinces. Most targets are for shares of electricity production, primary energy, and/or final energy by a future year. Most targets aim for the 2010-2012 timeframe, although an increasing number of targets aim for 2020. There is now an EU-wide target of 20 percent of final energy by 2020, and a Chinese target of 15 percent of primary energy by 2020. Besides China, several other developing countries adopted or upgraded targets during 2006/2007. In addition, targets for biofuels as future shares of transport energy now exist in several countries, including an EU-wide target of 10 percent by 2020.

Policies to promote renewables have mushroomed in recent years. At least 60 countries-37 developed and transition countries and 23 developing countries-have some type of policy to promote renewable power generation. The most common policy is the feed-in law. By 2007, at least 37 countries and 9 states/provinces had adopted feed-in policies, more than half of which have been enacted since 2002. Strong momentum for feed-in tariffs continues around the world as countries enact new feed-in policies or revise existing ones. At least 44 states, provinces, and countries have enacted renewable portfolio standards (RPS), also called renewable obligations or quota policies.

There are many other forms of policy support for renewable power generation, including capital investment subsidies or rebates, tax incentives and credits, sales tax and value-added tax exemptions, energy production

payments or tax credits, net metering, public investment or financing, and public competitive bidding. And many developing countries have greatly accelerated their renewable electricity promotion policies in recent years, enacting, strengthening, or considering a wide array of policies and programs.

Policies for solar hot water and biofuels have grown substantially in recent years. Mandates for incorporating solar hot water into new construction represent a strong and growing trend at both national and local levels. Many jurisdictions also offer capital subsidies and/or conduct solar hot water promotion programs.

Mandates for blending biofuels into vehicle fuels have been enacted in at least 36 states/provinces and 17 countries at the national level. Most mandates require blending 10-15 percent ethanol with gasoline or blending 2-5 percent biodiesel with diesel fuel. Fuel tax exemptions and/or production subsidies have become important biofuels policies in more than a dozen countries.

Below the national and state/provincial level, municipalities around the world are setting targets for future shares of renewable energy for government consumption or total city consumption, typically in the 10-20 percent range. Some cities have established carbon dioxide reduction targets. Many cities are enacting policies to promote solar hot water and solar PV, and are conducting urban planning that incorporates renewable energy.

Market facilitation organizations (MFOs) are also supporting the growth of renewable energy markets, investments, industries, and policies through networking, market research, training, project facilitation, consulting, financing, policy advice, and other technical assistance. There are now hundreds of such organizations around the world, including industry associations, nongovernmental organizations, multilateral and bilateral development agencies, international partnerships and networks, and government agencies.

Eric Martinot of the Worldwatch Institute and Tsinghua University is the lead author and researcher on the Renewables 2007 Global Status Report.

Source: <http://www.renewableenergyworld.com/rea/news/infocus/story?id=51744>



IREDA'S Guidelines for Loan Assistance

BACKGROUND

India is today at the forefront in harnessing renewable energy resources and has one of the largest/ broad-based programme in Non Conventional Energy. The Ministry of Non-Conventional Energy Sources has been entrusted to provide a thrust and importance to the renewable energy sector. The future requirements may necessitate distributed generation and demand side management. Renewable Energy is emerging as an effective option for ensuring Green House Gas abatement and to provide a degree of National Energy Security.

Realizing the potential and the importance of New and Renewable Sources of Energy (NRSE) in national development with particular reference to rural sector and to implement the Government policy of conserving/ generating energy, the Government of India established IREDA as an independent specialized Public Sector undertaking under the Ministry of New and Renewable Energy (MNRE) for continuous and constant interaction to translate the policies of Government of India into realities. The Company was incorporated as a Public Limited Government Company w.e.f. 11.3.1987 under the Companies Act, 1956 primarily as one of the instruments for promoting, developing and financing NRSE technologies and thereby accelerating the momentum of development and help in large scale utilization of renewable energy sources. IREDA has also been notified as a "Public Financial Institution" under Section 4 'A' of the Companies Act, 1956 and registered as Non-Banking Financial Company (NBFC) with Reserve Bank of India.

The potential of power from various renewable energy sources has been estimated at 84,776 MW comprising Biomass - 16,881 MW , Wind - 45,195 MW , Small Hydro - 15,000 MW , Cogeneration (bagasse) - 5,000 MW, Municipal Waste to Energy - 2,700 MW . In addition , vast potential from solar energy is also available for grid power

applications depending on future developments making solar technology cost competitive. The renewables constitute 7.7 % of the total grid capacity of Indian Power Sector and IREDA's share accounts for 30% of the total power generating capacity of this. The Draft Renewable Energy Policy sets goal of electrification of 18000 remote and un-electrified villages and achievement of 10% from renewable in the new power capacity projected up to 2012. IREDA has also fixed targets to sanction additional capacity of 1750 MW during 11th Plan.

