May 7, 2024 via Email to:

Representative Joseph J. Solomon, Jr.,
Chair, House Corporations Committee
Rhode Island State House Providence, RI 02903
Rep-solomon@rilegislature.gov

Re: H7815; An Act Relating to Public Utilities and Carriers -- Renewable Energy Standard and H7811: An Act Relating To Public Utilities And Carriers – 2024 Energy Storage Act

Dear Representative Solomon and Committee,

The following supplements my testimony to the Committee on March 21, 2024. I spoke about the inability of battery storage to fill in demand gaps from intermittent solar and wind. Because I am not an energy expert, I used model calculations by Michael Armenia, BS/MS/MBA Mechanical/Nuclear/Computer Science. Mr. Armenia has spent a career in US military energy research. He attests by signature hereto.
Respectfully submitted,

Lisa Quattrocki Knight, M.D., Ph.D.

Current federal energy policy and RI advocacy toward an “all renewables” electric grid favors **battery storage (H7811)** as the solution to the intermittency of Solar and Wind. Intermittency varies daily, monthly, seasonally and locally. Daily variations are short duration due to clouds, fog, nighttime and local wind patterns. Here in New England seasonal variations are more extreme with times of little wind, weeklong fog, or times of severe winds. Since we cannot predict longer-term variations our state regulators (PUC and ISO-NE) examine grid reliability at worst-case scenarios. Here on the East Coast that could be 2 weeks of fog or a hurricane. In New England the current practice for filling “renewables” gaps is fossil-fueled natural gas generators. As these get retired by State policy, you the policy makers have been marketed “long duration” batteries. This is a dangerous undertaking because such technology does not exist. Battery state-of-the-art for two decades remains Lithium Ion Batteries

(LiBs) of the type that power an electric vehicle. The cells come from China. They do not scale up in size. They are small like a “C” cell flashlight battery. About 6000 of these are wired together in a EV car pack or about 50 in an eBike. All are short duration – meaning they last less than 4 hours. To charge/discharge faster causes fires which we see commonly in cars, busses and eBikes. Long duration grid batteries need to store months of energy. We are nowhere near that “Energizer Bunny.” Policy makers may be told we can sequentially fire off millions of short duration batteries to keep the energy flowing – we might but it will bankrupt the country. It would be like using a million solid gold matchbooks in place of logs for a campfire. In terms of energy storage, Li-ion batteries are gold matches; fossil or nuclear are cheap logs.

The cost of Li-ion energy storage is astronomical compared to fossil or nuclear fueled generators. The average US home uses about 30 units of energy per day (30 kWh). That costs about $8 on your fossil/nuclear fueled electric bill. That is enough for the electric company to recover the capital expense of these long life generators. To have that same 30 kWh delivered daily by a sequential Li-ion battery chain would cost you hundreds of times more than fossil or nuclear backup.

The use of batteries is ludicrous if we apply their cost and effectiveness to backing up thousands of OffShore Wind (OWS) Turbine Generators (WTGs) being installed on the Atlantic East Coast (EC). The worst case we need to model is a hurricane traversing the EC. A more local case might be 2 weeks of fog from Georges Bank to Coxe’s Ledge. Both cases become extremely costly using battery backup. When winds get to about 70 mph, the WTGs go into lock down mode. When the WTGs are locked down and the land grid goes down, the WTGs lose the grid’s “hotel” support power and suffer damage due to lack of lubrication and inability to move the blades away from the wind.

Proposed battery storage must replace grid energy during the storm itself, and while crews inspect and repair damages to the WTGs before a restart. WTG technology at a smaller scale was developed in the North Sea off the UK to the Nordic peninsula. There are no hurricanes there. The larger WTGs being erected off our cost in shallow water fishing grounds will see wind and wave actions that can move foundations, destroy blades, or uplift the cables carrying the electricity. (This happened in normal wave conditions on the first wind project at Block Island.) When an EC hurricane strikes, a large fraction of the WTGs will be out of commission until

inspected and repaired. The questions we need to answer are: (1) How much energy needs to be stored in batteries to make up for the outages? (2) How many batteries? (3) At what cost? A detailed spreadsheet is available for all the calculations described below.

The hurricane case: The current federal Executive goal is 30 GigaWatts (GW) by 2030. This will take about 3000 WTGs on the continental shelf from Maine to Virginia: a typical WTG has a nameplate power rating of 10 MegaWatts (10 MW) at a capacity factor of about 40% meaning in a year it will deliver energy 40% of the time. During the other 60% nothing is delivered so developers will have to overbuild the WTGs to separately store energy in batteries for a "non-fossil" grid. Energy equals Power in Watts x Time in hours. The average home in the USA consumes about 12,000 kWh a year. A 10MW WTG generates 10MW x 0.4 CF x 8760 hrs = 35,040 MWh per year, enough to power 2920 homes (off-grid equivalent).

