

Issues with Grid-Level BESS Units

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Introduction

As an electrical engineer, I have recently been working with a citizen's group protesting the placement of a grid-level Battery Energy Storage System (BESS for short) close to peoples houses and a busy highway. As a result, I have acquired a lot of information about BESS units and their funding by "shadow banking" organizations, which I am presenting here in the hope that it may be useful to other groups facing similar situations.

For background, I live in a small town in central Massachusetts, which US State has the unique distinction of being run, in the past, by a Governor who was still in Federal Penitentiary. To say that sometimes shady and underhand dealings happen in our towns and cities would be an understatement and should be borne in mind when looking behind the motivation for the installation of these BESS units.

What originally motivated this group of citizens to come together was the fear of the proposed installation of a 5 MW "farm" of 4 BESS units in close proximity to their homes. Their fear was originally that these units would catch fire, explode and emit toxic fumes that would kill them as they slept in their beds.

But, while it turned out that, with newer battery technology, these fears may have probably been overstated, it turned out that, upon examination, the actual problems were far worse and much more far reaching for the citizens of our town.

Exploding Batteries

BESS stands for Battery Energy Storage System – Grid Level refers to those used for power leveling, enabling their operators to purchase power from a power utility, such as National Grid, at times when spot rates are cheap (such as in the middle of the night) and resell it back to the power utility at a higher cost when spot rates are high (such as in early evening).

Theoretically these units are useful load-leveling devices for the electrical grid but, in practice, they have many disadvantages which it is important to understand. Their deployment is being strongly promoted by our State's officials as part of their green energy initiative. As a result, many towns may have no alternative but to deploy BESS units.

BESS units may use three types of chemical batteries:

1. NMC which stands for Lithium Nickel Manganese Cobalt Oxide, a family of lithium-ion (Li-ion) battery chemistries commonly used in electric vehicles (EVs) and portable electronics, and lessening amounts in stationary energy storage. This has the highest energy density and highest fire risk due to thermal runaway. It is the technology that is used in the exploding cars and school buses that make for spectacular videos on social media and the evening news. This was used in grid-level BESS units up to about 2021 when LFP technology took over.
2. LFP which stands for Lithium Iron Phosphate, and is now being extensively deployed in grid-level BESS units because it provides much better safety than NMC technology, with lower risk of thermal runaway. In addition, it has a longer cycle life, better thermal stability, and is lower cost than NMC technology.
3. Na-ion which stands for Sodium Ion, which is an emerging technology that is expected to replace LFP technology within about two years in Grid level BESS units as it is even safer than LFP, although it has slightly lower energy density than LFP, but this does not matter in grid-level BESS installations.

A single BESS unit may contain many thousands of these batteries, such as the one shown here.

A good way of differentiating between the battery technologies is that an NMC battery, which is largely made of Lithium, has the highest energy density but can catch fire and emit an explosive gas cloud if it is damaged. In contrast an LFP battery is made of inert components but has a flammable Lithium based electrolyte between its anode and cathode. The Na-ion battery goes one step further in that it uses, what is essentially salt water as its electrolyte and is claimed to be non-flammable.



Thermal runaway in NMC and LFP batteries can start when a short circuit occurs within a battery. This may be due to physical damage, such as due to a deer-hunter accidentally shooting a bullet through the side of the BESS and into a battery.

Or it may be due to a minute manufacturing defect, due to microscopic contamination, that forms a dendrite (like a stalactite in a cave) that grows over many battery cycles into a short circuit between anode and cathode surfaces, which are typically only separated by just over ten micrometers (about one tenth the thickness of a human hair).

Once started the heat from one cell causes the next cell to go into thermal runaway, and so on until the whole BESS is in thermal runaway and, if it is Lithium based, emitting large amounts of toxic and explosive gases.

Once thermal runaway starts the resultant fires cannot be put-out with water as they are entirely due to the exothermic runaway of the battery, which is caused by a short circuit in the battery. They then have to be left to burn out, sometimes for days with Grid Level units, and then the local town has a toxic hazardous waste zone, to clean up at great expense.



Even, if they do not catch fire the life of a grid-level BESS is limited to about 15 years before the batteries will no longer hold their charge to a sufficient level to make operating the BESS economical. Just like your cell phone battery after a few years.

The first Na-ion based grid-level BESS was deployed in Colorado in spring 2025 and CATL, the world's largest battery manufacturer, is in the process of switching its production of BESS batteries to Na-ion from LFP. Even better, the Na-ion batteries are currently 64% of the cost of equivalent LFP batteries and are expected to decline to possibly one tenth the cost as automated battery production ramps up.