Energy Efficiency and conservation holds huge potential in domestic, commercial and agriculture sectors. Major industries alone have at least 15000 MW energy saving potential. Government have enacted a comprehensive Energy Conservation Act which will provide the legal framework for promoting efficient use of energy resources and its conservation in the country.

SECTORS ELIGIBLE FOR ASSISTANCE

- * Small Hydro Power
- * Medium & Large Hydro Projects above 25 MW (In Consortium / Co-financing with other Banks / FIs)
- * Wind Energy
- * Bio-Energy
- * Solar Energy
- * Energy Efficiency & Energy Conservation
- * Bio-fuel / Alternate Fuel
- * New & Emerging Technologies
- * Developmental Activities/ New Initiatives



TYPES OF SCHEMES

- | | |
|--|--|
| <ul style="list-style-type: none"> (i) Project Financing (ii) Equipment Financing (iii) Loans for Manufacturing (iv) Market Development (including Export Promotion) (v) Energy Centers (vi) Financial Intermediaries (vii) Business Development Associates (viii) Renewable Energy / Energy Efficiency Umbrella Financing (ix) Non-conventional Energy Technology Commercial Fund Scheme (x) Financing of commissioned projects including take over of Loans from other Banks / Fls. (xi) Additional / Bridge Loan against SDF Loan | <ul style="list-style-type: none"> iv) Individuals, Proprietary concerns and Partnership firms unless security of Bank Guarantee from Scheduled Banks/ Pledge of FDR issued by Scheduled Banks as described in RBI Act, is provided v) Applicants with accumulated losses (without taking in to account effect of revaluation of assets , if any) as per audited Annual Accounts of the immediate preceding financial year unless security of Bank Guarantee from Scheduled Commercial Bank / Pledge of Fixed Deposit Receipt (FDR) issued by Scheduled Commercial Bank as described in RBI Act is provided. vi) Loss making applicants as per Audited Annual Accounts of the immediate last year of operation unless security of Bank Guarantee from Scheduled Bank/ Pledge of FDR issued by Scheduled Banks |
|--|--|

unless Bank Guarantee from Scheduled Banks / Pledge of FDR issued by Scheduled Banks as described in RBI Act, is provided.

iv) Individuals, Proprietary concerns and Partnership firms unless security of Bank Guarantee from Scheduled Banks/ Pledge of FDR issued by Scheduled Banks as described in RBI Act, is provided

v) Applicants with accumulated losses (without taking in to account effect of revaluation of assets , if any) as per audited Annual Accounts of the immediate preceding financial year unless security of Bank Guarantee from Scheduled Commercial Bank / Pledge of Fixed Deposit Receipt (FDR) issued by Scheduled Commercial Bank as described in RBI Act is provided.

vi) Loss making applicants as per Audited Annual Accounts of the immediate last year of operation unless security of Bank Guarantee from Scheduled Bank/ Pledge of FDR issued by Scheduled Banks

The provisions under (v) and (vi) above shall not apply to the loss incurred due to preliminary & preoperative expenses in the case of projects promoted by Special Purpose Vehicle (SPV)

GENERAL ELIGIBILITY CONDITIONS

All types of applicants, who have borrowing powers and powers to take up renewable energy and energy efficiency projects as per their Charter, are eligible to avail financial assistance from IREDA **except the following:**

- | | |
|---|--|
| <ul style="list-style-type: none"> i) Government Departments ii) State Electricity Boards (SEBs) / utilities unless they are restructured or in the process of restructuring and are also eligible to borrow from REC/PFC. iii) Trusts /Societies with accumulated revenue deficit or revenue deficit immediately during the past year | <ul style="list-style-type: none"> vii) There is erosion of paid up equity share capital of the Applicant as per the latest Annual Report. viii) Applicants whose existing Debt Equity Ratio* exceeds 3:1 after taking into account the proposed borrowings from IREDA and Debt Equity Ratio of 5:1 in the case of NBFCs meeting the Capital to Risk Assets Ratio (CRAR) prescribed by the Reserve Bank of India. The above, however, can be considered against the security of BG/FDR for 100% loan amount from Scheduled Banks as described in RBI Act and / or the same is permitted elsewhere in the guidelines. |
|---|--|



