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Power System Operator Demonstrates the Fine Art of Grid Management

Hydro and Gas Generation Capacity Underpin Resilience in Symbolic Switch-Off

Prime Minister Narendra Modi called on citizens to switch off their lights on at 9pm for 9 minutes on April 5 to show solidarity on the 9th day of India's national coronavirus lockdown, and to light earthen lamps or torch lights instead.

His intention was to bring the people together in unprecedented times, but the gesture also created a major challenge for power system operators to manage grid stability.

In the face of great apprehension, how the system operators managed grid voltage and frequency is a work of art. They deserve a pat on the back.

In preparation for the event, the Power System Operation Corporation Limited (POSOCO) analysed the load behaviour of a typical day, the previous Sunday, to anticipate the lighting load of household consumers. POSOCO convened a meeting with various stakeholders including national, regional and state load despatch centres (LDCs), generating companies to finalize the operational guidelines for maintaining system stability and reliability during the big switch-off.

The Ministry of Power and India's system operator made arrangements and put protocols in place to handle the rapid changes in electricity demand that the switch-off would create. They predicted a fall in demand of around 12–14 GW for a 2- to 4-minute period when the lights went off, with recovery just a few minutes later. In the actual event, total reduction in demand was 31 GW (2.5 times the anticipated demand reduction), with minimum recorded demand of 85.8 GW at 9.10 pm.

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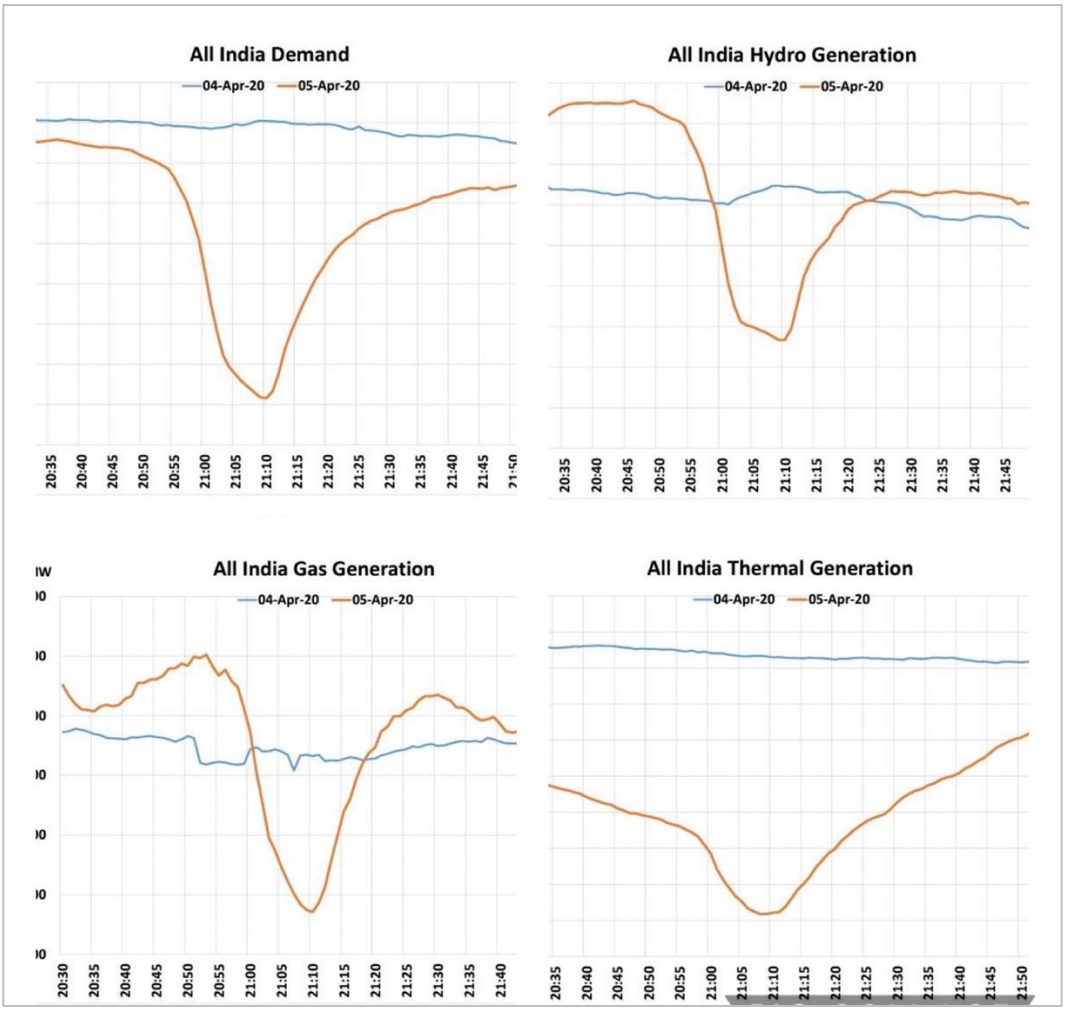
Power authorities adopted a bottom-up approach, using the data on number of household consumers to estimate the total lighting load. However, the data available extended only to 31 March 2019, and more households have since been electrified. Moreover, a large number of consumers are still not metered and their actual consumption is not recorded. Any estimation is only as good as the data, reflecting India's need to improve metering and recording of demand.

