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Utility Scale Battery Energy Storage System (BESS) Safety Study Group

Commissioned by the New Paltz Town Board to better understand the safety concerns for Utility Scale BESS

Town of New Paltz Climate Smart Taskforce


Study Group Objective:
To better understand Utility Scale BESS and the associated risk and reward.

Preface

The Town of New Paltz Board approved this study group for the purpose of better understanding Utility Scale BESS. It was instigated by the Town's efforts to establish law/code applicable to Type 1 and Type 2 BESS and concerns about BESS safety.

This presentation makes no recommendations and is purely for education purpose and uses trustworthy factual information to inform the community. The purpose is to better understand Utility Scale BESS, the safety risks they have, and rewards that can come from them.

The question of what local building codes and zoning use is appropriate for BESS remains and needs to be addressed to establish a path forward.

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Section 1: What is a Utility Scale Battery Energy Storage System (BESS)

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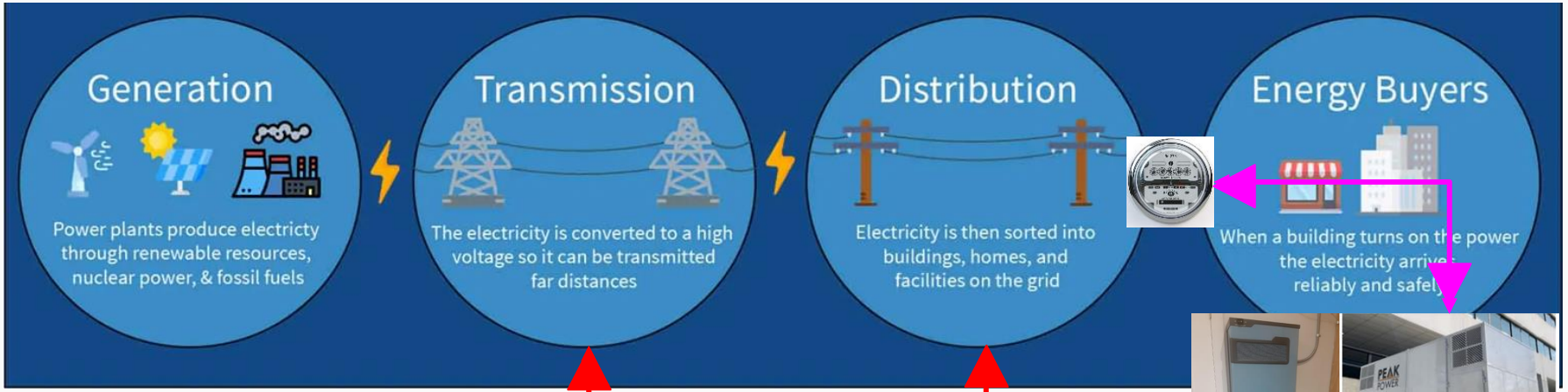
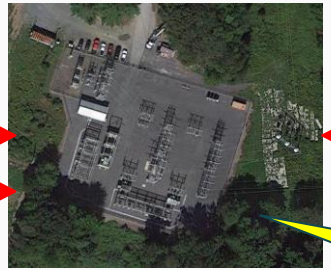
What is Utility Scale BESS? Storage for Electricity!



Behind Meter
Type 1 BESS

Front of Meter
Type 2 Utility Scale BESS

Voltage Stepped Up or Down



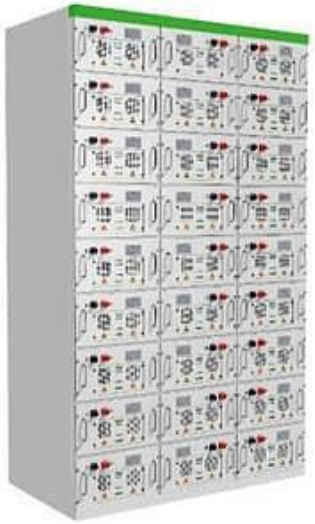
Substation

BESS facilities need to either build or have access to a substation

BESS Architecture

A componentized construction that allows standardization and compartmentalization

Various form factors and manufacturing processes.



See backup page 26 for a look inside the battery that explains how a battery works

Compartmentalization is part of the safety design, including container spacing

Cell Module Rack Container

Section 2: Understanding the risk

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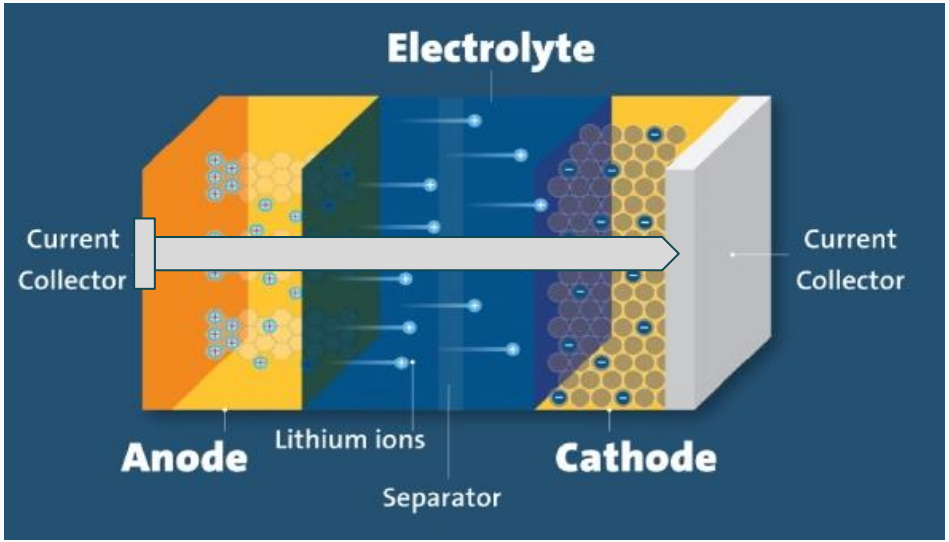
How is a fire started? From a short circuit that creates a thermal runaway.

If a short is created in the cell, or system, it will allow electricity to flow and generate heat.

