Modelling impacts of scaling up energy-efficient cleaner technologies for thermal comfort in India using E3-India

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Demand-side energy efficiency can go a long way in changing the trajectory of energy transitions in emerging economies like India. This paper compares the impacts of technology interventions for providing more energy-efficient thermal comfort alternatives for Indian households. For example, the household ceiling fan is a universally penetrated technology with strong integration in the economy. The study captures the impacts of the mass introduction of more efficient ceiling fans for the Indian households.

We compare and analyse the impacts of more efficient fans not only on the energy sector, but also on the economy and the environment at the regional level using the E3-India model. The comparison is drawn to provide various incentives to manufacturers and households for the technology switch, and its overall impact on the economy providing a holistic policy prescription using an integrated modelling framework. This paper estimates the reduction in energy consumption and emissions and the economy-wide impacts over time from promoting efficient ceiling fans in India.

Ceiling fans are probably the most common electrical appliance used in Indian homes for providing thermal comfort. Fans consume about 20 percent of the electricity in Indian households. Furthermore, their numbers are growing rapidly. Production of fans in India during 2008-09 was about 40 million units, of which about 29 million were for sale within India. With a growth of 10 percent per year in sales, we can expect that of the fans in 2020, about 70 percent will have been added just since 2009 (Prayas, 2012).

This paper estimates savings in terms of the reduction in energy consumption and emissions and the economy-wide impacts on employment and income over time from the promotion of efficient ceiling fans in India. We further estimate the investment (and associated emissions) required for various incentives to manufacturers and households for the technology switch and the reinvestment of savings into other sectors of the economy.

The impacts of these alternative policy scenarios are estimated based on their economy-wide impacts using a coupled input-output econometric framework and the future technology transitions (Mercure, 2012) module of the newly developed E3-India model. The model captures the relationship between Economy, Energy, and Emissions, covering 20 economic sectors, 8 energy users, and 5 income quintiles for India's 28 states and 4 union territories.

This method helps to quantify the additional monetary and environmental benefits of efficiency-improvement programs beyond their direct impacts. It also helps to identify negative impacts associated with demand-side appliance efficiency programs that need to be addressed for policy implementation. Finally, the approach provides an empirically evaluated insight for the policymakers facilitating integrated decision-making inclusive of the economic, environmental, and energy impacts of any policy intervention.