We must boost power system flexibility to achieve 500 GW of non-fossil energy by 2030

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Flexibility in generation capacities can be introduced through pumped storage, battery energy storage and reciprocating gas engines to make a resilient power system.

As India aims to achieve 100 percent renewable energy, addressing challenges and enhancing power system flexibility is paramount. Archana Bhatnagar shares her views on the issue in talks with EPR Magazine.

Why is the need for a significant increase in investment in the RE sector?

Climate change is a global challenge, reflected in the growing incidences of extreme weather conditions across many countries. Energy needs are increasing, and simultaneously, we want to limit the amount of fossil fuels due to high carbon emissions. To achieve the climate goals set in the Paris Agreement, renewable energy paired with flexibility is the key to making the power system sustainable. Additionally, renewables have decreased in price and will continue to do so. Thus, utilities are increasingly adopting renewables and hydropower (albeit with some limitations).

Renewable energy has the potential to turn into a baseload gradually, provided the variability and intermittency associated with it can be tackled. However, as utilities invest in renewables, they have begun to realise that their current fleet of traditional baseload generating assets needs to be more flexible to balance and integrate renewables. This, in turn, leads to problems in power system reliability. Ensuring sufficient flexibility alongside renewables for a stable power supply is the biggest challenge associated with renewable energy.

How can India enhance its power system flexibility to meet energy capacity targets?

India needs to ramp up its power system flexibility to meet the 500 GW non-fossil fuel energy capacity target by 2030, a major part of which is solar and wind energy. India's current installed capacity is approximate ~410 GW, of which already ~110 GW (27 percent) is solar and wind, and the share of renewables will continue to grow to reach the above-said target by 2030. This will increase the energy contribution from renewables significantly, and rightly so.

But renewables alone are not enough to deliver the change we need. To enable wind and solar to thrive, we need to build flexible energy systems that are reliable and affordable. Flexible energy systems comprise a robust transmission system, demand side management and flexible generating capacities. While the first two are simpler to decide on, and State and Central Governments are already taking steps in that direction, flexibility in generation capacities needs urgent attention. It can be introduced through primarily three technologies – pumped storage, battery energy storage and reciprocating gas engines to make a resilient power system.

How can the challenges of inflexible power plants be addressed?

For generations, we have relied on traditional, inflexible power plants, such as coal, combined-cycle gas turbines (CCGT), and nuclear power, to provide baseload power for our electricity grids. These traditional power systems now need to adapt, with large-scale additions of solar and wind. In the future, the capacity mix will change, and renewable energy is expected to constitute a significant part of the total energy mix. Running intermittent wind and solar power alongside inflexible baseload power plants, which cannot quickly ramp up and down to match the changing levels of renewable power, can create significant issues, such as instability, unreliability for our power grids, or renewable energy curtailment. As the level of renewable energy increases in the coming years, a large share of these inflexible power plants will face issues of constant cycling, leading to faster wear and tear and eventually becoming uneconomical to operate. Therefore, we need to combine renewables' build-out with a substantial increase in flexible generation capacity, such as grid-balancing internal combustion engines (ICE) and energy storage, which can quickly ramp up and down to support wind and solar power. They help maintain the grids' stability and reliability and ensure maximum absorption of renewable energy.

What is the most cost-effective approach to achieving 100 percent renewable energy?

Through extensive study and simulation of over 190 global energy systems using advanced software, we've discovered that the most cost-effective strategy for achieving 100 persent renewable energy globally involves integrating renewable power with flexible solutions. These include grid-balancing gas engines, energy storage, and pumped hydro plants where possible.

These options provide high dispatchability and adapt quickly to varying conditions. For the final transition to 100% renewable energy, these grid engines can utilise sustainable fuels like green hydrogen, ammonia, or methanol in the future. This combination ensures reliable, low-cost renewable energy, making clean power more affordable.

Wärtsilä and Lappeenranta-Lahti University of Technology (LUT) Finland did a joint power system study, which explored the feasibility of a net-zero emissions power system in India by 2050.