# *ELECTRIC POWER TECHNOLOGY COMPETITION IN LOW CARBON SCENARIOS: A MODELLING ASSESSMENT FOR INDIA*

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## Overview

Renewable electricity technologies have been promoted in India over past several decades through varied government policies. This had led to early penetration and rising share of large non-hydro renewable energy technologies, from almost negligible in 1990 to 28 GW in 2013, representing about 12% of total installed generation capacity in India (MoP, 2013). Lately, the low carbon technologies have found support from India's National Action Plan for Climate Change (NAPCC). This, together with the global climate negotiations targeting 2°C stabilization, has exposed the electricity sector to the influence of global carbon price. This would further alter the competitive dynamics in the electricity generation sector especially since under the BAU, the electricity system in India remains overwhelmingly dependent on fossil fuels.

This paper examines the implications of global 2°C stabilization target on the competition among India's electric power technologies.

## Methods

The paper makes use of a soft-linked integrated modelling system which includes a global integrated assessment model (GCAM) and a national level energy system model (ANSWER-MARKAL). The modelling assessment spans over the period 2010 to 2050. To assess the shifting dynamics among competing electricity generation technologies, three scenarios are examined: i) business-as-usual (BAU) scenario, ii) conventional low carbon scenario (LCS), and iii) sustainable low carbon scenario (SLCS). While forecasting approach is used for LCS, the SLCS makes use of the back casting approach. In the LCS, the focus is on market instruments and global carbon tax to achieve the 2°C stabilization target is used as the main tool to alter the competition. The corresponding carbon tax trajectory is obtained from GCAM. In SLCS, along with market instruments, several other sustainability measures are included, like demand side management, energy efficiency, and clean supply-side energy technologies. The aim is to deliver national benefits such as improved local air quality and energy security. Besides, SLCS is constrained to identical carbon budget as LCS over 2010-2050. A comparative scenario analysis is carried out to determine the social value of carbon, assess the change in electricity technology mix and resultant changes in the delivered cost of electricity, loads of local pollutants, and energy security implications. Based on comparative scenarios assessments, policy implications are drawn and a policy roadmap is provided.

## Results

Initial results indicate that in SLCS the technological span is more comprehensive than LCS and major transitions occur in demand side technologies (e.g. solar photo-voltaic, electric vehicles etc.) and transmission technologies (e.g. oil and gas pipelines, electricity transmission etc.). Improvements in energy efficiencies of appliances along with introduction of smart grid systems help in greater integration of renewable technologies, both grid connected as well as off-grid. Electric vehicles (EV) emerge as a storage option under SLCS giving further push to renewable integration, particularly solar (EV2PV). There are also co-benefits in terms of better local air quality and improved energy security under SLCS. Nuclear energy's share increases in LCS compared to BAU, but does not further increase in SLCS largely on account of additional investment required for nuclear safety mechanisms. This additional investment required becomes a significant component of overall nuclear cost. As CCS technology gets mature and as its' costs come down, it finds greater application combined with biomass (bio-CCS) along with fossil fuel (fossil-CCS). The price competition for electric power technologies comes out to be different in the three scenarios owing to differences in direct price change and other sustainability co-benefits. The social value of carbon comes out to be lower in SLCS compared to LCS and BAU.

## Conclusions

For a country with large electricity market, like India, transitions in supply and demand side provide options for technological cooperation between private sector and government across many fronts. For example, by providing an option for electricity storage, EVs could lead to greater penetration of renewable technologies. The substantially lower social value of carbon under SLCS means that the cost of low carbon transition on Indian society would be lower which could encourage policymakers to take pro-active actions. The competition in electric power technology emerges not only between fossil fuels and non-fossil fuels, but also among non-fossil fuels, which is important to be recognized especially when any one technology is pushed while ignoring the other. Finally, owing to initiatives under SLCS, there are several co-benefits in terms of improved local air quality and improved energy security which are accrued.

## References

MoP. (2013). Power Sector at a Glance "ALL INDIA". Ministry of Power, Government of India.