McKinsey on Electric Power and Natural Gas

Perspectives on electric power and natural gas

Number 1,
Winter 2008

McKinsey&Company

Renewable energy:
Bridging India's power gap

Large and growing electricity shortages, as well as favorable natural conditions, make the future of renewable energy in India very bright.

Jaidit Brar, Rahul Sankhe, and Vipul Tuli

Propelled by accelerating economic growth, India's demand for power is likely to soar from around 120 gigawatts (GW) in 2008, to between 315 and to 335 GW by 2017[1]—100 GW higher than most current estimates. While capacity is likely to more than double, it will remain insufficient to meet demand; the shortfall for peak electricity generation is expected to increase from close to 15 percent in 2007 to almost 20 percent by 2017. Most of the capacity-building initiatives underway focus on coal plants: more than 80 percent of plants commissioned in 2007 are coal-fired, as are 70 percent of plants currently under construction. While these power plants will provide much needed new capacity, they also increase concerns about energy security and the environment, making renewable energy an attractive and increasingly economic alternative.

The case for renewable-energy sources

Exploiting renewable-energy sources to help meet India's growing demand for electricity makes sense for at least five reasons: India possesses major sources of renewable energy; renewables can help mitigate rising carbon emissions; they can address energy security concerns; renewables are particularly useful in meeting rural power needs; and they are becoming increasingly more competitive with traditional energy sources.

Significant natural potential. The total potential for primary renewable-energy sources—wind, solar, and biomass—in India exceed 300 GW (Exhibit 1). Only a small fraction of this potential has been exploited, with total installed renewable capacity slightly more than 12 megawatts (MW) in 2008 (Exhibit 2). Wind power dominates current installed capacity and has grown at more than 30 percent per annum since 2002, to reach 8.7 GW in 2008. However, while solar and biomass energy also have tremendous potential, they have remained underexploited.

- *Wind*: The Center for Wind Energy Technology (C-WET), the R&D center established by the Indian government's Ministry of New and Renewable Energy, has identified the total potential for wind-generated

[1] *Powering India: The road to 2017*, McKinsey & Company, July 2008.

power at more than 50 GW, with some estimates as high as 65 GW. As more wind sites are profiled, estimates of wind potential are likely to rise further.

- *Solar*. India has one of the world's highest solar intensities, with an annual solar energy yield of 1700 to 1900 kilowatt hours per kilowatt peak (kWh/KW_p) of installed capacity. This implies enormous potential in energy generation running into several hundred GW with current solar technologies. As the cost of building solar capacity continues to fall over the next five to ten years, a significant scale-up of solar generation (in multiples of tens of GW) is a very realistic possibility.

- *Biomass*. Some estimates suggest that India's biomass potential is at least 20 GW and could be as high as 70 GW. Bagasse-based cogeneration can yield 5 GW, and 400 million metric tons of agricultural waste could yield another 18 GW in power plants with capacities ranging between 10 and 100 MW.[2] Use of wasteland for growing feedstock (woody biomass) is another potential source of biomass power generation. A program to cultivate fast-growing energy crops—perennial grass crops and trees, such as poplars and cottonwoods, that are also water efficient—on just a quarter of India's 80 million hectares of degraded land, for example, could generate 45 to 50 GW of power.[3]

Not only does renewable energy have significant natural potential in India, it also has four additional persuasive arguments in its favor.

Tackles rising carbon emissions. Given the current coal-dominated energy mix, India's greenhouse gas emissions will double by 2017 to more than 2.4 metric gigatons (Gt) of CO_2 equivalents per annum, making the country the fourth largest emitter on the planet. The power sector alone is expected to account for more than 40 percent of

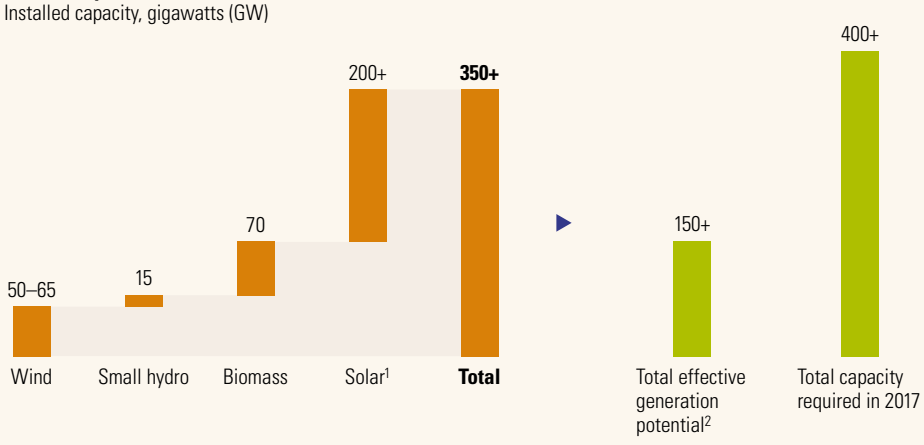
[2] *Biomass Resource Atlas of India*, Ministry for New and Renewable Energy, 2007 (http://lab.cgpl.iisc.ernet.in/Atlas).