It is expected by most experts that LFP technology will be replaced by Na-ion, or some similar technology over the next couple of years, just like LFP technology replaced NMC technology from about 2021 onward. This is because the new technology is safer and less costly and also has another major environmental benefit.

NMC and LFP batteries contain Lithium and cannot be disposed of in landfills. They also have to be transported partially charged otherwise they cannot be recharged, if fully discharged. This makes these batteries a safety hazard to transport to the BESS site and to dispose of when the BESS reaches its end of life.

CATL and the US-based Peak Energy both claim that their Na-Ion based batteries can be transported fully discharged and then charged upon arrival at the BESS site. They can also be fully discharged when they reach their end of life and can then be safely disposed of without fire or explosion risk. This substantially reduces the risk and cost of end-of-life disposal of the BESS.

Today, Grid Level BESS operators have to use LFP technology if they need to purchase insurance against environmental damage caused by their BESS units. But this is expected to change as Na-ion batteries become available.

It is important that the Grid Level BESS units should be certified by a professional engineer to conform to National Fire Protection Association NFPA 855 and Underwriter's Laboratory UL 9540A standards. And, if they are to be sited in residential areas, they typically need to be sited with setbacks to property lines of 100 feet and nearest residential dwelling of 500 feet.

As a result, today's BESS units are reasonably safe provided they are properly sited, installed and well maintained. As a result, many of the initial fears of the citizen's group about exploding batteries were probably unfounded, especially if the BESS units use the newer Na-ion battery technology rather than obsolete LFP technology.

But that is not the end of the story.

Noise Pollution



While LFP technology is much safer than the older NMC technology, its batteries do generate a lot of heat when being charged and discharged. As such the LFP BESS units do need to have top mounted fans to cool the batteries, as well as to cool the electronics used to convert from the batteries' direct current to the alternating current of the grid.

This can result in a high-level of noise generation, especially with co-located multiple BESS units. As such the BESS units need to be sited well away from homes and places where people congregate, such as children's playgrounds so as not to damage their hearing.

There are state rules for the allowable levels of noise pollution but these are not always acceptable at night when people are trying to sleep.

The newer Na-ion technology is claimed to generate less heat when in operation but these BESS units still require cooling for their electronics which, while probably less than with LFP units, may still generate substantial noise pollution.

For this reason, it is generally recommended that these Grid Level BESS units be sited in industrial parks rather than in residential areas.

The Home Insurance Crisis

A survey of local insurance companies indicated that they would not insure houses located within one mile of a BESS unit or, at the very least, would substantially increase the required insurance premiums by many times over. Most also indicated that they would not renew insurance policies on homes located within one mile radius of a grid-level BESS.

As most people's home mortgages contain a clause allowing the lender to immediately insist on full payment of the outstanding balance if the borrower was unable to obtain or pay for insurance on their house (as this was collateral for the loan). This would, in most cases, force the homes into foreclosure because people would not have the cash on hand to pay off their mortgages in

full. This would also make these houses not able to be resold, because of the insurance crisis forced by the location of a BESS in a residential area.

In our town's case, the one-mile radius from the proposed BESS site would include about 30% of all residential homes in town and of all the municipal offices. This would further exacerbate the homeless crisis in our state, as these homes would now become uninhabited, due to their foreclosure, and the town would probably go bankrupt, as its real-estate revenues plummeted.

It seems strange to me that our State Governor, who professes to really care about homelessness should be forcing towns to install BESS units which could result in millions of the State's residents becoming homeless.

The Money Trail

A significant share of grid-scale BESS (Battery Energy Storage System) projects in the U.S are funded by private equity (PE) firms with private credit funds - sometimes referred to as "shadow banks" rather than installed by the local electrical power utility.

These PE investors are involved because BESS projects generate substantial short-term fees and have long-term contracted cash flows which qualify for tax incentives under the Inflation Reduction Act and can then be quickly sold as collateralized debt obligations to other investors.

Each grid-level BESS project is typically placed in its own LLC (Limited Liability Company).

The Private Equity (PE) shadow bankers then borrow the money for this project from a regular bank, which they immediately loan to the BESS LLC. The loan to the BESS then becomes collateral from the shadow bank to the regular bank.

The loans taken out by the BESS LLC from the Private Equity (PE) organization are then used to pay for the BESS, including large fees for the PE Shadow Bankers who hired the engineering company that got the BESS approved, purchased, sited, and made operational.

Typically, loans to multiple BESS LLCs are bundled into investment products that are similar to collateralized debt obligations (CDOs) and sold to institutional investors, such as Pension Funds. The income from the BESS units is then used to pay the investors, in these collateralized debt obligations.

