A CALIFORNIA ELECTRIC ENERGY UPDATE

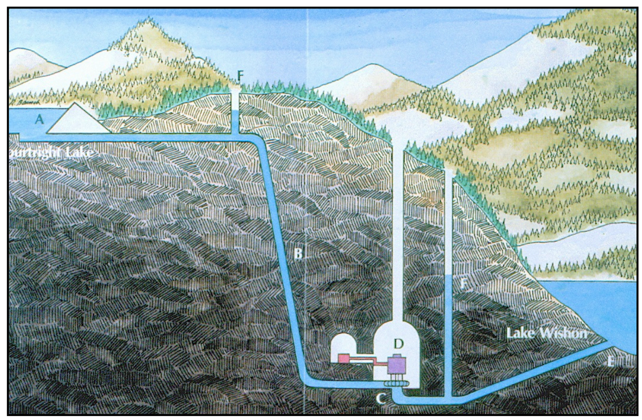
(Utility Electric Generation with Renewables)

Blog #92 CaliforniaGeo 5-26-23

Despite plenty of continuing pressure and lobbying by some business and ideological interests, there is a continuing march to utilize electric energy in every way possible to eradicate carbon emissions. ***Electrification*** is both a catch-phrase and a policy, and it's reached the nation's electrical utilities. Can policy priorities turn the tide on carbon when that tide comes from powerful interests for maintaining the status quo or to only tinker around the edges of the problem? Possibly (or probably) yes, The timetable for this is the least certain, because the available time to oppose climate change is shrinking. (See **Hoboken v. fossil interests**.) The nation's electric utilities will continue with a central role in distributing electricity—one that will increasingly involve renewable sources.

The decades-old prescription for electricity availability was to build and maintain large, base load generating stations that ran close to 100% of the time—something referred to as a "high load factor" that was sought for financial efficiency. The growing problem with that approach was that customer consumption did not equal the fixed output of those base load generators (and in those days there was no storage except for a bit of hydro hold back, utilized for a period of peak consumption).

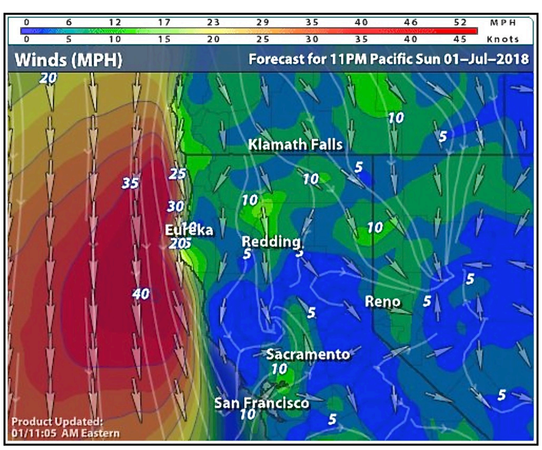
Where possible, hydroelectric resources were developed for "pumped storage," making use of two-way pump/generators that could bank a hydro resource uphill to temporary storage during grid surplus periods, allowing for it to fall-back on command to generate power during the peak.



The 1,200 megawatt facility at right is on the western slope of the Sierra at over 8,000 feet, so it gets dependable water recharge. Many other pump storage facilities face periodic low water access, and droughts can take away the usefulness of this technology. Part of the reason for this Helms Power Plant (at right) was to take post-peak capacity from that utility's Diablo Canyon nuclear plant. This better utilized full capacity generation to build a hydro "reserve" to fight peak grid usage on the following day. Consistent use of this method helped the utility to rely a bit less on smaller gas-fired "peaker" plants to satisfy peak grid demand.

Cost and Stability of Renewable Electric Resources-

Generally, electric generation by renewables produces energy that's a bit more consistent than drought susceptible hydro resources. But it is still a daytime only (solar) or fickle intermittent resource (onshore wind) that cannot be predicted other than a few days in advance. Offshore wind offers better consistency.



The recognition of increased importance that's connected to renewable generation is that it's always FREE, once the infrastructure to capture it is in place. Foreign or domestic market scheming cannot alter this fact. The public increasingly recognizes that renewables won't emit carbon, and they are far quicker to site, permit, and build. As renewable technology has improved, it has simultaneously fallen in cost. This makes it increasingly attractive against conventional power plants.

Utilities can locate renewable generation at current or future choke points on the grid, perhaps requiring fewer miles of upgraded supply lines to customers or upgraded substations. Increasingly, such renewable generation is being matched with **industrial-scale battery storage** that can help shave peaks and/or adequately supply power after sundown. Response time for the conversion of DC battery storage to useful grid energy is the quickest of ANY generating resource.

These combined advantages from renewables helps to push them to the bottom of the 20-year measure of **Levelized Cost of Energy**. This is the standard metric for the planning and analysis of new generating capacity that utilities are always concerned with. It combines the cost to build each particular generation technology with its maintenance over time, against the amount of power it can produce over a 20 year period. With renewables, there are no emissions, no imported fuel, no consumption of water, no boost to local humidity or fog, and no noise.