*{Debt Equity Ratio is the ratio of total borrowings (other than unsecured loans and working capital loan) to net worth.}

- ix) Applicants who are in default in payment of dues to Financial Institutions, Banks, NBFCs and/or IREDA at the time of submission of application.
- x) Applicants/ Group Companies and/or main promoters of the applicant company which are in default in payment of IREDA dues at the time of submission of application.
- xi) Applicants/ Group Companies and / or main promoters of the applicant company classified as willful defaulters as defined by RBI/ classified by other FIs.
- xii) Second-hand project, equipment and machinery except for transfer of existing loan to third party(ies).
- xiii) Cost over run financing except for additional cost arising out of changes in project parameters / scope of work
- xiv) Applicants / Group Companies and / or main promoters of the applicant company who had availed OTS from IREDA
- xv) Applicants requesting financial assistance of less than Rs.10 lakhs (other than Market Development, Establishment of Energy Centres, Infrastructure Loans to Business Development Associates and user category in Solar Energy programmes)
- xvi) Applicants/ Group Companies and/or main promoters of the applicant Company convicted by court for criminal/ economic offences or under national security laws.
- xvii) Applicants registered outside India.
- xviii) Companies which do not have minimum paid capital as prescribed in Company's Law for private and public companies.

MINIMUM LOAN AMOUNT

The Minimum loan eligibility from IREDA will be regulated as under :

(Rs./lakhs)

| S No | Sector | Category | | |
|------|---|----------|----------------|---------------|
| | | Users | Intermediaries | Manufacturers |
| 1. | Low Grade Solar Thermal Systems | 5.0 | 10.0 | 10.0 |
| 2. | Solar Photovoltaics (excluding Pumping Programme) | 5.0 | 10.0 | 10.0 |
| 3. | Energy Centre | 5.0 | - | - |
| 4. | All other Sectors | 10.0 | 10.0 | 10.0 |

The loan eligibility under Market Development Assistance (including Export Promotion) Scheme and Infrastructure loans to Business Development Associates will be regulated as per the respective schemes.

FINANCING NORMS

The financing norms relating to maximum moratorium, repayment period and minimum promoter contribution , in brief , for different type of eligible projects are indicated in **Annexure-I**.

Wherever the funds for sectors are to be provided by IREDA out of the funds to be received from International / Bilateral agency , the stipulated procedures including norms of financing, procurement procedures, EIA / SIA guidelines etc. , are to be followed by the borrowers applicable to the schemes/ Line of Credit.

SECURITY NORMS

IREDA gives financial assistance under various schemes as given above under the head "Types of Schemes." The Borrowers of IREDA include Proprietorship and Partnership concerns NGOs, Trusts, Societies, Private & Public Limited, Government Companies, TCO, SNA and National & Local Productivity Councils and State Utilities for loans for



particular limits under, various types of Schemes based upon Legal Status of Borrower of loans up to certain limits by the Borrowers. As such keeping in view, the Schemes, Legal Status of the Borrower and quantum of loan, risk perception, nature of industry and background of each project, final decision for accepting a particular type of security shall vest with IREDA. The Loan shall be secured against following securities :

(a) Bank Guarantee from Scheduled Banks/Pledge of FDR issued by Scheduled Banks as described in RBI Act **OR**

(b) State Government Guarantee **OR**

(c) Unconditional and Irrevocable guarantee of All India Public Financial Institutions having "AAA" or equivalent rating **OR**

(d) Mortgage of immovables by way of deposit of title deeds (except in case of Equipment Financing Scheme).

(e) Hypothecation of movable assets, both existing and future, subject to prior charge of Banks on specified current assets.

One or more of the following additional securities can also be stipulated by IREDA based upon and as provided for in the categories of Project / Borrowers in CRRS:

(a) Guarantees by promoters and / or promoter directors and / or promoter companies.

(b) Deposit of Post Dated Cheques in accordance with repayment schedule of principal loan amount and interest.

(c) Demand promissory note

(d) Bank Guarantee/FDR for an amount not less than 10% of IREDA loan amount outstanding for a period of 3 years to be renewed from time to time with validity / renewal during currency of loan and with or without sanction of 100% margin from IREDA. The amount of BG/FDR shall remain the same as original up to repayment of 50% of IREDA's Loan Amount and thereafter, it may be renewed at 10% of loan outstanding at any point of time.

