December 9, 2023

Hello LADWP:

Attached below are two excepts from the new book *Green Breakdown: The Coming Renewable Energy Failure*. The first excerpt is a section from Chapter 5, titled “Approaching 100 Percent Renewable Electricity.” This section points out that, traditional coal, natural gas, and nuclear generating plants must be maintained as a ready reserve as more and more wind and solar are added to the electricity grid. This results in doubling or tripling of the electricity capacity that must be maintained, causing electricity prices to double or triple. The section references a 2016 paper by Brick and Thernstrom.

The second excerpt is a section from Chapter 10, titled “Rising Electricity Costs and Falling Reliability.” This section references a 2022 report from the New England ISO. The New England ISO studied plans to approach 100 percent renewables in the six New England States by 2040. They concluded that even with 300 percent overcapacity and large amounts of grid-scale battery capacity, the projected system would suffer 15 days of power blackouts annually and an additional 36 days in which system reliability would be at risk.

Approaching 100 percent renewable electricity is not possible without a doubling or tripling of electricity prices and also incurring a major increase in the risk of electricity blackouts.

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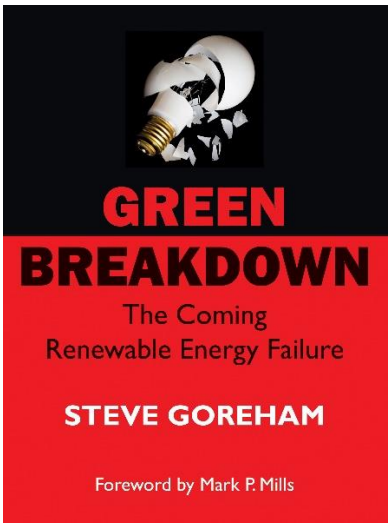

APPROACHING 100 PERCENT RENEWABLE ELECTRICITY

Despite the issues of high land usage, intermittency, and cost, most government administrations appear determined to try to move to 100 percent renewable electricity. As we discussed, unless nuclear power is reconsidered as a favored power source, this renewable transition must be dominated by installation of wind and solar systems.

From 2000 to 2020, wind and solar output rose from zero to an 11 percent share of US electricity production as coal-fired output declined. But over the same period, the share of US electricity provided by natural gas rose from 16 percent to 40 percent. Like in the US, natural gas now dominates the electricity supply of many nations.

Because of intermittency, the capacity of wind and solar systems does not equate to the capacity of traditional power plants. Passing clouds interrupt the output of solar arrays, and wind output varies with the whims of zephyrs. Electrical power operators count on only about 10 percent of the rated capacity of wind and solar systems as a reliable contribution to overall system capacity. This means that, as more and more wind and solar are added to a power system, most traditional power sources *must* remain in service to maintain continuity of electricity supply.

A 2016 study by Stephen Brick and Samuel Thernstrom analyzed electricity systems in California, Germany, and Wisconsin. Their analysis looked at changes to system capacity and cost with increasing penetration of intermittent wind and solar resources. They estimated that, as more and more renewables are added to power systems, 90 percent of traditional power plants must be retained as backup for wind and solar. The traditional power plants are run at lower and lower capacity factors as renewable penetration moves from 50 percent to 80 percent of electricity output. This results in a rising level of system size that must be maintained, as well as rising electricity costs for consumers.

Brick and Thernstrom projected that, in the case of California, overall system capacity would rise by 69 percent with 50 percent renewable penetration, and rise by 130 percent when renewable penetration reached 80 percent. The price of wholesale electricity would rise 85 percent for 50 percent wind and solar penetration, and would rise 269 percent for 80 percent penetration, almost tripling in price. The authors recommended using a more balanced approach of increasing the use of nuclear power with wind and solar to limit increasing system size and electricity cost.

Stephen Brick and Samuel Thernstrom, "Renewables and Decarbonization: Studies of California, Wisconsin, and Germany," *The Electricity Journal*, Mar. 22, 2016, https://core.ac.uk/download/pdf/82637221.pdf

RISING ELECTRICITY COSTS AND FALLING RELIABILITY

Five of six states in the northeastern US—Connecticut, Massachusetts, Maine, Rhode Island, and Vermont—mandated an economy-wide reduction in carbon dioxide emissions of 80 percent or more from levels found in 1990 or 2001. In 2021, New England's power generation came from natural gas (43%), nuclear (21%), imports (17%), hydroelectric (6%), renewables (12%), and other generators (1%). About half of the electricity generated from renewables was from wind systems.

The Integrated System Operator New England (ISO) is responsible for reliable operation of the New England power system and for planning future system operation. The ISO issued a report in 2022 that looked at four scenarios to decarbonize the future New England power grid by 2040. The report included government efforts to electrify home and business heating and transition from conventional cars to electric vehicles.

Today, most homes and businesses in New England heat with natural gas, propane, and oil. In August 2022, Boston Mayor Michelle Wu announced plans to ban gas and oil in new building construction and renovation.[59] The ISO projects a transition to heat pumps, with the demand for electricity for heating increasing by 340 times to over 23 GW by 2040. The ISO also projects that EVs will increase the demand for power by more than 10 GW.[6] Of the four scenarios in the ISO report, only one could meet the decarbonization goals set by member states when including the additional power demand from heating and EVs. That scenario called for 84 GW of new wind, solar, and storage, to comprise 56 percent of generated electricity by 2040. Imports (16%), natural gas (13%), nuclear (12%), and hydroelectric (3%) would provide the remainder.

But the New England ISO concluded that such a wind-, solar-, and battery-dominated system *would not be reliable*. The report stated,

> The variable energy resources in the future grid scenarios lack the controllability and predictability of the region's current dispatchable resources. … Modeling showed that by large margins, available resources were repeatedly unable to match their aggregate output to system demand.

In other words, the wind-, solar-, and battery-powered system would suffer repeated failures, requiring imposed blackouts to avoid total shutdown. The analysis showed that even by installing 2,400 GWh of battery-energy capacity and boosting system reserve margins from 15 percent to 300 percent, the system would fail during 15 days, and be at risk for failure during an additional 36 days, each year. Note that increasing reserve margins to 300 percent would mean building *three times as much* capacity as is needed to serve usual demand.

The ISO's proposed transition to getting 56 percent of its electricity from renewables, much of it offshore wind, would be hugely expensive. The average construction cost for onshore wind in the US is about $1,300 per kilowatt.[65] Offshore wind and batteries are more expensive. The cost of adding 84 GW of new renewable generators would be over $125 billion. Additional large costs will be needed to build transmission. In 2021, residential power prices for the New

England states were already all in the top 10 in the nation, at between 17.03 and 22.91 cents per kilowatt-hour. Look for these prices to double or triple if the electricity decarbonization plan is pursued, accompanied by rising power outages.

"2021 Economic Study: Future Grid Reliability Study Phase 1," New England ISO, Jul. 29. 2022, https://www.iso-ne.com/static-assets/documents/2022/07/2021_economic_study_future_grid_reliability_study_phase_1_report.pdf