

# **The Impact of Electricity Sector Restructuring on Coal-fired Power Plants in India**

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## **Executive Summary**

Beginning with Chile in 1982 the last two decades of the 20th century were marked by the restructuring of the electricity sector in countries throughout the world. Utilities that were functioning as vertically-integrated monopolies were unbundled and privatized in an attempt to increase competition and lower costs. Electricity deregulation paved the way for the entry of independent power producers and the creation of wholesale electricity markets. The resulting gains in operating efficiency and reduction in costs have been documented using plant-level data for the US and cross-country data for developing countries. In this paper we estimate the effects of unbundling generation from transmission and distribution on the performance of state-owned thermal power plants in India.

Between 1996 and 2009, 85 percent of the coal-based generation capacity owned by state governments was unbundled from vertically-integrated State Electricity Boards (SEBs) into newly created state generation companies. To examine the impact of restructuring on the operating efficiency of state owned power plants, we use electricity generating unit (EGU)-level data on measures of operating reliability and plant-level data on thermal efficiency as outcome variables. Operating reliability is measured by the percentage of time in a year an (EGU) is available to generate electricity (unit availability), and the percentage of time a unit is forced to shut down due to equipment failures (forced outages). Thermal efficiency is measured by coal consumption per kWh and by operating heat rate—the energy used to generate a kilowatt-hour (kWh) of saleable electricity. We also estimate the impact of reform on the capacity utilization of the EGU, i.e., the percent of time the EGU generates electricity.

To investigate the impact of reforms in the Indian electricity sector we construct a panel data set of coal-based EGUs for the years 1988–2009. The variation in the timing of reforms across states allows us to estimate the impact of unbundling on EGU reliability and plant thermal efficiency. We also use EGUs operated by central government owned generation companies as an additional control group. These companies operate outside the purview of state governments and thus were not directly affected by the reorganization of the SEBs.

Our results suggest that the gains from unbundling of generation from transmission and distribution were limited to the states that reformed before the Electricity Act of 2003—i.e., to states that unbundled their electricity sectors before being forced to do so by the 2003 Electricity Act. In these states, on average, EGUs at state-owned plants experienced a 5 percentage point reduction in forced outages as result of unbundling—roughly a 25 percent reduction compared to the 1995 average. The decrease in forced outages was accompanied by a 6 percentage point increase in availability. These results are driven largely by the improvements in operating

reliability at EGUs with lower nameplate capacity. Our results are not driven by the decommissioning of old and inefficient EGUs or a commissioning of new more efficient ones, and thus represent an improvement in existing capacity. This is an important distinction as increasing reliability at existing units can likely be achieved more cheaply than by installing new capital equipment.

On average, there is no evidence of an improvement in capacity utilization due to restructuring, although the results suggest a statistically significant increase at some EGUs. For states that unbundled prior to 2003, we find that unbundling led to a significant improvement in electricity generation at smaller generating units—a 9.4 percentage point increase in capacity utilization at 110/120 MW units. Importantly, our results show no evidence that unbundling of SEBs led to the improvement in thermal efficiency at state-owned power plants.

At plants in states that unbundled between 2005 and 2008, our results suggest that the initial years following reforms were associated with a reduction in availability and capacity utilization, especially at 110/120 MW EGUs, and a decrease in thermal efficiency. The estimated deterioration in performance may be due to initial adjustment costs to restructuring in the states that were forced to unbundle. It should also be noted that the reductions in availability at EGUs were due to increases in planned maintenance rather than increases in forced outages.

In summary, our analysis points to modest gains from reform. Operating reliability increased at EGUs in states that unbundled prior to 2003; but there is no evidence of an improvement in thermal efficiency. Our failure to find a larger impact from restructuring than reported in the US may also reflect the path that reform has taken in India thus far. In the United States unbundling resulted in independent power producers (IPPs) entering the market for generation. This did not occur on a large scale in India during the period of our study.

The incentives for improving fuel efficiency and maintaining equipment to prevent breakdowns also depend on how plants are compensated. Under the 2003 Electricity Act compensation for energy used in generation is to be based on scheduled generation and to depend on operating heat rate. Compensation for fixed costs is to be based on plant availability. There is evidence that state electricity regulatory commissions have set compensation for fuel use based on very high estimates of operating heat rate, suggesting that this may not provide much of an incentive for plants to improve thermal efficiency.