**Power Breakdown in Pakistan**

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February 9, 2023

The government was left scratching their heads when a nationwide power outage occurred. It was the third time the national electric grid had failed since 2021. Globally, Pakistan tops the list of national electricity breakdowns. The list includes Sri Lanka’s national blackout in 2020, and the power breakdown in Southern America in 2019, etc. According to the Minister for Energy, Khurram Dastagir Khan, a variation in frequency between Jamshoro and Dadu caused a ripple effect that led to a complete shutdown. Let’s delve into how the electrical system works, and its frequency, and brainstorm potential solutions and alternatives for Pakistan.

The electrical grid is a labyrinth of power lines that stretches from power plants to consumers’ homes. Power plants are responsible for converting kinetic energy into electricity. They use the kinetic energy from water in hydroelectric plants and steam in thermal and nuclear plants to spin a turbine, which acts like a magnet with a north and south pole. The turbine is surrounded by many copper bars, which pass through the magnetic field and generate electricity that is sent to transmission lines.

The turbine has two poles which are responsible for a direction change in every revolution, which is why the resulting electricity is known as alternating current (AC). Each revolution results in two changes in the magnetic field, but the number of changes per second depends on the turbine’s speed. The number of revolutions or oscillations per second is known as the frequency of the electricity system. For example, a turbine spinning 3000 times a minute has a frequency of 50 hertz. The electricity frequency in Pakistan is 50Hz, while in the USA it is 60Hz. If there is more electricity supply in the transmission system than demand, the frequency will rise and if demand is higher than the supply, the frequency decreases. Any distortion in the set frequency causes damage to the system and can kickstart the domino effect, which affects the whole system and grids start to blackout one by one, like a house of cards falling. This domino effect is due to the synchronization of the AC grids, frequency mismatch from one plant can trip the other generation plants in the system.

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To avoid this situation, frequency control and response measures are installed and employed. Technically, both the supply side and demand side responses are used in this context. The supply-side responses are expansive and technology-driven. The problem which triggered the blackout in Pakistan requires a thorough probe into possible solutions and a way forward.

Firstly, the long-term solution is obviously the upgrading of the national grid, which requires a huge amount of investment in terms of new transmission lines and grid synchronization measures. The role of Private Power Infrastructure (PPIB) will be crucial in this regard, to bring private investment into the upgrading of the national grid and modernized synchronization measures for the power generators based on artificial intelligence and up-to-date practices.

Secondly, the time is ripe to consider unbundling of the National Dispatch and Transmission Company (NTDC) so that the cascading of blackouts can be avoided through the separation of national grids. Furthermore, distributed generation is required to further strengthen the resilience of our electrical system. The concept of distributed generation is based on the construction of electricity generation plants near the area where it is required. This practice not only reduces the system losses and inefficiencies of transmission networks but also the ability to separate the grids through microgrids.

Thirdly, there is a need to establish microgrids in Pakistan so that the cascading effect can be controlled and limited to the faulted area. A microgrid in an electrical system is a self-sufficient energy system that transmits and distributes electricity to isolated and discrete geographic areas. The significance of a microgrid is enormous for strategically important electricity consumption units such as hospitals, airports, railways, and other institutions. The recent National Solar Energy Initiative which targets the generation of an additional 10000 Megawatts of solar power is a good testing ground to establish microgrids powered by solar power in Pakistan.

Lastly, for the consumers, the power breakdown is a wake-up call to invest in self-sufficiency and resiliency. In case of a power blackout, the alternatives included diesel and petrol generators, these alternatives are not suitable not in terms of widening trade deficits neither in their environmental adverse impacts. The answer to this dilemma is the investment in rooftop solar and power storage options. So that in future, green and economically sustainable alternatives can be used in times of such crises.

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