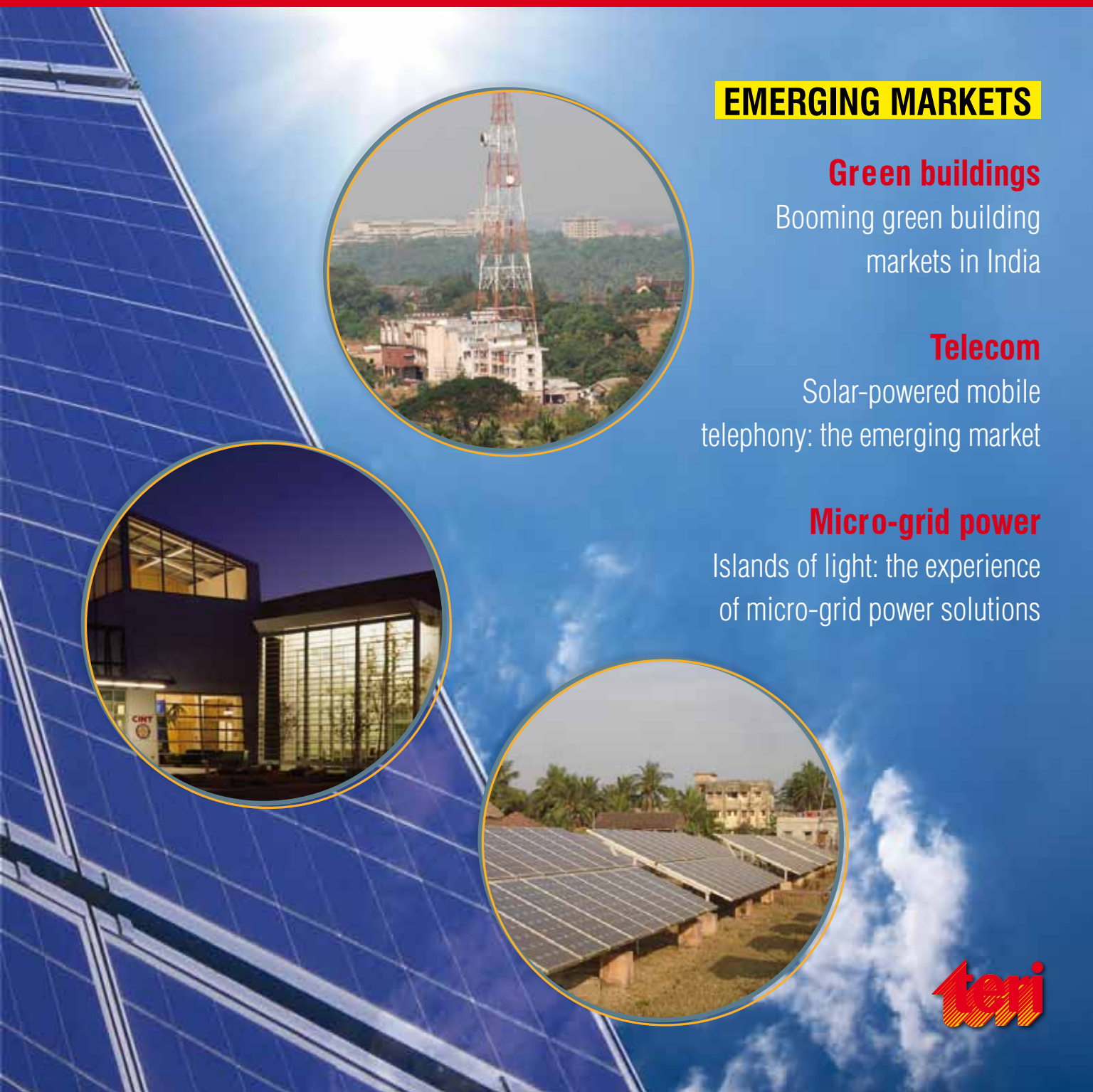
The SOLAR QUARTERLY

The Complete Solar Magazine

Volume 3 • Issue 3 • April 2011

Rs 200



EMERGING MARKETS

Green buildings
Booming green building markets in India

Telecom
Solar-powered mobile telephony: the emerging market

Micro-grid power
Islands of light: the experience of micro-grid power solutions

teri

TerraGreen

EARTH MATTERS

TERI's flagship monthly magazine – *TerraGreen* – is dedicated to disseminating information on issues of environment, energy, and sustainable development. Launched in 2004, *TerraGreen* has made an indelible impression on the minds of readers both in India and across the world. Today, it enjoys a readership of over 25000 and a subscriber base of close to 7000. Not only does *TerraGreen* focus on issues of crucial importance, it presents in-depth analysis of major environmental developments from around the world in crisp and simple language. Aimed at the common man the magazine stays away from all jargon and provides necessary knowledge and information. The rather vast coverage of issues makes the magazine one of its kind in the market—a gap it has filled with great panache.

Subscription rates for TerraGreen

Term (Yrs)	No. of Issues	Cover Price		You Pay		You Save		% Saving
		Rs	USD	Rs	USD	Rs	USD	
1	12	480	120	400	102	80	18	17%
2	24	960	240	750	192	210	48	22%
3	36	1440	360	1000	252	440	108	30%

Free online access for those subscribing for three years
Overseas subscriptions are accepted only in US Dollars

For further information, please contact:

TERI Press
Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi – 110 003, India
Tel.: +91 11 2468 2100, +91 11 4150 4900 • Fax: +91 11 2468 2144, +91 11 2468 2145
E-mail: teripress@teri.res.in

To advertise, contact:

Ravi Shukla, e-mail Ravi.Shukla@teri.res.in
Kakali Ghosh, e-mail kakalig@teri.res.in

Buy online at http://bookstore.terriin.org

Head Office
TERI
Darbari Seth Block, IHC Complex
Lodhi Road, New Delhi – 110 003
Tel. +91 (11) 2468 2100 or 2468 2111
Fax +91 (11) 2468 2144 or 2468 2145w
Regional Centres
Southern Regional Centre
TERI, CA Site No. 2
4th Main, 2nd Stage Domlur
Bengaluru – 560 071
E-mail terisrc@teri.res.in
North-Eastern Regional Centre
TERI, Chachal Hengrabari
Express Highway, VIP Road
Guwahati – 781 036
Western Regional Centre
TERI, F-9, La Marvel Colony
Dona Paula, Panaji – 403 004 (Goa)
E-mail teriwrc@goatelecom.com
Affiliate Institutes
TERI North America
1101 Pennsylvania Avenue NW, 6th Floor
Washington DC, 20004
E-mail terisna@teri.res.in
TERI Europe
27 Albert Grove, London SW20 8PZ, UK
E-mail ritukumar@aol.com
Overseas Representation
TERI Japan
C/o IGES
Nippon Press Centre Building (8th Floor)
2-2-1, Uchisaiwai-cho, Chiyodi-ku
Tokyo, Japan - 100-0011
E-mail teris@iges.or.jp
TERI South-East Asia
Unit 503, 5th Floor
Menara Mutiara Majestic
15 Jalan Othman, Seksyen 3, 4600 Petaling Jaya,
Selagor Darul Ehsan, Malaysia
E-mail nimtech@tm.net.my
TERI Gulf Centre
Flat No. 105, Dalal Building, Al Qusais,
Dubai, UAE
E-mail meejana@gmail.com

Printed on recycled paper

From the editor's desk...

The solar market is expanding rapidly. Several new and emerging applications are beginning to rely on the clean and reliable power coming from solar energy sources. Whether it is off-grid telecom sites or water treatment plants, solar is increasingly being considered as a viable alternative to diesel-based power supply. Not only in the off-grid areas, solar is also being promoted in the urban grid-connected areas as a reliable source of solar power backup, replacing diesel-based gensets and/or providing additional 4–5 hours of solar recharge to supplement the backup provided by inverter batteries.

This change in scenario, from off-grid rural to urban strategic applications, is taking place not because, today, people are more aware of solar or because the government has many more incentives and schemes in place to promote solar, but mainly because of technological and conceptual advancements in the systems designs, selection of components, and their integration, which has enhanced the overall performance of installed solar systems. The micro and modular solar power systems with state-of-the-art technology are being used by high-end service providers in the telecom, IT, health, and other sectors. Similarly, the smart grid/smart mini-grid concept (which involves sophisticated, intelligent control and automation technologies, driven by state-of-the-art power electronic devices) is facilitating the application of distributed solar power systems in energy generation. These new concepts are receiving attention because of their improved power quality and reliability, flexibility, and their ability to provide service during peak-power demand, as against power grids.

The Solar Quarterly has selected three of these emerging markets—smart mini grids, green buildings, and telecom where solar PV is beginning to make a mark. This issue provides an insight into these three markets, which are bound to receive a major impetus under the recently launched JNNSM, with the purpose of adding value to the emerging interest in this area.

Akanksha Chaurey
Director, TERI

Published by Dr R K Pachauri for the The Energy and Resources Institute, Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi – 110 003, Tel. +91 (11) 2468 2100 or 2468 2111, E-mail teripress@teri.res.in, Fax +91 (11) 2468 2144 or 2468 2145, Web www.teriin.org/pub, and printed at Excel Printers Pvt. Ltd., C-205, Naraina Industrial Area, Phase-I, New Delhi – 110028.

I am a regular reader of *The Solar Quarterly* magazine and must say that the magazine is very informative and interesting. In the January issue of the magazine, I specially liked the article titled 'Lighting up one million lights'. The article was a very interesting read. I think that the magazine should feature such case studies more often.

Kriti Singh
New Delhi

I read the January 2011 issue of *The Solar Quarterly* magazine. All the articles are very informative, but I specially liked the article titled 'Shikshadeep: a HAREDA initiative to empower the rural girl child through LED-based solar lamps'. I am pleased to know that various sectors are taking initiatives to educate women for a better future.

Hope to read such articles in future as well.

