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GUEST EDITORIAL

Bridging the gap between intentions and contributions requires determined effort

India has been lauded for the ambitious targets she has set for herself in the Intended Nationally Determined Contributions (INDCs) that the Government of India put forward at the recently concluded Paris COP 21 (Conference of Parties) of the Climate Convention. The relevant voluntary and self-determined targets that India has indicated are: (1) 'To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level.' Emission intensity is defined as tonnes of CO_2 generated per unit of GDP corrected for purchasing power parity. (2) 'To achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund.'

In an earlier section of the document, India described its mitigation strategies and actions. Various non-fossil installed capacity targets she has set for herself for the year 2022 are mentioned in it which include: 60 GW of grid-connected wind power; 100 GW of solar power (60 utility scale, 40 rooftop); 10 GW of biomass energy and 5 GW of small hydro. Nuclear capacity target is not mentioned for 2022, but for 2032, 63 GW has been targeted. No target is mentioned for large hydro plants, currently the largest source of non-fossil energy.

An installed capacity of 284 GW generated 1100 TWh of energy in 2015. Non-fossil sources of electricity constitute a little more than 30% of the installed capacity today, and they generate 21% of the electricity. Some commentators have called India's renewable energy targets ambitious and some have gone so far to label them as next to impossible, because no nation has expanded its renewable energy infrastructure at that pace. We do not share these views.

The GDP and the electricity sector have both grown at an average annual rate of about 6% in the past five years. Assuming a 6–8% annual growth rate for the economy and the electricity sector, a growth in power generation of 50–70% by 2022 and 140–220% in 2030 can be projected. Assuming that by 2022 the hydro and nuclear projects under construction today will be completed and that the new renewable energy targets of 175 GW are achieved, simple back-of-the-envelope calculations will show that non-fossil energy resources will constitute close to 40% of the installed capacity in 2022 itself. In order to meet the 40% non-fossil target in 2030, we will require about 300–400 GW of non-fossil capacity.

The past is only a guide to the future and not a predictor. The renewable energy targets did look ambitious when they were first announced in January 2015. A year later, we are in a very different regime when the costs of electricity generation from wind and solar plants are lower than those of electricity generation from thermal power plants using imported coal, and domestic coal in some cases. And solar energy costs are falling rapidly. New stringent pollution regulations will significantly increase the cost of coal-fired generators. Soon, owners of coal-fired power stations will be calling first for revoking of the clean energy cess, and then will be demanding subsidies.

Globally, 64 GW of wind and 57 GW solar PV facilities were commissioned in 2015, a combined increase of 30% over 2014. India installed 2.1 GW of solar PV and 2.6 GW of wind in 2015. Furthermore, India's ambitions in wind and solar PV are comparable in scope to new capacity additions in 2015 or future plans of China, Japan, USA or the EU. India expects to add, on an average, about 5 GW of wind and 15 GW of solar PV per year, to achieve the 2022 renewable target. There is little risk of our capacity additions distorting the market.

We do not claim, however, that it will be easy. While every bit will help, installing solar PV panels on a few thousand petrol stations or rail coaches will not come close to achieving the target. Most of achievements will come from large grid-connected wind and solar electricity farms. This is where the challenges lie. While at lower levels of penetration, the grid is able to tolerate and absorb the variability of renewable energy sources, at higher levels, problems of their integration into the grid will pose challenges.

The Government's non-fossil target is contingent upon technology transfer and low-cost international financing, including from the Green Climate Fund. However, here the past is a guide to what will happen in the future. Given the record of financing through the Climate Convention and the number of claimants that would be there for the pot, it is highly unlikely that any substantial amount of funds will flow to India from the Green Climate Fund. Fortunately, the private sector firms, both

Indian and international, are bidding aggressively to set up solar plants in India. A well-laid out policy could achieve the same for wind energy. Therefore, little public financing will be required for renewable power generation. Improving transmission facilities and integrating intermittent renewable power will require the bulk of up-front public investments.

