Comment on the Report:

Charging Forward: Energy Storage in a Net-Zero Commonwealth

A Report of the Department of Energy Resources

in Consultation with the Massachusetts Clean Energy Center

December 31, 2023

This report (*The Report*) on the value of energy storage in MA's effort to reduce greenhouse gas (GHG) emissions summarizes the study [Ref 1] by the same title (*The Study*) and is a communication by DOER to the legislature. *The Report* examines the value of energy storage in view of the choice that MA has made to electrify transportation and building heating, thereby as much as doubling electricity demand, while replacing fossil fuel electricity generation with intermittent renewable energy in the form of offshore wind (OSW) and solar photovoltaic (PV) generation. *The Report* tends to be misleading in that, rather than energy storage having "value" on a renewable energy grid, supplying most of MA's electricity demand via OSW/PV is impossible without energy storage (as back-up), given that MA plans to retire most or all of the GHG-emitting, dispatchable generation resources, while there are limits on available hydro and imported power. As such, *The Report*'s explanation of the value of energy storage relies on a circular argument.

The Report also sets aside the availability of more reliable zero-carbon technology which suits MA's decarbonization needs well and which does not require back-up, namely nuclear power. To be sure, in precluding the deployment of more nuclear power generation, the MA legislature and indeed the Commonwealth's administration have imposed a boundary condition on any work evaluating the future grid which skews the outcome towards increasing the deployment of intermittent renewables (requiring back-up) and energy storage (not energy generation, requiring recharging) to cover each other's shortcomings.

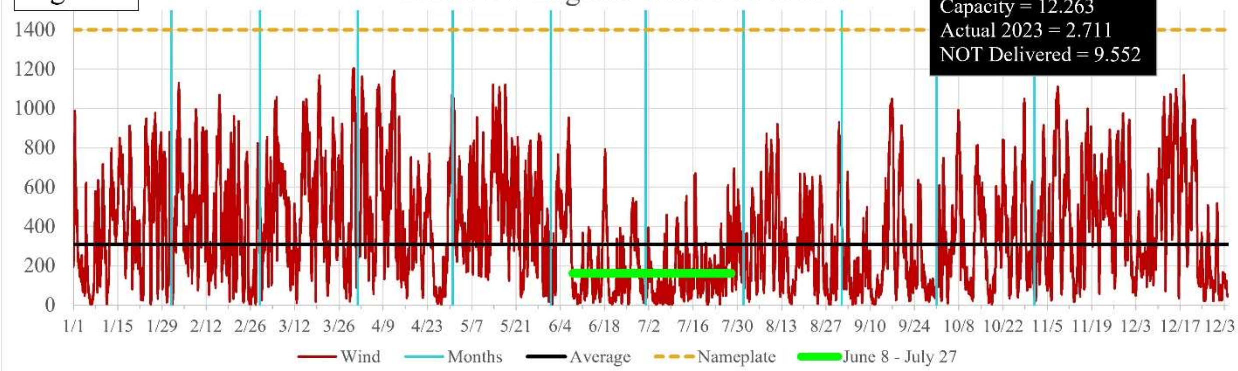
Again, a reliable grid that uses primarily OSW and PV generation is impossible without back-up resources. A 2016 study of deployment of intermittent renewables in 26 OECD countries during the interval 1990-2013 found that each 1% increase in "fast-reacting fossil" (FRF) generation capacity was associated with an increase of 0.88% capacity in intermittent renewables (wind/PV) [Ref 2]. The study concluded that deployment of intermittent renewables was *enabled* by FRF capacity since the latter could serve as dispatchable back-up, and the 1:0.88 ratio provides a real-world assessment of the quantity of back-up required. The relevance in the present discussion is that the planned use of energy storage as back-up, in view of the relatively small amount of hydro and imported power available on the ISO-NE grid, is questionable in the sense that energy storage as back-up requires additional generation resources to ensure the back-up can be charged while the normal demand is also supplied. These points are also raised, at least in passing, in ISO-New England's Future Grid Reliability Study: Phase I [Ref 3].

In the following, Section 1 discusses the wind power supplied to the ISO-NE grid for 2023 and Section 2 provides examples where *The Report* is misleading in its assessment of the value of energy storage. Section 3 contains some final points.