Megha Mathur
Maharashtra

I am a regular reader of *The Solar Quarterly* magazine. I feel that the magazine is a huge success as it gives enough information on the solar sector of India. Also, the magazine is very well designed. The articles are well-researched and are very informative and interesting to read.

I wish the entire team all the very best and hope they continue with the good work.

Praful Tewari
Uttar Pradesh

I am a student and have started reading *The Solar Quarterly* magazine recently. I must say that the magazine is very informative and interesting. It helps in enhancing my knowledge in the areas of solar energy as a form of renewable energy. Most of the articles are well written. I specially like the section on current research and development. We can gather all the required information about current research and development from this section.

All the best to the entire team of *The Solar Quarterly* magazine.

Aditya Sharma
Bihar

I would like to congratulate the entire team of *The Solar Quarterly* magazine. I am a regular reader of the magazine and find it extremely informative. I have also noticed a marked improvement in the layout and design of the magazine. I really like the font and some of the images that are used in the magazine.

As far as the articles are concerned, I specially like the articles titled 'Solarification of the Ladakh region: addressing energy and sustainable development issues' and 'Shikshadeep: a HERADA initiative to empower the rural girl child through LED-based solar lamps'. Both the articles were very interesting and informative.

I would like the magazine to carry more such case- and region-specific articles. Such articles make an interesting read and also attract a reader's attention as they can relate to such articles.

I congratulate *The Solar Quarterly* team for its efforts and wish the entire team good luck.

Gopal Srinivasana
Tamil Nadu

Thank you very much for your encouragement. The editorial team of The Solar Quarterly will make every effort to make this magazine highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
The Solar Quarterly

CONTENTS

Mobile phone towers to be powered by solar energy

The government is considering the use of solar energy to tide over power deficiency that is impeding the installation of mobile phone towers in tribal and hilly areas, the Rajya Sabha was recently informed. "We have to solarize the mobile towers," the Union Minister of State for Telecommunication and Information Technology Sachin Pilot said during the question hour in the Parliament. He said power shortage in some states is impeding the installation of towers and added that the government is looking at various options, including public private partnership, to make up for the deficiency. Sachin Pilot added that while 604 towers of Bharat Sanchar Nigam Limited (BSNL) installed in the tribal areas of Odisha have already been activated, 46 out of 1023 towers in Jharkhand and 107 out of 759 towers in Chhattisgarh are still to be activated. He assured the members that this will be done by June 2011. Pilot said 98% villages in Jharkhand have already been given rural telephone connections besides some satellite phones.

Source *Hindu Business Line*

NTPC in talks with KfW for funds to set up solar thermal power plant

State-run National Thermal Power Corporation (NTPC), which plans to set up a 15-MW solar power plant at Anta in Rajasthan, is in talks with the German bank, Kreditanstalt für Wiederaufbau (KfW), among others, for funds. The power utility would be signing a loan agreement with KfW for $100 million. "We are working out the modalities of the project and are in talks with various banks for loans. We are also in talks with KfW to tie-up for funds, but nothing has been finalized, as of now," an NTPC official said on condition of anonymity. A KfW senior official confirmed that soon it would be signing an agreement with the NTPC to lend $100 million for the solar thermal project. "We will be signing a loan agreement with NTPC for the project, in the next couple of months," KfW Director Oskar von Maltzan said. The cost of the project is estimated to be about ₹2250 million (₹150 million per MW). At present, the NTPC has a total installed capacity of over 33 650 MW. The corporation has formulated a business plan of capacity addition of about 1000 MW through renewable resources by 2017. A capacity addition of 301 MW through solar photovoltaic (PV) and thermal by March 2014 has also been envisaged in line with the Jawaharlal Nehru National Solar Mission. The German lender is also planning to expand its activities with the NTPC in the field of solar thermal in the next few years, Maltzan said. "We are currently busy supporting the corporation in writing detailed project reports for feasibility study for solar thermal power projects, which would be based in Rajasthan and Gujarat," he added.

Source *Business Standard*

France enacts further cuts to solar FIT

French Minister for the Environment Nathalie Kosciuso-Morizet has announced a new, reduced solar feed-in-tariff (FIT) rate, €0.12 per kWh, for both roof-mounted and ground-mounted systems over 100 KW in capacity. Ground-mounted systems will now receive FIT payments at least 57% lower than what was available in September 2010, according to a Germany-based market research firm, EuPD Research. Rooftop systems now face a 70% FIT reduction as against September 2010 rates. These systems were planned using a completely different calculation model, and some of them will partly be recalculated. The FITs for smaller photovoltaic (PV) systems will be reduced by 20%, and over the course of this year, quarterly declines of 10 percentage points will come into effect, EuPD Research adds. Furthermore, last month, France announced a PV market cap of 500 MW. "Such adjustments are ambitious, but nonetheless necessary for the long-term remedy of PV price divergences in various national markets," says Markus Monssen-Wackerbeck, head of energy and utilities at EuPD Research. The industry should use this pressure to bring high systems prices in the country down to a competitive, European level. The figures from the current European

PriceMonitor, published by the EuPD Research show, on an average, the cost for a French PV system, less than 10 kW, are about €4400 and peaks at €6000.

Source *Solarindustry magazine.com*

Concentrated PV projected to experience growth through 2015

Concentrated photovoltaic (CPV) technology, used for the production of solar energy, faces a number of challenges, not least because of potential limitations in deployable locations, according to Strategy Analytics. The company recently published a report, called the "CPV Technology Market Status Update and Future Prospects," that examines this market. Despite CPV's challenges, Strategy Analytics predicts that the technology's installed capacity will grow at a compound annual growth rate (CAGR) of 174% through 2015. Overall, the solar energy installations have continued to grow strongly, with new global installations reaching 16.3 GW in 2010, according to the report. Approaches utilizing crystalline silicon continue to be the primary technology, followed by strong momentum behind a host of thin-film technologies, including cadmium telluride and copper indium gallium selenide. "While offering 100% improvement in efficiencies compared to other solar technologies, CPV is effective only where there is high direct normal solar irradiation," notes Asif Anwar of Strategy Analytics. "While this has limited early deployment, the benefits of CPV will translate into rapid growth in these locations. In 2010, some significant projects came into play in the south-western US, the Middle East, Africa, and Australia," adds Eric Higham, director of the company's GaAs service. "CPV installations will grow at a CAGR of 174% to account for just over 4% of the global solar installations in 2015, he states."

Source *Strategy Analytics*

Comprehensive and advanced quality assurance measures for optimal yields from PV power plants

As it makes its way towards a non-subsidized market, the photovoltaic (PV) sector has to deal with decreasing margins. To ensure investment goals are met despite this, it is imperative that the PV power plants generate optimal yields. Comprehensive quality assurance for the PV power plants covers all phases of the completion process from the planning-to-system operation. This article explains the extent of standard quality assurance measures that include yield assessments, module measurements, system testing, and yield monitoring. It outlines the potential of linking these quality assurance measures and stresses the importance of the measures themselves being of high quality. Up-to-date scientific findings from Fraunhofer ISE are presented in order to further optimize the quality assurance measures.

Source *PVtech.org*

Business as usual at First Solar: efficiencies up, line run rate up, cost per watt down

Although, First Solar reported a revenue decline compared to the previous quarter as its released fourth-quarter results, manufacturing data strongly indicated that the quarter and full year were simply business as usual for the CdTe thin-film module leader. Production cost for modules produced during the fourth quarter was reduced to $0.73/W, down from $0.75/W in the previous quarter. Total manufacturing costs also declined to $0.75/W. Support from module efficiencies climbing to 11.6%, up from 11.3% in the third quarter, and production line run rates increasing from 59.6 MW to 62.6 MW, contributed to the cost-per-watt decline.

At the heart of First Solar's 2010 success was its continued focus on production milestones and overall productivity improvements. First Solar reported that production in the fourth quarter reached 395 MW, up 13% compared to the prior

quarter. The management said that the increase was due to a 5% improvement in the line throughput, coupled with previously implemented conversion efficiency improvements and 0.5% annual efficiency gain with modules now at 11.6% efficiency. This suggests that 12% efficiencies may well be seen before mid-2011. Management also noted that it benefited from creating six additional production days after moving to a calendar year production timeline. Annual line run rates had improved 17% in the last 12 months. Total production capacity reached 1.5 GW in 2010. However, the company guided a small increase in planned capacity expansions through 2012. The target is to reach a capacity of 2.9 GW, up approximately 138 MW per quarter due to the line run rate improvements achieved in the fourth quarter. Overall, capacity is expected to be about 92% higher by the end of 2012 than at the end of last year.

The management also added that the Malaysia Plant 5 began production in late December and would ramp to full production by the end of the first quarter. The second newest facility, Malaysia Plant 6, was said to be on schedule to ramp in the second quarter. The company's expansion of its second plant in Franfurt Oder, Germany, would now be ramped one quarter ahead of the previously guided plans, which means that the ramp will start in the third quarter of this year. New plants are, therefore, being ramped in each of the first three quarters of 2011.

Source *Solar Power Digest*

Delayed solar-power plants face fines as Gujarat sets precedent

India, which on an average has 300 sunny days a year, will impose fines on solar-power plants that delay start-ups in the country's largest programme to harness energy from sunlight, a state government official said. "There will be some penalty," S B Patil, senior executive of solar and wind at the state-run Gujarat Energy Development Agency, said in an interview. Five of six projects that agreed to start operating by 2011 are delayed, including the one by the New Jersey-based Zeba Solar, he said. The State of Gujarat has led India's nascent solar industry, awarding licenses for 959 MW to developers seeking a foothold in the state-subsidized renewable energy market. The first 48.5 MW were required to start operation by 31 December 2010, according to a list obtained by the Bloomberg News from the Gujarat Urja Vikas Nigam Ltd, the state-run company that will buy the power. How Gujarat deals with delayed projects will set a precedent for India's Solar Mission, a nationwide programme that calls for 20 000 MW of capacity by 2022, or the equivalent of about 18 new nuclear reactors. The Solar Mission awarded its first 620 MW of capacity in December. "The way these defaulting projects are dealt with would set examples for other projects in the pipeline," said Bharat Bhushan, a New Delhi-based analyst with Bloomberg New Energy Finance. "If deadlines are not strictly enforced, more project defaults could be expected." India is seeking to ramp up the sector with estimates showing that it may have among the highest solar potential in the world. The nation's sunny days may provide as much as 5000 trillion kWh per year of solar energy equivalent, far exceeding its total energy consumption of 848 billion kWh, according to the Ministry of New and Renewable Energy.

