On technology transfer and utility-scale power storage

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Vietnam's recent energy transition experience shows that grid congestion issues limit how fast a country can turn to solar PV and wind power. Utility-scale battery storage could alleviate problems by time-shifting the variable electricity production, deferring the urgency to upgrade the transmission network. However, the technology is hardly bankable now in low- and middle-income countries. We propose that forming a collective of transmission network operators may accelerate access to this technology.

Historical experience with the energy transition shows that installing lots of solar and wind generation capacity often leads to a curtailment problem. This problem is worse in developing countries, who find it difficult to expand their transmission network as fast as would be required. Constrained by the prospect of wasting much of the clean electricity produced during the windiest and sunniest hours, renewable energy policies are less ambitious. The grid expansion speed is a factor limiting a fast energy transition.

For example, Vietnam was able to install over 16.5 GW of PV capacity between 2018 and 2020. That saturated the transmission network in the southern provinces. In the first four months of 2021, the network operator had to curtail 13.3 % of solar (447.5GWh) and 4.8 % of wind production (19.7GWh)[1]. The practical answer has been that the next five years power development plan focuses on LNG[2].

Access to utility-scale electricity storage alleviates the curtailment issue. Storage de-couples the problem of installing solar and wind generation capacity from expanding the transmission network. Building hybrid solar + storage projects is not only a popular replacement option for diesel and gas turbine power generators in off-grid systems. More and more investors are starting to build hybrid solar + storage generation projects for the grid. For example, the 2.2 GW Huanghe Hydropower Development farm, completed in September 2020, includes 202.8 MW/MWh of storage capacity[3].

The market for battery storage is developing fast. Fortune Business Insights[4] found that « The global battery energy storage market size stood at USD 7.06 billion in 2019 and is anticipated to attain USD 19.74 billion by 2027, exhibiting a CAGR of 20.4% during the forecast period. » According to IEA Sustainable Development Scenario[5], the annual average energy investment in Battery Storage should increase by 855 % in ten years: from 3.235 billion dollars (2019) per year over 2015-2020 to 27.669 billion dollars per year (2019) over 2025-2030. However, lower-middle-income countries are only starting to integrate battery storage technology in their energy policy plans. In Vietnam, for example, the government briefly considered giving a preferential FIT to hybrid solar PV projects integrating 2 hours of storage at 25 % of capacity before dropping the idea (Draft decision 11 update, issued 25-02-2019 by MOIT).

Battery storage technology started to deploy at the top-end of the market because the less developed countries did not offer conditions to realize the value proposition of storage projects. Financing storage by arbitrage between the low and high prices periods requires a power market with spot pricing. Financing storage by fast-response ancillary services requires an ancillary services and frequency control market. Financing storage by time-shifting around curtailment hours requires a high electricity price and low battery costs.

Admittedly, the organization of the wholesale electricity market is not a simple function of a country's wealth. However, more complex power market structures require more capacity from the regulating agencies, which is more likely to be found in advanced economies. Vasigliasindi et Besant-Jones[6] found that « *a dichotomy emerges between high income countries characterized by a large system size for which unbundling and other reforms are significantly linked to better performance and low income countries characterized by small system power size for which there is no strong evidence that unbundling and other reforms delivered improvements in performance.* »

The value of time-shifting batteries to answer curtailment is driven by the value of electricity otherwise wasted. It depends on price and the severity of curtailment: how many days per year, for how many years. Consider a typical 50 MWp early solar power project in Vietnam from 2019. It receives a feed-in tariff of 9.35 of UScent/kWh for 20 years. As the Vietnam standard power purchase agreement stipulates, it does not receive payment when curtailed. There is no ancillary services market or congestion hours pricing, so battery storage at the PV farm can be motivated only by time-shifting or obligation.

The government considered the two hours of storage / 25 % capacity clause, which meant a 12.5MW/25 MWh system for a project like the one above. Typical storage modules pack two to four MWh in a twenty-foot container, so 25MWh amounts to less than a dozen modules. In 2019, systems this size were at the technology frontier and not ready for mass deployment in Vietnam, and the government dropped the clause.

One 25 MWh battery cycle at 9.35 of UScent/kWh would be worth 2 337 USD. According to the Vietnam Technology Catalogue[7], the capital cost for a 2-hour Lithium-Ion battery energy storage system will be around 0.7 $MUSD_{2019}$/MW in 2022. For a 12.5 MW size battery, it amounts to 8.75 $MUSD_{2019}$. Assuming O&M costs 1 USD/kWh ([7] quotes a range of 0.3 – 5 USD/kWh), they amount to 25 kUSD per year for the example system. There is a need to cycle the battery 3744 times, or once every day for 10.56 years, to cover the capital costs. The investment is not bankable, especially since curtailment will not happen every day for ten years.

