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India's Power Sector and the Climate Challenge

by
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Background

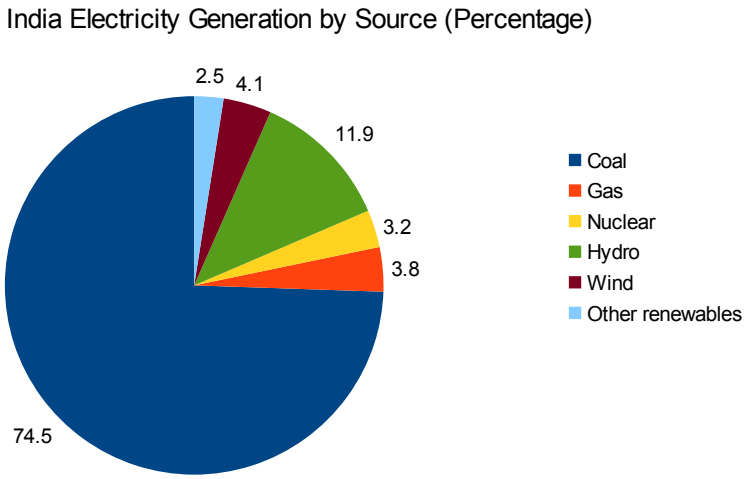
As the world's fourth-largest emitter (behind China, the US, and the EU) India is a key focus of the international community's goal to limit Greenhouse Gas (GHG) emissions to ensure planetary warming does not exceed 2 degrees C. Power generation contributes to the largest slice of emissions within the domestic economy at about 37% of the total[1]. It is also the second-fastest growing sector in terms of emissions. Thus the power sector is crucial to India's overall GHG mitigation efforts.

A structural tension has however traditionally existed between mitigation efforts in the power sector and the challenge of universal energy access in India. The figures are stark - nearly 30% of Indians (about 400 million) lack any access to electricity whatsoever, and a large fraction of those that are theoretically on the grid enjoy only a few hours of power every day. This is evident in India's per capita utility-driven electricity consumption which, at 806 kWh[2], lies somewhere between Bolivia and Gabon.

Coal-driven power dominates the mix, accounting for 75% of the total generation. Gas-based generation is small, at less than 4%. Low-carbon sources (renewables, nuclear, and large hydropower) account for 22%, with renewables making up 6.7% of the net generation (figure 1).

While coal and renewables are both growing at double digit rates, the raw number additions are much greater for coal as it is at a higher base. Gas has been in a steep fall for some years. Nuclear is growing at a moderate pace from a low base. Large hydropower generation has generally stalled compared to ambitious expansion plans.

Then there is a substantial amount of captive power in India not accounted under the above headings. Most of it is for industrial use and is heavily dominated by coal and diesel. Captive power, with a capacity of 39 GW, adds



about 15% to the utility-based power generation figure[3].

Figure 1: India's Electricity Generation by Fuel Source (FY 2014-15). Sources - Central Electricity Authority and Ministry of New and Renewable Energy.

1 World Resources Institute (2011), CAIT Database
2 Government of India, Central Electricity Authority (2015), *Executive Summary - Power Sector*.
3 Independent Captive Power Producers Association (2014)

India's Challenge

Assuming an optimistic scenario of energy efficiency improvements on the demand side, and given that its population is expected to grow beyond 2050, India would have to increase electricity generation about three-fold to achieve the energy security level of an upper-level developing country such as Turkey, and five to six-fold to reach full developed country status. If coal continues to dominate the mix throughout this pathway, this would imply large increases in its mining and consumption[4], an adverse scenario for GHG emissions. However, it is equally clear that denying India energy security and access at the level currently enjoyed by the developed world is not a practical or moral strategy going forward.

Given these competing imperatives, India relies on two core pillars for its mitigation efforts - energy efficiency (on both supply and demand sides), and expansion of low carbon sources such as solar, wind, and nuclear. From a strictly emissions mitigation perspective, it would be desirable for both efficiencies and barriers for expansion in coal to grow, and simultaneously those in natural gas, nuclear, and (particularly) renewables to fall away as quickly as possible. However, this requirement must also be balanced with the country's overall development goal of electricity for all by 2019.

