04 RENEWABLE ENERGY

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Census 2011 throws light on the darkness that exists across India today. Over 77 million households depend on kerosene for lighting; 1 million use wood and as much as 1.2 million households in India still remain completely in the dark. Even those who are connected to the grid cannot claim to be 'energy rich'; in many parts of India, electricity supply is erratic and just for a few hours. The country is paying huge developmental costs for this energy poverty: among the things that are getting stymied are education, health and economic progress.

But herein lies an opportunity, one that has the potential to lead to a new energy future for the world — those who are currently unconnected to the polluting fossil fuel grid can be leapfrogged to a relatively cleaner and futuristic energy source: renewable energy. It could be the way the world solves its twin problems of energy poverty and climate change, in one stroke.

In India, the total installed renewable power capacity (according to the Union ministry of new and renewable energy) is approximately 25 gigawatt (GW) as of March 2012. Of this, wind — with 17,353 megawatt (MW) — has the highest share; small hydro power follows with 3,396 MW, biomass with 3,225 MW and solar with 905 MW.

However, there is a problem — though renewable energy (RE) has lower environmental impacts compared to fossil fuels, it does affect the environment and people if installed in ecologically sensitive areas without proper planning. RE projects can be resource-intensive — 1 MW of solar power needs 2.5-3 hectares (ha) of land. This raises concerns of land acquisition, impacts on local ecology if the land area is large and in eco-sensitive areas, and issues of waste disposal. With the 23 per cent annual growth rate since March 2002, grid-connected renewable energy has substantial potential of affecting the environment.

What Centre for Science and Environment (CSE) recommends is making this sector more resource-efficient, ensuring effective checks and balances to minimise environmental impacts, and providing incentives to popularise mini-grids across the country.

Solar power

In June 2009, India did not have a single large-scale grid-connected solar power project. By June 2012, the 1-GW mark was all set to be breached — 979.4 MW of solar capacity had been commissioned in India within just three years. In June 2008, prime minister Manmohan Singh launched the National Action Plan on Climate Change (NAPCC). Eight 'missions' were part of the plan: increasing energy use from solar was one of them.

In January 2010, the government took the next step and announced the Jawaharlal Nehru National Solar Mission (JNNSM) — with the objective of making solar power affordable through its increased use and manufacturing. The ambitious Mission aims for 22,000 MW of installed solar capacity by 2022 (see Table 1: *Phase-wise goals*) — 20,000 MW grid-connected and 2,000 MW off the grid.

Besides JNNSM, the other key schemes and policies that have contributed to the development of installed solar power in India include the Roof-top PV and Small-Scale Generation Programme of the MNRE, the Gujarat Solar Policy, and the MNRE's demonstration programmes. Of these, the Gujarat Solar Policy is the biggest programme for installed capacity as of now. Launched in 2009, this policy originally aimed to achieve 500 MW of grid-connected solar power by 2014 in the state, a goal that has already been reached (see Table 2: *The states on solar*).

Table 1: Phase-wise goals

Application segment	Target for Phase 1 (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-2022)
Solar collectors	7 million sq m	15 million sq m	20 million sq m
Off-grid solar applications	200 MW	1000 MW	2000 MW
Utility grid power, including roof top	1000 – 2000 MW	4000 – 10000 MW	20,000 MW

Source: Anon, 'Jawaharlal Nehru National Solar Mission - Towards Building SOLAR INDIA', india.gov.in/allimpfrms/alldocs/15657.pdf

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Table 2: The states on solar – policies, targets and status

