ERCOT 2022 System and Alternatives for Fossil Fuel Elimination

By Eugene Preston July 5, 2022

These spreadsheets have energy storage using this methodology: https://egpreston.com/ExcelStorage.pdf .

https://egpreston.com/ERCOT22A.xlsx has the historical ERCOT 2021 hourly load, wind, and solar profiles per unitized. The historical demand is normalized to 1 per unit for the annual peak MW load. Historical wind and solar are normalized to the MWs divided by the installed capacity for each hour. ERCOT conveniently lists all this data in a single file which is referenced as VER data in the assumptions of the spreadsheets. Storm Uri's last 100 hours is normalized to a constant demand of about 67 GW. In this ERCOT22A file resources are added in 2022 to match what is installed in ERCOT going into the summer period. The load is set to 78 GW summer peak and 67 GW peak winter. Wind icing is retained in the 2021 wind data although gas is treated as reliable in 2022 which is an idealization for the gas reliability and the assumption wind cannot afford de-icing add on equipment. This system is found to be reliable if the weather isn't too extreme and natural gas is plentiful.

https://egpreston.com/ERCOT22B.xlsx is a balanced 40-40-40 resource plan with 40 GW each of wind, solar, and nuclear and 3263 GWh battery storage. This amount of storage allows this case to be fossil fuel free however the annual average energy cost is a whopping 35 cents per kWh because the battery costs a trillion dollars. The battery could be sized much smaller but then gas capacity would be needed to serve the storm Uri demand. If the battery storage is eliminated then natural gas fills in with a need to have 26.3 GW gas with capacity factor of 3.62%. Since this gas would run so infrequently it most likely would need to be emergency startup capacity that would only be used for extreme emergency events. Its not unlike homeowners installing gas generators at their homes and hardly ever needing them. Case 22B has the problem that adding 40 GW nuclear throws the wind and solar utilization out the window even if a lot of storage is added. This shows that just adding nuclear base load generation to a system may not result in a very well designed system.

https://egpreston.com/ERCOT22C.xlsx is an interesting application of Charles Forsberg's nuclear and thermal energy storage concept described in this draft paper https://egpreston.com/CRUSH.doc. The 25 GW of base loaded nuclear thermal energy goes to storage and powers 61.2 GW of electric generators from the 5,500 GWh of thermal storage. The plan is optimized at 30 GW wind and 58 GW solar with an energy cost of 11.3 cents/kWh. In this modeling nuclear base loaded is turned into peaking fast response generation replacing the role gas generation currently plays. Case ERCOT22C has no electrical batteries and no need for maintaining capacity in fossil fuels. Its operating features make it much more attractive than just base loading nuclear power.

If you want to see how gas capacity is brought back into the mix of generation in 22B and 22C simply set the storage to zero and the gas generation is automatically sized to fit the load requirement. Of course these deterministic simulations do not account for generation random failures so they are idealized just to study which works better and worse. 22A burns a lot of fossil fuels emitting a lot of CO2. 22B batteries are far too costly. 22C is the best plan but is contingent on the thermal storage system actually working.

In setting up these spreadsheets the information flow is from left to right. Sources and demand is just hourly data ERCOT has posted. Storage is calculated. Next the amount of gas generation needed each hour is calculated and remains zero as long as the load is being served before arriving at the gas generation column. Once the dispatch is completed there is a sanity check to the far right to insure that the load was exactly served every hour. In 22C there are 4 cost categories for hot rocks nuclear, so its being treated as very expensive at this point. It may very well be much lower in cost. Even with this assumption it's the best plan.