1. Characteristics of 2023 Wind Power on the ISO-NE Grid

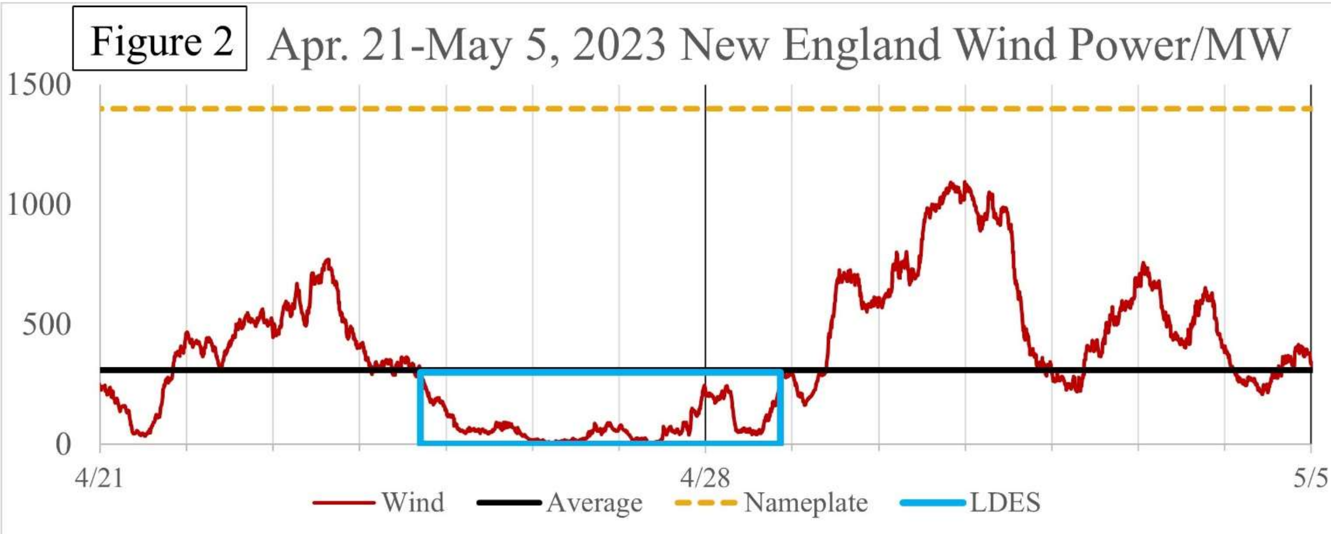
Figure 1 shows the wind power supplied to the ISO-NE grid during 2023. The red curve is the actual wind power, in megawatts (MW) plotted against time (month/day); the data (in time increments of a few minutes) were obtained from the ISO-NE website [Ref 3]. The yellow dashed line is the nameplate capacity of ISO-NE wind resources, 1400 MW, while the black line is the average of the actual delivered wind power for the year. These quantities (capacity and actual) are reflected in the black box in terms of energy (terawatt-hours; TWh), where also shown is how much of the capacity was not delivered; these numbers indicate a "capacity factor" of 22% for the wind power resources available to ISO-NE in 2023. The bright green line is the average wind power for the period June 8 to July 27, which corresponds to a time during which wind power dropped dramatically and remained on average at only half the level for the whole year, this during the high-demand period in the summer. Suffice it to say that these data make plain the unpredictability of wind power, which at no time in 2023 reached its full capacity and which frequently dropped to nearly zero, and therefore its unsuitability to provide power "on demand" or, more importantly, as so-called baseload.

Figure 1



Closer inspection of Figure 1 shows several occasions when there is essentially no wind power. One of these in late April is illustrated in Figure 2. Also shown in this figure is a blue rectangle which corresponds to a 100 hr discharge of a hypothetical 300 MW battery electricity storage system. This duration is proposed (in *The Study*) for "long duration" energy storage (LDES, as described in *The Report*), and the 300 MW is nearly sufficient to provide the 2023 average for wind power in New England. These real data confirm the need for 100 hour back-up storage at minimum. It is not at all clear how a 100 hour LDES rated to provide the "average" wind power output would have fared (vis a vis recharging) during the 7 weeks this past summer when only half the wind output was available. Figure 1 shows at least 5 other intervals when wind power remained near zero for at least 3 days: beginning on Jun. 8, Jul. 3, Sep. 10, Sep. 27 and Dec. 29 (extending into 2024).

The upshot in this discussion is that the plan to power MA/New England primarily on weather-based wind/PV by 2050 is modelled against weather patterns of the recent past, and cannot possibly account for the weather decades from now which derives from a climate we understand to be changing.



2. Concerns with *The Report*

As stated above, *The Report*'s discussion of the value of energy storage, comprising the 8 Key Findings, is largely a circular argument given that MA's planned extensive reliance on intermittent renewables and elimination of fossil-fuel generation resources is simply not possible without storage to achieve reliability.