A short can come from:

- Cell Manufacturing Defect
- System Integration Defect
- Operations and Lack of Control



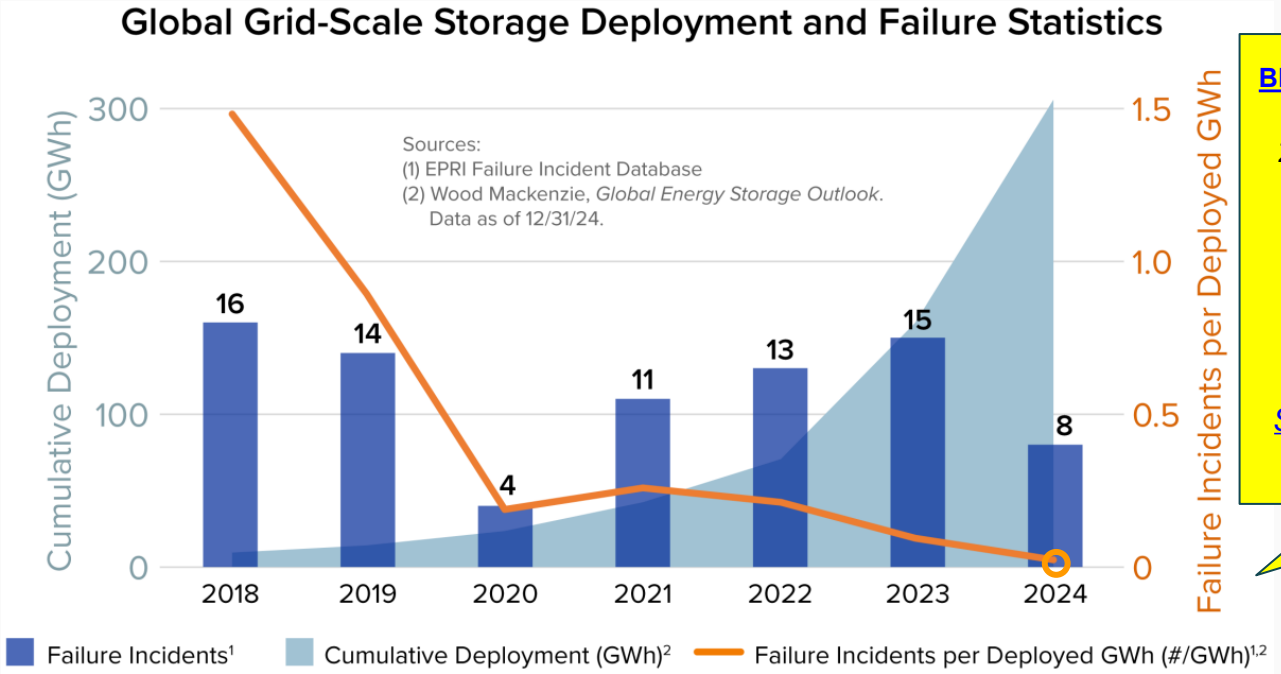
The heat produced can be conducted to other cells, modules, or racks and cause a thermal runaway*.

*A thermal runaway is the spreading of the increasing temperature that is unchecked.

As the temperature escalates it can vaporize the electrolyte and the separator and can result in a fire.

Incident Database for BESS Failures

As reported by the [Electric Power Research Institute (EPRI)](#) ……



[BESS Failure Incident Database](#)

24 Incidents have been reported in the USA in 11 States since 2012.

In New York, we have had 4 incidents reported and all were in 2023 and 0 in 2024.

[See the backup page 38 for discussion on the incident metric.](#)

The 4 NYS Incidents for BESS Fires

A 'smoldering battery' was reported, closing down roads and stopping train service for about an hour until the fire was contained. NextEra reported that an internal sprinkler system contained the fire.

Location	Capacity (MW)	Battery Modules	Integrator	Event Date	System Age (yr)	State during Accident
US, NY, East Hampton	5	LG Chem	Haugland Energy Group	5/31/2023	4.8	Operational
US, NY, Warwick	8	Powin Energy	Convergent Energy and Power	6/26/2023	0.1	Operational
US, NY, Warwick	4	Powin Energy	Convergent Energy and Power	6/27/2023	0.1	Operational
US, NY, Chaumont	5	General Electric	Convergent Energy and Power	7/27/2023	0.4	Operational

This event is one half of a larger simultaneous failure across 2 discrete sites in Warwick, NY. Both sites deployed the new "Centipede" model from Powin and both failures seemed to have occured within 24 hours of each other. The failure appeared to occur during a large storm that affected both sites in Warwick.

Fire was reported in an outdoor storage facility co-located with solar PV. A shelter-in-place order was issued for the surrounding community within 1 mile of the facility.

NYS Interagency Investigation Findings

In response to the BESS incidents in NYS, Governor Hochul convened an interagency Fire Safety Working Group (WG) to address safety concerns and in July 2024 published a final report.

Proposed Recommendations for Fire Code Updates

1. Peer review required
2. Additional explosion control
3. Fire personnel response time
4. Additional signage
5. Additional System Monitoring
6. Additional Security
7. No Utility Company exemptions

Proposed Recommendations for Fire Code Additions

1. Emergency response and Training
2. Central Station Monitoring notification
3. Periodic Special Inspections
4. “Cabinets” included in Code

See the backup page 34-37 for elaboration on these findings

Types of Impacts from BESS Fires

The authors of this presentation believe that impacts from incidents, or the probability of one, can be grouped into three basic categories;

1. **Physical harm including Loss of Life**
   Given that a BESS operates without staff, much like an electric substation, the potential for loss of life is perceived to be low. The media reporting on incidents has no injuries identified. With minimal parcel size requirements and setbacks from property lines it would further reduce the risk to lose a life.

2. **Environmental Pollution**
   BESS operate daily without emissions of any kind, but in the event of a fire it can be a risk to Air, Soil, and Water pollution. Water is the means to fight a fire and creates runoff. In the event of a fire, a radius of evacuation or remain indoors notice can be issued as a precaution.

3. **Economic Loss**
   Proximity to a BESS, or any property neighbor could result in economic loss from the decline in property value. No data, however, is available to evaluate this impact.

Air, Soil, and Water Findings from the NYS BESS Fires

The "New York State Interagency Fire Safety Working Group Air, Soil, and Water Data Finding" report was published in December 2023.

At 526 pages in length it's not easy to read but it provides an independent assessment of the environmental impact from the four BESS failures in NY.

The Executive Summary states…..

"Following a comprehensive review of analyses of air quality, soil, and/or water data collected in the days following each of the fires, OFPC and DEC, in collaboration with the State Department of Health, concluded that there were no reported injuries, no harmful levels of toxins detected, and no long-term off-site impacts involving any migration of contaminants associated with the fires."

Section 3: What is the reward?

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Possible Increasing Demand for Electricity

Electrification of Transportation and Buildings

- Adoption of EV's and Heat Pumps continue to grow, with variability, based on cost savings they offer and other benefits.