L. C. O. E.
Levelized Cost of Energy per Kilowatt hour (over 20 years)

(Equals)

SUM of costs over lifetime (in $)
÷
SUM of electrical energy produced over lifetime (in Kwh)

From Wikipedia, 2019

Until recently, calculation has been available that would include the societal cost of damage from climate change and reduced human health in the case of carbon emitting generation methods. These costs are significant and their inclusion in policy planning has just begun, such as municipal and state jurisdictions who elevate decarbonization to a priority. One Stanford University researcher theorized that the savings from less respiratory health treatment alone could pay for the conversion to carbonless renewables' build-out by 2050. A 2015 video of his presentation to a Zero Net Energy audience is available **HERE**.

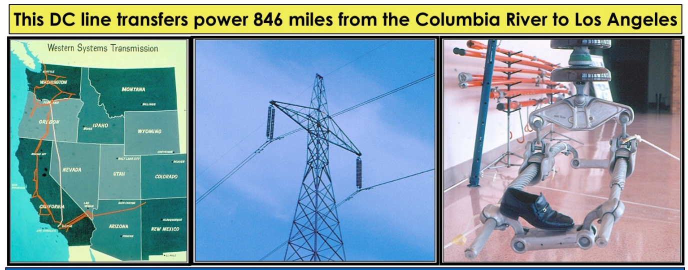
Distribution Challenges-

It's one thing to generate electric power by cost efficient or renewable means. It's quite another to send it where it needs to go to serve an increasing number of customers. This is akin to a fixed number of lanes on the Interstate for an increasing number of vehicles. More can be accommodated only if they narrow their separation and/or travel at a higher speed.

Primary electric utility conductors operate at high voltages which reduces their power loss. But greater distances between generation and high consumption has its limits. In the business of industrial scale renewables, these distances are increasing. Local battery storage at large wind farms in Wyoming with a standard-sized AC export line to Las Vegas and southern California will not help. Highest voltage (and lowest power loss) is possible only by the transmission of DC (direct current) power. New lines are close to construction, and the one called the Kansas Grain Belt Express is planned to take bountiful wind power from the midwest to the eastern seaboard's grid.

Long distance DC transmission has high capacity to move electricity, but is dependent on converter stations at both ends to convert AC to DC for transmission, and DC back to AC at the other end. There can be no branch circuits, so this is an all-or-nothing export. It was pioneered in the 1960s between the Columbia River's hydro and the City of Los Angeles.

This DC line transfers power 846 miles from the Columbia River to Los Angeles



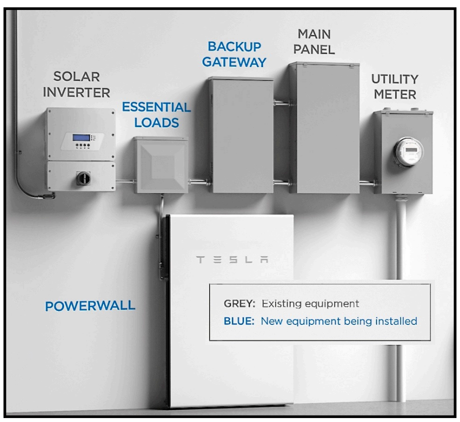
Completed in 1969, the Pacific Intertie carries 3,100 amps at 1,125,000 volts

DC transmission has its benefits, but the only systems that can helpfully share *between* regional electric systems must be based on AC current. With the increased focus on shared electric markets, surpluses and shortages can be traded back and forth between regions that lag daily capacity in their highest summer loads, or where localized heat waves exist for a few days. The ability to trade potential excess to neighboring grid systems lowers the overall cost compared to isolated regional systems. And with long distance DC power to help, some of its converted AC power can head for local grid batteries or be pushed out on the line for help with the peak. The (very independent and isolated) Texas grid is the poster child for **multiple grid emergencies by which its citizens suffered.**

Other Electric Generating Renewables-
The use of high temperature "Geothermal" steam powers another carbonless renewable source of electricity. The usual fossil-fired steam boiler is replaced by a direct connection to pressurized steam resources from under ground. This is used to power a turbine generator.

These sources are randomly distributed and usually away from population centers, but they are too good to pass up—particularly as decarbonization policies expand. The best ones are already tapped, but high electricity prices are making the widely distributed marginal sites more attractive. These act as 24/7 base load facilities and the largest ones boost the need for electric storage systems.

Non-Utility Distributed Generation—
Every time a rooftop solar project is part of a new building or an addition to an existing one, this electrical generation for consumption is as local as it gets. And when such solar PV installations are attached to large or small battery systems, they can serve up local power reserves during the peak or during outages. These factors potentially reduce the need to upgrade the transmission capacity of approaching high voltage lines and the substations they supply. It is a big infrastructural savings if power can be generated adjacent to where it is being consumed. The question arises as to whether the customer incentives for this are adequately attractive and whether they will last.



