CLIMATE POLICY INITIATIVE

Produced by Professors from Jawaharlal Nehru University and the Indian Institute of Technology

An Assessment of India's Energy Choices: What it Means for the Economy, Jobs, and Energy Security

India's economy is growing rapidly, and with it, so is energy demand. The IEA-IEO (2015) estimates that India's aggregate energy consumption will more than double by 2040.

The growing demand for energy has raised two major concerns. First, in the absence of stringent policies to mitigate energy-related emissions of gases, dust, and fumes from the power sector, industry, and transport, India's air pollution problems loom large. Second, dependence on imports of conventional energy like coal, oil, natural gas has posed a threat to India's energy security. With substantial potential for growth in per capita energy consumption as well as emphasis on enhancing overall energy access, these issues are likely to get worse.

Facing these dual issues, it will be important for India to adopt policies that enhance indigenous energy production as well as encourage the use of alternative, sustainable, and decentralized sources of energy, such as solar and wind. The Government of India has an ambitious goal to achieve 175 GW of renewable energy by 2022, which would amount to around 18.9% of aggregate renewable energy power consumption in India in 2022.

As India works to meet this target, it is important to explore the relationship between renewable energy penetration and key macroeconomic factors such as GDP, the fiscal deficit, energy imports, employment, capital returns, and population, to ensure that multiple national priorities are achieved simultaneously.

This paper, produced by Jawaharlal Nehru University and the Indian Institute of Technology is part of a four-part series led by Climate Policy Initiative for Shakti Sustainable Energy Foundation that looks at paths to renewable energy penetration in India along different dimensions including the social costs, macroeconomic impacts, environmental impacts, financial risk, and flexibility considerations.

This particular analysis takes on macroeconomic impacts of India's renewable energy pathway.[1] By establishing the relationship – negative, positive, or neutral – between key macroeconomic factors and renewable energy, we gain insight into whether India can meet economic and clean energy targets simultaneously. Using the model developed in this exercise, we then project three scenarios – a business as usual, optimistic, and pessimistic scenario - to forecast different levels of renewable energy penetration in India's energy economy.

We find that renewable energy is clearly associated with positive impacts for India's economy including the potential to add up to 4.5 million domestic jobs by 2042 under an optimistic, but realistic, scenario. However, we also find that despite these benefits, under the same optimistic scenario, India will not be able to reach its renewable energy targets by 2022, and, in fact, would reach less than half the 175 GW target by that date.

The key results and takeaways around the relationship between macroeconomic factors and renewable energy from this analysis are as follows:

- **As India's Gross Domestic Product (GDP) grows, so does renewable energy generation.** This implies that higher incomes induce a higher willingness to pay for renewable energy or a higher demand for renewable energy. This could also be because renewable energy is a normal good, meaning cleaner energy is demanded more at higher incomes or people shift their energy preferences from conventional fossil energy to cleaner energy with an increase in income levels.

- **As renewable energy generation increases, the fiscal deficit decreases, and vice versa.** A higher fiscal deficit is largely indicative of higher financial support to fossil energy generation. Therefore, a higher level of

1 Our analysis utilizes macro-econometrics and time series methods for these estimations. These include tests of stationarity, Granger causality tests and co-integration using an autoregressive distributed lag (ARDL) model structure.

renewable energy penetration is associated with lower fiscal deficit on account of a lower share of fossil energy generation. A policy implication, therefore, is to increase renewable energy penetration, in order to reduce the fiscal deficit.

• **Increased renewable energy generation is correlated to fewer net energy imports.** Energy imports largely consist of fossil energy. Thus, renewable energy substitutes for fossil energy in the aggregate, which, in turn, reduces net energy imports. A policy implication, therefore, is to increase renewable energy generation in order to reduce net energy imports, which assert a huge drain on the Indian economy.

• **Higher renewable energy generation corresponds to lower unemployment.** A policy implication, therefore, is to increase renewable energy generation, in order to increase employment and jobs.

• **Renewable energy generation growth is correlated to higher interest rates.** In general, a higher interest rate constitutes either a higher cost of capital (which may dampen investment in renewable energy) or a higher return on capital investment (which encourages investment in renewable energy equipment). At the macro-level, the latter effect appears to outweigh the former. This is quite an interesting finding, given that it does not support the hypothesis that a reduced cost of capital would reduce the cost of renewable energy, thus making it more competitive. This may require further investigation.