- Consequently, electric demand is forecasted to increase (even with greater efficiencies) and this demand has peak seasonal and time of day profiles.
See backup page 31 for NYISO forecast on electric demand

Technological Trends and Efficiency

- Burning fossil fuels to release energy have limits based on material properties and can only possibly achieve 100% efficiency from the combustion process
See backup page 31 for technical explanation

- PV for solar panels and battery chemistry may continue to make technological improvements and at lower costs, resulting in increasing energy per dollar.
See backup page 32 for technical explanation and trends

BESS Services are the source of possible benefits

Possible Global and Community Benefits

- Combats Climate Change by reducing Greenhouse Gas emissions in two ways;
  - Stores electricity from intermittent renewable resources, like solar and wind, allows them to maximize production which would otherwise be curtailed when demand is not present.
  - Responsiveness to peak electric demand, avoiding the need to start up gas fired peaker plants.

Possible Individual Benefits

- Can maintain electric grid quality by adding resiliency, reliability and flexibility. *See backup page 36 for a full list of services that BESS provide.*
- Potentially avoids even higher cost of electricity by not requiring additional Central Hudson investment in new transmission lines and electric generation.

Section 4: Location Considerations

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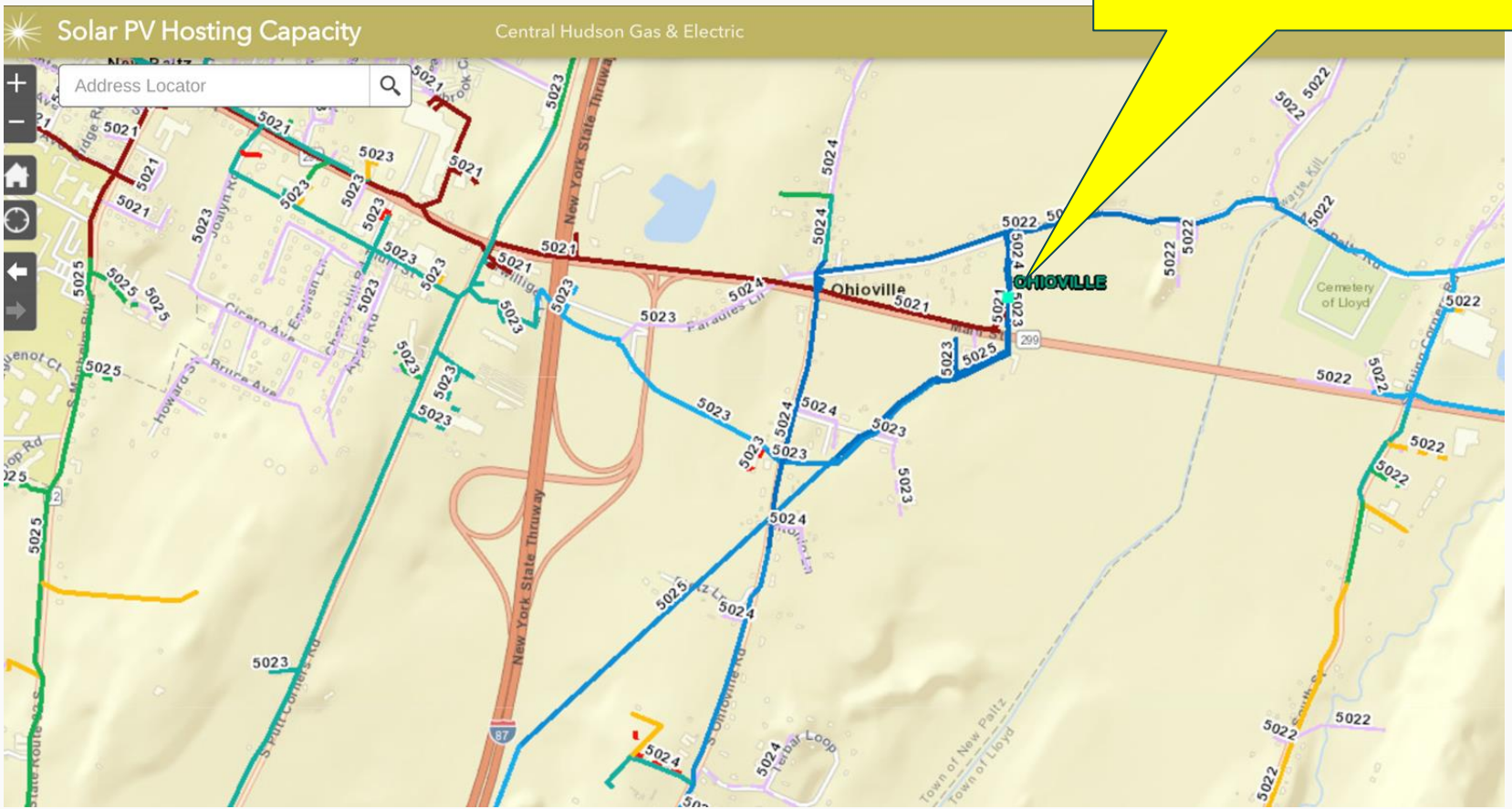
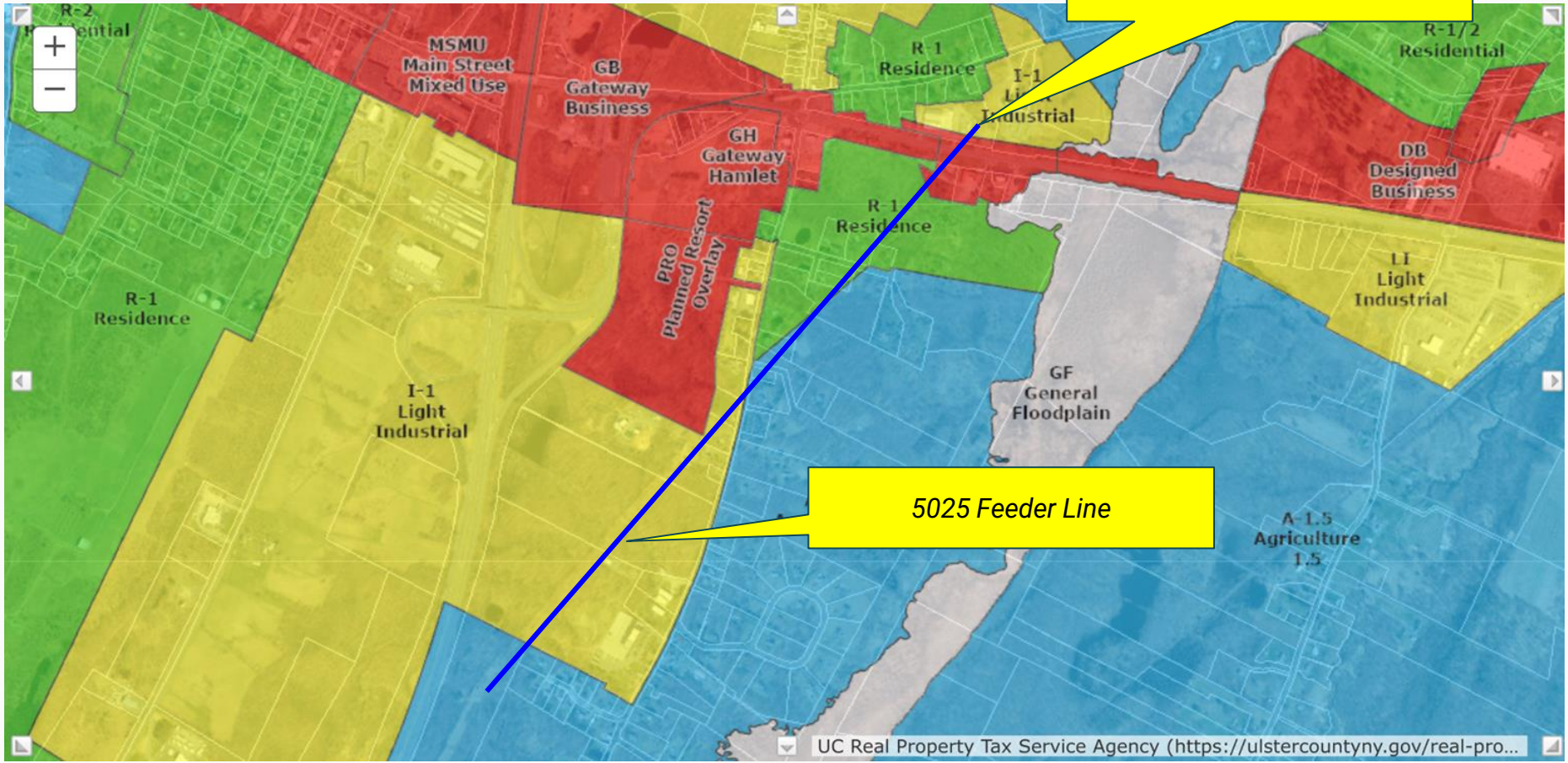
Key Infrastructure