Companies agreed to penalties that were laid out in their power purchase agreements, Patil said. "They will be charged accordingly," he added. The penalties for delays in beginning operations are ₹10 000 ($222) a day/MW for the first 60 days and ₹15 000 thereafter, according to the state power company that was contracted to buy the electricity. Lanco Infratech Ltd (LANCI), the Hyderabad-based developer that completed its 5-MW allotment on 20 December 2010, is the only company that met the deadline. Five projects awarded to Azure Power of New Delhi, Zeba Solar, Germany's Dreisatz GmbH, and MI MySolar24 Ltd were not completed. Azure, which built a 2-MW plant in Punjab, said that the first phases of the two plants were delayed due to untimely rains. The company was supposed to have completed 3.5 MW by now, according to the list. "We declared force majeure," said Inderpreet Wadhwa, the company's chief executive officer, whose investors include Helion Venture Partners, Foundation Capital,

and the private investment arm of the World Bank. Force majeure is an exemption to contract obligations due to unanticipated or uncontrollable events. Zeba Solar decided to switch to thin-film technology to build a more efficient plant, pushing its completion date back to August, said President Shahal Khan. "We were okay with delay for a few months and paying penalties to have something we can showcase," Khan said. "There are many people out there who are just rushing to meet the deadlines without really looking at quality control."

Source *Solarplaza.com*

The inverter market: cheap, flat, and crowded

As new low-cost entrants begin to dominate the solar photovoltaic (PV) module landscape, the threat of commoditization may already be realized. With module prices skydiving, developers and policy-makers alike are increasingly focusing on non-module components for cost-cutting initiatives. Programmes such as the US Department of Energy's (DOE) Sunshot Initiative that target installed costs at $1.00/Wdc include aggressive targets in balance of systems and inverter costs to $0.40/Wdc and $0.10/Wdc, respectively. Indeed, a recent SunRun report shows that standardized local permitting laws could reduce installation costs by $0.50/Wdc. Germany's balance of systems costs is half of average US's balance of systems costs. Inverters, however, tend to be ignored in discussions on system cost reductions. The drop from current factory-gate pricing of large-scale inverters to $0.10/Wdc is dramatic, but achievable by the DOE's goal of 2017, though some manufacturers have indicated that cuts in initial $/W need to be balanced with reliability and quality concerns. Similar to PV modules, raw materials comprise over 70% of the final product costs. Yet, though raw materials found in PV modules, like polysilicon, encapsulants, tabbings, and so on, are specialized and bill of materials are limited, part counts for inverters run into multi-hundreds. Most of these components are non-application-specific, which means that inverter companies have to compete with the larger electronics industry. In early 2010, with the greater semiconductor industry suffering from the effects of the global recession, critical power electronic components like insulated gate bipolar transistor (IGBTs) and controller boards were in dire shortage and led to global inverter shortages. With limited purchasing power, even leading inverter manufacturers were unable to procure components to meet the booming demand. The shortage, coupled with the growth of commercial and medium voltage segments in key markets, allowed newer companies to capture significant market shares at the expense of the global leader, SMA, which, however, still holds nearly three times the second largest player.

As component supply constraints have eased, plans for capacity expansion have skyrocketed, with announced 2010 year-end capacity reaching over 32 GW. This capacity value, however, can be misleading, as inverter throughput is a function of raw material procurement, labour availability (often in the form of temporary workers), and testing bandwidth. The capex costs for new facilities is extremely low, often below 1%–2% of the final cost of the product, and typically represents empty warehouse/assembly space and new testing equipments. As such, capacity is easily overstated. Actual shipments in 2010 were closer to 21 GW.

Source *Greentechmedia*


Courtesy: DOE/NREL

Upheavals in Chinese polysilicon market may lead to further PV cost reduction

New standards for polysilicon manufacturers may cause upheavals in the market, but will ultimately drive down costs, analysts say. In late January, the Chinese government released its "Polysilicon Industry Access Standards" specifying rules and restrictions for polysilicon manufacturers relating to site selection, energy consumption, environment protection, project capacity, and more. The following are the standard that any new solar polysilicon manufacturing facility must adhere to.

- Facilities need to have an annual production capacity of at least 3000 tonnes.
- Facilities may not be situated within 1000 km (620 miles) of any nature reserve, headwater areas or major residential areas.
- The electricity consumption of the solar-grade polysilicon reduction must be less than 80 kWh/kg and

further reduced to lower than 60 kwh/kg by the end of 2011.

- The recycle rate of silicon tetrachloride, hydrogen chloride, and hydrogen in the reduction tail gas shall not be less than 98.5%, 99%, and 99%, respectively.

Finally, solar polysilicon production lines whose integrated electricity consumption is higher than 200 kWh/kg must be eliminated by the end of 2011. Chinese solar industry experts expect serious fall out to occur. According to Meng Xiangan, deputy director of the China Renewable Energy Society, although the standard is necessary for the long-term and stable development of the industry, a majority of companies may not meet requirements due to technology and capital difficulties. Small and medium-sized firms, which are not meeting the requirements, will be forced out.

Dou Zeyun, an analyst at the Ping An Securities, said that even though the standard may slow down China's ability to grow its supply chain for the solar industry, ultimately it will increase the quality of the country's polysilicon and significantly reduce production costs, driving long-term and healthy development of the country's photovoltaic (PV) industry. Several players within the sector concurred, adding that the standard will change China's production pattern of polysilicon and bring about a reshuffle and consolidation of the industry. The weak will be forced out, while the strong will remain with their position further strengthened. For 2011, the industrial analysts said that the cutbacks in PV subsidies in some European countries (most notably Germany, Italy, the Czech Republic, and France), may have an adverse effect on polysilicon sales. However, this will be offset by rapidly declining costs for polysilicon-related raw materials.

Source *Renewableenergyworld.com*

Mercedes Benz inaugurates solar car port

The first solar car port of car producer Mercedes Benz was inaugurated last week in Mainz, Germany. On an area of nearly 1000 sq m, the car port produces annually about 125 000 kWh of clean electricity. That is more than 1700 kWh for each of the 72 parking places. The project was realized by juwi Solar GmbH for Rio Energie GmbH. Rio Energie GmbH is a joint venture between the utility Stadtwerke Mainz AG and juwi Group from Wörrstadt in Rhineland Palatinate. Besides, the solar car port, an electricity charging station has been installed on the site of the Mercedes Benz branch in Mainz-Bretzenheim, on which up to four electric cars can be charged at the same time. The solar car port has a rated power of 132.3 kW and uses 588 crystalline silicon modules of REC. Mercedes Benz has provided Rio Energie with the site, on which the carport is located. "For Stadtwerke Mainz AG, the issue of electric mobility is gaining importance. Last year, we have put into operation in front of our company headquarter the first electricity charging station in Mainz. Meanwhile, our car pool has its first pure electric car, and we will test or purchase further electric cars or scooters," says Detlev Höhne, head of Stadtwerke Mainz. Mayor Jens Beutel has affirmed the objective of transforming Mainz into a solar city. In 2020, 30% of the electricity consumption of Mainz is planned to be produced from renewable sources.

Source *Solarbuzz.com*

From diesel to solar energy

Sustainability is another name for independence and success. Realizing this, Moser Baer shifted its small education centre from diesel to solar energy to manage operations. The Moser Baer Trust installed a solar rooftop system at its Digital Literacy Centre at village Surajpur, Greater Noida, Uttar Pradesh. The concept will also be used in the company's three other plants located in the state. Designed and developed by Moser Baer Solar, the system will generate sufficient power to meet the requirements of the centre. "It is a 6-kW system, while the requirement of the Digital Literacy Centre is 2 kW. The system has a battery back-up to store the excessive power generated," said Nita Puri, Trustee, Moser Baer, adding, "the system not just lowers energy costs, but also reduces greenhouse emissions, incorporating clean power throughout our educational centres, thanks to the power of the sun." During its expected lifetime, a 6-kW solar panel system will provide CO_2 reduction equivalent to planting 1200 trees. It will produce 350 000 kWh of electricity. "Solar rooftop systems are helping in providing electricity to those villages, which otherwise, do

Courtesy: DOE/NREL

not have regular supply of electricity. To these villages, the system also means empowerment," said Puri.

