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Seminar on Solar & New Energy Resources: The Indian Perspective

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Solar & New Energy Resources: The Indian Perspective

Concept Note

Are Solar and New Energy Sources the answer to India's energy challenges?

Their potential is undeniable: in five years they could account for 18% of capacity—if only about 6% of generation is achieved. Wind and solar could contribute much of this alone. But scaling up renewable generation means resolving fundamental challenges of supply volatility, grid integration, geographic dispersion and un-competitiveness. Someone must bear the higher costs of renewable power sources. While the central government has developed several policies to this end, all states expect Gujarat* and some consumers might be less eager to finance further renewable development.

India is perhaps the only large country with a dedicated Ministry of New and Renewable Energy, MNRE, that has a number of programmes and also a national missions related to renewables and sustainability. As demand for all kinds of energy burgeons in the coming two decades, supply is expected to rise sharply (although it will still fall far short of needs). Part of that supply will be achieved through renewable energy, the growth of which is almost inevitable. How much of a share it will contribute, and what it will cost, however, remain uncertain. Renewables currently make up 12.1% of India's total energy capacity of 207 gigawatts (GW), but share of generation is likely closer to 4%, perhaps lower. With short-term growth rates for renewables higher than for the sector overall, by 2017 their share of capacity is projected to be approximately 18%.

Renewable sources: current status and future potential

Renewable energy as defined in India primarily covers four forms: wind, solar, biomass and mini-hydro. The installed grid-connected capacity of 3.4 GW of mini-hydro is slightly higher than the capacity for biomass, but biomass is growing faster, especially factoring in combined heat and power plants. While wind turbines and solar photovoltaic systems for electricity have the most visibility, biomass is the largest renewable source, accounting for a quarter of India's total energy consumption.

Biomass (mostly wood and, if available, cow-dung cakes) is used for cooking in about two-thirds of India's homes, and the overwhelming majority of rural ones. While theoretically sustainable, use of biomass is mostly without attendant reforestation. It also places an enormous burden on families, which might spend an hour or even more every day gathering firewood. Even more problematic is the use of inefficient stoves, which waste fuel and cause severe air pollution, particularly affecting the health of women and children who traditionally spend more time at home.

*The Development of Renewable Energy Sector is provided in a separate note.

Urbanization, increasing affluence and improved supply-chain logistics will hasten the shift away from wood biomass towards commercial cooking fuels, especially liquefied petroleum gas (LPG). While biomass's share of primary energy is projected to fall to 10% by 2030, the International Energy Agency, IEA, projects absolute consumption will grow marginally from an estimated 165 mega tonnes (MT) today to 175 MT by 2030.

Biomass power systems are typically suited for village-scale applications, where peak electricity demand comes in the evening, especially for lighting, necessitating a battery or other power-storage technology for standalone units. Ultimately, in India, unlike parts of Sub-Saharan Africa, the transmission and even medium-voltage grid reaches the majority of villages—the challenge is sending power over the last mile, to the home. This will remain a problem with village-level generation technologies. There are approximately 30,000 remote and distant villages where extending the grid is considered expensive, and for these areas the government offers 90% capital subsidy options for renewables-based decentralized distributed generation.

Even if every un-electrified home in India were given a solar panel and battery, enough for limited basic needs, it would still only translate to a capacity of 6 GW (60 m homes x 100 watts). Given plans to attain 20 GW of solar by 2022, most of this would have to be generated in large, grid-connected farms, in many ways not dissimilar to the 17.8 GW of wind power today. At that point, solar power would need to compete with grid power, since it would be generating more energy (kWh) than firm, dispatch-able capacity (kW).

Solar thermal energy has marked potential-especially for heating water, but it can even provide cooling based on vapour absorption cycles or other innovations, which are available but not yet commercially widespread. The city of Bangalore has mandated the installation of solar water heaters before an electricity connection is provided, but such schemes barely scratch the surface of the potential at a national level. Israel, for example, made solar water heaters mandatory for all new homes (except select high-rises), leading to penetrations of five-sixths of homes, and China has already installed over 180 m sq metres of solar thermal panels. The modest adoption of solar thermal energy in India is despite favourable economics: payback periods are about five years, even before factoring in central government capital subsidies of up to 30% and electricity discounts in some cities. Even the national mission target of 20 m sq meters of solar water heaters by 2022—itself ambitious, given this is almost four times the total installed capacity to date—isn't as grand as it sounds. Assuming the size of panels to be 2-3 sq meters per home, this is an order of magnitude lower than the projected growth of homes over the same period.