[3] *India Vision: 2020*, Planning Commission of India, December 2002.

Exhibit 1

Renewables in India have significant natural potential

Renewables need to be an integral part of efforts to meet India's power needs.



[1] Assuming a 50 megawatt per square kilometer (MW/km^2) installed capacity for photovoltaics (PV)and 2% of Rajasthan's desert area covered (4000 sq km).

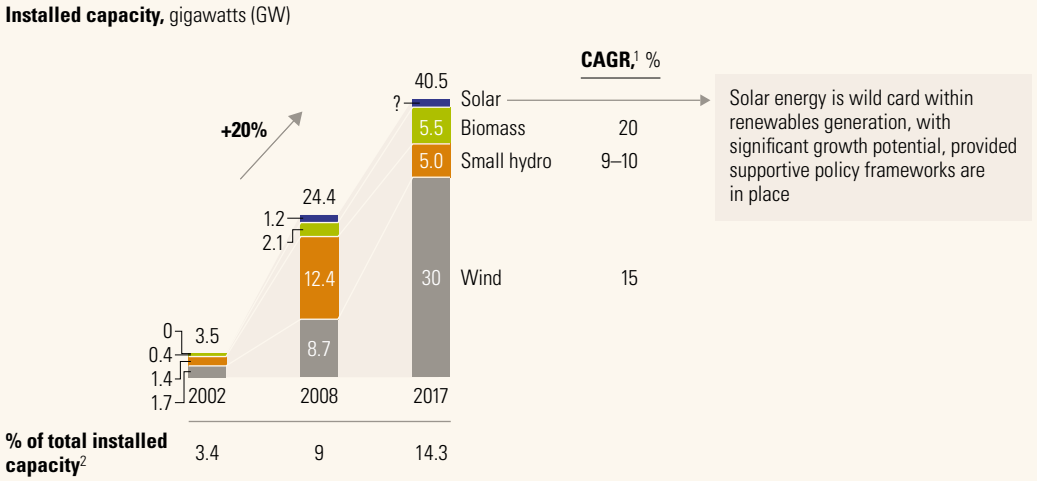
[2] Actual electricity generation (adjusting for respective plant load factors).

Source: Center for Wind Energy Technology (C-WET); Eleventh five-year plan (2007–12), Ministry of Power; Planning Commission, Government of India; McKinsey analysis

Exhibit 2

India only currently exploits 4% of its renewables potential

Driven by wind energy, renewables generation has witnessed strong growth, which is projected to continue until 2017.



[1]Compound annual growth rate, over 15 years from 2002 to 2017.
[2]Installed capacity in 2002 = 103 GW; 2007 = 140 GW; and 2017 estimated = 320 GW.
Source: Working group on new and renewable energy; McKinsey analysis

those emissions. Aggressive use of renewable, clean energy sources to generate power can help alleviate this projected increase.

Addresses energy security challenges. Despite having the fourth largest coal reserves in the world, India's energy mix is characterized by an increasing dependence on imported coal, with significant imported coal capacity now being built in coastal regions. Based on current projections, adequate natural gas supplies from domestic sources are unlikely to be developed, and dependence on liquefied natural gas (LNG) and transregional pipelines will increase. Since renewable sources are not import-dependent, they can help address energy security concerns and moderate price volatility.

Provides power for rural areas. Rather than relying on the slow extension of the electricity distribution grid to remote villages, renewables enable distributed generation, which can accelerate the process of electrifying India's villages. Providing electricity to rural areas in conjunction with microfinance opportunities can immediately boost the rural economy and reduce rural poverty. It will also help tackle a very India-specific source of emissions—burning kerosene for lighting. Reducing the consumption of kerosene can redirect subsidies currently given to this sector toward promoting renewable-energy use.