As the cost of battery storage declines, fossil-fuel-based generation is less and less competitive with variable renewable + storage. At some point in time, this will happen even in countries where a weak power transmission infrastructure hinders the competitiveness of renewable energy. The Vietnam Technology Catalogue finds that storage costs may drop in 2050 to 0.20 $MUSD_{2019}$/MW. In our example, the investment return period would be three years, interesting for a private investor. However, the switch point may be more than ten years away. The Technology Catalogue forecasts storage costs to be 0.40 $MUSD_{2019}$/MW in 2030, which makes the return on investment duration larger than six years under our example, with best-case assumptions.

Utility-scale power storage is a crucial energy transition technology for low- and middle-income countries. We have shown that it remains expensive. The urgency to limit climate change requires asking how to accelerate the diffusion of this technology.

The Climate Convention has recognized the need for technology transfer measures to support countries from the South in the energy transition. To the best of our knowledge, the UNFCCC Technology Mechanism[8] has yet to support energy storage. In the case of Vietnam, the Climate Investor One fund, supported by the European Union, the Green Climate Fund, USAID, the Nordic Development Fund, and other donors, has invested in two wind power projects without storage. The projects may be profitable, but the impact is small because private investors finance 142 other similar projects.

Multilateral development, climate diplomacy and climate finance offer many possibilities to organize an accelerated uptake of utility-scale power storage in countries from the South. To start further discussions on this subject, what follows proposes a vision of an organizational arrangement in that direction.

The organization could be an alliance between transmission network operators (TNO) in receiving countries. A climate impact financial institutions collective could sponsor the alliance, which would form within an existing regional TNOs network. The intervention logic would be to capture the storage value from generation and transmission investment deferral or reduction[9]. The estimates above show that the economics are not there yet for private project investors. For infrastructure, however, long payback periods are more acceptable.

The organization could lease its members storage-as-a-service solutions to facilitate the learning curve for new adopters. Storage is a modular technology; it can be installed or removed in a few months. For TNOs, the decision to conduct a short term reversible trial is easier to take than committing to buying a new kind of asset. The organization would also provide vendor-neutral technical advice.

Collective action would make access to storage cheaper. Size gives bargaining power to negotiate quantitative discounts with hardware providers. When a member TNO does not need the assets anymore, the organization could move the batteries to another place. Reversibility reduces the risk that solving curtailment creates stranded assets. Finally, the organization would have access to capital at favourable rates by having rapid measurable emission mitigation benefits, in addition to facilitating long-term energy transition policies.

In conclusion, grid congestion headaches will continue to limit the speed of the transition to variable renewable energy sources, at least for ten more years in developing countries. However, unless wind and solar become the backbone of *all* countries' energy systems within the next ten years, the world is condemned to dangerous levels of climate change. The Paris Agreement requires to accelerate the access of all countries to utility-scale power storage technology.

References

1. Nguyen H. K. Những thách thức của nhà đầu tư điện gió và đề xuất chính sách phát triển cho Việt Nam | Tạp chí Năng lượng Việt Nam (Défis des investisseurs éoliens et recommandations de politique de développement pour le Vietnam). *Năng lượng Việt Nam Online* (2021).

2. Ha-Duong, M. *Decentralized renewable energy broke Vietnam's power planning logic – Viet SE*. 18 https://vietse.vn/en/publication/decentralized-renewable-energy-broke-vietnams-power-planning-logic/ (2021).

3. Bellini, E. World's largest solar plant goes online in China — 2.2 GW. *PV magazine USA* (2020).

4. Fortune Business Insights. *Battery Energy Storage Market Size, Share | Global Report, 2027*. 240 https://www.fortunebusinessinsights.com/industry-reports/battery-energy-storage-market-100489 (2020).

5. IEA. Annual average energy investment in power in the Sustainable Development Scenario. *IEA, Paris* https://www.iea.org/data-and-statistics/charts/annual-average-energy-investment-in-power-in-the-sustainable-development-scenario (2020).

6. Vagliasindi, M. & Besant-Jones, J. *Power market structure: revisiting policy options*. (The World Bank, 2013).

7. EREA & DEA. *Vietnam Technology Catalogue 2021 - Input for power system modelling Nam*. 200 (2021).

8. Technology Executive Committee. *Innovative approaches to accelerating and scaling up climate technology implementation for mitigation and adaptation*. 44 https://unfccc.int/ttclear/innovativeapproaches (2020).

9. Mallapragada, D. S., Sepulveda, N. A. & Jenkins, J. D. Long-run system value of battery energy storage in future grids with increasing wind and solar generation. *Applied Energy* **275**, 115390 (2020).