

## **India's Transition to a High Share of Renewables: Next Steps for Policy and Research**

India's development will require large growth in electricity generation. Meeting this demand growth while minimizing environmental impacts is a significant challenge. At the same time, the recent dramatic reduction in renewables costs holds out the prospect of India following a different pathway from that of previous cohorts of industrializing countries, leapfrogging directly into a cleaner electricity system based largely on renewables in the mid-term.

But positive economics for renewables projects is not enough. A high renewables system requires a paradigm shift in operation, infrastructure, and investment, in order to balance the inherent variability of wind and solar electricity. This paradigm shift is the order of the day in India, where renewables have proven themselves such a competitive source of generation.

With this context in mind, TERI launched in 2017 the Energy Transitions Commission India project, together with the Climate Policy Initiative (UK and India) and the National Renewable Energy Laboratory (USA).

This thematic track will discuss the first outputs of the ETC India project and explore areas where additional research and dialogue is required to inform upcoming policy-making.

The project is structured around four central work packages:

1. Demand analysis and projection: we have analysed historical trends for electricity demand and its determinants, on a sector-wise basis at state and all-India level. In addition, we have conducted projections for electricity demand to 2030, using three different methodologies (econometric, end-use, and sector-wise cross-country benchmarking)
2. Supply scenarios and projection: the project has developed three different supply scenarios, based on different penetrations of variable renewables and coal. These scenarios have been analysed in terms of required investments, technology-wise generation costs, system costs, and generation.
3. Flexibility analysis and dispatch modelling: the project has analysed the need for different flexibility resources (reserves, ramping, intra-day flexibility, seasonal flexibility). In addition, the project has analysed different options for providing these flexibility resources, including batteries and pumped hydro storage, demand side management and demand response, and power plant flexibility.

The emerging conclusions for the project are as follows:

1. Demand growth is likely to be significant, albeit slower than GDP growth, reaching 2040 TWh by 2030 of grid-based consumption. There is likely to be a shift in the structure of demand, with services and residential sectors taking a relatively more important role. End-uses such as air conditioning and electrified transport are likely to grow at a rapid rate.
2. On the supply side, a high renewables scenario, with in the order of 28% of variable renewables generation and 35-45% of zero carbon generation, is cost-effective, with system costs that are no higher than a moderate renewables scenario.
3. Under all scenarios, flexibility needs are likely to grow faster than demand growth, and exceed the flexibility supply of the grid by the mid-2020s. A particularly rapid

growth in the need for intraday flexibility is observed. A balanced portfolio of flexibility options across storage, demand side flexibility, and power plant flexibility is likely to be lower cost and lower risk, and will substantially lower the costs of a high renewable pathway.

4. Developing the policy, regulatory and market framework to promote flexibility in the Indian power system is an urgent task.

### **Questions**

1. What supply capacity mix could be envisaged for 2030, and how high could the share of variable renewables be?
2. What would be the challenges associated with this supply mix, particularly in terms of the grid integration of variable renewables?
3. What other challenges and opportunities would be associated with an electricity system based on a high share of renewables, in terms of e.g. investments, tariffs, infrastructure, and grid integration, etc?
4. What are the policy priorities in the coming 2-3 years for India to realise this transition to a high share of renewables?
5. What areas of research should Indian policy-makers, academia and think tanks prioritise in order to continue to support this policy agenda?