State	Introduced	Target (in MW)	Tariff	Current scenario
Gujarat	2009	500-3000 by 2014; new target of 20% electricity from renewable sources by 2015; Gujarat is the only state in India where solar power plants have been commissioned under the state's solar policy	As fixed by GERC	By March 2013, had an installed capacity of 852.31 MW of solar power with PPA signed with 77 companies all across the state. In June 2013, Gujarat produced 1,01,725 MW hour from solar — 18 times more than biomass energy production (4,942 MWh) in the state and almost 30 per cent of wind power production in the same month. Solar power generation in Gujarat can supply electricity to 0.67 million people in the state
Rajasthan	2011	600 by 2017	Tariff-based competitive bidding process	Wants to sell solar power directly to DISCOMs through a two-phase approach. In phase 1, a total installed capacity of 200 MW is targeted by 2013. In phase 2, 400 MW will be installed till 2017
Odisha	2011	25	Tariff-based competitive/ reverse bidding process	Has largely followed the JNNSM in planning for its solar capacity, except for one difference: its penalties for project implementation are less than those proposed under the Mission. Alex Green, awarded the 25-MW project, completed the work by August 2013
Andhra Pradesh	2012	No specific target	Tariff-based competitive/ reverse bidding process	Invited bids with a benchmark tariff of Rs 6.49/ unit in 2013, but no allocations were finalised. AP wants to promote both grid-connected and off-grid solar but fails to incentivise off-grid
Tamil Nadu	2012	3000 by 2015	Tariff-based competitive/ reverse bidding process	Invited bids in January 2013, but no allocations have been done. A 5-MW solar PV power plant under the Generation-Based Incentive (GBI) scheme of MNRE has been set up and is operational. The purchase price of electricity under the scheme has been fixed at Rs 15/kWh
Madhya Pradesh	2012	200	Tariff-based competitive/ reverse bidding process	Welspun was awarded 130 MW of SPV installation capacity. The MP solar policy varies from other state policies in certain ways. It has not specified any geographical constraints on the location of the plants – developers can set up plants in any state they wish (land costs are cheaper in Gujarat and Rajasthan, and these states also receive more sunlight than Madhya Pradesh). But the minimum capacity of plants constructed outside the state has been fixed at 10 MW
West Bengal	2012	100 by 2017	No details available	In 2009, West Bengal lost more than Rs 500 crore in investments, when it had to turn away investors because it did not have a solar power policy. It now has a draft policy. In the 12th Five Year Plan, West Bengal plans to add 50 MW of grid connected solar SPV and 5,000 MW of solar thermal
Karnataka	2011	200 by 2016	Tariff-based competitive/ reverse bidding process	80 MW awarded. The state's total targeted capacity has been divided into five 'slots' of 40 MW each for the years between 2011 and 2016.
Chhattisgarh	2012	500-1000 by 2017	No allocation process announced	Only 4 MW of solar installed capacity has been added (as of March 2013). As per the Chhattisgarh Renewable Energy Development Authority (CREDA), solar power plants have been installed at 164 households and 10 Rahat Shivirs in Bastar district. There is hardly any grid-connected solar
Uttar Pradesh	2013	500	Tariff-based competitive/ reverse bidding process	Released its request for selection for installation.

Source: CSE

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In the off-grid segment, India stares at a challenge as well as an opportunity. Five states — Uttar Pradesh, Bihar, Odisha, Madhya Pradesh and Assam — constitute 63.2 per cent of the country's total households without access to grid power (see Box: *Five states: the energy sources*). On the other hand, as many as one million households — the size of a small European country — use solar energy in states where the grid has not reached.

In 1988, the Union ministry of power launched one of the earliest programmes for rural electrification — the Kutir Jyoti scheme. Its objective was to extend single-point light connections to the rural poor. In 2005, all the ministry's previous schemes on rural electrification were merged to form the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY). In the meantime, after the 2001 Census, the MNRE initiated the Rural Village Electrification Programme (RVEP). In 2010, the JNNSM superseded all the previous rural and urban solar schemes with new targets of 2,000 MW for off-grid capacity and 20 million solar lanterns by 2022.

Five states: the energy sources

The energy profile of states provides a clear direction on the need for focus — states that remain unreached by power and electricity provide the opportunity for the future

Access to the grid

- Uttar Pradesh, among all states in India, has the largest number of households [32,924,266] to begin with. The state also has the largest number of households [20,808,136] without access to grid power. This is about 8.5 per cent of the total number of households [246,692,667] in the entire country. Only 36.8 per cent of the households in UP [12,116,130] have access to electricity.
- Bihar has slightly more than half the number of households in UP [18,940,629]. However, it is close to UP in terms of those that lack access to grid power [15,834,366]. This is about 83.6 per cent of the total number of households in the state.
- UP and Bihar are followed by Odisha [5,506,819], Madhya Pradesh [4,924,339] and Assam [4,005,029] in terms of the number of households in each state without access to grid power. These five states together constitute 36.8 per cent of all the households in the country. However, 63.2 per cent of the households that lack access to grid power also lie in these five states.