Zoning Map from Ulster County Parcel Viewer



Location Considerations

- Proximity to both an Electric Substation and Transmission/Distribution are important aspects to site a Utility Scale BESS and can impact neighbors.
- Zoning should constrain where a Utility Scale BESS can be located.
- Parcel size needs to accommodate the scale of the BESS and the buffers that would be needed to protect neighbors and minimize view lines.
- The combination of proximity to infrastructure, suitable zoning, and parcel size limits the locations that a BESS could be located.

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Backup Content

Safety Study Members

Joe Londa

Study Leader, CSC Member and Retired from a 40 Year Career as a System Engineer

Matt DiDonna

Town Planning Board

Lyle Nolan

Town Planning Board

Battery Examples and Tiers

Residential

Commercial

Utility

Wall Mounted Size

Parking Space Size

Parking Lot Size

Tier 1 <600kWh

Tier 2 >600kWh

NYS Model Law for BESS is silent on why 600kWh is the criteria for Tier 1 and 2, but physical size starts to become material. See backup Page 32 for NYSERDA definition of BESS.

Inside a Lithium Iron Phosphate (LFP) Battery Cell

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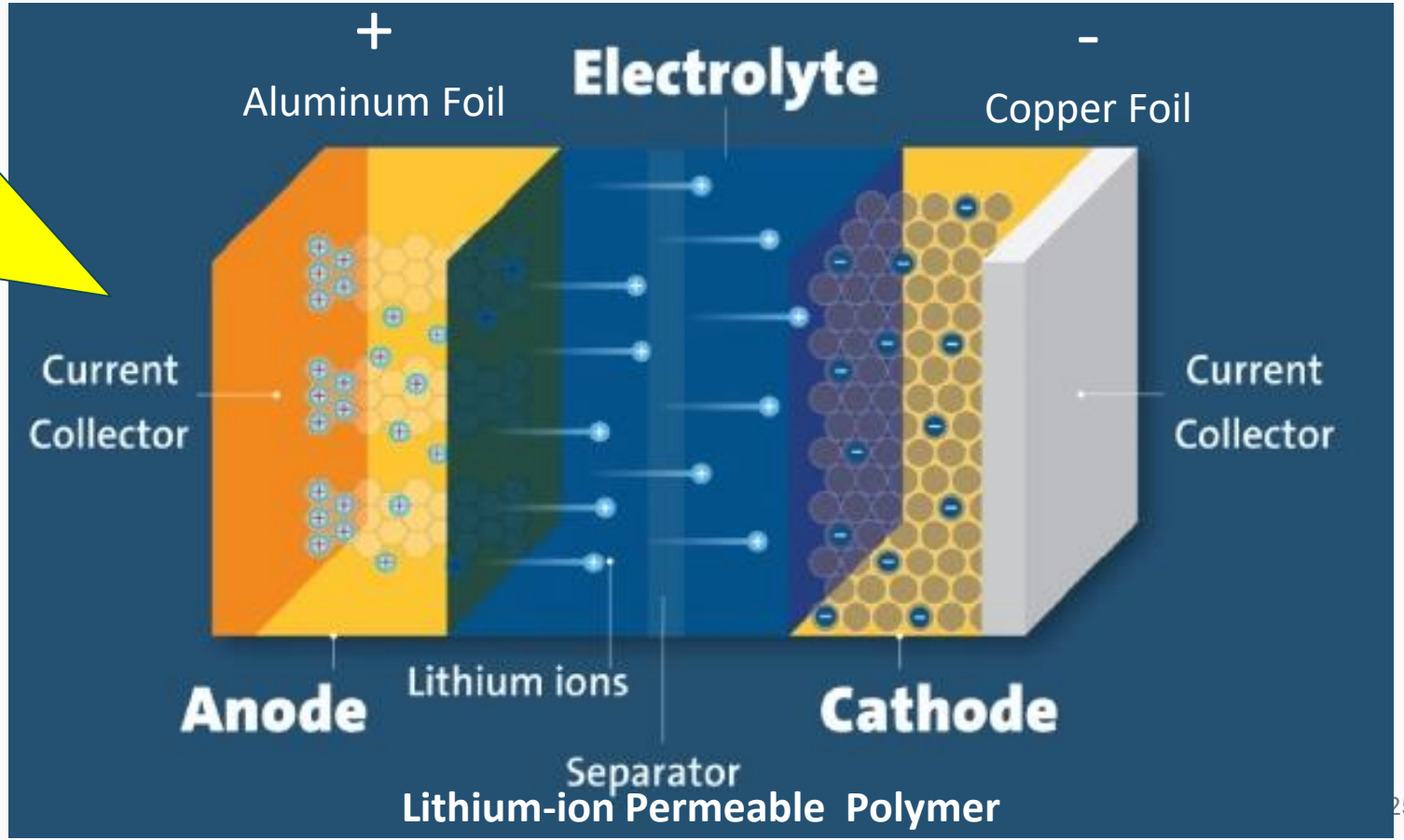
This diagram is greatly magnified.