(e) Mortgage of immovable properties urban or rural areas (excluding waste / barren lands) owned by

promoters, directors of the Borrower in their own name or relatives or friends of the promoters.

(f) Second charge on assets other than that is pending to the project financed by IREDA.

(g) Pledge of FDR, NSC Bond, Securities and Insurance wherever feasible.

(h) Charge on Escrow Account/Letter of Credit/Trust and Retention Account/Special Account depending upon type of Project, business of the applicant, merits of each case.

(i) Pledge of shares held by promoters and promoter companies in the Borrower's company/ies who are listed on stock exchange.

(j) Any other security as may be feasible.

(* In case of stipulation of following types of mortgage security of further mortgage by deposit of title deeds and hypothecation of movables is not required to be stipulated:

(i) English Mortgage of all immovable / movable properties and rights / privileges / in deeds / contracts, other documents.

(ii) Wherever the security stipulated requires promissory note/Guarantee/s. these would be obtained from promoters and / or promoter director/s and / or promoter companies without linking it with share capital.

(iii) BG/FDR not less than 10% of loan amount at any point of time as additional security will be applicable to all existing and new loans.

(iv) In case of co-financing of projects, IREDA may follow the terms, conditions of sanction and security pattern of Lead Institution.

Notes:

(i) Financial Assistance under Project Finance Schemes to Proprietorship and Partnership concerns, NGOs, Trusts and Societies shall be secured only against security at above.

(ii) (a) Loans upto Rs 25.00 lakhs to NGOs, Trusts and Societies under Equipment Finance Scheme /



Intermediary Scheme shall be secured against security at 1(a) to 1(c) or against DP Note, Hypothecation of movables and PDCs.

(b) Loans exceeding Rs 25.00 lakhs under equipment finance scheme / intermediary scheme shall be secured against the security at 1(a) to 1(c) above.

(iii) Loans to Company under Companies Act and societies under equipment finance scheme / intermediary scheme where mortgage of immovable properties is not stipulated, shall be secured by additional security of mortgage of immovable, non-agricultural properties in urban or rural areas (excluding waste / barren lands). Land belonging to promoters / directors or their relatives or friends having market value equivalent to 33% of IREDA Loan. Alternatively, security at one above shall be taken.

(iv) Advance as Financial Assistance under SPV Water Pumping Programme or MNRE agricultural related uses shall be secured against security at 1(a) to 1(c) above.

(v) Financial Assistance under market development assistance including export promotion to new borrowers shall be secured against security at 1(a) to 1(c) above and for existing Borrower as per the other security norms.

(vi) Infrastructure loans under Business Development Associates (BDA's) Scheme to Proprietorship and Partnership concerns, TCO/SNA/NGO/National and Local Productivity Councils will attract security of BG / FDR OR Demand Promissory Note, Hypothecation of movables, Personal Guarantees of promoter directors / companies and Post Dated Cheques for principal and interest amount.

(vii) **Subsidy** : Subsidy would be disbursed on reimbursement basis or in terms of guidelines prevailing from time to time as issued by the Authority, sanctioning subsidy after systems have been installed; documents have been produced to the satisfaction of IREDA and inspection has been carried out, wherever considered necessary. Subsidy release will be considered only if the amount of subsidy is received from the Ministry. Pending receipt of subsidy if any amount is released as advance, it will carry highest applicable rate of interest from IREDA.

SPECIAL EFFORTS & CONCESSIONS

IREDA provides special concessions to assist the promoters belonging to SC/ST, Women, Ex-service man and Handicapped categories and also for the projects in North Eastern States, Sikkim, Uttarakhand, Jharkhand, Chhattisgarh, Islands, Estuaries. The concessions include - rebate in interest rates; exemptions in payment of Registration Fee, Inspection Charges, Legal Charges (other than incurred for Recovery), Expenditure incurred on Nominee Director(s), Front-end fee.