Source *Asian Age*

World's first hybrid solar plant opens in Florida

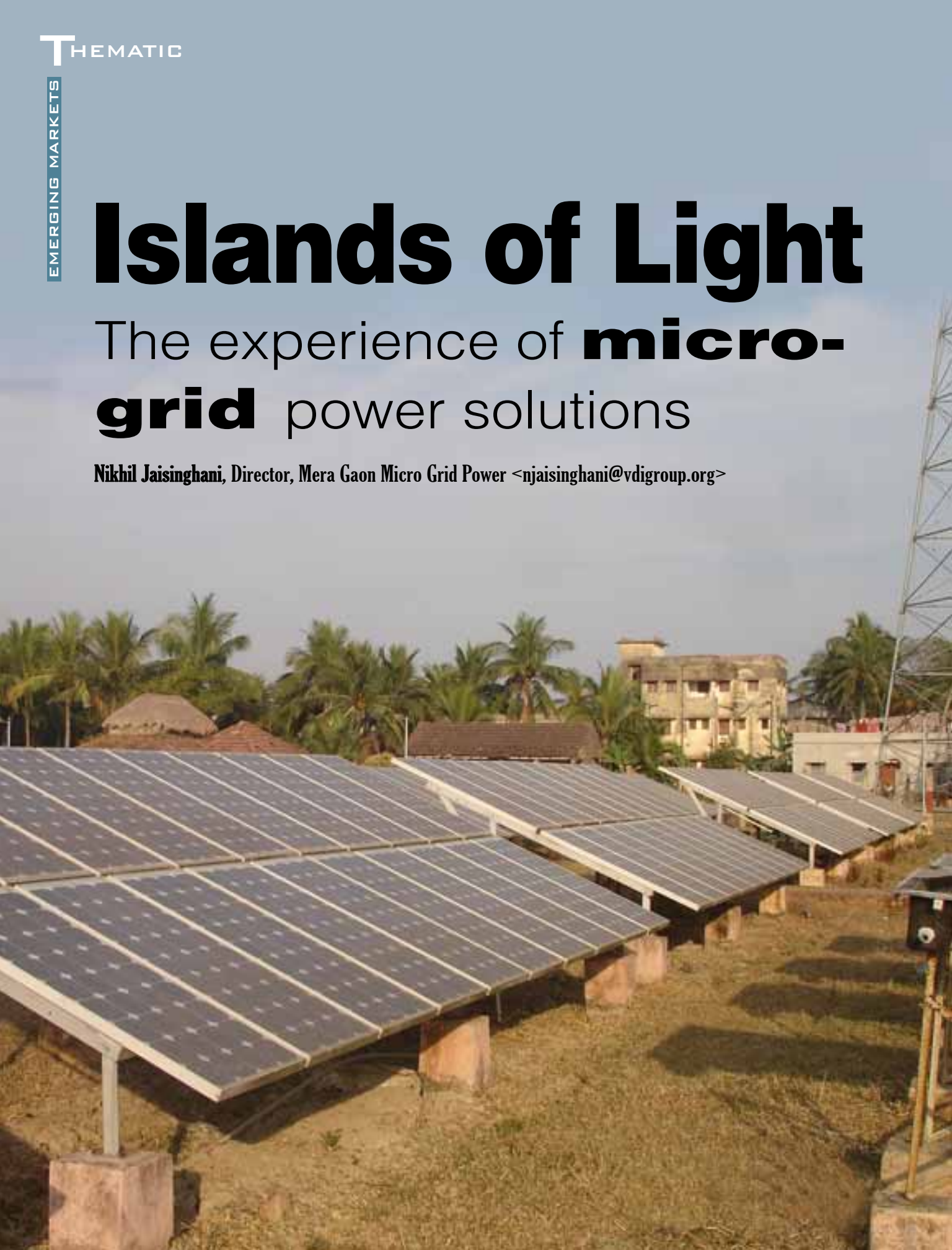
The first hybrid solar power plant in the world was inaugurated in Florida, US, by Florida Power and Light Company (FPL) at its Martin Next Generation Solar Energy Centre. It is one of three solar facilities commissioned by FPL. It features 190 000 solar panels that work in conjunction with an existing natural-gas fired power plant. The solar panels will concentrate the heat of the sun by 80 times and offset the carbon emissions generated by the use of natural gas. It has been called the large-scale equivalent of the hybrid car. The company says that the thermal plant is the largest one in the east of the US, with 75 MW on 500 acres. It can generate power for 11 000 homes and will save fuel cost equivalent to $178 during its lifetime.

Source *Solarfeeds.com*

Islands of Light

The experience of **micro-grid** power solutions

Nikhil Jaisinghani, Director, Mera Gaon Micro Grid Power <njaisinghani@vdigroup.org>



Introduction

Less than half an hour drive from Kanpur, a large industrial city in central Uttar Pradesh, India, is located Beja Khera, Lalu Khera, and Suwansi Khera. The cluster of these three villages with about 350 households lacks connection to the national grid. The situation has not changed despite many appeals to the state government. To finish their household chores, the residents' burn kerosene oil for two to three hours at night. The hard fact is that Uttar Pradesh, with a population of about 250 million people, has yet to electrify 42% of its villages. It is estimated that in India alone, 400 million people still live without the basic benefits of electricity. The total number of such deprived people is mind boggling, if, we take into account another 200 million people in other South Asian countries and nearly another 600 million people in Sub-Saharan Africa. Worldwide, the figure is about 1.5 billion.[1] Table 1 highlights these appalling figures along with the status of electrification in different regions of the world.

Case studies

In India, the limited generation, transmission, and distribution infrastructure has left many villages, and sometimes entire regions, without electric power. Data varies from one source to the other, but the trends are consistent. As of 2010, it is estimated that 60 million households and 48% of rural households are unelectrified nationally; Bihar, Jharkhand, and Odisha have electrified fewer than 35% of the rural households[2]. Data from the Ministry of Power puts the percentage of villages in Uttar Pradesh with electricity at less

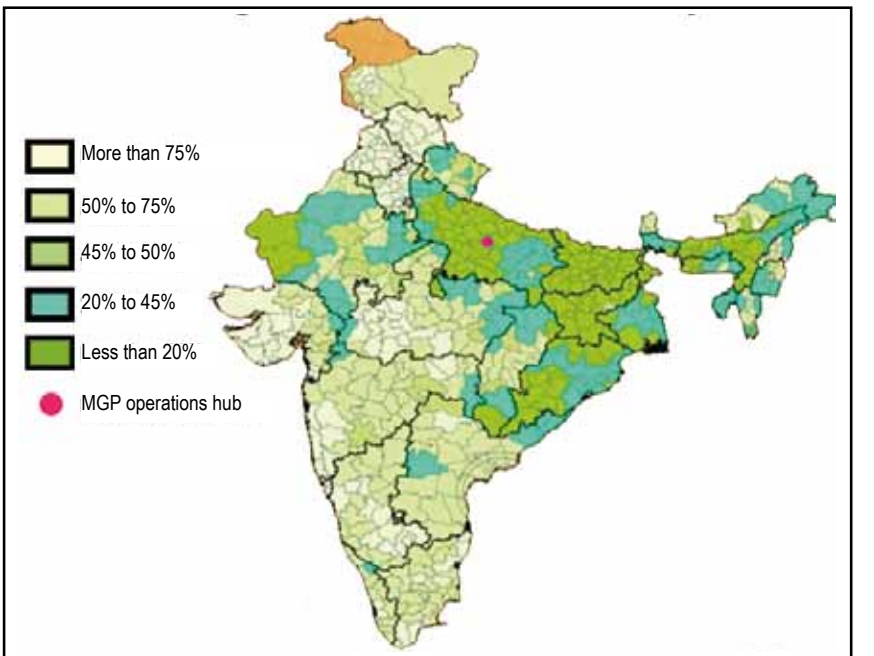


Figure 1 Percentage of households with electricity

Source Sustainable and Renewable Energy Environment Scan / Demand Assessment, India, Grow Wellington, February 2009.

Table 1 Status of electrification in different regions of the world

	Population without electricity (million)					Electrification rate (%)					Urban electrification rate (%)					Rural electrification rate (%)				
	2002	2005	2008			2002	2005	2008			2002	2005	2008			2002	2005	2008		
Africa	535	554	589	19	35	35.5	37.8	40	2.3	2.2	62.4	67.9	66.8	5.5	-1	19	19	22.7	0	3.7
North Africa	9	7	2	-2	-5	93.6	95.5	98.9	1.9	3.4	98.8	98.7	99.6	-0	0.9	87.9	91.8	98.2	3.9	6.4
Sub-Saharan Africa	526	547	587	21	40	23.6	25.9	28.5	2.3	2.6	51.5	58.3	57.5	6.8	-1	8.4	8	11.9	-0	3.9
Developing Asia	1019	930	809	-89	-121	68.7	72.8	77.2	4.1	4.4	86.7	86.4	93.5	-0	7.1	59.3	65.1	67.2	5.8	2.1
China and East Asia	221	224	195	3	-29	88.1	88.5	90.2	0.4	1.7	96	94.9	96.2	-1	1.3	83.1	84	85.5	0.9	1.5
South Asia	798	706	614	-92	-92	42.8	51.8	60.2	9	8.4	69.4	69.7	88.4	0.3	19	32.5	44.7	48.4	12	3.7
Latin America	46	45	34	-1	-11	89.2	90	92.7	0.8	2.7	97.7	98	98.7	0.3	0.7	61.4	65.6	70.2	4.2	4.6
Middle East	14	41	21	27	-20	91.8	78.1	89.1	-14	11	99.1	86.7	98.5	-12	12	77.6	61.8	70.6	-16	8.8
Developing countries	1615	1569	1.453	-46	-116	65.5	68	72	2.8	3.7	85.3	85.2	90	-0	4.8	52.4	56.4	58.4	4	2
Transition and OECD	7	8	3	1	-5	99.5	99.5	99.8	0	0.3	100	100	100	0	0	98.2	98.1	99.5	-0	1.4
World	1623	1577	1.456	-46	-121	73.7	76	78.2	1.9	2.6	90.7	90.4	93.4	-0	3	58.2	61.7	63.2	3.5	1.5

Source Figures from Alliance for Rural Electrification website

[1] World Energy Outlook, 2006.

[2] Rural electricity to speed up inclusion, *Economic Times*, 27 May 2010

than 42% in 2006 (and, therefore, rural household electrification is likely to be even lower). Off-grid demand is still not met by modern power services; and communities resort to low-quality sources of energy such as kerosene, wood, diesel, and disposable type batteries. Figure 1 presents the mapping of households with varying percentage of electricity availability.

Communities detached from the grid represent market imperfections, and with these imperfections come commercial opportunities to capitalize on price disparity. While efficiencies of scale may be lower, the higher tariff rates of off-grid projects can result in an even greater return on investment. The lower investment requirement makes financing more feasible and allows risk from one site to be off-set by the independent operation of micro grids, at other sites. In a recent report[3], the World Resources Institute estimated that the off-grid distributed energy (OGDE) in India is equivalent to the $2 billion-a-year untapped market.

