# WRESTLING THE 800# GORILLA

## BACKUP ENERGY STORAGE FOR A 100% GREEN U.S.

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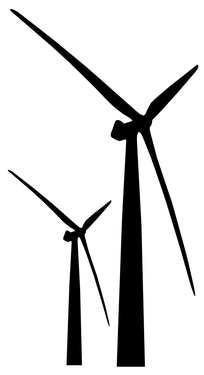
Although the number of solar panels and wind turbines required to electrify the entire U.S. energy system is beyond enormous, replacing all gas, oil and coal with Green electricity by 2050 may be possible. The 800# gorilla in the room then becomes long-duration storage; enough to keep the lights on during an energy crisis.

THE PROBLEM: **MAINTAINING A STABLE ELECTRICAL GRID THAT'S ENTIRELY POWERED BY SOLAR AND WIND GENERATION REQUIRES A <u>COLOSSAL ENERGY-BACKUP SYSTEM</u>**

## 1 HOW MUCH ELECTRICITY WILL WE NEED TO REPLACE ALL COAL, OIL AND GAS BY 2050?

**30 trillion kWh/yr*** (*Assuming 50% wind & 50% solar)

Increase the wind turbine #s to cover solar nighttime shutdowns and longer winter nights. The total solar/wind generation required to support all U.S. energy needs is then:



**40 trillion kWh/yr**

Producing that much energy will require:

**24 billion 330W solar panels**
**plus 3 million 3 MW wind turbines**

While we're at it, let's put the new solar panels in the Southwest where the sun shines, installed by a new "Clean Energy Agency". To finance this, let's encourage millions of individual citizens to each buy 20 panels, to be paid monthly for their generated electricity. Let's also use some of the income to build a High Voltage Direct Current Grid that crisscrosses the U.S. to carry that electricity.

**We're going to need it.**

## 2 HOW MUCH OF THAT ENERGY WILL WE NEED FOR LONG-DURATION BACKUP STORAGE?

Energy backup will be required to handle changes in electricity generation and demand. One scenario: Let's imagine that a few very cold winter nights cause a 10% unplanned increase in electricity demand to support our heat pumps, while cloudy and still days reduce nationwide energy generation by 20%.

Storage needed during 2 days of high demand and low generation in an all-electric U.S.:

2/365 x 30% of 40 trillion kWh
=**<u>66 billion kWh</u>**

## 3 HOW MUCH ENERGY STORAGE WILL WE NEED?

Are there systems that could handle that load? Here are some contenders: (Our example scenario requires **66 billion kWh**)

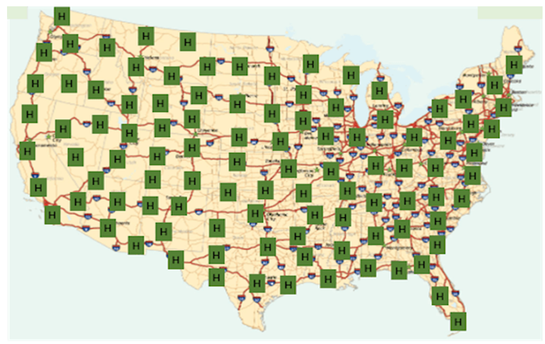
1) **Pumped storage?**
Seven hundred Lake Meads (our largest reservoir, capable of generating 2 million kilowatts of electricity), modified to store energy by pumping water up, then releasing it through generators when needed, could deliver that 66 billion kWh over a 2-day period. **BUT** we aren't going to build 699 more Lake Meads.

2) **Lithium-ion, flow or other batteries?**
Fifteen million metric tons of lithium could handle the scenario. **BUT** a system that large would require roughly the entire planet's estimated lithium reserves!

3) **Compressed Air Energy Storage?**
Hydrostor's Gem plant is being built in California at a cost of $1 billion for 4 GWh of storage. **BUT** the cost for 66 billion kWh of storage? $16.5 trillion.

4) **Other large-scale possibilities?** Let's talk...

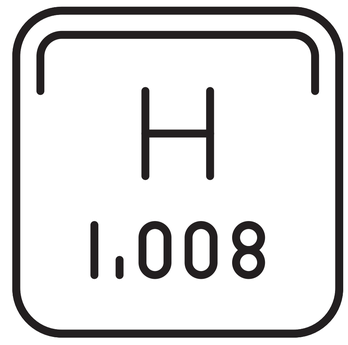
5) **<u>Hydrogen?</u> <u>Possibly!</u>**
About three million tons of hydrogen, extracted from water via electrolysis using green electricity, stored at 100,000 gas stations (30 tons of hydrogen at each), could deliver 66 billion kWh to the grid via fuel cells when needed. In the meantime, the stations would earn their keep by selling hydrogen as our primary long-distance fuel for trucks, rail, air and sea.



"Starter Kit" of 100 H-fuel stations

## 4 CONCLUSIONS

Converting all U.S. energy sources to electricity derived entirely from solar and wind would require a backup storage system much larger than is often anticipated. Most of the storage options being discussed are not realistic at this magnitude. However, if **hydrogen** becomes our fuel for trucks, trains, ships and aircraft as seems likely, the "gas stations" supporting that role might also function as our backup system.




*Find calcs, details, references, links and leave comments on my site: poweringaplanet.com

Other articles are available at hydrogenfuelnews.com (search: Bob Meyer)

Note: This poster assumes a 100% solar & wind energy system, primarily to make its huge backup requirements obvious. Such an entirely wind/solar system is in fact unlikely; another very large energy source will be needed to balance the mix. Nuclear power may be the only other renewable supply with adequate capability. Future nuclear plants must be *absolutely safe*. There are new, small units that may meet this requirement.
See my website for more on this. –Bob