ICSC
Institute for Climate and Sustainable Cities

POSITION PAPER

on Grid Reliability and System Flexibility

Reliability is Defined by System Flexibility

In ensuring a reliable power grid, the focus must be on the system as a whole, not on individual power plants. A reliable grid is defined not by whether solar panels produce at night or whether coal plants run 24/7 but by how well the entire network can adapt to constant change. Electricity systems are built to manage variability, yet outdated perceptions still regard it as an anomaly to be avoided despite the fact that variability is both predictable and manageable at the system level. The Institute for Climate and Sustainable Cities (ICSC) emphasizes that power system reliability is fundamentally about flexibility. Building a grid that thrives amid natural fluctuations is the key to a more secure, reliable, and affordable energy future for the Philippines.

Grid reliability is a system-wide challenge shaped by variability from all resources, not just renewables. While solar and wind generation is often singled out for its weather-dependent nature, this perspective overlooks the inherent fluctuations that are a normal part of any grid's operation.

Electricity Demand Is Variable and Requires Constant Balancing

Electricity demand is itself inherently variable, shifting hourly, daily, and seasonally because of weather, human activity, and economic conditions. In the Philippines, temperature-driven cooling loads heavily influence peak demand while holidays or sudden economic shifts can cause sharp drops. These variations require constant balancing regardless of the generation mix.

> *Example:* Large facilities, such as malls, commercial buildings, and factories, can cause sharp, sudden swings in demand when they start up or shut down. Major air-conditioning loads are a prime example. Power systems are already built to manage such everyday variability using their existing flexibility, demonstrating that balancing real-time supply and demand is a normal part of grid operations.

Conventional Power Plants Can Also Be a Source of Disruption

At the same time, conventional power plants are not immune to fluctuations. So-called baseload units are expected to provide stable output, but in practice, they experience forced outages that have become more frequent in recent years. Coal plants, in particular, are increasingly prone to forced outages as the overcapacity of rigid baseload capacity forces them to cycle more frequently, often on a daily basis. In 2024, 171 forced outages

in coal power plants were recorded. These outages, which often occur at unpredictable times, add to system variability and are more disruptive than renewable fluctuations, particularly when large units trip or go offline. By contrast, solar and wind power plants recorded only 13 and 10 forced outages, respectively, in 2024.

> *Example:* If a 500 MW coal plant suddenly trips offline, the system must immediately adapt by calling on the next-in-line plants in the merit order. Quick-start generators, such as diesel power plants, must provide power on demand but at a higher cost, thereby raising prices across the system until the outage is resolved.

Renewable Energy Is More Predictable and Manageable Than Commonly Assumed

In reality, variable renewable energy output is more predictable and manageable than commonly assumed. When solar and wind generation is aggregated across multiple plants and locations, variability is smoothed, and uncertainty is reduced, consistent with the law of large numbers.

> *Example:* If a cloud passes over a single solar farm, its power output dips. However, if solar panels are distributed across a wide geographic area, clouds are unlikely to cover every site at once; thus, the total power delivered to the grid remains stable and predictable. Even in the case of a widespread weather event that affects many sites, such large-scale shifts are generally predictable hours or days ahead, giving the system time to prepare and adapt ahead of time.

Solar follows a clear daily pattern, and wind's variability can be managed with better forecasting and geographic diversity. Therefore, the main challenge is integrating them into the system, not that they are inherently unreliable.

System Reliability Depends on the Grid as a Whole, Not on Individual Generators

The goal of any power system should not be to eliminate variable resources but to build a flexible system that can thrive amid this natural variability. System reliability does not depend on any individual generator operating continuously for 24 hours. Instead, it depends on the grid's ability, as a whole, to meet demand at all times despite these sources of variability.

Hence, reliability comes from the right energy mix. Our current mix, reliant on ~60% imported coal, lacks this much-needed system flexibility, which contributes to recurrent high prices, exposure to global fuel volatility, recurrent grid alert levels, and sometimes even blackouts. By integrating a diverse portfolio of resources,

including variable renewables, storage, demand-side flexibility, and flexible conventional plants, the system can reliably supply electricity without interruptions even if individual units have a certain level of variability.

The Way Forward: Building a Flexible System

The lesson for the Philippine power sector is clear: all resources, whether renewable and conventional sources, introduce variability. The key to reliability is not avoiding variability but managing it with a flexible system. This undertaking requires the following:

- Improved forecasting and operational planning
- Adequate ancillary services and reserves
- Demand-side measures that allow consumption to respond to system conditions
- Strategic investment in fast-ramping generation, energy storage, grid modernization, and stronger interconnections

Ultimately, reliability for the Philippines will come from the transition toward a more flexible, diverse, and modern system—one designed for the realities of an archipelago and a changing energy landscape.