Understanding the ODGE

The donor-funded projects are able to effectively prove the concept of the OGDE, but are not able to achieve the scale. This is mainly because of the limited resources available to fund additional infrastructure. Though, the market potential is enormous, the OGDE has not yet made the transition from non-profit to for-profit. Companies active in micro-grid energy generation and distribution are expanding very slowly and have yet to posit a model with attractive returns on investment, along with the operational simplicity necessary for a company to develop and manage a large network of OGDE facilities. The sector is hindered by non-uniform technical approaches, undeveloped non-technical processes (such as tariff collection, minimizing power theft, and response to system abuse), and the inability to get finances for early stage operations. These challenges mirror those of the micro-finance sector 10 years ago when the sector was making the transition from non-profit to for-profit, when micro-finance institutions (MFIs) were less focused on rapid expansion. Same was the issue when the investment community did not perceive the micro-finance sector to be a lucrative investment opportunity.

This article aims to take a closer look at micro-grid solutions to OGDE, globally and in India, specifically identifying trends from past experiences and identifying the trajectory of the sector as NGOs, governments, and enterprises aim to reach more off-grid households.

Why micro grids

The prevailing thought in most of the industries is that larger the project, greater the efficiencies of scale. For the power sector, specifically, power generation per kilowatt hour (kWh) by various fuel sources suggests that this is no exception. The national grids are often able to provide power at very low rates of $.20 per kWh or even lower. In India, rates vary close to ₹5 ($.11) per kWh. Solar, wind, and biogas projects, usually resulting in small-scale projects, has higher per kWh generation costs, thus, resulting in higher costs to an end customer.

However, this analysis is misleading. The national grids are heavily subsidized; India's Ministry of Power has acknowledged that it loses money for every unit of power it generates. The cost of transmission infrastructure is very high, and when not updated and maintained (a challenge most developing countries with limited budgets often face), lead to high power losses between the point of generation and the point of consumption. The upfront costs of expanding the transmission and distribution infrastructure become unrecoverable when attempting to serve rural households with more limited power demand. The 2005/06 cost data of Andhra Pradesh's Central Power Company shows that laying a 1-km-long 11-kV transmission line costs nearly ₹0.2 million. This is not all, as additional equipment is required to bring this power from the transmission line to a village and then distribute this power within a village. Installing a meter alone costs ₹1300. Add to this, the cost to generate the additional energy that the newly connected households consume and it will be easy to understand the challenges of connecting rural villages to the national grid. In this context, micro grids are able to serve rural villages at a lower cost per customer. If, this can be

[3] "Power to the people: Investing in clean energy for the base of the pyramid in India", World Resources Institute, Centre for Development Finance. <http://pdf.wri.org/power_to_the_people_front.pdf>

Table 2 Costs of constructing a 1-km long transmission line for select countries

Country	Material costs	Labour and other costs	Total costs ($/km)
Bangladesh	$6340	$350	$6690
Laos	$7230	$1420	$8650
El Salvador	$6160	$2090	$8250
Kenya	$5960	$6590	$12 550
Senegal	$10 810	$5150	$15 960
Mali	$15 170	$2590	$19 070

Source ESMAP 2000

done commercially, the challenge of serving off-grid households may only be in terms of perfecting the model accompanied by attracting the necessary finance to fully develop the micro-grid sector. Table 2 shows the cost of constructing a 1-km- long transmission line for selected countries of the world.

Micro grids generate relatively small quantities of power to serve the limited demand of rural households in isolated, off-grid villages. Even though, many of the households in the off-grid villages use large quantities of kerosene to provide limited amount of poor quality night-time lighting, micro-grid companies are not competing with the national grid, but with kerosene for the quality of service, hours per night, and, thereby, the monthly cost. The technology to compete with the quality of service and hours per night has been proven, as we will see later on in the article. There has also been progress in providing these services at prices competitive with kerosene. Once improved services can be offered at or below the cost of kerosene, the private sector will be ready to scale up rapidly, following in the footsteps of microfinance, which now serves nearly 100 million customers, globally.

Kerosene is the dominant source of night-time lighting in the off-grid villages in India. It is estimated that a kerosene lamp consumes between 0.03–0.06 litres of kerosene per hour; the average family burns kerosene for 4–6 hours per night for lighting, resulting in an average monthly consumption of 6–7 litres per household per month. While the Government of India subsidizes the first three litres of kerosene per month for families below the poverty line (BPL), additional litres sell for a premium, often ₹30 or more. As a result, the average rural household in India spends ₹150 (over $3) per month for poor quality kerosene lantern light.

The situation is similar in other countries as well. Lower-middle class families in off-grid villages of Senegal, consume 6 litres of kerosene per month, while middle class families consume 9 litres per month for lighting[4]. In Nigeria, where kerosene is also the dominant source of fuel for lighting, government subsidies are captured by middle men and not by the end consumer. Normally, kerosene prices are about $1 per litre, while in times of scarcity these can escalate to as high as $5, in more isolated regions.

Global experience

Micro-grid power generation and distribution is not a new concept. Donors and large companies, particularly the extractive industries, have often invested in various models for off-grid power delivery. In Nigeria, the oil and gas sector has made considerable investment in energy provision, largely through small diesel generator sets connected to small grids in rural areas. While these micro grids are technically sound and able to provide improved energy services to the households, far outperforming kerosene lighting, operations have been challenging. The requirement for a diesel supply chain as well as generator repairs have left many of these micro grids non-operational for extended periods of time, with some of them even being abandoned altogether. Since, both the construction and operation costs are funded by the oil and gas companies as part of their corporate social responsibility (CSR) agenda, these initiatives have not been commercially sustainable. In Mali, for

[4] While this data is old, it is indicative of the current trends.

example, diesel powered off-grid power generation facilities for small businesses and households were installed by the United Nations Industrial Development Organization (UNIDO) and the United Nations Development Programme (UNDP) in the 1990s. The initiative was replicated in Burkina Faso, Africa. The government intended to expand the initiative in these and in other countries, as well. In these cases, the operational costs were partially covered by tariffs, but the construction cost was still being met through donor or government funding. With limited public resources for expansion, these initiatives have, so far, only achieved a very small scale of penetration.

Another interesting example in Nigeria has been the Bonny Utility Company. Shell, Total, and ENI covered the cost of natural gas-fired power generation and distribution infrastructure to provide power to the residents of Bonny Island in the Niger Delta region. The utility company, which was formed, is community managed and customers pay a tariff for the power that they consume. Thus, till date, 10 000 customers have been connected. The natural gas, which fuels the power generation equipment, is abundant in the Niger Delta and is available as a result of the operations of the oil and gas companies involved; therefore, the fuel supply chain is not a major challenge and operational costs are covered through collected tariffs. The power provided is dependable and of high quality, as well. The only shortcoming of this model is that the capital costs were by grants funded and it is not clear whether a purely commercial model is feasible. Despite the great need for power and the abundance of unused natural gas, this model has not been replicated elsewhere in the Niger Delta.

Solar-based solutions have also been piloted. A 6-kW micro grid serving 26 households has been constructed in Akkan, Morocco. While the service is good, the project was not commercially funded. The panels alone would cost about $700 per household, today, and total capital costs would likely exceed $1000, per customer. Similarly, a donor-funded 3-kW solar grid was installed in Diakha Madina, Senegal, for street lights and a water pump. The African Solar Electric Light Foundation (SELF) also works at the village level to provide solar power at a per customer cost of $2600 to $7000. The estimated repayment period for all of these projects would be too long to allow any of the models to be replicated without significant non-commercial funding.

The People Centered Economic and Business Institute (IBEKA) in Indonesia uses 100-kW micro hydro plants to distribute power to about 60 000 homes (this was the scenario in 2009). At that time, the model was not yet commercially feasible with 50% of the costs of the facilities coming from donors. Small hydro projects have also been demonstrated in Kenya, though primarily to service the tea industry rather than individual households.

A US Agency for International Development (USAID)-funded micro grid in Sudan began the Yei Electric Cooperative (YECO). The Blue Energy Group uses donor funds to build wind-powered battery charging stations for household power consumption. These examples best demonstrate the limitations of donor and donation funded micro grids. YECO only reaches 900 customers while the Blue Energy Group has yet to reach 3000 beneficiaries, despite a few years of operations for each.

The lack of commercial projects is most evident in the "Access to Energy at the Base of the Pyramid" report prepared by Ashoka and Hystra. The section "Grid connections: transforming slum dwellers into attractive customers through business model and technology innovations" did not identify a single commercially viable business model for micro grids, instead focused on community operated, donor-funded micro-grid projects. While many other projects undoubtedly exist, the number of commercially attractive business models is scarce. Interestingly, there are just a few examples of commercial micro-grid operation that have been able to obtain profit and even draw some investments, but they are limited to a single region of the world, a region where innovation, low costs, high population density, low electrification rates, and multiple sources of available renewable energy fuel overlap. These models are all, curiously enough, found in India.

India's experience

Even though there are a number of non-profit micro-grid initiatives, including Desi Power and a Scatec-built, Development Alternatives-operated facility near Jhansi, Uttar Pradesh, but these initiatives face similar challenges to scale up as those already mentioned, mainly, funding the

scaling up of non-profit electrification through limited donor and government resources. Technical viability has been shown through the examples above. What makes India's case study interesting is the emergence of commercial micro-grid operations and the overcoming of non-technical challenges such as the following.

- Input supply chains
- Power monitoring
- Tariff collection
- Non-payment response
- Power theft deterrence
- Outreach to new villages

India has a few clear advantages over Sub-Saharan Africa because of its high population density, which creates relatively large customer bases for micro-grid companies within a small geographic region. The Indian private sector has also demonstrated innovative ability and a strong will to customize products and services for bottom of the pyramid customers. These may be the main reasons, which have led the few commercially viable micro-grid designs to be developed, piloted, and their potential assessed for replication in India.

Technology choices

The four primary renewable energy technologies appear viable: biomass, wind, hydro, and solar. Of these, three are being commercially tested. Also, bio-gasification has received a great amount of attention.