Solar power overall (both photovoltaic and solar thermal power generation) has developed robustly over the past decade, and it is no longer considered just an off-grid solution. A prominent initiative, the Jawaharlal Nehru National Solar Mission (JNNSM), is devoted to creating grid parity and domestic competitiveness, while harnessing 20 GW of grid-connected and 2 GW of off-grid solar power by 2022. Aggressive bids under the JNNSM have produced grid-connect megawatt (MW) sized plants generating even less than 15 US cents per kilowatt-hour (kWh), among the lowest in the world. While the total installed solar capacity is currently modest (just crossing 2.2 GW), a significant increase is expected in the coming decade, especially in its latter half. Even this enormous growth is a tiny fraction of the theoretical capacity for solar power. An area of 100 sq kilometers could power hundreds of gigawatts of capacity (depending on conversion efficiency and fill factor). This would be at peak

capacity, but Indian solar radiation has among the highest intensity in the world: it has a large available area receiving 5.5 kWh per sq metre per day, principally in less-populated regions. By contrast, the best parts of Germany (the world leader in per-capita consumption of photovoltaic energy) receive a third less sunlight. But in terms of generation, the prize goes to wind power. Even in the absence of a bold direct target, wind power has done quite well, with capacity reaching 21,262.23MW by May 2014, the fifth highest in the world. It is also growing briskly: the actual growth of wind power capacity over the 12th Five-Year Plan (2012-17) may exceed the official target of 2,400 MW per year.

Wind power in India has developed in phases, partly based on the support mechanisms in place. These included very high depreciation allowances, which were supplanted by generation-based incentives, feed-in-tariffs and now Renewable Energy Certificates (RECs). Given that electricity is a concurrent (that is, a central and state) subject in India's constitution, the main pricing decisions for power purchase and retail are taken at the state level. Each state offers different support for renewables; for wind power, feed-in prices mostly range from Rs. 3.00 to Rs. 4.50 (around 6-8 US cents) per kWh. How much potential is there for wind? For many years, the government cited a figure of about 50 GW, but this was based on 50-metre hub-heights and 2% of land usage. High tower hubs for modeling, the potential has roughly doubled. Assuming greater land availability, and a willingness to pay more per kWh, some studies indicate 600 GW of potential wind energy. Unfortunately, many of the best (windiest) sites are already taken by early adopters of wind power, added to which India's wind speeds are at least one, if not two, classes lower than those for good sites in North-western Europe or the US. This raises costs, making a Rs. 3.00 per kWh tariff less attractive.

The good news is that India is innovating low wind turbine technologies, and state policies are fixing land usage regulations to allow dual usage of wind power generation without "conversion" – a costly and time consuming logistical process. All of these initiatives are likely to lead to continued growth in wind power – more so than solar power. This is even before tapping off-shore wind, which is at its prototype deployment stage.

Worldwide, renewables face a challenge of economics, especially when compared with conventional power. Renewables also faces fundamental problems from a grid perspective, namely variability and unpredictability. The plant load (that is, capacity utilization) factors for most renewables are about three to four times lower than that of a new conventional (coal fuelled) plant. So a capital cost of US$1.2/watt for wind—almost 50% higher than that for a coal fuelled plant, albeit for a power source with no fuel costs—begins to look less attractive. Solar's capital cost per watt is about double that of wind. These costs also have an impact on system planning, since these resources are for the most part not dispatch-able. The end-July 2012 blackouts reinforced the challenge of grid balancing and management. While wind power may account for 8.6% of capacity in India today, it accounts for only about 3% of generation (and most of that occurs around the monsoon, when demand is not at its highest).

Another major issue for renewable resources in India is that they are heavily geography dependent: five states produce most of today's wind power and solar power's potential is similarly concentrated. This poses economic and operational challenges for these states. Tradable RECs have been introduced to overcome the financial implications, but the practice is young and promoters cannot use both RECs and preferential tariffs.

At grid level, transporting power from a windy or sunny site is a well-known problem but one just needs transmission infrastructure to be resolved. Much harder is grid management to handle enormous variability. For example, the south Indian state of Tamil Nadu has about 45% of its capacity as wind power. When the wind dies suddenly, there is virtually no peaking power available, and feeder-level load shedding in the state is far worse than it is in most of India.

