**Regional Impact of India’s Renewable Energy Mandates: An Application of E3 India Model**

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India’s energy demand is expected to triple between 2010 and 2030 and with the projected population growth to 1.5 billion and rapid urbanization within the same period will lead to increase in electricity demand from all the sectors and regions of the country. Currently, energy demand has outpaced domestic energy production, which has intensified India’s dependence on the imported energy. Its dependence on fuel imports is expected to rise further from 30% to over 50% in near future. Thus, there is an urgent need for innovative ways to generate power in economic and environmentally sustainable manner. To achieve this goal, increasing the share of renewable energy in total energy mix is required along with increase in energy efficiency and the infrastructural & technological development in the energy services.

Access to renewable sources of energy is in line with ensuring India’s energy security by providing for affordable, reliable, sustainable and modern energy to all and taking progressive steps towards climate change mitigation. In addition, it also aims to target Sustainable Development Goals (SDG) 2030, and meeting its Nationally Determined Contributions under the Paris Climate Agreement of achieving 40% of its power demand through Renewable Energy Sources and reducing its emission intensity of GDP by 33-35% by 2030.

India has a great potential for harnessing power from Renewable sources of energy. The Government of India has set an ambitious national target of reaching 175 GW energy capacity through Renewable Sources by 2022 comprising of 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small-hydro power. In view of this goal, the government has outlined regional target strategies for the ‘Resource-rich states’ in terms of solar and wind energy potential - Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan which constitute 59% of the national target. However, these six states have achieved only 62% of the allocated target and it is highly unlikely that the balance capacity will be met within one year. In order to accelerate the capacity installation, the government intends to increase indigenous manufacturing capacity of solar photovoltaics (PV) and wind industry equipment for which financial support is essential since the RE industry is at the preliminary stage of development in the country. To this end, the Ministry of New and Renewable Energy, Government of India incentivizes solar PV equipment manufacturing by providing 30% of the total project cost as subsidy and 40% accelerated depreciation for new wind turbines can be availed by domestic manufacturers.

The study evaluates the effectiveness of government incentives for the RE industry on India’s transition towards adoption of clean energy sources in the long run. The year of achievement of the target is estimated at the national and regional level and the policy impact on macro-economic variables such as GDP and Sectoral Output has been analysed. The study further addresses the impact on the environment by estimating CO2 emissions as a result of additional RE capacity in the long run. A Business-As-Usual (BAU) scenario has been developed and an alternative RE scenario has been constructed on the basis of targeted government policies to promote capacity building in clean energy. The methodology adopted for this study is an integrated macro-econometric dynamic simulation model named as E3-India model which is designed to capture Economy, Energy and Environment (E3) inter-linkages at the national and state level.

The model provides interesting results. The BAU scenario shows that India will achieve its wind capacity target by 2026 and solar target by 2029. The solar subsidy and accelerated depreciation for wind industry does not contribute significantly in reducing the timeline. Nevertheless, subsidies partly help the investment process with wind energy investment increasing by ten times compared to solar energy and coal sector investment simultaneously witnessing a negative trend at the national level between 2021-30. With more than 90% of wind industry equipment being produced indigenously compared to solar PV which is highly import-dependent makes the wind industry a lucrative destination for investment. The environmental implication of increased RE sources in India’s electricity mix shows a decrease in CO2 emissions of 0.2% between 2021-30.

At the regional level, only Karnataka (southern Indian state) achieves its RE target by 2022. Madhya Pradesh which is predominantly a coal-bearing state in central India witnesses one of the highest increase in wind energy investment simultaneously with the largest drop in coal investment, thus providing an indication of transition towards alternative RE sources. It also observes the largest decrease in CO2 emissions of 2.9% between 2021-30. The indirect sectoral impact shows that increase in output is higher for metal goods and electrical equipment industries whereas impact on GDP is negligible at the state and national level since the RE industry is at a nascent stage in the country. Overall, the results indicate that positive economic and environmental impact of government incentives does not translate into faster capacity installation at the national as well as state-level.

With wind energy outperforming solar energy in most of the macroeconomic parameters, we propose an alternative scenario in which the capacity allocation targets are reversed, with 100 GW for wind and 60 GW for solar. The results reveal that wind capacity target is achieved by 2033 in BAU scenario, however, with accelerated depreciation, it reaches the target 4 years earlier by 2029 with solar achieving the 60 GW target by 2025 in both scenarios. A higher capacity target for wind energy will yield higher positive impact on the economy as shown in the RE scenario such that the expansion of wind industry will contribute positively towards the national and state-economy.

India has set a long-term target of 450 GW RE capacity by 2030 which constitutes 280 GW for solar, 140 GW for wind and 30 GW for small hydro and biomass. The results from our study indicate that wind energy should constitute larger share of the target due to its existing manufacturing base in India. Simultaneously, in the short to medium-term, imposition of import duties on cheap solar modules imported from China and Malaysia is pivotal for domestic capacity building in the solar industry. In the long run, large hydro projects which have been excluded thus far should also be considered within India’s long term RE roadmap. Such a strategy will ensure a balanced RE growth trajectory in India while ensuring it meets the SDG goal of tackling climate change and its commitment in the Paris Climate Accord by 2030.