The mono cell construction is perhaps as thick as a few pieces of paper.

To understand how LFP improves battery safety see page 27



What are Battery Tiers?

From the NYSERDA Model Law for Battery Energy Storage System

BATTERY ENERGY STORAGE SYSTEM: One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time, not to include a stand-alone 12-volt car battery or an electric motor vehicle. A battery energy storage system is classified as a Tier 1 or Tier 2 Battery Energy Storage System as follows:

A. Tier 1 Battery Energy Storage Systems have an aggregate energy capacity less than or equal to 600kWh and, if in a room or enclosed area, consist of only a single energy storage system technology.

B. Tier 2 Battery Energy Storage Systems have an aggregate energy capacity greater than 600kWh or are comprised of more than one storage battery technology in a room or enclosed area.

The New York State Fire Code makes use of this same definition.

Battery Chemistries have different abilities to induce a thermal runaway?

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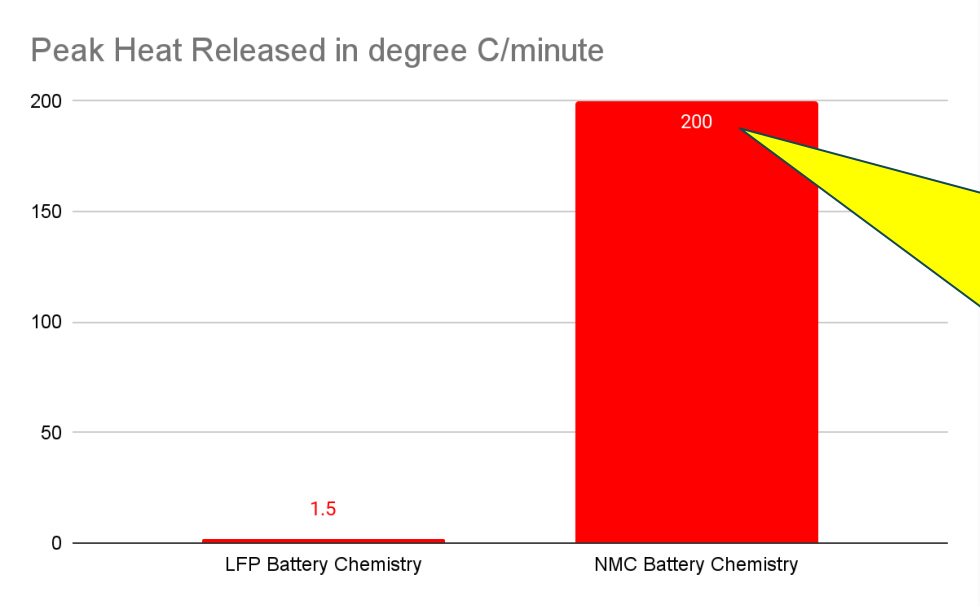

NMC batteries was the preferred chemistry and used by Tesla in earlier models of EV's based on charging rates

LFP have a much lower heat generation rate which reduces the propagation of heat and potential for thermal runaway and this has become the standard solution.

Ongoing evolution of batteries will likely add diversity and focus on charging rate and safety, solid state batteries for instance.

See the backup page 28 for a more technical explanation

From "New Developments In Battery Safety for Large Scale Systems" by independent Researchers

Battery Chemistries have different abilities to induce a thermal runaway?

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Log Scale

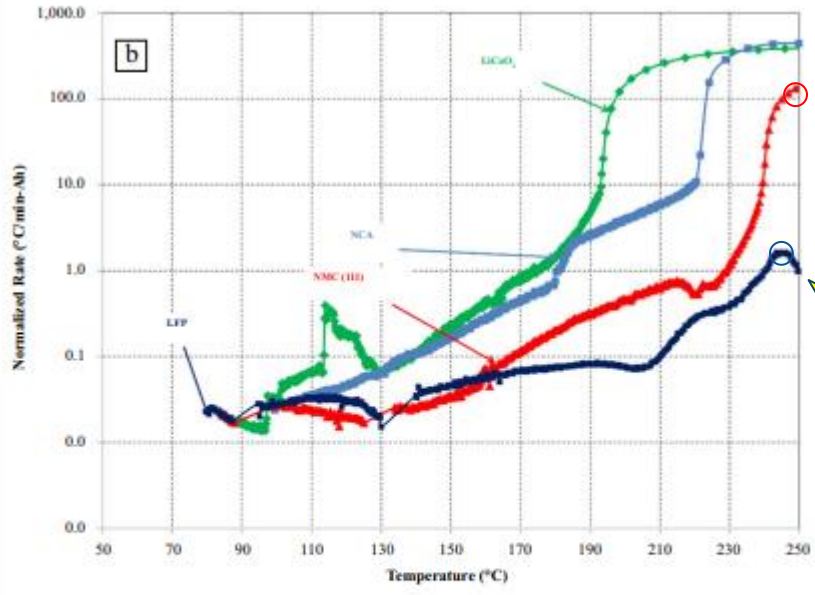

Figure 2. Accelerating rate calorimetry showing thermal runaway events of various active materials. (a) The peak width of these plots can generally be interpreted as the total energy released during thermal runaway with the peak height relating to how rapidly heating is able to occur. Other important values include the onset temperature of the peak, showing the temperature at which high rate thermal runaway will occur. (b) Select plots are also shown in a log scale showing the lower temperature, low rate behavior comparison of these cathode materials.

From "New Developments In Battery Safety for Large Scale Systems" by independent Researchers

The LFP reaches a peak of 1.5 ℃/min of heat release compared to about 200 ℃/min (red line) for Lithium Nickel Magnesium Cobalt (NMC) batteries

NMC batteries were the earlier preferred chemistry

This much lower heat generation rate reduces the propagation of heat and potential for thermal runaway and that ongoing evolution of batteries will likely add diversity and focus on the contest between slow/fast charging and safety.