Moreover, the government advisory asked households to only switch off their lights, and leave on appliances such as computers, televisions, fans, refrigerators and air conditioners. However, it is believed that during the 9-minute switch-off the reduction in demand was more than just the lighting load.

While the actual demand reduction was more than the anticipated, grid frequency during the event remained stable in the range of 49.70 Hz to 50.26 Hz with minimum and maximum frequency ranging from 49.7 Hz at 8.49 pm to 50.2 Hz at 9.08 pm. The reduction in demand was managed by reducing hydro (17.5 GW), thermal coal (6.9 GW), gas (1.9 GW) and wind (2 GW) generation to maintain grid stability. When demand started to rise, these resources were gradually scaled up to meet the increase.

Figure 1: All India Grid Demand Response on April 5, 2020



Source: POSOCO.

The night of April 5 amply demonstrated the robustness of India's national electricity grid. Planning and contingency measures prevented cascading outages that could have threatened the synchronous grid. The management of the symbolic

switch-off also demonstrated how investment in flexible peaking capacity and a centrally coordinated smart grid has afforded India's power system the capability to integrate an increasing amount of low cost but intermittent renewable energy.

Pumped hydro and gas-powered generation provided much-needed flexibility to the system, and renewable wind generation also contributed to maintaining system stability. But there is still a need to promote investment in these flexible generation sources, especially pumped hydro, that can respond quickly to variability in demand and supply.

Although the April 5 management of highly variable demand was done without any market price signals, it established the fact that technically the grid can manage large variations. However, the day-ahead market at Indian Energy Exchange (IEX) where small quantity of power is traded, witnessed a drop in price by 65% (in a 15-minute time block) at 9 pm, the day's lowest price of Rs 0.70/kWh at the time of the event.

An accurate market price signal to incentivise investment in building flexible peaking capacity is needed now. India also needs additional storage and demand side measures to supplement the increasing share of variable renewable energy into the grid. And there is also a need for institutional and individual capacity building, so that operators have the skills to plan and manage the grid effectively.

India's Central Electricity Regulatory Commission (CERC) had planned to implement real time market pricing from April 1, but because of the Covid-19 lockdown, delayed implementation until June. While real-time settlement in the day-ahead market will yield savings by despatch of least-cost generation to meet energy requirements, it is complementary to time-of-day pricing and will offer incentives to develop flexible generation capacity to meet grid balancing requirements and maintain system stability.

The real-time market will further inform generation planning and investment decisions for more flexible generation sources and prevent generation assets from becoming stranded. It will also allow commercial and industrial consumers to provide demand response and shape their consumption pattern to take advantage of low-price periods.

April 5's grid management effort was a successful real-time test. It establishes more confidence in the system operator's ability to manage variability in demand and supply without compromising grid stability. A well-functioning real-time market with the right price signals can help India accelerate its energy transition and absorb more renewable energy generation into the system.

That is not to say, however, that such unprecedented power-supply events are necessary to prove the system's robustness. Nowhere in the world has a power system operator had to manage 31 GW of load variability in a time span of 9 minutes. Renewable energy generation also varies over time and that is the reason the real-time market is designed with a gate closure of 30 minutes. What India's grid system operators achieved is comparable to winning a battle, but it would be

unwise to send grid and system operators into combat again. They have won the battle this time, but such challenges are best avoided.

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About the Author

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Energy Economist Vibhuti Garg has advised private and public sector clients on commercial and market entry strategies, investment diligence on power projects and the impact of power sector performance on state finances. She also works on international energy governance, energy transition, energy access, reallocation of fossil fuel subsidy expenditure to clean energy, energy pricing and tariff reforms. In addition to India, she has worked in Nepal, Bangladesh, Vietnam and in the Caucasus.