What are the key political economy drivers and barriers in the power sector from a climate mitigation perspective? What would be a enabling policy environment to achieve climate-related goals? Can sectoral structure and composition give us clues to what may lie ahead? How will this affect negotiations at the Paris conference later this year?

Overall Drivers and Barriers in the Power Sector and their Climate Impacts

Some of the barriers in the power sector are common to all fuel classes. Although India has had a healthy 8.8% annual growth in net capacity addition over the past 5 years, the growth in actual electricity generation is only 6.3%[5]. This has led to plant load factors (PLFs) declining from 78% to 65% over this period[6].

A key driver for the lag in generation as compared to capacity addition is the severe financial crisis faced by the chiefly states-run distribution companies (Discoms) who are in debt to the tune of $33 billion[7]. Political pressures, large subsidies to agricultural consumers, and poor governance have cumulatively led to the Discom crisis over many years, with an average 22% shortfall on cost recovery. The result is that Discoms under-purchase power and are increasingly reluctant to sign long-term power purchase agreements (PPAs) with generating companies. This has weakened the link between capacity and generation and made many recently-built power projects financially unviable.

This demand-side barrier in the electricity sector in India has the effect of curbing emissions to the extent it slows the expansion of coal-fired plants. The ill-health of Discoms is however even more of a barrier for wind and (especially) solar expansion as costs of electricity from these sources tend to be higher than domestic coal. Thus it is desirable that the financial health of Discoms be restored as quickly as possible if low-carbon energy is to get the major boost required from the carbon mitigation standpoint.

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4 This implies a coal consumption of 1.3 billion tonnes per year by 2032 even under a scenario of large expansion of renewables. Government of India, Planning Commission (2014), T*he Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth*, available at http://planningcommission.nic.in/reports/genrep/rep_carbon2005.pdf

5 Government of India, Ministry of Power (2015), *Power Sector at a Glance - All India*, available at http://powermin.nic.in/power-sector-glance-all-india

6 Government of India, Ministry of Power (2015), *Power Sector at a Glance - All India.*

7 Government of India, Planning Commission (2014), *Annual Report 2013-14 on The Working of State Power Utilities and Electricity Departments.*

The Indian electricity sector also suffers from high transmission and distribution (T&D) losses, which stand at about 23%. Reducing T&D losses would achieve more energy security at a lower quantum of emissions.

Financing and land acquisition are two major barriers in the power sector on the supply side. Interest rates from Indian lenders are typically high (12 - 14%), and with a number of recent power projects without adequate fuel linkages or PPAs, developers have been reluctant to begin new projects. International financing, such as from the EXIM Bank in the US, is available at lower rates, but typically is tied to import requirements from the lender nation. Western financial institutions are also increasingly reluctant to lend to coal-based power projects due to climate concerns.

Land acquisition is a challenge faced by all infrastructure industries in India, with power being no exception. The Modi government is attempting to pass a new law on land acquisition, but strong domestic opposition has stalled the bill in the Indian parliament.

Unlike China, India has not put in place a sub-national or national emissions trading system (ETS) for carbon emissions. However, thermal power plants are covered in a cap-and-trade scheme for energy efficiency known as Perform, Achieve, and Trade (PAT) managed by the central government's Bureau of Energy Efficiency (BEE). The PAT scheme is widely seen as having been highly successful in raising the bar on efficiency standards. Public sector thermal power companies owned by the central government and most major private players have generally met PAT standards, but state-level generating companies have not always done so.

A major driver for mitigation actions in the Indian power sector in the past has been the UN-administered Clean Development Mechanism (CDM). India was among the highest earners of carbon credits. However, with the crash in carbon prices, CDM is no longer a significant factor in Indian plans.

Currently sectoral drivers for mitigation actions are at two levels. Market forces are increasingly incentivizing moves towards energy efficiency and renewables expansion, particularly when strong regulatory and policy frameworks are in place. Second, progress towards an international accord in Paris as symbolized by bilateral deals between the US and China on overall emissions and the US and India on HFCs, has energized actions in India towards greater mitigation.

In addition to the above drivers and barriers, there are a number of factors specific to each power sub-sector. This memo focuses mainly on the most important of these - coal and renewables (wind and solar). A brief summary is also provided on the status of natural gas and nuclear.