Kerosene usage

- 97.9 per cent of households in UP that lack access to grid power [20,808,136] use kerosene [20,380,121] for their lighting purposes. This observation is similar in the other states as well — Bihar (98.6 per cent), Odisha (97 per cent), Madhya Pradesh (97.6 per cent) and Assam (98.3 per cent).
- In southern India, at least a million households in each state including Tamil Nadu, Karnataka and Andhra Pradesh still depend on kerosene as their basic source of lighting.
- 95.9 per cent of all the households in the country without access to grid power [77,545,034] depend on kerosene as their source of light. This comes to 31.4 per cent of all the households in the country [246,692,667].

Lighting through solar

- In 2011, West Bengal was the highest user of solar lighting systems [240,807 households] for its basic lighting needs. This is 2.6 per cent of all the households without access to grid power in West Bengal. However, 95.6 per cent of the state's households without access to grid power still depend on kerosene for their lighting needs.
- Uttar Pradesh is the second largest user of solar energy [164,621 households] as a source for lighting needs, which accounts for only 0.8 per cent of the households without access to grid power. This is followed by Bihar where 0.7 per cent of the households without access to grid power [113,644] depend on solar lighting systems. Again, in each of these two states, at least 98 per cent of the households without access to grid power depend on kerosene for their lighting needs.

No access to electricity

- The Census also reveals figures on households that have no access to lighting whatsoever, be it kerosene, solar or any other oils. Maharashtra has the highest number of households [214,475] that have absolutely no access to any sources of lighting.
- Gujarat has the second highest number of households [121,817] in this category followed by Odisha [106,271], Rajasthan [100,650] and West Bengal [100,336].

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Primary concerns and solutions

India's solar power policy is now entering round two. The next phase of JNNSM has kicked in from 2013. The MNRE has set a target of 9,000 MW of solar power by 2017, of which 5,400 MW will be paid by cash-strapped states. The sector, however, has some issues and concerns which it must address.

- Procedures for awarding and monitoring projects under JNNSM have been found to be questionable and non-transparent. This has allowed a few companies to bend rules and corner the bulk of the projects under the first batch. The country must get its **institutional structures and processes** right for a transparent, vibrant and competitive solar sector.
- There is no **money** to pay for the second phase of solar power development. Despite falling prices, solar energy remains expensive compared to conventional energy. Most state electricity boards are facing bankruptcy. There are some domestic sources of funds, such as the National Clean Energy Fund, but they will never be sufficient. International funding is too little and cumbersome. Therefore, all sources of funds will be necessary — domestic as well as international — at least in the next 10-15 years for the expansion of solar power in India. Any move to give capital subsidy to the solar sector would be counter-productive; feed-in tariff remains the best way for the growth of the sector in an efficient and transparent way (see Box: *What ails solar*).
- A strong **domestic manufacturing sector** is essential. This sector should receive public support for R&D in technology development and manufacturing.
- Solar power development affects **land and water**. Land, in fact, is at the centre of dispute at most

What ails solar

The solar power sector in India is reeling. In the first phase of the national solar mission, one unit of expensive and clean solar power was bundled with four units of cheaper and dirtier coal power to pay for the price difference. But this was when the country had unassigned electricity from NTPC's coal-based thermal power plants. Now there is an energy shortage. Bundling is not possible.

Another bad news is that 90 per cent of domestic solar manufacturing has closed or filed for debt restructuring. Solar imports have flooded the market. This is when the stated aim of the national solar mission was to encourage domestic manufacturing. It even specified domestic content requirement for the first phase, which would be ramped up subsequently. But when JNNSM specified domestic content requirement for solar PV installations, it left out thin-film technology from its ambit, focusing on crystalline silicon technology. As a result, imported thin film technology, which is not so durable and efficient, today dominates the Indian solar industry.

The reason is simple. There is a glut in global solar module market. China has built a huge capacity, which has no buyers in the increasingly cash-strapped world. In this over-supplied market, the price has come crashing down. It is estimated that in 2011, PV modules cost 60 per cent less than what they did in 2008.

