The Intermittency Bogeyman

Unfortunately, due to the large sums of money involved in energy infrastructure development, related public funding, and the heavy influence of government regulation on electricity markets, the subject of electric power systems has been politically and socially polarized. Threatened by the disruptive nature of renewable electricity, unsurprisingly, legacy market gatekeepers and their lobbyists manufacture misleading narratives to sway political and public opinions. In our guide, "Managing Solar Energy - Fundamental Science to Practical Systems", we try to provide an objective basis for assessing how different types of power generation are beneficially integrated for sustainable and universal electricity access.

For years, the leading narrative against the widespread adoption of renewables, in particular solar photovoltaic (PV) power, was that it is too expensive. The narrative fell apart, sooner than the market incumbents would have liked, as PV prices sharply dropped below the competition. It was quickly replaced by another antagonistic narrative about the intermittency of renewables. The main arguments are that renewables cannot operate 24x7x365 like conventional power plants, destabilize the grid, and even though PV projects might seem cheap, there is a grid system-wide effect of increasing electricity costs.

The problem with this line of arguments is a false premise: no type of electric power plant can operate 24x7x365. Even a perfect nuclear power plant cannot perform this feat, as the plant has to refuel offline for one to two months after about every eighteen months. Further, real-world nuclear plants are prone to sudden, unexpected power outages. As the plants age, the maintenance periods prove to be much longer than expected. Detailed citations of supporting facts are presented in the guidebook. The "intermittency" tag was largely replaced by "variable" electricity generators for renewables, though some persist with the older pejorative term. Renewables are indeed variable generators, in that the power output depends on the variability of weather conditions. At the point of consumption, the consumer does not know where the kWh electricity unit came from – it is indistinguishable, whether from a PV or fuel-based power plant. What matters to consumers is the variability in the price and availability of the kWh for when they need it. Since there is no variable fuel cost involved in PV generation, the marginal production cost is essentially zero. As a result, the underlying price variability is much less than that of fuel power. There is no risk of fuel price shocks or related inflationary pressure.

PV systems have contractual obligations of > 98% guaranteed availability. The kWh output however varies depending on the solar irradiance and ambient temperature. Part of the variability is predictable, e.g. no one expects solar power at night, and priced into the solar electricity purchasing. Conventional power plants have predictable variability as well, e.g. for maintenance schedules, that is factored into the pricing. Solar PV plants are not taken offline for the lengthy maintenance periods, necessary for nuclear or fossil fuels, and do not suffer from long, unexpected power outages. Redundancy and a diversity of backup power sources are planned accordingly, for solar or conventional power plants, to ensure uninterrupted power supply to the consumer. Over the long run, the solar resource is highly predictable with a fraction of a percent for lifecycle standard deviation. It is the short duration unpredictability, from the effects of aerosols, water vapour, and clouds in the sky that requires careful attention.

A quantitative analysis in our guidebook shows how this unpredictable short timescale variability can be reduced to grid tolerances by geographic distribution. The greater the number of spatially distributed PV plants in a load balancing area, the lower the aggregated unpredictability. There will be some residual uncertainty, in particular from severe weather conditions. All types of power plants are affected by the weather to varying degrees. Nuclear or fossil fuel thermal power plants are often dialled down or taken offline in unusually hot weather, when the cooling requirements can no longer be met.

The residual uncertainty can be removed by coupling pumped hydro or battery energy storage systems (ESS) to PV power. These PV-ESS systems are precisely controllable for multifunctional grid support to dramatically reduce system-wide costs. The grid becomes more flexible and resilient. Since neither PV nor ESS suffer from any unpredictable fuel input costs, the pricing of the energy output is stable. As for PV, the ESS costs have plummeted with economies of scale. Round-the-clock, economical, and flexible electricity from PV-ESS is a growing trend. This potent combination offers minimum variability in expected power output and market prices to consumers.