Coal

The new government in India has announced a massive increase in *both* coal as well as renewable targets. Coal production will be doubled to 1 billion tonnes by 2019 through an additional investment of $25 billion, and eventually tripled. Imports of thermal coal, growing at double digit rates in recent years, will be curbed with the explicit goal of reducing them to zero within three years. Therefore curbing coal consumption *per se* is not a goal India has signed up to, though coal imports are seen as creating undesirable dependencies and adding to the trade deficit.

It is not clear if India can eliminate coal imports entirely. In any case, recent trends on international coal prices are steadily lower, with net differentials in the cost of electricity with domestic coal as low as 30% depending on transportation costs accrued in specific power plant locations[8]. With the two largest global consumers of coal - China and the US - having apparently peaked in consumption, the current coal glut in the international market is likely to continue for several years, reducing barriers to importing coal in the future if prices fall even further.

8 transportation costs are a significant factor for coal power.

India has however introduced a modest tax of Rs 200 ($ 3.20) per tonne on coal. Proceeds from the tax have been channeled to a special fund set up known as the National Clean Energy Fund (NCEF), which had a corpus of $3 billion at the end of 2014[9]. There remains considerable uncertainty on how this fund be utilized however; at least a part of it could be used for environmental projects not directly related to carbon mitigation.

Currently, more than 90% of Indian coal plants use sub-critical boiler technology with operating efficiencies close to 30%. India has committed to ramping up its currently low penetration of High Efficiency Low Emission (HELE) technologies such as super-critical and ultrasuper-critical boilers, which can increase efficiencies to as high as 46%. Every percentage point increase in boiler efficiency results in a 2.5% reduction in GHG emissions. Therefore, if half of India's coal boilers were HELE-based by 2030, this could lead to avoided emissions of roughly 400 million tonnes of CO2[10].

Policy has mandated that all new Ultra Mega Power Plants (UMPP) - the term used to denote very large plants with more than 4 GW capacity - adopt HELE technologies. The Low Carbon Growth Report also envisaged 50% of all Indian coal-based plants to have adopted HELE technologies by 2030.

Sector composition and shifts give us clues as to which players are the most critical in these transformations now and in the future. Currently, public sector companies own the majority (68 %) of coal-based power. However, new capacity additions trends are almost exactly the reverse - 67 % of the coal capacity expansion over the past three years came from the private sector.

There is also a trend of thermal power companies crossing over into renewables. The Tata conglomerate, a leading player in thermal power, is also a major renewable energy player with presence in solar, wind and hydroelectric sectors. Public sector NTPC, India's largest thermal power corporation which owns 26% of the country's thermal capacity, has recently taken on a target of 10 GW in solar power. It has already signed a PPA with the state of Andhra Pradesh for a 1 GW solar plant and an additional 2 GW capacity is expected to be added within the next year. Adani Power has recently announced plans to enter solar with a massive 10 GW solar plant in the state of Rajasthan and a solar PV manufacturing unit in collaboration with SunEdison. As formerly thermal-dominated companies take on increasing levels of solar and other renewable commitments, their interests will no longer be solely tied to coal - a positive development for carbon mitigation efforts.

Renewables

In 2014, the Indian government greatly its increased targets for renewable energy. The goal was set to 176 GW of renewable capacity by 2019[11]. Much of this is to come from solar (100 GW) and wind (60 GW), the remaining from biomass (10 GW) and SHP (5 GW). While the figures for solar and wind do represent a much higher level of ambition as compared to previous plans, they are challenging goals to achieve under any circumstances.

Renewable energy investments in India appear to be on an upswing reversing the trend over the past three years. Investments peaked at $13 billion in 2011, then dropped steadily to $6 billion in 2014[12], but are now projected to surge to $10 billion in 2015[13]. However, they would need to be at a much higher level for India to achieve its targets.

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9 Government of India (2015), *Economic Survey 2014-15*, available at http://indiabudget.nic.in/survey.asp

10 with the assumptions of a constant share of emissions from coal-fired plants and a 5% year-on-year increase in CO2 emissions till 2030.

11 the current renewable power capacity according to the Government of India is 36 GW, with wind dominating at 23 GW, and solar at nearly 4 GW.