Using a state-of-the-art EV-car Lithium Ion battery (LiB) how many do we need to backup **one** WTG for **one** month of downtime? The answer is 38,933 EV size LiB battery packs each costing about $30,000 for $**1.1 Billion total for just ONE WTG down for ONE month.** That's the cost to initially build the complete Revolution Wind project on Cox's Ledge! However for the mandate we will need **3000 WTGs** on the EC offshore. It is reasonable to say that half of these will be locked down in the typical EC Atlantic hurricane path. In our model these 1500 WTGs remain locked down for 2 weeks to allow for inspection prior to restart followed by up to 3 months to make repairs on some of them. **For that period we will need about 27 million LiBs costing $65 Trillion dollars, over twice US GDP. These battery packs will occupy over 2 Million football field size industrial sites.**

Therefore a thoughtful "all renewables" legislator would halt the construction of all East Coast OSW WTGs immediately on the cost basis alone.

$65 Trillion is over twice the US GDP. Other studies have looked at non-storm, seasonal intermittent backup for an "all renewables" US **land** grid utilizing batteries to fill in gaps of solar, wind and hydro (no nuclear backup). They report battery backup costing **15 times US GDP.** [(2)]

The supply chain for "all renewables" including batteries comes from outside the US made using predominately fossil fuels. Those emissions are not revealed in developers' proposals. **H7815** would change that. The

rest of the world using fossil fuels comprising 90% of global CO2 emissions , especially China, Russia India, Indonesia, and Africa --will be economically unchanged after a storm. China where renewables components or materials originate will be waiting for our leaders to hand over the keys to our kingdom.

We can stop here and demand that H7815 (emissions verifications) be passed and H7811 (battery usage) be rejected. Read on to review battery technology readiness using US Dept of Energy reports.

<u>Battery Technology</u>: Li-ion Battery utility scale storage exists experimentally in a few places: Australia, California and Peru. Australia's and California's caught on fire, the latter requiring a regional shelter in place order due to hazardous fumes. The fires cannot be put out with water. The batteries are classified as hazardous materials. Leaked materials will pollute a drinking water supply. Therefore this technology must be housed in special containers with air conditioning or heat depending on location.

One of these containers pictured above can hold about 10 equivalent EV car battery packs. 100 of these containers will fill a football field. For our model of hurricane backup these would cover **over 2 Million football fields for the 30 GW OSW EC build–out.** This is not feasible due to cost, ($65 trillion) but if policy makers force us incrementally down that path, like solar projects it would require clear cutting millions of acres of forests away

from cities due to fire dangers. Unless policy makers come to their senses we will soon be seeing some of these tax subsidized football fields in Rhode Island alongside the solar fields that need battery backup.

Advocates for batteries point to studies showing technology breakthroughs. Here is a bar chart from a recent Dept of Energy (National Renewables Energy Laboratory) meta-study [(1)] showing research goals for Li-ion batteries with 4 to 10 hours duration. We have annotated it to show that only the 2- 4 hr batteries exist – the rest are goals, the highest being 10 hours. A 10-hour duration is still vastly inadequate for an all renewables grid. [(2)]

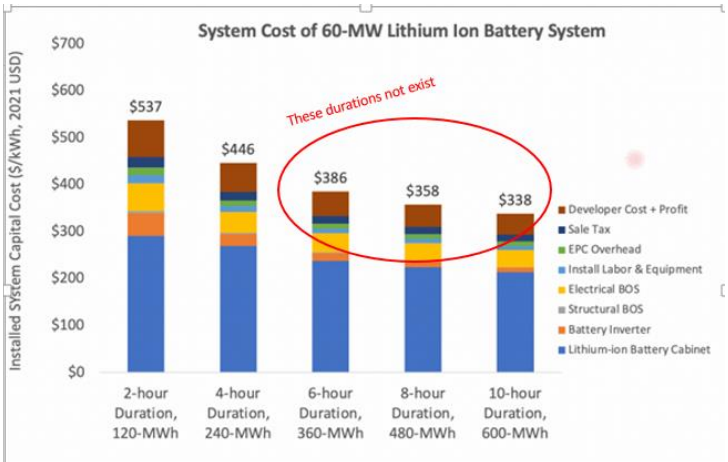


Figure 1. 2022 U.S. utility-scale LIB storage costs for durations of 2–10 hours (60 MW_{DC}) in $/kWh

Other studies are centered on "distributed" energy grids where (2 million) football field size batteries would be placed in regions close to solar fields and onshore turbine projects. Another NREL metastudy[(3)] shows virtually endless combinations of "hybrid" battery, wind and solar (but no nuclear) revealing no standardization or agreement on what will work from a ratepayer/taxpayer cost point of view. Costs are usually ignored in government basic research. DoE/NREL grant money (our money) flows to many researchers that engage in "sustainability and resilience" but often not engineering, economics or arithmetic.