BESS Generations

Evolution in technology and products happens sometime without notice over years or decades. That evolution results in additional benefits that must contend with short comings and impacts along that evolutionary timeline.

1. **Generations are not always defined in advance and may be defined from a look back**
   For example, the transition from wood and fabric biplanes to aluminum and graphite monoplanes. Our legacy generations may go into a museum, but they may also linger in society based on the practical uses they offer.

2. **Change benefits both the developers and the public**
   Developers compete with each other for market share and profits, along with the heart and mind shares for the consumers and public. The consumer and public are often willing participants in that they use the economic and regulatory process to create guardrails and address the wants and needs they have, even when unspoken.

3. **Adoption varies**
   Some people and communities are willing to be early adopters, others are late adopters, and many fall in between when conditions are satisfied.

Electric Demand, and Energy Limits of Fossil Fuel

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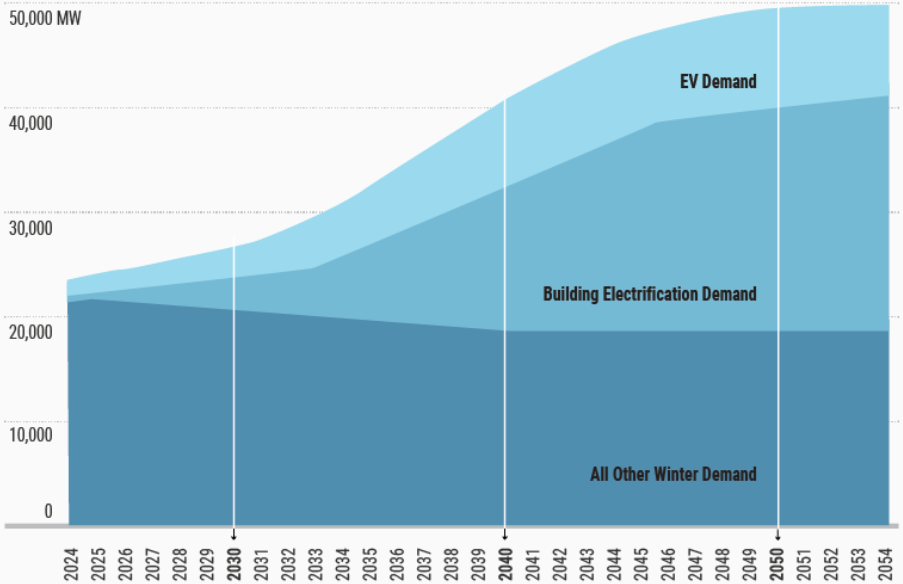
NYISO Forecast of Electric Demand



Energy Limits of Fossil Fuel

The **heating value** (or **energy value** or **calorific value**) of a substance, usually a fuel or food (see food energy), is the amount of heat released during the combustion of a specified amount of it.

The *calorific value* is the total energy released as heat when a substance undergoes complete combustion with oxygen under standard conditions. The chemical reaction is typically a hydrocarbon or other organic molecule reacting with oxygen to form carbon dioxide and water and release heat.

PV and Battery Storage Improvements in $/Watt

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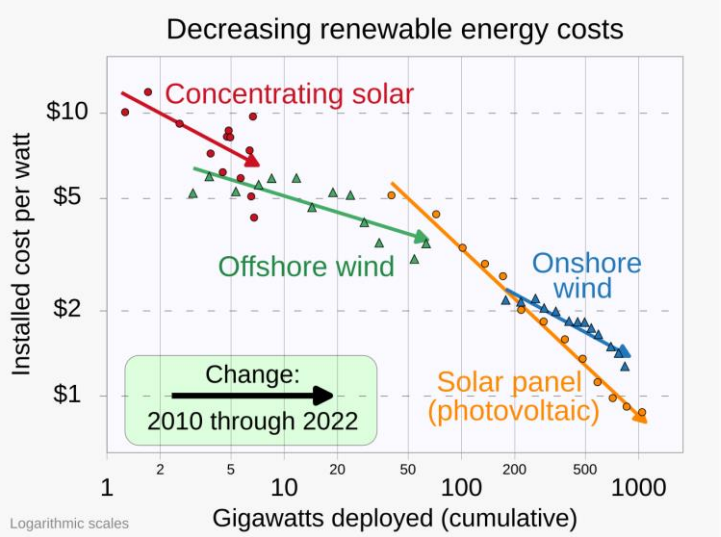
Solar Cell Efficiency and $/Watt Trends

Many research paths continue to improve Solar Cell Efficiency and drive the industry to greater improvements in Cost/Watt as the trend data shows.

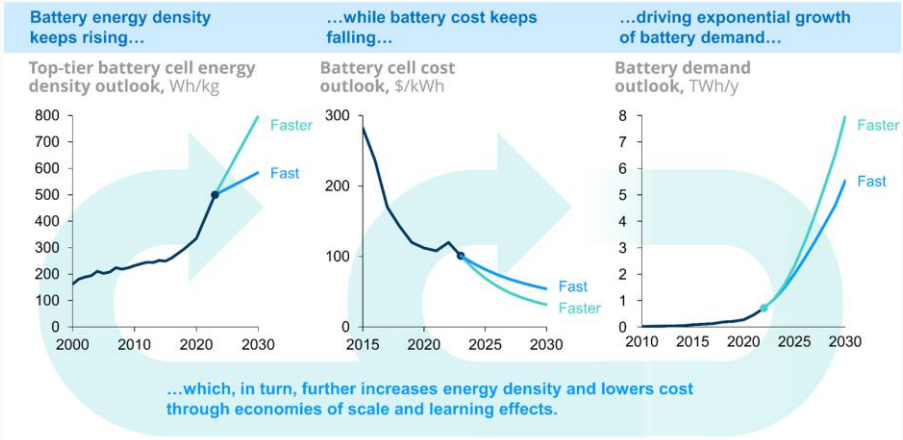


By RCraig09 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=138126541

Li Battery Efficiency and $/Watt Trends

Storage efficiency as measured by round-trip efficiency (RTE) with lithium-ion batteries exhibiting high RTE (80-90%) with many paths of research

The Rise of Batteries in Six Charts and Not Too Many Numbers



Source: Ziegler and Trancik (2021) before 2018 (end of data), BNEF *Long-Term Electric Vehicle Outlook* (2023) since 2018, BNEF Lithium-Ion Battery Price Survey (2023) for 2015-2023, RMI analysis.