• **Interestingly, the higher India's population, and the larger the percentage of that population with access to energy, the less renewable energy generation, and vice versa.** Intuitively, a higher population level or higher access of population to electricity places heavy demand on the economy in terms of demand for energy. However, our model shows the opposite. This is quite an interesting finding, given that it does not support the hypothesis that renewable energy can help improve energy access. However, this may be due to the limited time series dataset (for 27 years only) and India's excessive dependence on fossil energy to-date; this may undergo a change as more renewable energy diffusion happens.

Based on these economic indicators, we project three scenarios for India's renewable energy penetration.

Notably, our estimates show that in order to meet India's clean energy and growth goals we need to focus more on strong renewable energy policies, and also on strong macroeconomic policies. Specifically, we find that the 175 GW target is likely to be achieved during 2029-30 under the business as usual scenario, a bit earlier, in 2027-28 under the optimistic scenario, and a lot later, in 2032-33 in the pessimistic scenario. This is in consonance with the recent apprehensions expressed in this regard, especially given the available policy framework moving away from feed-in-tariffs to auctions-based purchases, lack of grid infrastructure, and evacuation constraints (Live Mint 2017).

We find that under the optimist scenario, India would add 4.5 million renewable energy jobs by 2042. Using shares across different renewable energy technologies unchanged over the years of forecasting, and relying on norms of job creation for these technologies, we obtain the following direct incremental job generation potential for India in 2022 (CEEW-NRDC, 2017): 251,000, 286,000, and 311,000 in pessimistic, business as usual, and optimistic scenarios respectively. In 2032, these are expected to rise to 978,000, 1.4 million, and 1.5 million respectively under the three cases. And finally, in 2042, these are expected to rise to 2.05 million, 3.98 million, and 4.52 million jobs.[2]

Table ES1: Renewable energy values under three realistic scenarios

Values	Year	Pessimistic scenario	Business as usual scenario	Optimistic scenario
Renewable energy (MTOE)	2022	14.71	15.56	16.13
	2032	31.93	42.15	45.08
	2042	57.44	103.16	115.83
Renewable energy capacity installed at 25% plant utilization (GW)	2022	78	83	86
	2032	170	224	239
	2042	305	548	615[3]
Share of renewable energy generation in primer energy supply (%)	2022	1.38	1.42	1.45
	2032	2.12	2.75	2.86
	2042	2.9	5.15	5.74

2 We have assessed the contribution of renewable energy to job creation potential using renewable energy sector specific data. This is subject to the proviso that these numbers may not necessarily be incremental. For a more accurate estimate, a more extensive, economy wide general equilibrium analysis is required.

3 The estimate for the year 2040 is 510 GW, which is closer to the estimates by the NITI Aayog.

Our findings show that India's energy security increases significantly under all three scenarios. To discern the future of energy security for India, we compute the energy security index (ESI) for India under alternative scenarios[4]. The ESI is normalized in a manner as to lie within the range of 0 and 1. A value closer to 1 denotes a higher level of energy security, while a value closer to 0 implies lower energy security. We calculate that India's ESI is currently 0.41, which is on the lower side. It is highest in the optimistic scenario, where it reaches 0.44 in year 2022 and 0.58 (a moderate value) by 2042, a more than 40% improvement. However, we also find that energy security does not vary too much across the scenarios.

Policy implications

Based on our analysis we find that renewable energy penetration in India is positively associated with important economic growth indicators including GDP, employment, and energy security, and therefore, additional renewable energy is consistent with strong growth targets.

We also find that a higher economic growth rate, a higher return on investment, and a more remunerative renewable energy tariff is likely to spur renewable energy growth. Alternatively, a higher fiscal deficit, and higher energy imports will dampen renewable energy diffusion.

India can therefore take steps to meet both clean energy and growth goals by focusing not only on strong renewable energy policies, but also on strong macroeconomic policies.

4 We compute a comprehensive index of energy security by relying on several indicators of energy security, namely, market liquidity, share of renewable energy generation in total primary energy supply, net energy imports to total primary energy supply ratio, Herfindahl-Hirschman market index of energy imports to India, percentage of population with access to energy and energy outlay.