An article on why grid-scale storage penetration increases in the next 10-20 years

Renewables (especially PV solar and wind) energy contribution by percentage is increasing lately[1]. Because renewables are cost-competitive with conventional fuel. And various states have Renewable Portfolio Standards[2] (RPS) which most if not all utilities have met or exceeded. And states like New York have Clean Energy Standard that calls for 70% of New York's energy to come from solar and wind by 2030[3]. This increased renewable production has caused more non-inertia-based generation on the grid. Leading to increased grid-scale storage because the grid needs are also increasing from short-duration 2/4/6-hour storage to more long-duration 8/10/12 hours of storage. This increased renewable production is my first leg of the stool to stand on to say that the grid needs storage.

Hence if Lithium-Ion battery is the "go-to" guy for the storage industry today, in the next 10-20 years, it might be time for flow-based battery or storage technologies that are long-duration, higher density and cost-effective. On the last point of cost-effectiveness of storage, the only thing that's stopping or slowing this transformation towards more storage right now is the current price of natural gas at $2-4 per MMBtu. Once natural gas increases at say more than $8 per MMBtu – you see more grid-scale storage being cost-effective. This natural gas price is my second leg of the stool to stand on.

We don't think about it but – there is some relationship between crude oil and gas at the pump[4], which I am using as the third leg to stand on to say that, with the increased price of gas at the pump, electric vehicles and hydrogen storage become more economical. If you think I am crazy talking about hydrogen storage[5], read this statement from Xcel Energy CEO Ben Fowke[6]:

"The federal research agenda should also encourage the development of hydrogen and other power-to-gas technologies that have the potential to link renewables and other sources of clean electricity to the rest of the economy and dramatically increase the amount of energy storage capacity in the nation."

Increased renewable energy production, price of natural gas, and the relationship between crude oil and gas at the pump are the three legs of the stool to make the argument that the grid needs storage. But that is not the only reason.

I jumped to the "why" grid-scale storage increases without explaining the "what," so, let me back up for a bit. Energy storage is like the "holy grail" of the electricity network. Unlike natural gas or other commodities – electricity cannot be stored in large quantities. You must balance supply and demand in real-time hence, if you are an electricity producer – you end up producing only when there is demand.

Now, enter renewables like PV solar and wind into the picture. They are variable. There are exceptions to this, like on a cloudy day, there is minimal solar energy production, and on a windy day during day time, there is a lot of wind production. But remember – supply and demand must be balanced. So, what ends

[1] https://www.eia.gov/todayinenergy/detail.php?id=38752#
[2] http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2019/07/RPS-CES-June2019.pdf
[3] https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard
[4] https://www.stlouisfed.org/publications/regional-economist/october-2014/rockets-and-feathers-why-dont-gasoline-prices-always-move-in-sync-with-oil-prices
[5] Did you know one tank of hydrogen in a car equals 350 miles?
[6] https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=953DD5A9-EB18-49CC-B7E7-FCD9FDF44CC4

up happening is if there is too much production of wind and solar when there is no demand or less demand – that excess renewable energy is "curtailed." Instead of curtailing some countries in Europe are generating hydrogen using electrolysis[7] (you split the water molecules by the direct current generated from the renewables into oxygen and hydrogen).

Well, why don't we store this excess renewable energy? We can and until recently we can only store small quantities in batteries that too mostly Lithium-Ion batteries. The grid always had hydro energy and flywheel technologies. But we are here in the industry talking about grid-scale storage due to Lithium-Ion batteries only. And that's because of rising consumer demand on electric vehicles. And why are consumers demanding more electric vehicles – because they don't want to be the cause for tail-pipe emissions from their cars? And let me tie this back to the hydrogen storage prospects I mentioned earlier. With the high price of gas at the pump (I established there is some correlation there by believing the Federal Reserve economist research), there is a reason to believe – more electric or more non-fossil-based fuel is cost-effective.

I explained why and what. So, let me explain the "how" – how I think more grid-scale storage occurs in the next 10-20 years? Let's go back to that concept of "inertia" in the electric system. Every large fossil-based unit on the grid provides a service to balance that supply and demand. Remember I said electricity is balanced in real-time? Conventional fossil units supply this grid balancing service. And with more conventional units retiring or being un-economic, plus renewables do not provide built-in inertia[8] – The grid needs more storage, which can provide balancing services. Why do renewables not have inertia? Because no significant moving parts are creating that spinning mass. See excellent explanation below[9],

"*The large, rotating turbines in these base-load units create spinning mass, which contains kinetic energy known as inertia. Inertia is the momentum and energy built up in the turbines that resist changes due to changing loads by adding to or absorbing energy from the system*."

Also, renewables are generating direct current (DC), not alternating current (AC). Our appliances at home run on AC, not DC. So, what ends up happening is, if we take that solar production on my garage roof as an example – that direct current gets converted into alternating current by an "inverter."

With a lack of inertia on the system and more inverter-based systems – there is going to be an increased need for grid balancing services, which storage can provide. Storage can quickly provide balancing supply and demand services on an "as-needed" basis in seconds, minutes, and hours. And I am thinking with more renewables on the system; there is an increased need for more than 2/4/6 hours of storage, somewhere in the 8/10/12 hours of storage. Hence, if you believe there must be more renewables on the system in the next 10-20 years – then, my line of sight says, there is a need for more storage on the system.

[7] https://www.nrel.gov/hydrogen/hydrogen-production-delivery.html
[8] New rules for large generator interconnections from FERC mandate reactive power requirements
[9] Federal Energy Regulatory Commission (FERC) Reliability Primer