NYS Interagency Investigation Findings

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The recommendations were for the New York State Fire Prevention and Building Code Council (Code Council) for revisions and enhancements to the Fire Code of New York State (FCNYS or Fire Code).

Proposed Recommendations for Fire Code Updates

1. **FCNYS 1206.8 PEER REVIEW**
   Require industry-funded independent peer reviews for all projects.

1. **FCNYS 1206.13.3 EXPLOSION CONTROL**
   Expand the requirement for explosion control to include BESS cabinets in addition to rooms, areas, and walk-in units. Additionally, provide design requirements or language for what constitutes a passable system.

3. **FCNYS 1206.7.1 FIRE MITIGATION PERSONNEL**
   Require that qualified personnel are available for dispatch within 15 minutes and able to arrive on scene within four hours to provide support to local emergency responders.

NYS Interagency Investigation Findings Continued

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4. FCNYS 1206.11.8 SIGNAGE

Extend safety signage requirements beyond the BESS unit itself to include perimeter fences or security barriers and include a map of the site, BESS enclosures, and associated equipment.

5. FCNYS 1206.9.2.1 SYSTEMS MONITORING

Update the Fire Code to ensure that Battery Management System (BMS) data incorporates high resolution sensor data, including voltage, state of charge, and temperature measurement of each cell or each series-connected cell group, and is monitored by a 24/7 staffed Network Operations Center (NOC). Critical failure notifications should be immediately communicated to the site owner/operator to take corrective actions as necessary.

6. FCNYS 1206.11.9 SECURITY OF INSTALLATIONS

Update the Fire Code to incorporate requirements for video surveillance systems, specifying their intended use as both a continuous monitoring tool and a post-event analysis resource.

7. FCNYS 1206.2 APPLICABILITY

Remove the Fire Code exemption for BESS projects owned or operated by electrical utilities to ensure that all projects comply with the Fire Code.

NYS Interagency Investigation Findings Continued

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Proposed Recommendations for Fire Code Additions

1. EMERGENCY RESPONSE PLANS and REGULAR FIRE DEPARTMENT TRAINING

Include a requirement for an Emergency Response Plan (ERP) and offer annual local first responder training for every BESS installation.

2. CENTRAL STATION MONITORING OF BESS FACILITIES

Include a Fire Code requirement for monitoring of fire detection systems by a central station service alarm system to ensure timely, proper notification to the local fire department in the event of a fire alarm.

3. PERIODIC SPECIAL INSPECTIONS

Introduce a new provision in the Fire Code mandating industry-funded special inspections for BESS installations to ensure thorough safety and compliance.

4. CURRENT PERCEIVED EXEMPTIONS FOR BESS CABINETS

Include “cabinets” in all Fire Code requirements that pertain to rooms, areas, or walk-in units, except for fire suppression requirements, as they may be inappropriate for cabinet.

NYS Interagency Investigation Findings Continued

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Additional Considerations

1. ROOT CAUSE ANALYSIS (RCA)

The WG concluded that the Fire Code may not be the appropriate place to require a Root Cause Analysis (RCA). It goes on to make suggestions.

2. WATER SUPPLY

The WG recommends enhancing guidance for water supply serving BESS facilities, including whether water is appropriate for different technologies, in an emergency response to a BESS fire and determining if more specific requirements are necessary.

3. TRANSFORMERS CONTAINING HIGHLY FLAMMABLE MATERIALS

Recommend that the Code Council have further discussions around clearance distances of oil-insulated transformers from BESS.

4. FIRE STOPS, BARRIERS, or FIRE BREAKS

Mandate the installation of fire stops for all BESS enclosure penetrations to prevent the propagation of fires from one BESS unit to another through these pathways.

Rate of Incident for BESS Thermal Runaway

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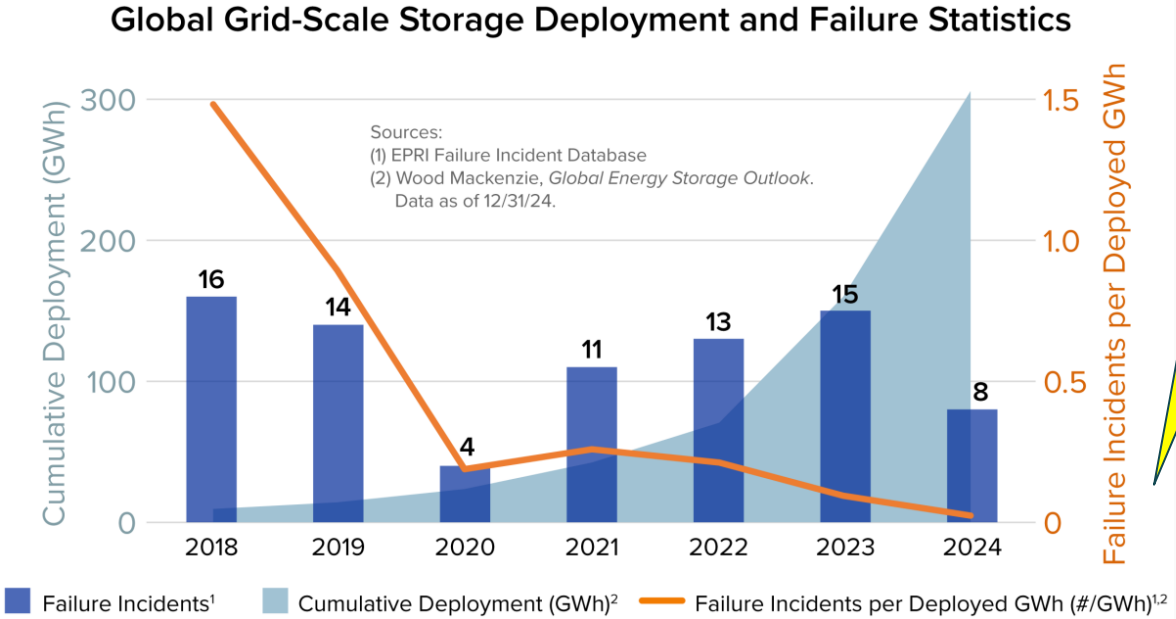
As reported by the EPRI Database……



EPRI uses “Failures/Cummulative Deployed GigaWatts” or #/GW as the key metric to describe risk.

Naturally, if incidents remain low the risk will decrease as deployments increase.

The authors of this presentation feel ambiguous about this metric because its not an easy to relate to metric.

Perhaps make it more akin to home fires with a metric like fires per containers.

