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COMMENTARY

Role of Energy Efficiency and Demand-side Management in India's Clean Energy Transition

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Abstract: India aims to achieve 500 GW of non–fossil fuel capacity by 2030, a substantial share of which would be contributed by variable and intermittent solar and wind. Further, India's electricity demand is expected to increase with urbanization, income, and temperature. Energy efficiency and demand-side management programmes can play a critical role in India's clean energy transition by reducing the demand for electricity and shifting it to times when solar and wind power can be most efficiently generated. Balancing the supply-side push for renewables with energy efficiency and demand-side management would be more cost-effective, less resource-intensive, and pose fewer social and environmental challenges compared to a renewables-only approach. This commentary highlights the importance of such an approach to India's clean energy transition.

Keywords: Clean Energy Transition, Energy Efficiency, Demand-side Management, Renewables.

1. CONTEXT

As Delhi temperatures hovered at 44 degrees Celsius in April this year, much sooner in the year than the typically warm/hot summer months of May and June, millions of Indians struggled with their daily lives. The peak power demand surged to a record high of 207 GW, and electricity distribution companies (DISCOMs) scrambled to supply electricity to their customers (The Indian Express 2022). Rajasthan, a renewable energy–rich state, announced scheduled power cuts of one to three hours for general consumers and provided only 50% of the required load capacity to

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industrial customers between the unusual hours of 6 pm to 10 pm (The Economic Times Energy World 2022).[1]

In this context, balancing India's supply-side push for renewables with demand-side management programmes and energy efficiency provides a significant opportunity to manage such crises and spur the clean energy transition. Moreover, doing so would contribute to meeting the country's climate objectives, as it would reduce the dependency on coal for balancing the grid as more renewables are added to the supply mix.

At present, India's power system relies heavily on coal; the country is trying to balance the need to reliably supply electricity to its people and businesses while simultaneously meeting its climate objectives. The International Energy Agency (IEA) has said that "All roads to successful clean energy transitions go via India" (IEA 2021, 16). As the first major economy to be developing in a carbon-constrained world, India could pioneer an economic growth and sustainable development model that breaks away from fossil fuels. If India is successful, it can act as a template for other countries on the frontiers of development in Asia and Africa.

At the 2021 Glasgow Conference of Parties to the Climate Convention, Prime Minister Modi announced five commitments or "Pachamrit", raising to a new level India's ambitions for addressing climate change (Ministry of External Affairs 2021). One of these goals involves achieving 500 GW of non-fossil energy capacity by 2030. As of December 2021, India's installed renewable capacity was about 151 gigawatts (GW), making it 38% of the total installed capacity of 393 GW (Central Electricity Authority 2022).

While renewables are important for fostering the clean energy transition and achieving energy independence, they require colossal amounts of investments. To achieve the goal of 500 GW of non-fossil energy capacity by 2030, for example, it is projected that India will need to invest $30 to $40 billion each year in infrastructure (Garg 2022). In this context, it is important that India not allow its energy demand to outpace its goals. To use the analogy of a faucet and a tub, if we wish to fill the tub (achieve energy security through renewables) while increasing supply, we must also reduce the leakage (i.e., inefficiently managed demand) by promoting energy efficiency. One critical step involves improving appliance efficiency standards. In the last six years, the government-owned Energy Efficiency Services Limited achieved significant success when it distributed over 300 million LED bulbs to replace CFL lights, thereby saving 39 million tonnes

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[1] High solar radiation, wind speed, and availability of land to establish utility-scale solar parks make Rajasthan a renewable-rich state in India.

(MT) of CO_2 emissions annually (Energy Efficiency Services Limited 2022). Success at this scale needs to be replicated for the top 10 appliances whose ownership is expected to accelerate significantly in this decade and beyond. These appliances include air conditioners, ceiling fans, refrigerators, TVs, lights, electric water heaters, agricultural pumps, washing machines, and motors. Modelling shows that India's peak electricity demand from the top 10 most electricity-consuming appliances and equipment alone will constitute 200 GW or ~60–70% of the projected total peak demand before 2040 (Abhyankar *et al.* 2017). This is equal to the output of nearly 400 large thermal power plants.

Managing the growth in energy demand—especially during peak hours—would be extremely beneficial to India, including by reducing the investment required for the unabated expansion of non-fossil fuel power, which also runs into the challenge of limited land availability. Furthermore, it helps in managing the challenge of a clean grid posed by the intermittent nature of renewables. At present, to supply consumers with power when renewables are not available, DISCOMs rely on fossil fuel–based resources. One of the most important solutions to a fossil fuel–free grid is battery storage. Despite being a robust technology, grid-scale batteries are not yet cost-competitive in India, leading to a reliance on coal plants, which contribute to air pollution. However, India can easily consider cheaper yet reliable demand-side options or demand response/demand flexibility—including distributed storage and load shifting—to remain firmly on the clean energy transition trajectory.

In the US, utility-administered demand response (DR) programmes play an essential role in lowering peak demand to lessen the chances of blackouts (US Energy Information Administration 2019). DR programmes typically offer customers a financial incentive for reducing energy use during specified hours and help reduce the need to build new generation plants to meet peak power demand.

Another complementary approach is leveraging distributed storage systems. These are small-scale standalone systems such as electric vehicle batteries or small battery systems that can send electricity back to the grid during peak hours to manage reliability. The California Public Utilities Commission (CPUC) recently approved three vehicle-grid integration pilots to manage peak power demand and achieve climate benefits (California Public Utilities Commission 2022). Combined, such comprehensive approaches constitute 'demand flexibility', which benefits DISCOMs, consumers, and the environment.

These demand-side options would remain relevant even when battery storage becomes cost-competitive because they will reduce the extent to which additional power infrastructure, including power plants and batteries, would be needed.

2. EFFICIENCY FIRST

Any path towards a self-reliant India that also addresses energy security and environmental challenges must go concomitantly with 'energy efficiency'. Investing in energy efficiency programmes and managing electricity demand is much cheaper than building new power plants as the cost of conserved electricity through energy-efficient appliances in India is lower than the consumer tariff (Abhyankar *et al.* 2017).[2] Doing so has the potential to save 300 terra watt-hours (TWh) of electricity annually, reducing the peak load by ~80–100 GW, reducing power cuts such as those being witnessed in New Delhi right now (Abhyankar *et al.* 2017). As per the IEA *India Energy Efficiency Outlook* (2016), the power sector is going to avoid producing approximately 875 TWh in 2040, about an $18 billion per year reduction in investment for electricity generation, through improved energy efficiency.

3. CONCLUSION

Around the world, key economies are vying to have a clean electricity grid—one that is free of fossil fuel use—as fast as possible. While India does so, it is also essential to maximise the potential for energy efficiency and decouple economic growth from energy intensity. Adding more renewables to meet India's growing energy demand and replace fossil fuel–based generation is critical to India's sustainable growth; however, a renewables-only approach that ignores energy efficiency will produce reliability-, cost-, and land-related challenges. Additionally, energy efficiency will produce multiple benefits for the nation and the people while addressing concerns arising from India's growing demand for electricity, especially during peak demand periods in the summer months. Energy efficiency is a precursor to India achieving its climate goal, and along with other approaches being prioritised, will help place India strongly on the net-zero emissions by 2070 pathway.

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[2] Energy efficiency measures are considered cost-effective when the cost of conserved energy (CCE) is lower than the price of energy it replaces.

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