REGISTRATION FEE

All applications submitted to IREDA for financial assistance should be accommodated with a demand draft payable at New Delhi in favour of INDIAN RENEWABLE ENERGY DEVELOPMENT AGENCY LIMITED towards one time non-refundable Registration Fee as given below :

| Loan applied | Registration Fee per application |
|--|--|
| Upto Rs.1 crore | 10,000 + plus service tax & education cess, as applicable |
| Above Rs.1 crore & upto 20 Crore | Rs.30,000/-+ plus service tax & education cess, as applicable |
| Above Rs.20 crore and upto Rs.40 crore | Rs.50,000/-+ plus service tax & education cess, as applicable |
| Above Rs.40 crore | Rs.60,000/- + plus service tax & education cess, as applicable |

FRONT END FEE

i) The borrowers will have to pay front-end fee as below :

| Loan slab | Front-End- Fee(% of loan amount) |
|-----------------|---|
| Upto Rs 5.0 Cr | 0.50 % plus service tax & education cess, as applicable |
| Above Rs 5.0 Cr | 1.00 % plus service tax & education cess, as applicable |



ii) **Front End Fee for Take Over Loans** (loans availed from other Banks / FIs and swapped to IREDA) :

- # For home coming : 25 % of above@
- For others : 100 %

Borrowers who had pre-paid the loan and returning back to IREDA.

@ Balance 75 % front end fee to be charged in case of pre-payment within reset period in addition to applicable pre-payment charges.

This amount will have to be paid on sanction before signing of the Loan Agreement or as stipulated and is non-refundable. The amount of front-end-fee can be included as a part of the project cost and is to ensure borrower's commitment to utilize the funds and execute the project sanctioned. In case of State Nodal Agencies, the rate of front-end-fee will be 0.5% irrespective of loan slab. Additional loan, if sanctioned will also be governed by above table with reference to total loan amount, but front end fee shall be chargeable on the additional loan component.

RECENT POLICIES DEVELOPMENT

a) Introduction of Bridge Loans Scheme for SDF supported Cogeneration Projects

In order to attract addition business avenues in Bagasse based sugar development fund (SDF) supported cogeneration projects , IREDA has introduced bridge loan scheme against SDF loan where IREDA can extend loan upto 90 % of project cost (in case of profit making existing sugar mills).

b) Scheme for Taking Over of Loans

Earlier , there was no provision in IREDA's guidelines for taking over of loans from other FIs/Banks for projects commissioned earlier than one year from the date of application to IREDA. As a result, IREDA was not able to take advantage of such market opportunities. IREDA has introduced a scheme to consider such proposals for taking over of loans. The financing norms for the proposed

scheme, are the same as applicable to the fresh proposals received. However, in the case of 'home coming' proposals [projects earlier financed by IREDA], minor concessions are given in the Front-end Fee.

c) Scheme for Solar PV Grid Connected Projects

Subsequent to formulation of scheme for SPV grid interactive power plants by the MNRE , IREDA has introduced financing scheme for SPV grid connected power plants. The scheme shall facilitate the borrower to avail loans for setting up SPV grid interactive power plants in the country.

d) Scheme for Medium & Large Hydro Projects

IREDA had scheme for financing of hydro projects more than 25 MW under co-financing / consortium financing arrangements where IREDA was not a lead institution. To have more share in financing of hydro projects more than 25 MW , IREDA has introduced a new scheme for financing of hydro projects above 25 MW, in consortium / co-financing with Banks/FIs where IREDA can be lead institution.

Loan Application to IREDA is to be submitted in prescribed form. The application form is available free of cost and may also be downloaded from IREDA's website www.ireda.in For submission of loan application form, clarification/discussions, please contact:

The Chairman and Managing Director
 Indian Renewable Energy Development Agency Limited
(IREDA)
 (A Government of India Enterprise)
 East Court, Core 4-A, 1st Floor, India Habitat Centre, Lodi Road, New Delhi - 110003
 Telephones : 24682214 to 24682221
 FAX : 011-24682202,
 E-mail: cmdireda@ireda.in
 World Wide Web: www.ireda.in

The Entrepreneurs may also get in touch with State Level Nodal Agencies of Ministry of New and Renewable Energy, Government of India, IREDA's Business Development Associates (BDAs); and refer to IREDA's Website, for assistance with regard to IREDA's financing details about NRSE Sector.