Biomass

Two companies, Husk Power Systems (HPS) and Saran Renewable Energy (SRE), have installed 25-kW systems and larger bio-gasification and power generation facilities in Bihar. HPS uses rice husks, which they say is abundantly available and affordable too. Their other input is labour, some of which must be skilled labour to operate and maintain their equipments. The input supply may become a challenge as the company usually considers the scale and manage a larger number of facilities in a certain geographic region. While the company operation is limited for the time being to rice growing areas, the overlap between rice producing farms and villages without electricity provides them with a large potential customer base, where they can grow. SRE has faced more immediate challenges in terms of input supply. Their facilities are built to use non-husk biomass, which they say is cheaper than husk. However, sourcing the input has been more of a challenge leading to unanticipated down time; this could have been due to the lack of an established market for the biomass that they consume. SRE has instead instituted a plantation model for its facilities and is operating more smoothly now. HPS charges ₹80 per month for six hours of light from two light points and unlimited mobile phone charging, while SRE charges ₹75 per month for a single light point.

Hydro

Hydro, while available in limited areas, appears to be the most commercially viable option for power generation. SBA Hydro has been operating its facilities in the mountainous region of northern India. SBA's approach is slightly different than other companies; it has particularly designed its business to avoid tariff collection. Instead, it distributes energy on behalf of the state electricity board. SBA charges ₹2 per kWh of power produced. Because of the hydro-power's lower cost per kilowatt, this is a commercially attractive rate for SBA, which has been able to attract commercial financing to take its model to a larger scale.

Solar

Two companies have begun the operation of solar-powered micro grids. Azure Power has a 2 MW peak facility in Punjab, which is serving about 4000 households. This amounts to 500-watt peak of solar power generation capacity per customer (the generation costs alone

would amount to about ₹50 000 or $1100 per customer). While it is a profit-oriented company, the high upfront costs per customer make financial viability uncertain. A second company, Mera Gaon Micro Grid Power (MGP), is in a start-up phase, but has what it believes to be the lowest per customer capital expense of any micro grid in operation. MGP opted to build its solar powered micro grids to service off-grid communities' primary energy need—lighting. By building its facilities around a specific need, MGP was able to identify efficiencies from generation to utilization. This company distributes power through low voltage power lines to light up low-powered LEDs installed in customers' houses. According to MGP, its current construction costs are estimated to be ₹2500 per customer and is dropping further. MGP has just two operational facilities, and is now working on improving the tariff collection.

Solar panel costs are high, but solar technology has some advantages too. Solar panels are expected to run for decades with minimal maintenance requirements. This reduces labour and expected repair costs. Solar also has the advantage of eliminating the need for supply chains. This can best be exemplified in the words of the director of MGP company.

> "I was visiting an eco-hotel in rural India. The generator did not work because the hotel authorities could not source a belt that had broken down earlier. The pool could not be used because they could not arrange for one of the parts used in the filter. The roofs leaked because the tiles they used were not available for replacement. Even yoghurt had to be ordered a day in advance because of lack of availability. In rural India, supply chains are liabilities. Thus, it was important for us to minimize our daily dependencies as much as possible."
>
> **Director of MGP company**

Wind

Though, India has high rates of agricultural production to supply husk and biomass and sufficient sunlight to generate solar power, the greatest untapped potential may be wind. Small wind turbines are cheaper per watt than solar and are able to operate for longer hours per day. The operational costs for wind are lower than biomass as wind turbines do not require an input supply chain. Thus, the relatively low capital costs and operational costs offer tremendous potential for future micro grids where there is a dependable source of wind. In order to justify investments in wind power generation, reliable wind maps must be created and made public. Without accurate wind maps, investments in wind turbines are a gamble that private companies may not be quite willing to take. If, wind resources are mapped and made public, micro-grid operation may become cheaper and more profitable. It will stimulate greater participation by entrepreneurs and also greater investment from the private capital markets.

The goal of commercial operation

Though, the market potential is enormous, most companies active in off-grid energy distribution are not able to access sufficient capital to expand. The following are the reasons for limited investment in this sector.

- A variety of different technical designs, each of which is individually engineered and not improved upon by the larger micro-grid sector
- Non-standard processes for tariff collection, minimizing power theft, and response to system abuse
- Inability to access sufficient financing to scale up rapidly

All three reasons are largely due to the lack of consolidation in the sector. The first two reasons could be addressed through an open collaboration between micro-grid operators through regular dialogue with operators identifying challenges and agreeing on the best practices for facility design and operational processes. Through the identification of these

best practices, standard metrics for analysing risks and compliance with best practices could be developed helping investors better understand commercial viability and make more informed investment decisions.

The larger canvas for micro grids

Till now, there is not much competition in the micro-grid sector. The national grid still serves only about half of all the rural households with regular power. Also, the micro-grid companies do not face competition from one another. Few of the micro-grid companies with promising commercial models are still proving their ability to achieve meaningful scales. While solar lantern companies work to have a national presence with a wide outreach, micro-grid companies will have greater efficiencies by narrowing their reach to smaller geographic areas. Thus, micro-grid operators will not be fighting for the same customers until the market is closer to saturation. For this reason, open dialogue and unimpeded collaboration is in the interest of all those who are closely involved with the sector.

The greatest competition that the micro-grid companies' face, the competition they must seek to beat at both quality and price, is kerosene. For the micro-grid sector to reach a significant scale, companies must remove barriers to supply, demand, and scalability. By working together, these companies can develop models capable of the following.

- Generating an attractive (greater than 15%) return on capital with a short turnaround between investment and revenue generation. This will encourage equity investment among micro-grid operators and make the micro-grid sector attractive for project finance (thus, ensuring companies can supply new customers).
- Providing lower cost, higher luminosity, longer running lighting sources than kerosene (thus, ensuring demand for services).
- Reducing operational costs, simplify operations, and eliminating supply chain dependencies (thus, ensuring companies can focus on scale rather than maintenance).

Setting the acceptable performance norms

The scale and explosion of MFIs was in part enabled by addressing two key information needs—an MFI handbook for best-practice operations and a standardized way to assess these institution. The ACCION-developed Capital Adequacy, Asset Quality, Management, Earnings, and Liquidity Management (CAMEL) assessment methodology was critical in scaling the sector as it enabled investors to more clearly quantify the potential risks of a particular investment. It also enabled enterprises to learn and measure themselves against peer institutions. This information input enabled more capital flow leading to the maturity for the sector. Once the microfinance sector was standardized and operational models consolidated, micro-financial services were scaled up at a rapid rate and are now provided to 26 million borrowers and 2 million depositors in India and nearly 100 million borrowers globally. The micro-grid sector is on the verge of a similar growth trajectory and could reach tens of millions of households and hundreds of millions of beneficiaries in the next 10 years. In order to spur such a transition, the standard process, metrics, and the platform to adopt them are essential. With them, the micro-grid sector can consolidate and attract the necessary levels of investment; without them, the sector will continue to be fragmented and investors will be unable to make informed investment decisions.

Operational challenges

Operational challenges are the greatest hindrance to a more robust commercial micro-grid sector. These operational challenges include community engagement and outreach, input supply chain management, tariff collection, non-payment response, power theft deterrence, and financing the scaling up of potentially viable businesses.

Negotiating power tariffs and land access with communities

An important factor determining the micro-grid sector's success is the ability to work with communities and come to an agreement on tariffs, easement, and rules of use. Communities must understand that the commitment to pay standard tariff each month is critical for the micro-grid operator's ability to provide service. Evidence suggests that the strong desire of off-grid residents for improved lighting combined with the ability of micro grids to compete with kerosene on price and quality will make such negotiations fairly routine, once a standard for engagement is developed.

Input supply chain management

When supply chains break down, companies dependent on them fail. Management of supply chains must be perfected or dependency on supply chains should be eliminated. SRE invested in a plantation model to service its input needs, thus, reducing the dependency on individuals to supply them. Azure and MGP use solar to eliminate supply chain needs. The sector would benefit from public investment in dependable wind maps, which would allow low-cost-wind turbines to complement or replace solar-based models

Tariff collection

Companies such as HPS and SRE have already paved the way forward for

collective pressures similar to that used in the micro-finance sector to collect tariffs. HPS villages are broken down into 20 housing units each ,which collectively must pay monthly tariffs. When the units are unable to pay the full amount, the entire unit loses power. As a result, each unit has an incentive to make sure that others pay for their power or to make up for the shortfall by making additional payments, themselves. The microfinance sector has also invested heavily in developing effective tariff collection methods. While many of these have been questioned in India, the experience is worth reviewing and learning from .

Non-payment response

The experience with the national grid has created a precedence for non payment. It is likely that each micro-grid company will, at some point, face a situation where a village attempts to receive power without making payments. Companies should experiment with active engagement after construction, disconnection of non-paying houses if, non-payment is household specific; remotely turning systems off if, repayment is a village level problem; and removing micro grids if, non-payment is somehow chronic.

Minimizing power theft

Along any power distribution network, power theft is always a risk, particularly, in the rural areas where oversight may be less regular or rigorous. However, technology and creative design can help mitigate theft. HPS has developed a low-cost prepaid power meter, which controls and meters current flow to the individual houses. When customers have consumed all of the power for which they have paid, service to the household is discontinued until additional credit is added. MGP opted out of metering; instead, it distributes power at 24 V direct current. While, there are products that run on such current, the majority of electrical appliances available in the Indian market run on 240 V alternating current. MGP's power will not run these appliances. Further, MGP also installs 1 amp circuit breakers at the beginning of each distribution line and automatic timers to limit power distribution to preset the time period at night. During the day, power is not available along the distribution system and, thus, attempts to plug in high amperage equipment like phone chargers, televisions, and fans at night will either trip the circuit breakers or not function because of the voltage.

Financing the operation

The risks mentioned in this section are some major concerns for financiers. To ease investor sentiment, micro-grid operators must develop some standard operational processes to address these risks. Overall, to scale up, the sector needs consolidation. As with the micro-finance sector, once best practices are shared and commonly instituted, standard means for assessing risks and viability are developed and adopted as standards, and financiers are educated about the investment potential, the sector can scale up rapidly. The Network of Micro Grid Operators may be a key instrument for achieving these goals.