A significant increase in wind turbines and solar PV facilities will require a robust, flexible and responsive electricity grid. Renewable resource facilities, especially wind farms, will be geographically concentrated and significant investment in transmission infrastructure is required to transmit power from remote areas to load centres. Solar PV is available only during the day; the rest of the grid should be able to ramp up and ramp down generation rapidly in order to complement this unique generation profile. The entire country, and perhaps all of South Asia, should operate as one grid in order to geographically average out the impact of the variability of solar and wind energy.

The remaining variability has to be balanced by a combination of strategies. First is the energy storage in the form of pumped hydro, compressed air energy storage, batteries, etc. Next, flexible deployment of hydroelectric plants and gas turbines and to a lesser extent, coal and nuclear plants will be expected. Demand response in the form of smart grid technologies that can remotely manage demands like AC, heating, lighting, etc. as well as flexible thermal energy storage in room heaters, water heaters and air conditioning systems will also play an important role. Irrigation pumps, often energized only during nights, could be creatively used as a remotely managed flexible demand response to balance the variability in renewable power generation.

Precise real-time monitoring and control of load and generation – in other words, a 'smart grid' – is a prerequisite for a transmission and distribution grid to be able to handle significant renewable generation. The electricity grid will begin to incorporate aspects of information and communication technologies. Pilot testing and implementing of these ideas will require a strong commitment to research, development and deployment by the funding agencies, research community, electricity regulatory commissions and distribution companies. Policy reform and willingness to re-imagine the business model of a distribution company will be required. Right incentives and opportunities will open up space for start-ups and other companies to innovate and invent new solutions to challenges that the electricity grid will eventually face.

India's INDCs rightly combine emissions intensity targets with low-carbon electricity generation technologies. India's emissions intensity has been steadily declining and is right on the trend line of the last 25 years to be able to achieve 33–35% target in 2030. This secular trend is primarily a result of energy efficiency improvements and the increasing share of the service sector in the economy (currently 60%). While increase in services tends to decrease emissions intensity, the increase of the industry sector in the GDP (currently 26%) tends to increase it. Emissions intensity can also rise, as a large fraction of the population enters the middle class and significantly increases the consumption of manufactured goods, electricity, AC, heating, automobiles and air transport. This transition has recently started in India.

India has already taken many steps towards enhancing energy efficiency. For example, the Bureau of Energy Efficiency's Star Appliance Labeling Program, the Bachat Lamp Yojana (for the promotion of CFLs), the Domestic Efficient Lighting Programme (for the promotion of LEDs), etc. have saved energy and reduced peak power demand. It is estimated that the programme to replace all incandescent bulbs with LEDs by 2020 will reduce the evening peak (currently about 150 GW) by 10 GW. This also helps the deployment of solar PV by reducing the evening peak load, and hence, the daily ramp up of conventional generation to balance the setting sun.

Energy efficiency, especially in refrigeration and air-conditioning, will make the biggest difference to residential and commercial electricity demand. According to some estimates, the peak AC load alone could be as high as 140 GW in 2030, almost the same as the all-India peak today. ACs, room and water heaters, chillers, refrigerators, etc. have tremendous potential for energy savings. Increasing energy efficiency, adding thermal storage and providing the grid operator the ability to remotely manage these loads will help with both INDC targets.

The lion's share of the emissions intensity improvements would be expected to come from efficiency gains in industries, in the transportation sector, in the use of public transport and in the changes in the structure of the economy. Our emphasis here highlights those that also benefit India's goals on renewable energy generation.

We conclude by recalling the most important policy recommendations and the problems we think, should be high priority for research, development and deployment.

On the policy front, we think that time-of-day pricing and reform of the distribution companies should have the highest priority. Time-of-day pricing incentivizes power saving, load spreading and solar PV – the best example of a policy with multiple co-benefits. Without profitable distribution companies, India's goals for power, renewables and economic growth will meet with failure.

Perhaps the biggest challenge facing the energy research community is the development of new ideas and technologies, to transform the current make-shift Indian grid system to a smart grid system, in order to absorb massive increase of renewable energy, and to also improve the quality of energy services.

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