Once the money is received by the Shadow Bank from the sale of the CDO they then repay the loan from the regular bank after subtracting hefty fees. This leaves the regular bank and the PE shadow bank free and clear with no contingent liability for the BESS project. The only responsible party should things go wrong, is the BESS LLC which has no assets except the BESS and its income stream.

This all works fine, with the earnings from the arbitrage on the differential cost of power being collected from the local power utility covering the cost of payments to the pension fund holding the loan, plus payment to the company maintaining and operating the BESS, plus probably "consulting" fees to the PE shadow bankers and their lawyers.

So, what could go wrong?

1. The public utility could stop selling its surplus power at reduced cost to the BESS LLC because they have no surplus power to sell, possibly because they are charging their own stored energy units at night.
2. The BESS unit could suffer a catastrophic breakdown, possibly due to a battery fire. This may not happen immediately but over the projected 20-year life of the BESS is quite likely.
3. The green energy initiatives, supporting the deployments of these BESS units, which are so favored by our State's political elite, may become politically unacceptable to the people of this state and subject to withdrawal-of-funding pressures from the Federal Government, resulting in the withdrawal of favored tax status and other funding for these BESS units.
4. The cost of BESS stored energy proves much more expensive and environmentally hazardous than pumped storage projects like that in Northfield, MA which has operated very efficiently by National Grid, with minimal pollution, for over 50 years.



One might ask the question “If these BESS units are so great, why does not National Grid or some other power utility operate these BESS units themselves?” Maybe its because they have been operating projects like Northfield for 50 year and are still building more of these systems, which generate reliable profits year over year rather than the politically and environmentally toxic BESS units.

Clean Up

When the BESS catches fire, becomes uneconomical to operate, or stops working after 15 or 20 (if we are lucky) years, then the host town will be stuck with the cost of the potentially hazardous waste disposal of the BESS, as the original sponsors and the private equity group will be long gone.

Also, ordinary people's pension funds will be stuck with an investment that, at best is a total loss, and, at worst, is a major liability. That is, unless the town insists that the project sponsors place sufficient money in an escrow account or carries pre-paid insurance to cover future liabilities.

It should also be noted that little benefit accrues to the host town, as most of the profits from each BESS goes to the private equity group of shadow bankers and, if they are lucky, to some

pension fund. Yes, there will possibly be some payment for real-estate taxes but this will be minimal relative to the potential cost of clean-up, which will probably be borne by the town.

In fact, all the town really gets is a liability for hazardous waste cleanup as well as putting its citizens, including its fire personnel, at risk should the BESS catch fire.

Summary Recommendations

1. Make sure that the BESS uses LFP or preferably Na-ion technology and not NMC technology due to fire and explosion risk.
2. Make sure that the BESS is sited in an industrial park and is sufficiently distant from homes such as to not impact house insurance costs or availability. Note that this appears to be a one-mile radius from the BESS with LFP technology but may shrink with the use of Na-ion batteries.
3. Make sure that the BESS is certified by a professional engineer to meet the requirements of the National Fire Protection Association NFPA 855 and Underwriter's Laboratory UL 9540A standards.
4. Include top vented fans in the design to cool the unit and disperse any battery fumes upwards. Also make sure that the BESS is located sufficiently far from homes, playgrounds, etc. so as not to cause noise pollution for people.
5. Make sure BESS is 500 ft from nearest house or dwelling and 200 feet from nearest public road to avoid problems with wind-blown toxic gas if LFP technology is used.
6. Insist that BESS sponsors purchase pre-paid insurance for hazardous waste site cleanup due to fire and escrow funds for site cleanup at end-of-life of BESS.

Commentary

I often ask myself "Is there a link between the green initiatives being pushed by our political elites and the large amounts of money being made by shadow bankers out of these BESS installations and other green initiatives?"

I will not allow Lithium-Ion batteries to be charged or stored in my house because of the fire risk. They are consigned to my separate garage. I also recommend that my manufacturing clients not use Lithium Ion based batteries for uninterruptable power supplies or for fork-lift trucks and instead use Lead-Acid batteries, or NA-ion batteries when they become available.

I am personally horrified that people are putting smaller BESS units in homes and apartments, for power-outage backup, some of which use the older NMC technology and which can easily catch fire. I also consider putting school children in an NMC Lithium Ion powered school bus to be a tragedy waiting to happen.

Author

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Dr. Green is currently the technical director of a high technology company, where he is engaged in projects to detect counterfeit pharmaceuticals and to help ensure the safety of our food supply. As part of applying his expertise in Artificial Intelligence, Dr Green has devoted his career to preventing mistakes and disasters in manufacturing, construction, space and defense related activities and projects.

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