All over the world solar manufacturing industries are feeling the heat. Companies have filed for bankruptcy in the US and Europe. Even Chinese companies are reportedly reducing production or shutting shop. In this situation dumping and protection is the name of the game. Already the US and Europe have imposed hefty anti-dumping duty on Chinese solar imports. India is reportedly contemplating a similar move. But this is not the only issue at hand. Indian solar industry, in fact, has less to do with China and more to do with the US. The bulk (no exact estimates exist) of the commissioned plants have been built with low-interest loans (at 6-8 per cent) from the US Exim Bank. These loans came with conditions that procurement will be from US manufacturers only. Indian manufacturing industry is hit hard.

This is not the only injury. Under the climate change agreement industrialised countries have agreed to provide fast-track financing to developing countries. To fudge accounts, the US has added these commercial and conditional loans provided by US Exim Bank to Indian solar industry as part of its contribution to climate change finance. So, there is double benefit for the US—its domestic industry benefits and it gets accounting advantage in climate negotiations. The question now is how India will marry the two objectives of cheap energy, which it gets because of crashing solar prices, and domestic manufacture, critical for employment and energy security.

Another problem is grid-based solar power continues to reach only those households that are connected to energy supply. In fact, what it does is to subsidise expensive solar for the already-reached population. In a situation where the transmission and distribution losses are 20-25 per cent, it also means that all power generated by solar plants is "lost". These plants work at a maximum of 20 per cent capacity.

Source: Excerpts from 'Clouds over solar', editorial by Sunita Narain in Down To Earth, *January 31, 2013*

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major solar sites. While it has immense potential for upsetting the industry's growth trajectory, it also provides an opportunity to redefine relationships between communities that own the land and solar power developers who want that land. Land should not be acquired, but leased to companies. India must also start working on making solar energy more land and water efficient.

- In off-grid, the good news is that households across India are using small-scale solar systems to light up their homes and shops. But most of the models that are being implemented — such as the lantern or the solar panel with a few light-bulbs — are designed to **limit the usage and potential** of distributed solar energy. These work when people are poor, not when they become richer or have more energy needs.
- There is no model yet to **upscale** these efforts. Where the state has stepped in to upscale, the programmes have fallen apart due to the lack of a well-established and working delivery system as well as official apathy. The problem is that the government's off-grid programme is built on the assumption that the ultimate solution is to bring conventionally powered grid to the villages — distributed solar energy is seen as just a transitory solution.
- The government must **incentivise mini-grids**. Like grid-connected projects, these mini-grids projects should be provided with an assured feed-in tariff. These mini-grids will meet the local energy needs and when the grid reaches the villages they could be made grid-interactive. That is, the village can export power to the grid as well as import from it for growing needs or deficits. In this way, small businesses and social entrepreneurs who will set up smaller power plants to serve the local population will be encouraged. These will create local jobs and help build the local economy.

Small hydro power

In India, small hydro power (SHP) refers to a hydro power plant with a generating capacity below 25 MW. However, according to a 1982 document attributed to the Central Electricity Authority (CEA), a statutory body attached with the Union ministry of power, SHP has been categorised as a plant having a capacity under 15 MW. Small hydro projects are further classified as small, mini, micro and pico. Micro and pico projects generate below 100 kilowatt (kW), and are generally not connected to the grid .

The total installed capacity of SHP projects in India as of March, 2013 was 3,632 MW, spread over 950 projects; hence, the average SHP project capacity is 3.8 MW. This however does not include micro-hydel plants. The draft 12th Five Year Plan has 2,100 MW of SHP capacity, as its target. The total potential country-wide capacity is estimated at 19,749 MW, of which about 1,250 MW is under development.

SHP plants have been viewed as being an environmentally benign energy source, and are categorised by the MNRE as a green and renewable technology, and are exempt from Environment Impact Assessment (EIA). SHP can, however, exert multiple impacts on local environment and ecology. The impacts which are perceived to be of critical importance are ecological (on aquatic flora and fauna), physical (on water quality, sediment carrying capacity, erosion,

Table 3: Extract of all reported environmental impacts from the 27 small-scale hydro power plants and how often the various impacts are reported

Type of environmental impact	Per cent of impacted cases reported
Reduction in water flow	100
Fish and fauna affected by the project	78
Areas with no prior and major encroachment (INON)	67
Anadromous fish present in affected part of river (not only by passed stretches)	56
Cultural and Heritage sites affected	44
Pipelines causing landscape encroachment/impacts	11
Changed water quality	11
Organisms living in or close to water/cryptogams by waterfalls negatively affected due to reduced flows	7

Source: Bakken et.al, Development of small versus large hydropower in Norway- comparison of environmental impacts, Science Direct- Energy Procedia 20(2012) 185-199

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groundwater quality and recharge, climate, soil and geology), and human-induced (such as interference with drinking and agriculture water availability, solid waste generation and socio-economic factors).