Grows economically more competitive. Technological improvements will ensure that the cost of power generated through renewable sources will decline, especially for solar energy. For example, from 2013 to 2017, the cost of solar thermal power is expected to decline to $0.10 to $0.12 per kilowatt hour (kWh), and reach grid parity during this time. This process will be reinforced by continued high prices for conventional sources of power such as oil, coal, and natural gas. In many areas, renewable energy is already competitive compared to peak power prices or retail prices for commercial and high-end residential customers in cities like Mumbai. India has a peak power deficit of 15 percent,

which is likely to further worsen, to more than 20 percent by 2017. The current gap results in peak rates of $0.20 to $0.25/kWh, as peak power is largely supplied through local, diesel-based capacity. Meeting peak demand through distributed renewable sources like solar panels on residential rooftops and commercial buildings or from hybrid renewable plants can prove economically viable even today.

Significant opportunity for renewable-energy players

If India commits to implementing the 10 percent Renewable Purchase Obligation (RPO) based on actual power generated, it will require an addition of 50 GW of renewable capacity by 2017 (Exhibit 3), implying a total capital expenditure of more than $100 billion and a revenue pool from generation of more than $30 billion per annum. Even at the current trajectory without additional incentives from the government, wind and biomass are expected to grow at more than 15 to 20 percent per annum.

Use of wind power has grown rapidly in the last decade due to a combination of an 80 percent accelerated depreciation and preferential tariffs that have been attractive in a few select states. Utilities have been willing to purchase wind energy at higher rates due to the power deficit situation and strong push by state level electricity regulators. This growth is expected to continue at 15 to 20 percent per annum due to continued support from the central and state regulatory authorities in the form of depreciation and generation based incentives. Additionally, a scheme for enabling "repowering" of old wind assets is also under development, which will enable replacement of lower capacity, low plant load factor (PLF) turbines with more modern and efficient models. This will ensure optimal exploitation of the most attractive wind sites, which are currently locked in by older, lower efficiency turbines. Once this scheme is implemented, acquisition of secondhand wind assets could become an attractive option for new entrants in this space.

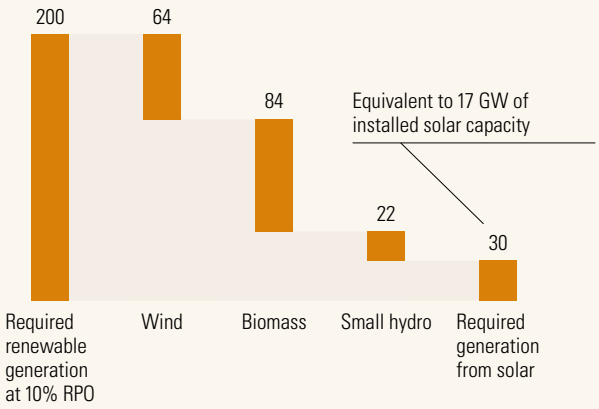
Solar is likely to grow even faster, with a high-priority focus on the National Solar Mission (one of the eight missions of the National Action Plan on Climate Change). The stated aspiration of the solar mission is to add a minimum of 10 GW of installed solar capacity by 2020. If the first decade

Exhibit 3

Significant opportunities for renewable-energy players

To achieve a Renewable Purchase Obligation (RPO) of 10% by 2017, India needs to add 50 gigawatts (GW) of renewable capacity.

If India enforces a 10% renewable purchase obligation (RPO) by 2017,
terawatt hours (TWh)



This additional renewable capacity includes 12 GW of biomass and 17 GW of solar capacity

of this century belonged to wind energy, the next decade could signal the growing importance of solar-based power. There is already significant interest in a pilot incentive program based on feed-in tariffs, which was capped at 50 MW, although applications for setting up 2000 MW capacity were received.

Significant opportunities exist for players across the value chain, from equipment suppliers to IPPs[4] and utilities, and India should clearly be on the radar of every clean-energy investor and renewables company. At the same time, given that the policy road map and regulations are still evolving, it is not entirely clear what approach companies in this sector should take to exploit these opportunities. In such a scenario, a legitimate option is to wait and see, but we believe there is significant merit in acting now.

Favorable regulations are likely to emerge over the next three to six months (especially for solar and biomass), and hence companies and investors should evaluate their go-to-market strategies for the Indian market and try to establish a foothold. Even given the current regulatory scenario, there are attractive opportunities that players can exploit by developing a strategy that focuses on three key elements:

- *Concentrate on a few key states,* such as Maharashtra, that have a favorable stance towards renewable energy, relatively attractive renewable tariffs, and favorable open-access criteria. Even if there is a lack of formally defined renewable-procurement tariffs, state regulators are often responsive to case-by-case dialogues on renewable-energy power purchase agreements (PPAs), particularly with interested parties that have a compelling proposition.