A recent paper [(4)] by Miles Bidwell, PhD was recently published in USA Today and uploaded to the Rhode Island General Assembly in support of **bill H7815**. It is a review of 4 prior studies showing that the use of wind turbine energy around the world shows **negligible displacement or abatement of fossil fuel CO2 emissions.** There are no known studies that show an emissions abatement benefit. (NREL has yet to do one.)

This is because natural gas turbine generators are used extensively for filling the gaps in wind and solar production. The gas turbines are always spinning, ramping up and down, filling in wind and solar minute-by-minute, year by year. They were not designed to operate this way therefore they emit substantial greenhouse gasses, but without them the grid would collapse in a matter of minutes. Other studies are proposing Generation IV, small modular reactors to back up renewables. The reactors produce no emissions. These small reactors could be manufactured and shipped from assembly lines at Quonset Point next to nuclear submarine manufacture. Like the submarines, they do not contain nuclear fuel during manufacture and once sited some designs using liquid thorium fuel cannot melt down.

In Summary:

(1) Doing away with natural gas generators leaves existing "renewables" extremely unreliable and dangerous; during storms the electric grid can go down for long periods resulting in deaths by freezing or heat followed by economic collapse, a national security issue.

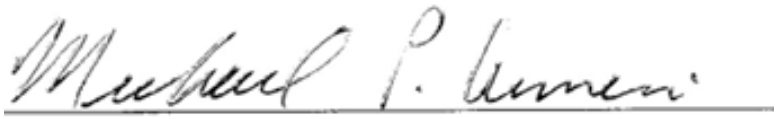
(2) Substituting chemical batteries (**per bill H7811**) is technically inept, outlandishly costly and environmentally dangerous.

(3) **H7815** (emissions verification) will shed light on both of these serious problems by mandating internationally recognized analysis for future "renewables" projects. The developers will have to present costs of grid storage backup choosing between low cost, existing fossil-fueled backup or short duration batteries costing up to 15 times annual US GDP.

(4) The required long duration storage batteries **(assumed in H7811)** do not exist. Because of these serious mismatches our electrical engineering-trained regulators will review developer proposals **(per H7815)** to decide if a project can be built for proposed costs and if the project can displace any fossil fuel generation.

Legislators should pass H7815 and reject H7811.

Data and calculations in this testimony attested by



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Captain, U.S.N. (retired). I have no conflicts of interest in the field of energy research and the opinions and conclusions herein are my own.

Notes:

(1) *https://atb.nrel.gov/electricity/2023/utility-scale_battery_storage*

(2) The Energy Storage Conundrum, Francis Menton, Briefing 61, The Global Warming Policy Foundation © Copyright 2022, The Global Warming Policy Foundation. https://www.thegwpf.org/content/uploads/2022/11/Menton-Energy-Storage-Conundrum.pdf?mc_cid=80a8bdfb6a. *This reference concludes:* "We review recent government reports on the current and projected cost and capabilities of battery technologies that have been seriously proposed for grid backup in the absence of fossil fuels. …..the capital cost alone could be 15 times annual GDP. In addition, it is not just costs that render the goal infeasible, but also practical limitations. Current battery technologies provide about four hours of discharge at maximum capacity, but weather patterns mean that grids need batteries that can store as much as a month's demand, and then discharge that energy over the course of six months or more. Such 'long duration' batteries have not yet been invented"

(3) 2022 NREL: "Hybrid Distributed Wind and Battery Energy Storage Systems." National Renewable Energy Laboratory. NREL/TP-5000-77662. https://www.nrel.gov/docs/fy22osti/77662.pdf. *This reference shows that much more research and testing is needed before battery integration into various proposed designs of wind and solar "distributed" energy can be integrated into "microgrids". Control systems for regional and national battery integration do not yet exist.*

*(*4) https://www.rilegislature.gov/Special/comdoc/House%20Corporations%202024/03-21-2024--H7815--Wind%20Farm%20data%20-%20Miles%20Bidwell.pdf . *This reference reviews all existing studies of wind and solar developments ability to reduce CO2 emissions. The conclusion is negligible abatement.*