A single SHP plant has a relatively lesser impact on the surrounding area. However, since its output is also less, more plants are required to generate the same amount of electricity as one large hydro power plant. Four hundred SHP projects of 5 MW each have the potential to affect more tributaries directly compared to one large hydro power project of 2,000 MW. The river Ganga is a case in point — 70 hydropower projects on it with a capacity of 9,580.3 MW have affected 60-80 per cent of the river, without taking into consideration the river's ecological flow (e-flow). This leaves large stretches of the river dry, affecting the aquatic flora and fauna, water quality, sediment carrying capacity, erosion, groundwater quality and recharge, climate, soil and geology. It also interferes with drinking and agricultural water availability.

CSE recommends mandating environmental and social impact assessments for SHPs. It also proposes setting nationwide norms on ecological flow and on the distance between two hydro power projects, including the percentage of river that can be disturbed.

Wind energy

In this sector, by the end of March 2013, India had a total installed capacity of 19,051 MW, with 1,699 MW installed in 2012-13 — fifth largest in the world. The total wind power generation in 2011-12 was 23,399.5 gigawatt hour (GWh), or about three and a half times the output of a new 1,000-MW nuclear reactor — sufficient to provide power to four crore people. In terms of capacity, wind power is now the third largest source of electricity in India after coal and hydropower.

The 12th Five Year Plan aims to install 15,000 MW between 2012 and 2017, which will almost double the total capacity of wind power in India. Assuming an average wind turbine capacity of 1.5 MW, this means a total of 10,000 new turbines in the country. Most of the installed wind power in India is concentrated in two areas — the southern states of Tamil Nadu, Karnataka and Andhra Pradesh and the western states of Maharashtra, Rajasthan and Gujarat (see Table 4: *Wind power — state-wise achievements and potential*).

To manage the environmental fallouts of this rapid growth in this sector, better environmental norms are the need of the hour. Wind developers are setting up projects in forest areas in states like Karnataka and Maharashtra. The Union ministry of environment and forests (MoEF) says 3,932 hectares (ha) of forestland have been diverted for wind power since 1980 — this is excluding the forestland diverted for roads and transmission lines to and from wind power project sites. About 88 per cent of total forestland diverted for wind projects has taken place in Karnataka (57 per cent) and Maharashtra (31 per cent).

Table 4: Wind power — state-wise achievements and potential

State	Estimated potential at 80 metre hub height (MW)	Achievement (MW) till August 1, 2012
Andhra Pradesh	14497	264
Gujarat	35071	3016
Karnataka	13593	2025
Maharashtra	5961	2772
Rajasthan	5050	2079
Tamil Nadu	14152	7072
Others	14464	40
Total	102788	17644

Source: http://www.cwet.tn.nic.in/html/departments_ewpp.html

Most importantly, forestland has been diverted, including in ecologically sensitive areas like wildlife sanctuaries, without any Environment Impact Assessment. There are no green norms for the sector. Even for large wind power projects of more than 100 MW, no EIA studies are required. Most state pollution control boards (SPCBs) don't even ask wind power projects to apply for "consent to operate" and therefore, do not regulate pollution from these establishments.

According to CSE , India must adopt strict green norms for sustainable growth of the wind power sector. The recommendations include:

- Strategic Impact Assessment studies, to be implemented by the MNRE, for all potential wind sites. Based on these studies, the wind power development plan should be formulated.
- Mandatory EIA and an Environment Management Plan (EMP) for large wind power projects.
- Setting of standards to protect human health from impacts like noise and shadow flickers.
- Policy and standards for decommissioning of wind turbines to optimize the use of land resources.
- Sharing the benefits with the local community, including the first right of the community over the power produced by the wind projects.

For more on this subject, please refer to CSE's report on solar, small hydro and wind energy