Aspen Global Change Institute Energy Project

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INDIA'S PATHWAYS TO MEETING ITS RENEWABLE ENERGY GOALS

Indian Prime Minister Narendra Modi met with President Obama and the U.S. Congress in June to affirm India's dedication to the December 2015 Paris Agreement. India is the third largest carbon emitter in the world, behind China and the U.S., making Modi's commitment to join the Agreement by the end of 2016 key, as the Agreement is not official until at least 55 countries accounting for 55% of the world's emissions have signed on.

India had been considered a bit of a wild card going into the Paris talks, having made clear its prioritization of equitable allocation of the remaining carbon budget, an unwillingness to compromise on coal production, and a request for $2.25 trillion in assistance to meet its ambitious renewable energy goals. At the Paris talks, no commitments to climate justice (carbon allocation) were reached, and a global commitment of $100 billion in financial assistance for all developing nations certainly fell short of India's proposed budget. However, India opted to honor a spirit of compromise at the Paris talks instead of forcing these issues.

Despite these setbacks, India is forging ahead on its climate action plan to ramp up renewable energy production. As part of India's voluntary targets, the country has committed to 1) decrease the carbon intensity of its GDP by 33-35% (below 2005 levels) by 2030, 2) increase its non-fossil electricity to 40% by 2030, 3) implement afforestation that will provide a carbon sink for 2.5-3 billion tonnes of CO2, and 4) scale up low-carbon and sustainable lifestyles for its citizens (Chakravarty 2016).

Renewable energy has been expanding rapidly in India over the last decade, in spite of obstacles associated with renewables, such as intermittency and high initial capital investment (Tripathi et

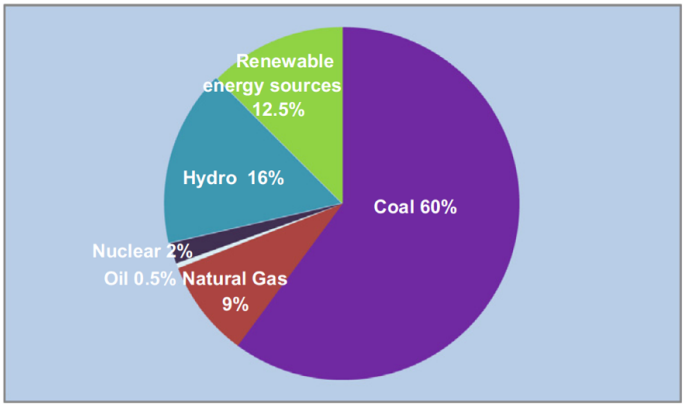

Figure 1. Sources of electricty in India by installation acapacity as on 11/31/2014, from Tripathi et al 2016

al. 2016). In 2002, renewable energy supplied only 1.5% of India's capacity, compared to 13.2% in 2015 supplied by wind, solar, small-scale hydro, and biomass (with an additional 20% supplied by large-scale hydro which is categorized separately) (Kumar and Madlener 2016; Tripathi et al. 2016). Due to a rapidly expanding population, increasing per capita energy demand, and limited availability of indigenous oil and coal, renewable energy is not only viewed in India as necessary for curbing climate change, but paramount to the country's energy security (Kumar and Madlener 2016; Shrimali et al. 2016, Tripathi et al. 2016).

Modelling techniques are proving to be valuable tools in assessing energy demands and how best to meet them efficiently using renewable energy. The Long range Energy Alternatives Planning system (LEAP) was used by Kumar and Madlener (2016) to illustrate a pathway with aggressive adoption of renewable generation coupled with sector efficiency improvements. This pathway achieves a 74% decrease in CO_2 emissions by 2050 as compared to a business-as-usual scenario, with renewables accounting for over 35% of the energy mix (over 50% if including large-scale hydro). This outcome relies upon the assumption that the government will either provide subsidies and cheap loans to renewable start-ups, or a carbon tax of up to $1.60/ton on coal.

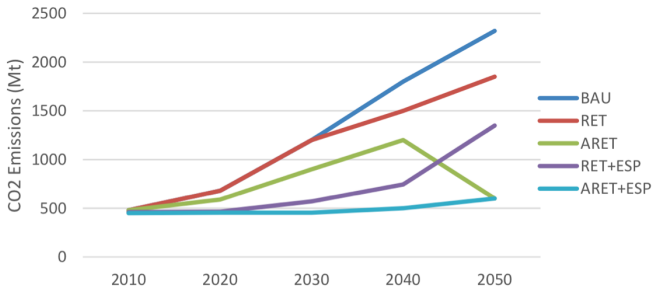

Figure 2. Carbon dioxide emissions in aggressive renewable technology and its various energy savings scenarios, 2010-2050, from Kumar and Madlener 2016

Renewable energy will need to be implemented on both a utility and a distributed microgrid scale in India in order to meet the energy needs of urban and rural populations alike. Using the Integrated Renewable Energy System (IRES) model, various researchers are experimenting with which energy sources most optimally suit rural energy demands. In the IRES model, electrical and cooking/heating needs in isolated areas can be matched to locally available renewable energy sources like micro-hydro power, solar, wind, biomass, and biogas. The model assesses which combination of these resources is most available and economically viable for the research area, optimizing efficiency in supplying local energy demands (Chauhan and Saini 2016). This kind of optimization is an important technique as India seeks to increase accessibility of renewable energy (Rajanna and Saini 2016).

Also important to a successful scaling up on renewable energy in India will be improved efficiency, smart grids, and storage (Chakravarty 2016). Energy forecasting is still evolving, and making accurate forecasts of the production of intermittent sources like wind, solar, and ocean energy still proves difficult. Possible solutions include investing in better storage (using water, or compressed air and flywheels in water-poor regions (Kumar and Madlener 2016), and/or implementing smart grids spanning India or even all of south Asia that can transfer electricity rapidly on a macro-scale from where it is being generated to where it is in peak demand (Chakravarty 2016).

Most successful scenarios of renewable deployment on a scale required to meet India's Paris Agreement targets rely on government support in the form of policies, subsidies, and other financial incentives. Prime Minister Modi has indicated his commitment to offering government support and already has certain policies and financial incentives in place. These policies have resulted in much more competitive costs of electricity between renewables and fossil fuels – wind (unsubsidized) is now cheaper than imported coal. But other renewables, especially solar, still require new policies to upscale. Shrimali et al. (2016) find that the most cost effective existing policy is *accelerated depreciation*, which allows developers to write off renewable energy project asset values for the initial development years. They go on to discuss an even more cost-effective means of supporting renewable energy (resulting in 96% reduction in the total cost of support): a combination of *reduced cost,* and *extended-tenor debt*. Under this policy, the government addresses the high costs of loans required to invest in renewable infrastructure, by offering loans at rates below commercial rates and over an extended tenor.

Renewable energy can successfully be integrated at scale in India – it has the renewable resource reserves, and technological capacity. But this will require a combination of careful planning, government policy and financial support, and adaptive methods of deployment across micro- and macro-scales (Tripathi et al 2016). The targets set by Prime Minister Modi are indeed ambitious, but with sustained political will and action over the coming decades they can be realized, in which case India will emerge a pioneer of renewable energy deployment at scale.

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