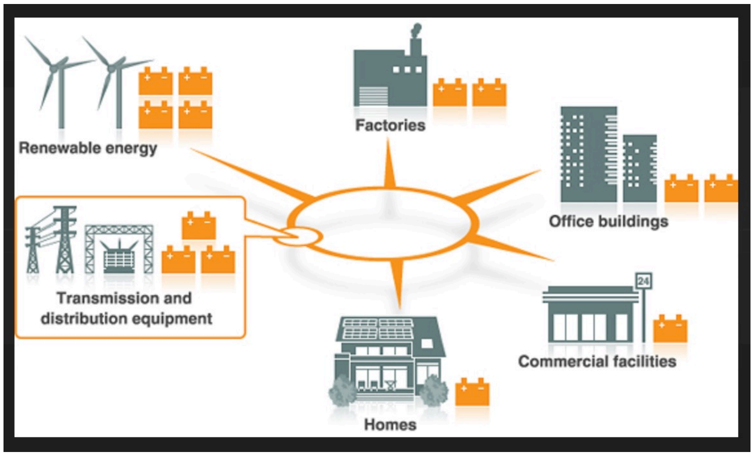
Until the residential power wall concept (at left) became marketed at scale, the only way to store locally made residential solar power was in lead-acid batteries. Those require fluid maintenance and good ventilation to export gas emissions, which Lithium-ion batteries don't require.

The power wall design has also become more popular with the increase in home charging of vehicles containing batteries, and a new technology called V2G (vehicle-to-grid) is being tested by Florida Power & Light using Ford F-150 Lightning pick-up trucks.

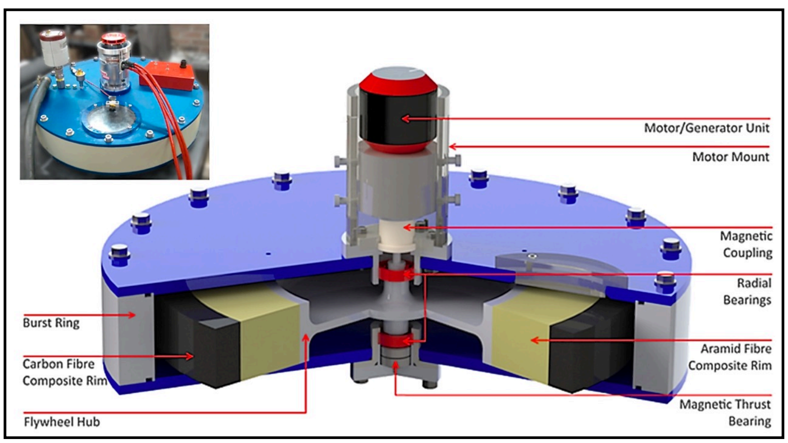
V2G means that power can be sent to or from a home or workplace parked vehicle, depending on time-of-day power pricing and a vehicle owner's preference to sell back custom amounts of power. Those owning big vehicle batteries and not anticipating long trip needs could charge when it's cheap and sell back for some extra utility credit. This includes drawing from or re-filling their home battery systems. Increasingly smart controls make this possible.

Other Storage Systems for Electricity-

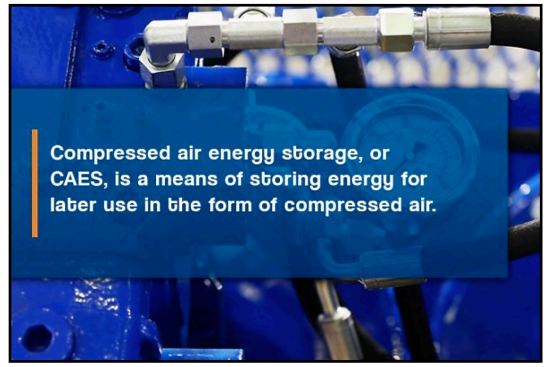
There is growing concern about Lithium-ion battery types due to raw material availability and cost. Their use is growing by use in cordless tools and electric vehicles. Lithium systems comprise most of the utility-based storage systems across the U.S.



That's why alternative storage methods for utility-scale storage are popping up. Among them are kinetic momentum devices called *flywheel storage* where electric motors spin medium or large mass wheels to high rpm. The discharging kinetic energy is used to spin the electric motor to generate current back up the conductor that originally supplied it. It's not too much of a stretch to understand this being like *regenerative braking* in an electric car. In that technology, braking resistance against rolling forward is translated to a generator that puts DC electricity back into the car's battery system.



Another new electric storage technology is to use compressed air. Spare electricity powers a high pressure air compressor that delivered to strong storage tanks. When desired, that compressed air (under controlled release) is used to spin a vaned turbine that makes electricity.



With expansion to greater installations, the cost of both flywheel and compressed air storage will be reduced. The technologies are established. Refinements for how they are constructed and manufactured will lead to improvements and lower costs. Again, there is no carbon consumption with these methods, the technology is portable, independent of necessary water, and involves no chemical reactions as in batteries.

As is the case with a number of renewable electricity generators, these storage systems can be “right-sized” to match a designed surplus from a solar, wind, or hydro facility so that the storage system provides the most efficient utilization of that surplus to be sent back to the grid on command.

Though the proportional causes of this march to decarbonized electricity are not precise, it is certain that a combination of climate change fears, new regulations against carbon, and higher electricity prices has made them possible.

—Bill Martin