OPINION: Building climate-resilient power infrastructure

In addition to adaptation measures, increasing the awareness and capacity of utilities to identify short-term and long-term climate risks, vulnerabilities in systems, and the impact on different points along the power system chain is needed.

- *January 21, 2021*

The rise in temperature, high rainfall variability, and increased frequency of extreme events in recent decades are all evidence of climate change. In India, these trends are projected to worsen—temperature likely to increase by 4°C, frequent heat waves to persist over longer durations, heavy rainfall events to get more frequent, dry spells to extend, and the sea level to increase by about 3 metres by the end of the century.

Extreme weather events in the last two decades have resulted in loss of lives, decreased agricultural productivity, and infrastructure damage. Data from the International Disasters Database shows that during 1998–2017, India experienced an average of 16 extreme weather events resulting in a total economic loss of USD 45 billion, compared to an average of 10 events during 1978–97 with USD 20 billion in losses.

Power infrastructure, which includes assets for generation, transmission, and distribution of power, is vulnerable to manifestations of climate change. Given that thermal power constitutes about 62% of the power generated in India, climate risks to the sector need to be appropriately assessed, with resilience plans put in place. Thermal power plants are vulnerable to increases in air and water temperature (reduced plant efficiency), flooding (equipment damage), and reduced streamflow for cooling (reduced generation). During 2013–17, about 17 billion kilowatt-hours of power generation was lost in India because of water shortage.

Risks to power sector

A study in Karnataka illustrates the range of risks faced by the state’s power sector. While an increase of more than 2°C in the summer maximum temperature threatens thermal plants located at Ballari, Bijapur, and Raichur, a doubling of the frequency of heavy rainfall events threatens the Udupi thermal plant. Moreover, Ballari, Raichur, and Bijapur, which have recorded droughts in the past, are likely to witness heavy rainfall events.

While temperature increase is a direct impact of climate change, it can also have cascading impacts on water availability and water temperature. In 2016, the reduced availability of cooling water forced thermal plants across India to shut down, costing power companies INR 2,400 crore. Invariably, droughts and heat waves coincide and exacerbate the severity of these events, as seen during 2015–16 in Karnataka.

At the other end of the climate change spectrum, incessant rains disrupted power supply in Telangana in 2020. Such power outages due to natural shocks and impacts on quality and quantity of electricity supply and demand due to long-term climate change have also been reported from the US and Europe.

Thus, the exposure levels for distinct natural hazards vary geographically. While extreme events mostly impact the transmission and delivery of power, assets are at risk when sited in zones prone to disasters such as cyclones, droughts, and floods. Further, changes in the nature of extreme events such as those projected for certain drought-prone districts of Karnataka highlight the need for district-level spatial climate-risk mapping for all Indian states.

Why build climate resilience?

Infrastructure investments are usually large and consider historical climate bands for operation. These considerations do not include high-impact–low-probability events, which are increasingly becoming more frequent, resulting in disruption and losses. That around USD 2.5 trillion (at 2014–15 prices) is needed between 2015 and 2030 for implementing adaptation- and resilience-building actions in key sectors in India, including infrastructure, makes it necessary to consider climate and disaster risks in the siting, design, construction, operation, and maintenance of infrastructure.

Since improving the robustness of all power infrastructure can be quite costly, resilience building in infrastructure with likely high exposure to climate hazards is the way forward. This requires data on the probability and spatial distribution of climate hazards, as well as their potential evolution due to climate change at sub-regional scales. Peru's disaster management centre assesses climate hazards and vulnerabilities, and identifies susceptible elements to increase the resilience of public infrastructure at the local level. Similarly, in the UK, a National Infrastructure Assessment is conducted once in every Parliament to outline long-term
infrastructure needs.

Adaptation measures

Adaptation strategies could be broadly categorised as (i) technological, which promote better design, improved standards, and deployment of new technologies, (ii) planning related, which include investment decisions, and (iii) policy related, which span adoption and/or promotion of policy frameworks, incentivisation mechanisms, diversification of the energy mix, and development of insurance mechanisms.

Technological interventions have demonstrated the potential to reduce damage and losses. In New Zealand, hardening of transmission and distribution infrastructure saved the country $30–50 million in direct asset replacement costs. Similarly, in Tonga, grid upgradation brought down cyclone damage to 4.7% compared to 45.9% damage in non-upgraded portions. Some thermal power plants replace the water-cooling system with an air cooling, a dry cooling, or a recirculating system to improve the plant performance during droughts.

While the existing infrastructure requires tweaking in design, operation, and maintenance, new plants require revised planning criteria and methodology to include resilience in design and siting of the asset itself. An example of this is seen in New Zealand, where planning and design helped quicker power restoration after the Christchurch earthquake.

In addition to adaptation measures, increasing the awareness and capacity of utilities to identify short-term and long-term climate risks, vulnerabilities in systems, and the impact on different points along the power system chain is needed. This will help in identifying mechanisms for the costing of climate change risks and subsequent development of ‘green finance’ and other insurance and incentivization mechanisms.

[This piece was authored by Indu K Murthy, Principal Research Scientist, Adaptation and Risk Analysis Team; and Priyavrat Bhati, Sector Head, Climate, Environment, and Sustainability, Center for Study of Science, Technology and Policy (CSTEP)]