Given these challenges, is charging a premium for renewables appropriate? For off-grid or remote applications, any premium over average grid prices may be competitive, especially compared to diesel or kerosene (which is heavily subsidized). But the economics of renewables depend on scale. Wind turbines are best at megawatt size, and only photovoltaic panels are close to being scale-appropriate for households.

Renewable Power Generation: Issues and Challenges

The financial ill-health of Distribution Companies (DisComs) is having a cascading effect on all aspects of the power sector, including renewable energy in addition the reduced ability to pay for this renewable energy; the weak enforcement of RPO; the uncertainty in Renewable Energy Certificates (REC) have all impacted the RE investments. According a study conducted by PWC (Price Waterhouse Coopers) the…

- Accumulated losses is of the order of Rs. 2 lakh crore,
- Non-solar RECs trading at floor price and the volumes stagnant; and
- PPA robustness is an issue; and flow of subsidies from states often delayed.

The other challenges faced by developers are on a smaller scale, but still relevant and important to overcome. The highlight some of the challenges are:

Insufficient resource assessment data

- Especially in solar projects
- Lenders' confidence in project and therefore bankability of project affected
- C-WET & MNRE have initiated efforts to measure, collate & share data

Statutory clearance issues

- Many sites located in forest / no-go areas
- Land acquisition process not streamlined in most states
- Single window clearance mechanisms being instituted by many states

Inadequate evacuation infrastructure

- Insufficient inter & intra state transmission capacity
- Delays in construction due to right of way issues
- State specific policies vary on responsibility for evacuation infrastructure
- Integrated planning is the need of the hour

Intermittency issues

- Current grid not equipped to handle intermittent generation
- Backup power requirement of captive RE users
- Weak regional coordination
- New technology demo projects underway

Policies and support: green from the government

Despite these challenges, the advance of renewables is inevitable. Present growth rates indicate that their share of capacity will increase measurably in the coming years. Their small size and rapid construction schedules also help renewable power projects. However, the enormity of scope and the relatively diffuse nature of renewable power sources mean that even game-changers like storage technologies (that go beyond proven pumped hydro) or smart grids are unlikely to create a dramatic upturn in renewables share of India's total energy output. They will jog business-as-usual projections for renewables upwards by just a few per cent. Indeed, constraints on the growth of renewables are likely to come from the project developers themselves, based on the challenges of implementation. For its part, the Indian government is putting its might behind renewables in policy and practice, including a cess on coal power for a green fund. Even if a technology is expensive, the government has always believed in costs-plus support (as the much lower price of mini-hydro compared with wind and solar attests). It has even advocated a policy of socializing costs—for example, a proposed cost-sharing for deviations in output for wind power. For solar power, a subsidiary of NTPC (a behemoth public-sector thermal generation company) will be the nodal agency for Purchase Obligations, varying by state and based on the National Tariff Policy of 2006, have come into force recently. But these are conservative (for example, the state of Karnataka had reached its target on day zero). More serious is the fundamental issue of finance: all the states are in deficit, at an average of 2.7% of state GDP as of March 2011. In the long run, economics will be a determinant of scalability: at what point will renewables reach true grid parity? As for Indian consumers, do they love renewables? Except for a small niche, it is unclear whether they are ready to pay more for green power, at least beyond a minimal load such as for lighting. When hundreds of millions lack electricity connection - and even those who have a connection often face hours of power outages every day - green power may be the last thing on their minds. Whilst every effort has been taken to verify the accuracy of this information, neither

New Energy Resources & Technologies As far as new renewable resources and technologies are concerned, the central ministry has already put in place programmes on various New Technologies. As part of these programmes, research, development and demonstration projects have been initiated at various research, scientific and educational institutes, universities, national laboratories, industry, etc. These projects are helping in the development of indigenous research and industrial base, expertise, trained manpower and prototypes/ devices/ systems in the country:

- Hydrogen Energy
- Chemical Sources of Energy (Fuel Cells)
- Alternative Fuels for Surface Transportation
- Geo Thermal Energy
- Tidal Energy
- Bio-fuels

This session therefore is meant to discuss the development of alternative technologies, its overview and issues and challenges facing the renewable energy power sector, in hopes that it will encourage even more rapid and extensive development of the renewable energy resources on the Indian subcontinent.