Several of the arguments supporting the value of energy storage involve its use in ancillary services. To the degree that ancillary services are currently procured on the real-time 5-minute wholesale market, it is obvious that these services are significantly more expensive than the power provided via the day-ahead market. Ancillary services, often provided by "marginal" generators that reap large profits, usually represent a small overall cost to ratepayers because they are normally required to deal with the inevitable small differences between real load and forecast demand and, infrequently, when larger contingencies occur.

The Report indicates that as the deployment of OSW/PV increases, the need for ancillary services will increase, thereby assuring the owners of energy storage systems (now another form of "marginal" generator) of sufficient returns on their investments. Given that ancillary services are inherently more expensive than baseload and accurately forecast variable load, it is clear from *The Report* that the increasing deployment of OSW/PV, along with the necessary energy storage to back these up, rather than amounting to greater value for ratepayers, represents a greater expense for ratepayers.

The energy arbitrage described in *The Report* is almost a special case of circular argument. Clearly the application of energy storage to "smooth" wind power's ups and downs, presumably in a way that allows wind power output to more nearly approximate the "average" output level (black line) in Figure 1, provides a value to the grid, but not an inexpensive one: two large systems, neither of which can do the job alone, to provide one stable output. *The Report* dwells somewhat on the value of energy storage in shifting the daily maximum PV output to the evening peak, claiming that this has enhanced value in reference to the Clean Energy Standard. Here the energy storage, now charged by the greater deployment of intermittent renewables, counts as a source of clean energy, which further improves investor returns. These energy arbitrage opportunities for energy storage owners exist, on the scale considered here, only because of the need to compensate for the inadequacies of intermittent renewables.

Certainly there are rational uses of energy storage systems in the context of GHG emission reduction. *The Report* outlines the value in replacing the fossil-fuel generator systems currently at critical facilities (for example: hospitals, municipal water supplies) to deal with occasional power outages. It is worth noting that these applications of energy storage are not complementary to intermittent renewables (and therefore do not contribute to the circular logic). It is not obvious, however, that these critical facilities could be induced to rely on back-up for which there may be no refueling when the required energy supply is depleted.

Another issue *The Report* touches on has to do with supply chain, specifically for lithium ion battery systems both in terms of manufacturing capacity and of raw materials. Logically, if many other grid jurisdictions, including other countries, undertake a similar approach to MA in terms of renewables with storage back-up, the supply of storage systems will become and remain more expensive and, indeed, shortages are likely. A significant omission in *the Report* regarding materials, and more generally in MA's planned reliance on OSW/PV, is the sheer mass of materials required to implement MA's plan for renewables generation and for energy storage back-up. The enormous extractive economy (out of sight/out of mind, far from MA) required to provide these materials for a poor return of power (compared, for example, to nuclear power) is likely to impinge on other areas of the economy, not to mention the environment. Moreover, the relatively short service life of wind turbines, solar panels and lithium ion battery systems ensures a stressed supply chain as long as these technologies are in use. There is apparently already evidence of a foreshortened service life owing to the federal subsidy landscape for renewables "repowering" [Ref 5]. Perhaps it is ironic that MA's wealth could trump its interest in energy justice if its willingness to pay the higher prices prevents poorer regions from achieving similar impacts on GHG emissions.

3. Final Comments – the Artful Dodge

The bottom line regarding the Cost Benefit Analysis mentioned in *The Report*:

- Energy storage has value for ratepayers because it will prevent outages that would otherwise occur because of the unreliability of wind/solar.
- Energy storage has value for the Commonwealth in that is a critical component of a weather-based generation scheme that will allow MA to claim to have successfully met its GHG reduction goals.
- Energy storage has value for investors/system owners in that MA will assure profitability.

Quote from *The Report* (p. 9) in reference to development of MDES/LDES which are not currently available in suitable form for grid back-up: "It is uncertain how they should be compensated for that service and by whom." It has become an artful dodge by legislators and industry stakeholders to point to each other when asked "who will pay?"

Given that the pools of ratepayers and taxpayers overlap nearly perfectly there is no question who will pay. The question is why the Commonwealth has chosen to commit its taxpayers' resources to build an unproven, resource intensive grid to harness weather-derived electricity, with storage to mitigate that system's unreliability, when a proven zero carbon alternative exists.

References:

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Submitted by: Dale Levandier, 3 Sandas Point Rd, Ayer, MA.
DL is a retired PhD research scientist formerly affiliated with Boston College, the Air Force Research Lab, and Physical Sciences, Inc.