Way forward

It is interesting to note that commercially viable models of micro-grid operations are primarily in India. This may be partially explained by the population density, the negative consumer perception of solar lanterns, and an environment policy, which perhaps not very encouraging, is at least not a hindrance to micro-grid construction and its operation in rural off-grid villages. Still, while the number of unelectrified households in South Asia is higher than Sub-Saharan Africa, the number is dropping in the former case and alarmingly rising in the later. A solution to distributed energy provision in Sub-Saharan Africa must be found and governments encouraged to allow, if not fully support, such operations. As many Sub-Saharan African countries have natural gas resources and gas flaring continues to be a social, environmental, and operational challenge for oil companies in oil producing African countries, access to natural gas for commercial micro grids in off-grid communities should be well facilitated.

Given that the commercial micro-grid sector is more advanced in India, it can be seen as an incubator for commercial micro-grid operations much as it was an incubator for commercial microfinance. The Network of Micro Grid Operators is an important instrument through which operators and other partners can consolidate the sector, institute, and apply the best practices, educate the investment community, and structure the sector for bankability. While this network may be able to facilitate investment and take to scale, undoubtedly the pace at which companies and the sector are able to take models to scale will be much slower without the support of the Indian government. The Government of India should consider reallocating the subsidies that it provides to the national grid to micro-grid solutions. Funds can be diverted from costly extensions of the national grid to more efficient, privately managed micro-grid operators, which in turn may be able to provide energy services to off-grid households for a fraction of the cost.

Finally, wind power should become the key to the public and private sectors' strategies for micro-grid expansion, across the country. Biomass, hydro, wind, and solar are all viable solutions in India, though each has its distinct regions of comparative advantage. Wind power will play an important part in the micro-grid sector's future in India, and advancing it early on will be advantageous for taking the much needed services to off-grid communities.

Sources

"Reducing rural poverty through increased access to energy services: a review of the multifunctional platform project in Mali", <http://www.undp.org/energy/reducmali.htm>

Access to energy for the base of the pyramid", October 2009, <http://www.hystra.com/opensource/energy.html>

<http://sisp-sudan.com/?pname=open&f=doc100685_newspiko27_to3_web250px.jpg&id=685&type=html>

Alliance for rural electrification website <http://www.ruralelec.org/9.0.html>

MixMarket website <www.mixmarket.org>

Azure Power website <www.azurepower.com>

Meragao micro grid power website <www.microgridpower.org>

ANNOUNCEMENT

The Product Update section

The Solar Quarterly magazine invites updates and information on all new products in the solar energy sector. The update and information provided will be featured in the 'Product Update' section of the magazine.

Send in your write ups to

Arani Sinha
TERI Press
The Energy and Resources Institute
Darbari Seth Block
IHC Complex
Lodhi Road
New Delhi 110 003
Tel: +91 11 2468 2100 / 2468 2111
E-mail: arani.sinha@teri.res.in

www.teriin.org

Booming Green Building Markets in India

Sudipta Singh, Research Associate, TERI <sudiptas@teri.res.in>

Introduction

India's energy demand has risen to 68% between 1990 and 2005 (about 3.5% annually) due to the rapid economic growth, rising income levels, and greater availability of goods and services. India's emissions increased 65% between 1990 and 2005 and are projected to grow by about 70% by 2020. Such a tremendous growth in economic activities is putting equal pressure on the natural and environmental resources. There is growing evidence that human activities are causing an irreversible damage to the global environment. It will ultimately have an adverse impact on the quality of life of the future generations. The rising concern for the environment, in response to global warming, is driving thinkers to seek sustainable energy solutions. In this context, understanding the impact of green buildings in India poses many challenges. The building market is diverse and complex. The commercial relationship between many players, fragmentation within the building sector, the value chain, and non-integration amongst the specialists are the crucial areas of concern. Also, India lacks financing options for green projects like the European Union (EU) and the US. The Indian companies need to look at these options and enable mainstreaming of the green building projects in India.

Key attributes of a green building

Green buildings are expected to be efficient in their use of energy, water, and other resources and are designed to create better environment for the occupants. It also has lower energy, operating, and life cycle costs and can, thus, yield higher building values and asking rents.

Benefits of a green building

The benefits offered by a green building are manifold and may be categorized along three fronts—environmental, economic, and social.

Environmental benefits

- Minimizes depletion of natural resources during its construction and operation
- Minimizes pollution of water, air, soil, and so on
- Uses minimum energy to power itself
- Maximizes the use of renewable energy/green energy sources
- Uses low-energy building materials and accompanying construction practices
- Efficient water management practices
- Reduces waste generation (liquid and solid)
- Reduces emissions: low CO_2/GHG emission

Social benefits

- Habitable living and working environment for construction workers and minimal negative impact on the surroundings
- Improved health and well-being of the occupants and enhanced per worker productivity due to day lighting, natural ventilation, low volatile organic compound (VOC) treatment, universal accessibility, and so on.

Economic benefits

Green buildings have lower ongoing cost than non-green buildings in the following areas.

- Lower energy cost
- Lower overall operating costs
- Lower total life cycle cost over a period of 10 years

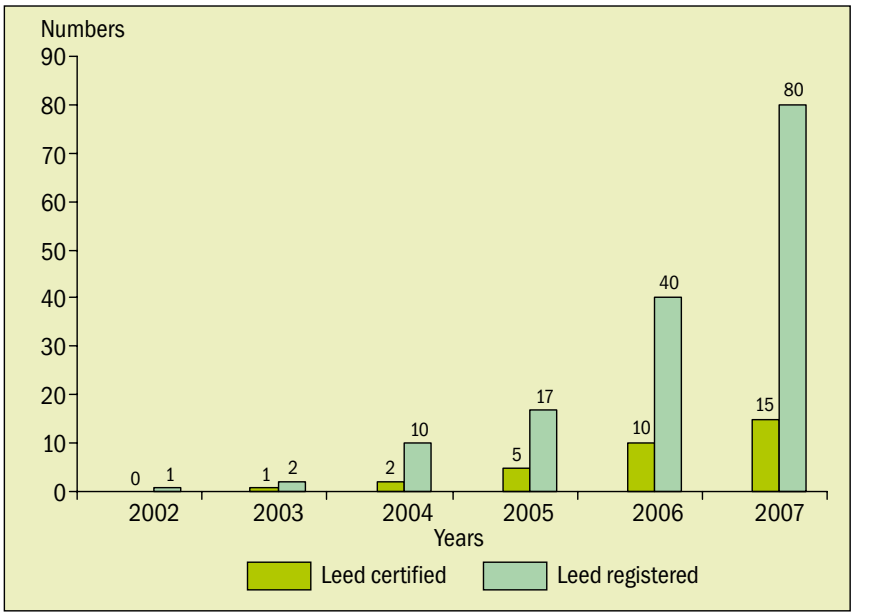


Figure 1 Growth of LEED buildings in India

Also, green buildings have better financial performance than non-green buildings in the following areas.

- Higher building values
- Higher asking rents
- Greater return on investment
- Higher occupancy rates

Widespread acceptance of green building rating systems

Shortage of water and power at the national level are amongst the significant factors encouraging India's focus on the green building programme. Lately, the major driver for the green building sector in India has been the introduction of the Green Buildings Rating Systems, such as Leadership in Energy and Environmental Design (LEED)-India and Green Rating for Integrated Habitat Assessment (GRIHA).

LEED-India

According to the Indian Green Building Council, the market for LEED-rated green buildings in India is projected to increase to A$5 billion by 2012, and the total market for green building materials and equipment is estimated to be more than 10 times the size of the LEED-rated green building market in India. The green building footprint has grown from a bare 1858 sq m in 2003, to projects covering 12.54 million sq m by mid-2008 in India (Figure 1).

Environmental Science Building, IIT Kanpur, first 5-star GRIHA rated building

- Bureau of Indian Standards (BIS)
- Central Pollution Control Board (CPCB) guidelines

All the GRIHA-rated buildings claim a reduction of 30%–40% in operational cost with a negligible impact on project cost. This is a simple, inclusive, single window process, from design to rating stages. GRIHA is the only rating system that exclusively covers ventilated, air conditioned and non-air conditioned, developments, such as housing, institutional, tier 2/3 development projects, and so on. A total of 102 projects, with an aggregated area of 45 lakh sq m, have been registered with GRIHA, by the end of 2010 (Figure 2).

GRIHA

GRIHA is a tool to evaluate the 'greenness' of a building in India. GRIHA has been developed by The Energy and Resources Institute (TERI) and, since 1 November 2007, it is endorsed as the national rating system for green buildings by the Ministry of New and Renewable Energy (MNRE), Government of India. This star-based rating system comes with a set of 34 criteria and 100 (+4 innovation points) point system with differential weightage and applicability of various criteria. The Government of India has taken a decision that all new buildings of the central government/public sector undertakings would at least meet the requirements of GRIHA - 3 Star. Meanwhile, the Central Public Sector Works Department (CPWD) had already taken a decision to follow GRIHA ratings in all its buildings.

Highlights of GRIHA

This is a Government of India initiative with strong technical partnerships and high credibility with end users. This system is adapted to the Indian climate, technology, and buildability factor. GRIHA has been developed based on all the national, environmental, and building codes, such as the following.