12 UNEP (2014), *Global Trends in Renewable Energy Investment 2014*

13 UNEP (2015), *Global Trends in Renewable Energy Investment 2015*

A critical challenge in ensuring that renewable power is integrated into the grid is the management of variability and uncertainty. This requires retooling the grid and expanding the balancing area beyond the envelope of the individual states[14]. There is also a serious lack of grid evacuation capacity at many renewable generation sites. Large investments are required to achieve the high capacity and quality grid India needs. The Indian government recently announced its intention to invest $16 billion in grid upgrades.

One of the most critical demand-side tools for the creation of a market in renewables is by requiring Discoms to purchase a set quota of renewable energy, known as Renewable Purchase Obligation (RPO). Shortfalls expected in renewables-deficit states are to be made up by purchasing Renewable Energy Certificates (RECs).

However, RPO compliance is currently extremely poor with most states far short of meeting targets. Supply of certificates far exceeds demand, as renewables-poor states are highly reluctant to purchase RECs for which they get no extra power[15]. In short, the RPO policy has generally failed in the Indian context. The current government is considering intervening in what is normally a state subject by levying penalties for non-compliance of RPOs. A Renewable Generation Obligation (RGO) on large power producers may also be introduced.

Ultimately however, unless the demand side constraints that plague the overall power sector are removed, investments will turn into non-performing assets, and the promise of renewables in India will not be realized. Therefore, a key metric on the viability and sustainability of the current surge in renewables is to track how many projects actually sign PPAs.

Specific barriers and drivers pertaining to wind and solar power sub-sectors are summarized in the sections below.

Wind

Within the renewables space, wind power is the most mature industry in India. Installations increased rapidly beginning in 2007 to reach a net capacity of 21 GW at the present. The levelized costs of wind power are already at grid parity in several states when compared to the cost of electricity from imported coal.

The wind sector is a highly fragmented market dominated by many small and medium private players. The turbine manufacturing sector is however much more concentrated. The leading players are Suzlon, Gamesa, Enercon, Reger, and Inox. Turbine manufacturers also own and operate several wind farms.

However, capacity addition has slowed of late due to policy uncertainty on subsidies. The subsidy regime has fluctuated between capital-based and generation-based approaches. Both were removed in 2012, leading to a sharp drop in capacity addition. They were then restored in 2014. Many of the best wind sites are populated with older, lower-capacity turbines but upgrading to new turbines involves a significant capital cost not covered under the subsidy regime.

Another serious challenge to the wind industry is the lack of accurate wind forecasting, which leads to major issues of supply-demand mismatch and the consequent wastage of generated power. The Renewal Regulatory Fund initiative introduced a forecasting and scheduling regime in 2013 for the wind industry by requiring wind farms to forecast output at 15-minute intervals to within 30% accuracy, however this mandate was later converted into a guideline after protests from wind suppliers.

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14 Government of India, NITI Aayog (2015), *Report on India's Renewable Elecricity Roadmap 2030: Towards Accelerated Renewable Electricity Deployment* , available at http://cii.in/Publicationform.aspx?enc=+VOmGxIxCxf2n7zt4OXyAPIVd3fgdmCZV7kw5/hjnpuzgK7ClVUXiBcqoTbbOvrf

15 Government of India, NITI Aayog (2015), *Report on India's Renewable Elecricity Roadmap 2030*

Solar

Compared to wind, solar is a brand-new sector in India. Even if India does not achieve the ambitious 100 GW target by 2019, the future of solar in India appears bright from the supply side standpoint. A total of 2.5 GW capacity addition is projected in the country in 2015-16[16], more than double compared to the previous year figure of 1.1 GW[17]. The projected solar figure is comparable to the quantum of wind capacity added in 2014-15. These numbers are however still about 10 times smaller than projected thermal capacity additions.

The sector is almost entirely dominated by private players, though the entry of thermal majors such as NTPC and the advent of state-run Solar Energy Corporation of India (SECI) is introducing a public sector element in the mix. Capacity is shared between a number of players, though some of these such as Tata, Azure, Welspun, Reliance, and now NTPC are larger than others, the market has a moderate level of fragmentation. The solar market is at an early stage in India, therefore a stable structure has not yet evolved for the sector.

Costs of solar technology are rapidly falling due economies of scale, technology improvements, and the movement of manufacturing to lower-cost sites, principally in China. Solar PV is now close to being competitive with imported coal in some Indian states, with a recent bid by FirstSolar in the state of Andhra Pradesh at Rs. 5.25 (0.085 cents) per kWhr. If these trends continue, grid parity is expected within two to three years for utility-scale solar as compared to power plants fueled by domestic coal.