- *Target specific customer segments* that are already paying high power tariffs either for utilities or in the form of back-up diesel power. For example, commercial customers in Mumbai pay high power tariffs and can potentially be targeted under open-access regulations that allow power generators to directly sell power to end users.

- *Directly approach state regulators and governments* without waiting for comprehensive regulations or policies to evolve when companies or investors have a compelling value proposition, such as bringing additional generation capacity on stream or setting up manufacturing facilities that create jobs.

In addition, entering now will help players establish an insider position, which has three major advantages. First, it allows building of local understanding and knowledge that will provide an advantage in securing better assets. For example, there is significant difference in the energy poten-

[4] Independent power producers.

tial of individual wind sites. Moreover, potential challenges like land acquisition can be better anticipated and managed. Second, critical relationships can be forged with regulators, suppliers, buyers, and other players. Third, early entry provides an opportunity to shape regulations in an investor-friendly way.

What India must do to emerge as a global leader

Government policy has to evolve to attract investment. Driven by favorable policies and rapid growth in wind energy generation, the total installed renewable capacity in India reached 12.4 GW in 2008. India, however, still has a long way to go in its journey to achieve global leadership. Realizing the full potential of renewables in India will require four critical policy steps: set high aspirations; create a comprehensive and robust policy framework; modify tariff policies to attract broad-based investment; and drive solar cost reduction through scale and R&D investments.

Set high aspirations

A good starting point would be to put in place a consistent and enforceable policy to ensure a minimum share of renewable power in total power consumption. At present, different states have different policies that are often not enforced. Setting a clear target of generating, say, 10 percent of power consumption through renewables by 2017 would imply an addition of over 50 GW of installed renewable capacity—25 GW from wind power, 12 GW from biomass, and 17 GW from solar energy. This requires over 5 GW of capacity additions each year, a target significantly higher than the current addition of 1.5 GW per annum.

Create a comprehensive and robust policy framework

While the current set of policies and mechanisms has encouraged growth of renewables-based power generation in India, there are several additional policy areas that need to be addressed to accelerate growth.

- Establish a renewables policy that addresses not only power generation but also R&D, equipment manufacturing, grid connectivity, and talent capacity creation.

- Set aggressive renewable-energy standards and facilitate availability of low-cost project capital.

- Ensure a clear message of regulatory stability to potential investors by demonstrating that the full power and authority of the government of India behind the various regulations and incentives.

Modify tariff policies to drive broad-based investment

While there has been significant growth in renewable capacity, the sector still lacks broad-based participation. Wind regulation continues to attract investors with a tax appetite, with the 80 percent accelerated depreciation the key attraction. At present, feed-in tariffs by themselves do not provide attractive enough returns. Other than a few exceptions where private companies have set up large wind farms, the prevalent business model involves the wind equipment vendor developing and operating wind farms, as well as selling the offering to investors primarily as an investment product. As a result, more than 90 percent of installed wind capacity is owned by investors (as opposed to IPPs) who have only limited

incentives for actual power generation. As part of efforts to rectify this imbalance, the central government recently introduced an experimental generation-based incentive (Rupees 0.5/KWh) but tariff policy needs to be modified so feed-in tariffs by themselves can provide attractive returns.

Drive solar cost reduction through greater scale and R&D investments

The current installed cost of a typical silicon-based photovoltaic system is in the range of $6 to $8 per watt, of which 60 percent is accounted for by the module (the cost of silicon, cell manufacturing, and module fabrication) and the rest by system components. This is expected to drop to $3 to $4 per watt installed over the next five to seven years, driven by reduction in margins as a result of capacity addition, efficiency improvements, and process innovations. Achieving this cost reduction in the shortest possible time frame is essential to ensure sustained robust growth of solar installations in the country. Such rapid cost reductions are only possible through greater scale and increased investments in R&D, which could be enabled through the creation of a government R&D fund.

Given the vast potential of its renewable-energy resources, India has the opportunity to achieve a sustainable growth trajectory of renewable-energy generation within the next decade and reap the benefits of greater energy security and a cleaner environment. The right set of policies—and an investor-friendly regime—can ensure rapid growth that will allow India to emerge as a global leader in clean energy.

The authors would like to thank Aakash Gupta, Nakul Saran, and Ramdoss Seetharaman for their contributions to this article.

Jaidit Brar is an associate principal in McKinsey's Delhi office, where **Vipul Tuli** is a principal; **Rahul Sankhe** is a consultant in the Mumbai office.