- Energy Conservation Building Code (ECBC)
- Environment Impact Assessment (EIA)
- National building Code (NBC)

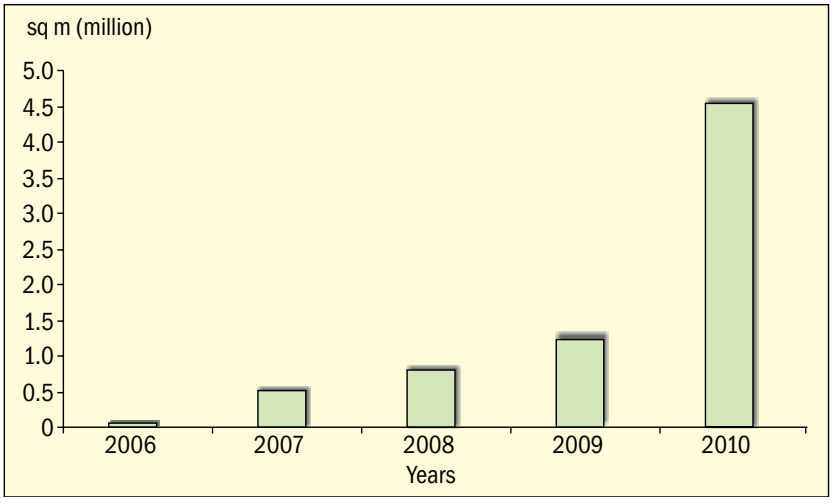


Figure 2 Growth of GRIHA buildings in India

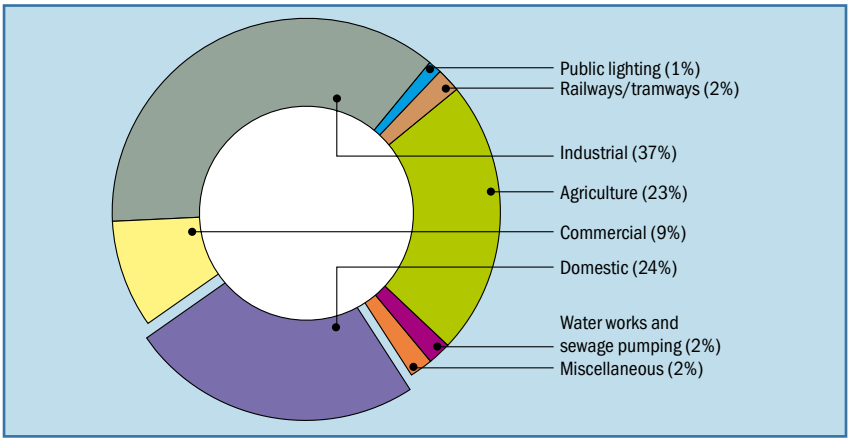


Figure 3 All India energy sales (utilities only) in 2006/07

Use of low-embodied energy technologies for housing

Green practices in domestic sector

The sectoral break up of annual electricity consumption (455 billion units) in India shows that the residential or housing sector is responsible for more than twice the electricity consumption as well as greenhouse gases (GHG) emission in comparison to the commercial sector. Therefore, the domestic sector should start integrating green practices into the building design and construction industry, at the earliest (Figure 3).

Moving towards green housing

The easiest and low-cost, but intensive way of moving towards green housing is the vernacular approaches to building design, such as solar passive architecture, traditional method of construction, use of local materials, use of local labour, and so on. And, the medium cost-intensive method is the adoption of energy conservation building code in envelope design and use of labelled appliances for households (particularly applicable to middle- and high-income group housing).

Green housing initiatives in India

- Green rated housing: energy and resource efficiency looked at holistically, in addition to indoor environmental quality and societal issues.
  - GRIHA
  - LEED rating for homes
- Solar cities programme: integration of renewable energy systems in addition to Energy Efficiency (EE) options.
  - Eco-housing programme in Pune (western India)
- Other state-level initiatives
  - Mandate for using solar water heating systems in buildings (residential, commercial, institutional)
  - Mandate for using solar passive architecture in public buildings in some hilly states
  - Solar street lighting mandated through environmental clearance of large construction projects
  - Tariff incentives
  - Rainwater harvesting mandatory in many states

Obstacles in the path of green buildings

Despite the growing interest and publicity around green buildings, a number of such developments in many emerging real estate markets are facing the following obstacles.

- Higher construction cost or perception on incremental costs
- Length of required payback period due to lack of knowledge to carry out life cycle cost-benefit analysis
- Absence of integrated design approach
- Lack of awareness of low-cost green design interventions or solar passive principles
- Extensive documentation and cost of the certification process, including consultancy for green building

Myth

Green building is expensive!

The public perception is that, "green building means insulation, high performance glass, energy-efficient lighting and HVAC equipment, control systems, all of which are very expensive, and renewable systems, such as solar PV, windmill, which are also highly expensive."

Fact

Green building is not expensive!

A research study done by TERI on seven green-rated buildings to ascertain impacts on costs and benefits show that even though capital investment for these green buildings is higher than that of conventional buildings, cash savings that take place from these green buildings not only compensate for the initial cost increment, but provide benefits to the owners/occupants throughout the lifetime of the building. The increment in the initial investment cost of these green buildings is in the range of 4%–32%. However, discounted payback period calculation shows that all seven cases have discounted payback periods between 1–3 years, well below the study period.

Experts speak

Mili Majumdar, Director, Sustainable Habitat Division, TERI

The green building industry is currently witnessing boom in the materials and products that claim to be green without appropriate testing and certification. It is important to evaluate the greenness of a product in correct perspective prior to application in buildings. The current policy push in green building along with increasing consumer's awareness holds a great potential for the green building market in India. However, suitable mechanisms need to be put in place to avoid "Green Washing"…

Pradeep Kumar, Associate Director, Sustainable Habitat Division, TERI

Despite the best possible efforts from the design team, most of the existing buildings in India still perform inefficiently or are akin to non-green buildings. The reason for this is, building designs never get analysed before construction and there is no such regulation that mandates analysis of building design at the approval stage to ensure its greenness. GRIHA provides a regulatory framework in terms of environment rating of the buildings so that all the new designs need to be analysed at the design stage. The existing national building code, along with the energy conservation building code and environmental rating systems, not only ensures that most of the upcoming buildings would be resource efficient, but also provides a complete platform to uplift the green building market in India.

Usha Rangarajan, Principal Architect, Landmark Design Group, Pune

Only about four years ago, when I was all eager to have some of my major developer clients consider building "green", they scoffed at the idea, saying, "What is in it for me?" Most people considered it a fad; one that would soon die out. The reluctance also stemmed from the general perception that a green building would cost considerably more than a conventional building. However, in recent times, thanks to increasing awareness about climate change and the impending energy and resource crises, "green" has become the new "mantra". Organizations are realizing that "going green" is not only about "corporate responsibility", but also makes sound economic sense. End users of commercial and residential properties too are now becoming aware that savings in operational and life-cycle costs are indeed substantial, thus driving the demand for green buildings. One awaits the day when all of us realize that "going green" is the only way forward, and not a matter of choice.

Karan Grover, the first architect to win the USGBC "Platinum" Award for the greenest building.

In 20 years time, a green building in India will reflect the Indian culture much better than today, when we are striving towards modern buildings copied from the West. Passive strategies and designs are crucial for every building, new technologies are there to support, but not to replace passive strategies. A building has a identity, and we should aim to root this identity to our place, tradition, and culture. There is no community, which has a greater impact on the world's energy consumption than architects. About 50% of the world's energy is consumed by buildings. Architects can save at least half of a building's energy consumption by passive design elements and with the help of energy-efficient technologies.

Source www.inspiredgreen.in

Overcoming the obstacles

If, India continues on its current high growth path, the building industry market must undergo a major transformation. The real challenges for green buildings in India lie in creating market mechanism using the following methods.

Effective policy, law, and institutional system

Statutory obligations may encourage interdependence amongst the stakeholders by adopting holistic and integrated approaches that assure a shared responsibility towards greenness in the building.

Implementing proven financial mechanisms

India should work on its financial mechanism, such as loans with lower interest rates, incentives for land cost for green projects, reduced taxes, and tariff on CO_2 emissions of green building rating systems.

Improving certified training, quality education, and information dissemination mechanism

Our country needs credible institutions and programmes to provide training and education in the area of green buildings. Institutions need to offer accreditation of professionals like energy auditors, facility managers, building products, and so on. Credible resources of information and extensive educational curriculum in institutions need to be accessible through innovative dissemination strategies like e-learning, virtual live conferences, and so on.

Conclusion

The incremental growth curve of GRIHA and LEED-India projects prove that there is a slow, but definitive investor and occupier demand for more amenable and efficient living and working spaces. The major drivers for the green building sector in India are coming from the central government, state governments, and the private or corporate sector, spurred by the introduction of the GRIHA and LEED-India rating systems.

Recently, more and more investors are witnessing opportunities for investments in green buildings. Solar technology systems like solar PV and hot water systems, primarily driven by incentives and climatic relevance of its application in the country, are being mandated in some states in India, besides being mandatory criteria in the national rating system, GRIHA. Capacity building of green building personnel through institutions and research centres are also being seen as viable investment options. Mainstreaming renewable energy systems like biomass, wind energy, and so on, and developing research capacities like material testing laboratories, and innovative lighting laboratories are viable medium-term investing opportunities in the country.

Thus, there are indeed positive changes alongside the important challenges in the green building industry in India. Viewed against the backdrop of the ongoing global debate on key environmental issues like climate change and greenhouse gas emissions, the move towards green building projects in India is a significant step in the right direction.

Media bites on the booming green building market in India

In recent years, India has emerged as one of the world's top destinations for green buildings and has implemented a number of home-rating schemes and building codes, which open up a wide range of opportunities in construction, architecture, and engineering design, building materials, and equipment manufacture.

According to the Clean Energy Council, Australia

- These trends suggest significant and growing market opportunities for green building in India.
- Companies in the architectural sector may be required to establish a local presence or build partnerships with Indian firms to win work and to utilize Indian cost structures for detailed design of Australian concepts.

Source *A research paper published by the Renewable Energy and Energy Efficiency Partnership (REEEP) and the Clean Energy Council, Australia <www.cleanenergycouncil.org>*

Green building market worldwide expected to grow 780% by 2020; China and India are likely to represent about 30% of all certified new green construction by 2020.

According to the Pike Research Publication

Cumulative green building certified space worldwide will grow from about 0.6 billion sq m in 2010 to about 5.3 billion sq m in 2020.

Source *A recent publication by Pike Research <www.pikeresearch.com>*