FINANCING NORMS RELATING TO MAXIMUM MORATORIUM , REPAYMENT PERIOD AND MINIMUM PROMOTER CONTRIBUTION

A. PROJECT FINANCING

| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|-----|---|--------------------------------------|----------------------------------|-------------------------------------|--|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1. | Hydro Energy (i) Small Hydro upto 25 MW Capacity (ii) Hydro above 25 MW (in consortium / co-financing with other Banks/FIs) | 10.35 to 10.75 10.55 to 11.00 | 10 15 | 30 30 | Upto 70 % of total project cost Upto 50 % of total project cost | IREDA will finance above 25 MW in consortium/co-financing with other FIs Banks and can also take up position of lead institution |
| 2. | Wind Energy Development & setting up of wind farms on ownership/lease basis including offshore wind farm projects | 9.85 to 10.25 | 10 | 30 | Upto 70% of total Project Cost | Projects set up by manufacturers or their subsidiaries with minimum capacity of 5 MW, may avail additional loan up to 15 % secured by Bank Guarantee/ FDR and generation guarantee is provided for entire loan period to the Borrowing Company and the same is assigned to IREDA. |
| 3. | Biomass Co-Generation & Industrial Co-generation ^ | | | | | |
| 3.1 | (a) Small scale co-generation (except sugar industry) upto 7.5 MW installed capacity (b) Above 7.5 MW installed capacity (Both for Sugar and Non-Sugar Industry) (Minimum applicable boiler pressure will be 63 Kg/cm ²) | 10.80 to 11.25 10.80 to 11.25 | 10 10 | 30 30 | Upto 70% of total project cost* Upto 70% of total project cost | If alternate fuel is required for extension of operating days in a year, fossil fuels upto 25% of annual consumption is allowed |



| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|-----|---|---|----------------------------------|-------------------------------------|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 3.2 | <p>SDF Supported Bagassed based Cogeneration Projects</p> <p>Additional/Bridge Loan Scheme for SDF supported Bagasse based Co-generation Projects :</p> <p>a) New / Greenfield Sugar Unit</p> <p>b) Existing, Profit Making Sugar Company, for last 3 Financial Years.</p> | <p>10.80 to 11.25</p> <p>10.80 to 11.25*</p> <p>10.80 to 11.25*</p> | <p>10</p> <p>10</p> <p>10</p> | <p>10</p> <p>10</p> <p>10</p> | <p>50 % to 70 % of total project cost</p> <p>Equivalent to SDF loan limited to total IREDA loan exposure upto 70 % of the project cost</p> <p>Equivalent to SDF loan limited to total IREDA loan exposure upto 90 % of the project cost</p> | <p>For all SDF supported Bagassed based Cogeneration Projects , IREDA may treat the SDF Loan as Promoter's Contribution upto 40 % of project cost as directed by the Govt. of India in the Gazette.</p> |
| 4. | <p>Biomass Power Generation # (Direct combustion mode) 1 MW to 10 MW (Minimum applicable boiler pressure will be 63 Kg/cm²)</p> | 10.35 to 10.75 | 10 | 30 | Up to 70% of totalproject cost | <ul style="list-style-type: none"> • If alternate fuel is required for extension of operating days in a year, fossil fuels upto 25% of annual consumption is allowed |
| 5. | Solar PV Grid Connected | 9.85 to 10.25 | 10 | 25 | Upto 75% of total project cost | |
| 6. | <p>Waste To Energy</p> <p>I. Recovery of Energy from Industrial Waste</p> <p>II. Recovery of Energy from Urban and Municipal Wastes Electricity through any technology up to 6 MW</p> | <p>12.00</p> <p>12.00</p> | <p>10</p> <p>10</p> | <p>30</p> <p>30</p> | <p>Upto 70% of total project cost</p> <p>Upto 70% of total project cost</p> | <ul style="list-style-type: none"> • Loan is restricted to energy generation system and excludes pre-fuel processing system. |

*1.0% additional interest rate will be charged for bridge loan.



| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period Incl. Moratorium [Years] | Maximum Moratorium [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|-----|--|---------------------------------|---|----------------------------|-------------------------------------|--|--|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 7. | Energy Conservation/ Efficiency Projects (including DSM) and Projects implemented in ESCO mode. | 10.80 to 11.25 9.85 to 10.25 | 10 8 | 2 2 | 30 30 | Upto 70% of total Project cost Upto 70% of total Project cost | |
| 8. | Grid Inter-connection Facility for Eligible Utilities for Renewable Energy Power Evacuation. | 12.75 | 10 | 1 | 30 | 100% of eligible equipment cost limited to a maximum of 70% of total project cost. | Applicable to all grid connected power projects. |
| 9. | Transmission/Distribution facility (where Borrower uses not less than 50% of its electricity requirement from renewable energy) | 12.75 | 10 | 1 | 30 | 100% of eligible equipment cost limited to a maximum of 70% of total project cost. | Applicable to all grid connected power projects. |
| 10. | Bio Fuel (a) Ethanol production through Biomass / Sugar juice / Molasses (b) Bio-Diesel Production | 11.75 11.75 | 8 8 | 2 2 | 30 30 | Upto 70% of Project Cost. Upto 70% of Project Cost. | IREDA loan is available only for projects for oil extraction & trans-esterification process. |
| 11. | Fuel Cells (Power applications / Vehicle applications) | 11.75 | 8 | 2 | 30 | Upto 70% of Project Cost. | |



| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period Incl. Moratorium [Years] | Maximum Moratorium [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|--|--|------------------------|---|----------------------------|-------------------------------------|--|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| B. MANUFACTURING OF EQUIPMENT/FACILITIES RELATING TO: | | | | | | | |
| 1 | Battery Powered Vehicles and Special Batteries for Battery Powered Vehicles/ SPV and Electric Vehicles | 12.75 | 10 | 2 | 30 | Upto 70% of total project cost. | |
| 2. | Energy Conservation/ Efficiency Systems and Equipments | 12.75 | 10 | 2 | 30 | Upto 70% of total project cost | |
| 3. | Solar Thermal Systems | 12.50 | 10 | 2 | 20 | Upto 80% of total project cost. | |
| 4. | Production of SPV Cell, Silicon ingots / Wafer for SPV, SPV modules and systems | 12.75 | 10 | 2 | 20 | Upto 80% of total project cost. | |
| 5. | Wind Energy | 12.75 | 10 | 2 | 30 | Upto 70% of total project cost | |
| 6. | Manufacturing of Kits to be used in Engines for using 10% or more ethanol and other bio-fuel blends | 12.75 | 10 | 2 | 30 | Upto 70% of the total project cost. | |
| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period [Years] | Maximum Moratorium [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| C. EQUIPMENT FINANCING: | | | | | | | |
| 1. | Battery Powered Vehicles and Special Batteries for Battery Powered Vehicles/ SPV and Electric Vehicles | 12.75 | 5 | 1 | 25 | Upto 75% of the Cost of eligible equipment | |
| 2. | Solar Thermal Systems | | | | | | |
| | <i>Direct</i> | | | | | | |
| | Domestic Users | 12.50 | 5 | 1 | 15 | Upto 85% of total project cost | Effective rate will be 2% subject to MNRE upfront Interest Subsidy. |



| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period [Years] | Maximum Moratorium [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|-----|---|------------------------|----------------------------------|----------------------------|-------------------------------------|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Institutional users (not claiming 100% depreciation) | 12.50 | 5 | 1 | 15 | Upto 85% of total project cost. | Effective rate will be 3% subject to MNRE upfront Interest Subsidy. |
| | Industrial & Commercial users (Claiming 100% depreciation) | 12.50 | 5 | 1 | 15 | Upto 85% of total project cost. | Effective rate will be 5% subject to MNRE upfront Interest Subsidy. |
| | <i>Intermediaries \$</i> | | | | | | |
| | Domestic | 12.50 | 5 | 1 | 15 | Upto 85% of total project cost. | Effective rate will be 0% subject to MNRE upfront Interest Subsidy. |
| | Institutional (not claiming 100% depreciation) | 12.50 | 5 | 1 | 15 | Upto 85% of total project cost. | Effective rate will be 1% subject to upfront MNRE Interest Subsidy. |
| | Industrial & Commercial (Claiming 100% depreciation) | 12.50 | 5 | 1 | 15 | Upto 85% of total project cost. | Effective rate will be 3% subject to MNRE upfront Interest Subsidy. |
| 3. | Energy Conservation/ Efficiency Systems and equipments (including DSM) | 12.25 | 10 | 2 | 20 | Upto 80% of the total equipment cost. | <input type="checkbox"/> Direct Users including intermediaries |
| | | 10.25 | 7 | 1 | 20 | Upto 80% of the total equipment cost. | <input type="checkbox"/> The equipment cost is inclusive of cost of Energy Audit & DPR preparation. |
| | | 9.75 | 6 | 1 | 20 | Upto 80% of the total equipment cost. | |
| 4. | Biomass Fuel Processing Machines (Only for IREDA funded biomass projects) | 12.75 | 7 | 2 | 25 | Upto 75% of the total equipment cost. (Eligible Components comprise baler, shredder, choppers, tractor with front end loader & trailer) | IREDA can finance total system as whole or individual items depending on the need & request. |



| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period [Years] | Maximum Moratorium [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|-----|---|------------------------|----------------------------------|----------------------------|-------------------------------------|---------------------------------------|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 5. | Bio-mass Gasification (1000 kWth and above) | 10.75 | 5 | 1 | 25 | Upto 75% of the total equipment cost. | IREDA loan is available only for thermal application for captive use. |