While utility-scale solar is seeing a strong pickup from the supply side, distributed solar has had a much slower rise. Though 40 GW of the 100 GW solar addition by 2019 is targeted to be rooftop, the focus in the Indian government seems to be more on building up centralized capacity. The Ministry of New and Renewable Energy (MNRE) has recently announced a subsidy cut in rooftop from 30% to 15%. In any case the subsidy regime has been only minimally operational, as the needed funds have been released much more slowly than claims.

Electricity tariffs in India for large commercial or industrial consumers are typically much higher than those for the average residential user. Rooftop solar is already at grid parity in this market. Therefore there is a strong case for the rooftop solar subsidy for high-value customers to be withdrawn and directed instead to the residential market or towards enabling more financing in this space.

Net metering, a crucial requirement for rooftop implementation, has however only been implemented in 11 states in India thus far, and only a subset of these have enabled Third-Party Ownership (TPO). Its rapid rollout and creating user-friendly policies for maximum adoption are a prerequisite for distributed solar to become a reality in India. Much of the onus for these actions falls on state governments.

With the increasing viability of solar, India is seeing the beginnings of its own "fuel switching" - away from expensive diesel. Initiatives to switch nearly 450,000 mobile towers to hybrid diesel-solar sources are proceeding apace with the telecommunications regulator having released guidelines for the switch.

Natural Gas and Nuclear

Two other lower carbon fuel sources for electricity production – natural gas and nuclear power-- have been mooted for India but both face significant barriers.

Natural gas is touted as a "bridge fuel" in the pathway to fully renewable power, generating close to half the emissions as compared to coal for an equivalent amount of electricity. Fuel switching from coal to natural gas has contributed substantially to the reduction of carbon emissions in the United States. In India however, gas-

16 UNEP (2015), *Global Trends in Renewable Energy Investment 2015*

17 Government of India, Ministry of New and Renewable Energy (2015), *Physical Progress (Achievements)*, available at http://www.mnre.gov.in/mission-and-vision-2/achievements/

based generation is in a crisis, falling steadily for the past few years. Currently only 4% of power is generated from natural gas, and PLFs in this sector have dropped to an abysmal 24%. Three major drivers account for this fall, a fall in domestic production as a result of pricing disputes between the government and producers, stalled negotiations in new gas pipelines, and the high cost of imported Liquified Natural Gas.

Nuclear power is an excellent low-carbon energy source that promises to achieve energy security and climate mitigation simultaneously for many developing countries. The civil nuclear deal between India and the United States in 2005 opened the door to a major ramp-up of nuclear power in the country, with heady projections of 63 GW capacity by 2032[18]. In the decade since however, it has become clear that the reality will fall well short of target. Two major barriers to expansion of nuclear power in India are domestic opposition/land acquisition issues and civil liability dispute with international suppliers, the latter remaining unclear despite the agreement with the United States announced in spring 2015

India at Paris

With both coal and renewables as a major focus in India's push to achieve energy security for all its citizens, Paris will present a curious paradox for the country as far as the power sector is concerned. At one level, India can tout its accomplishments in the renewables space with generation as a percentage of the total being now higher than the US or China. On another level, the continued reliance on coal and plans to greatly expand domestic mining will engender opposition from several actors in Paris. However, though India is not alone in coal being on a growth path, the US-China deal on a peaking year for overall carbon emissions, and the fact that both countries appear to be reducing coal consumption may put pressure on India to step up on its commitments.

One solution is for India to more actively embrace HELE technologies, which are currently well below potential. The international community can speed up these efforts by considering innovative financing and technology transfer approaches, perhaps aided by some portion of the Green Climate Fund, and India can energize this effort by redirecting wasteful subsidies on kerosene and diesel. India can also reduce the current policy uncertainty on renewables which detracts from a sustainable expansion of this sector. Finally, on the demand side, it is critical that India reform its ailing distribution companies if the many planned renewable projects are to become financially viable.

18 Urjit Patel (2010), "Crucial Deadline for Nuclear Energy Business in India," Brookings Institute, available at http://www.brookings.edu/research/opinions/2010/08/17-nuclear-energy-india-patel