D. FUNDING SPV UNDER MARKET DEVELOPMENT PROGRAMME

| | | | | | | | |
|---|--|-------|----|---|----|-------------------------------------|---|
| (a) Systems of all categories except Pumping | | | | | | | |
| (i) All applications | | 12.75 | 6 | 1 | 20 | Upto 80% of the total project cost | Effective rate will be 5% for domestic and 7% for non domestic applications subject to MNRE Interest Subsidy. |
| (b) Wind - SPV Hybrid System | | 12.25 | 10 | 1 | 20 | Upto 80% of the total project cost. | |

E. MISCELLANEOUS SCHEMES

| | | | | | | | |
|----|--|-------|----|---|----|---|--|
| 1. | Infrastructure Loan under BDA Scheme | 5.75 | 8 | 2 | - | The advance should not exceed Rs. 3 lakhs | For NER & Sikkim, the interest rate will be "0%". |
| 2. | Renewable Energy/Energy Efficiency Umbrella Financing Scheme | 10.25 | 10 | 2 | - | Line of Credit : Minimum Rs.25 lakhs & maximum Rs.1 crore | For NER & Sikkim the interest rate will be 5% p.a. |
| 3. | Market Development Assistance (including Export Promotion) | 10.75 | 5 | 1 | 30 | The term loan will be up to 70% of last 3 years average expenditure on promotional efforts (or the previous year/s of operation in case of applicants with less than 3 years of operation). In case of new companies/ enterprise the term loan will be up to 70% of the estimated | |



| S.N | Sector | Interest Rate (%) p.a. | Maximum Repayment Period [Years] | Maximum Moratorium [Years] | Minimum Promoters' Contribution (%) | Term Loan/ lending Norms of IREDA | Remarks - |
|-----|---|------------------------|----------------------------------|----------------------------|-------------------------------------|---|--|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | | | | | | expenditure for the activity. Minimum loan amount of Rs 2.50 lacs and a maximum of Rs 10.0 lakhs per client subject to eligibility. | |
| 4. | Establishment of Energy Centres a) A1 & A Cities | 12.75 | 7 | 2 | 30 | Upto Rs. 50 lakhs | As classified by the Govt. of India for the purpose of City Compensatory Allowance |
| | b) B1 and B2 cities | 12.25 | 7 | 2 | 30 | Upto Rs. 30 lakhs | |
| | c) Other cities and District / Block / Taluk / Mandal/Tehsil / Headquarters | 11.75 | 7 | 2 | 30 | Upto Rs. 20 lakhs | As classified by the Competent Authority |
| 5. | Electrification of Remote Villages (Projects implemented in ESCO model) | 11.25 | 10 | 2 | 20 | Upto 80% of the Project Cost | |

NOTES :

1. In addition to the interest rate indicated in column '3' above, 1% additional interest rate will be charged by IREDA for all grid connected power generation projects till commissioning.
2. The interest rate indicated above are variable and may be changed any time as and when decided by IREDA.
3. The Interest Rates indicated above will remain fixed for first 03 years (except for those opting for 10 years fixed interest) commencing from the date of first disbursement. The interest rate will be subject to revision as per the rate prevailing on the expiry of every 03 years/ 10 years, as per the Interest Reset guideline notified by IREDA. Three years reset clause will be applicable to all sanctions except those opting for 10 years fixed rate of interest
4. Projects would be eligible for rebate in interest rates, as per prevalent policy of IREDA, in the event of Borrower furnishing security of Bank Guarantee, equivalent to the amount disbursed by IREDA, from scheduled banks as described in RBI Act or Unconditional or Irrevocable guarantee from All India Public Financial Institutions with "AAA" or equivalent rating or pledge of FDRs issued by Scheduled Banks.
5. Biomass direct combustion power projects exceeding 7.5 MW capacity upto a maximum of 10 MW, will be considered on case to case basis subject to careful examination, particularly with reference to Biomass availability, presence of other Biomass power/ Biomass cogeneration projects in that area, linkage for off-season fuel, water availability etc. and the loan from IREDA shall not exceed loan for 7.5 MW of the project
6. For all power generation projects except in wind sector and Solar PV Grid Connected , maximum repayment period of 10 years with maximum 1 year grace period after commissioning of the project is allowed subject to commissioning of project within a period of 3 years from first disbursement.
7. In case of wind sector and Solar PV Grid Connected, maximum repayment period of 10 years with maximum 1 year grace period after commissioning is allowed.