BESS Services

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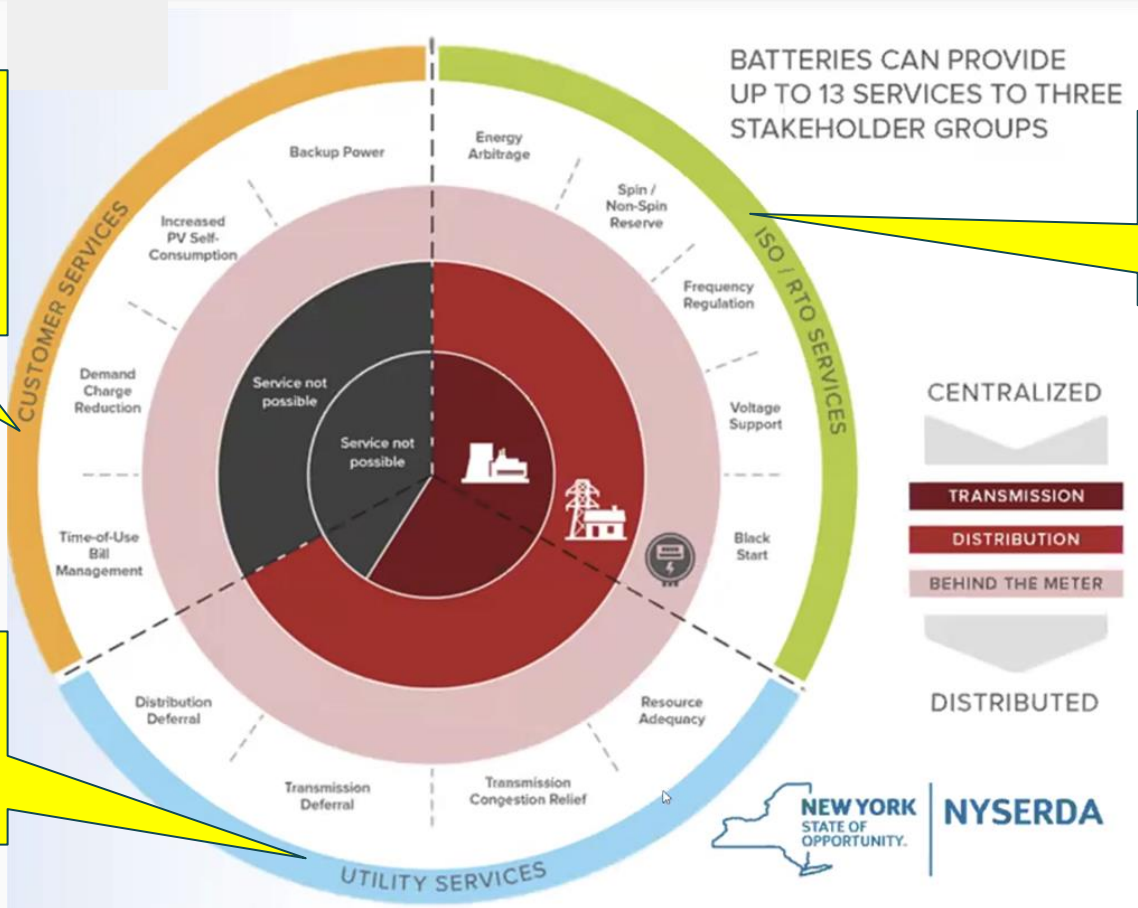
Behind the meter BESS for Residents and Commercial customers have these Services

Utility Scale BESS provide these ISO/RTO Services

Utility Scale BESS provide these Utility Services



Risk and Reward Concept

- A system rarely has zero risk and through an iterative improvement process it can become low enough that we begin to ignore the risk.
  Cars, Airplanes, and Homes are examples of this.

- People can accept risk if the benefits, to them individually or to society, are great enough relative to the risk.
  Playing the lottery is an example of this, risk one dollar for a low odds chance to win a million dollars.

- This is the basic economics concept of risk and reward.
  A Utility Scale BESS would have this same relationship but the risk they have are still iteratively improving and being understood, given the length of time that BESS systems have been deployed and advancements in technology.

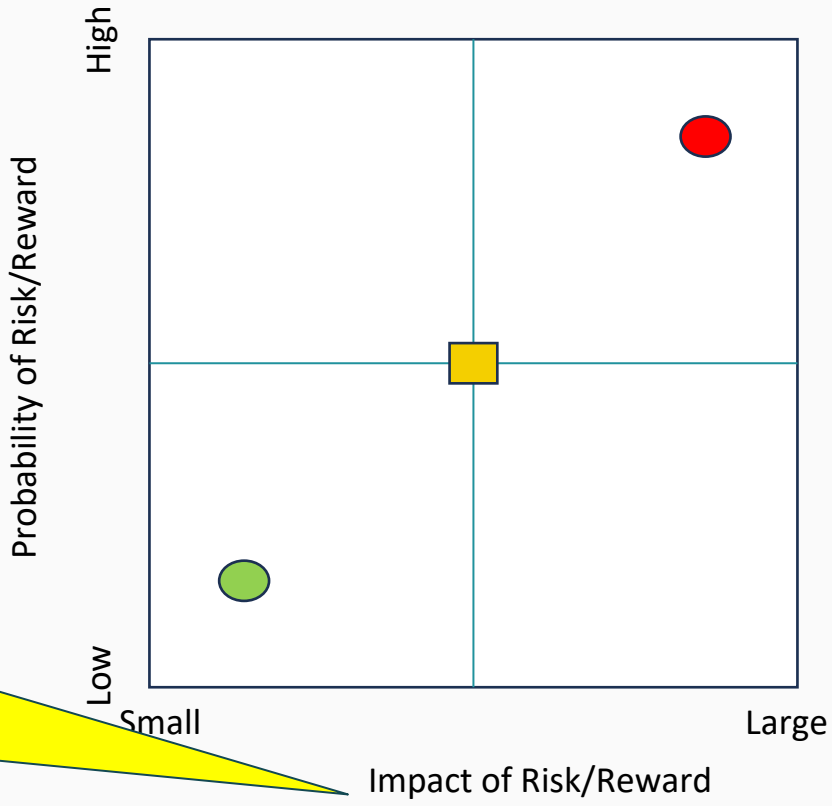
Understanding Risk and Reward

Man made things can fail. They do so at a certain rate or probability but perception of risk are often more influential.

Depending on maturity of the technology, it may be difficult to establish the probability.

Incidents can result in different impacts that occur at the same time.

The type of impact can have different probabilities that we need to be informed about



Individual A

Perceived Risk/Reward

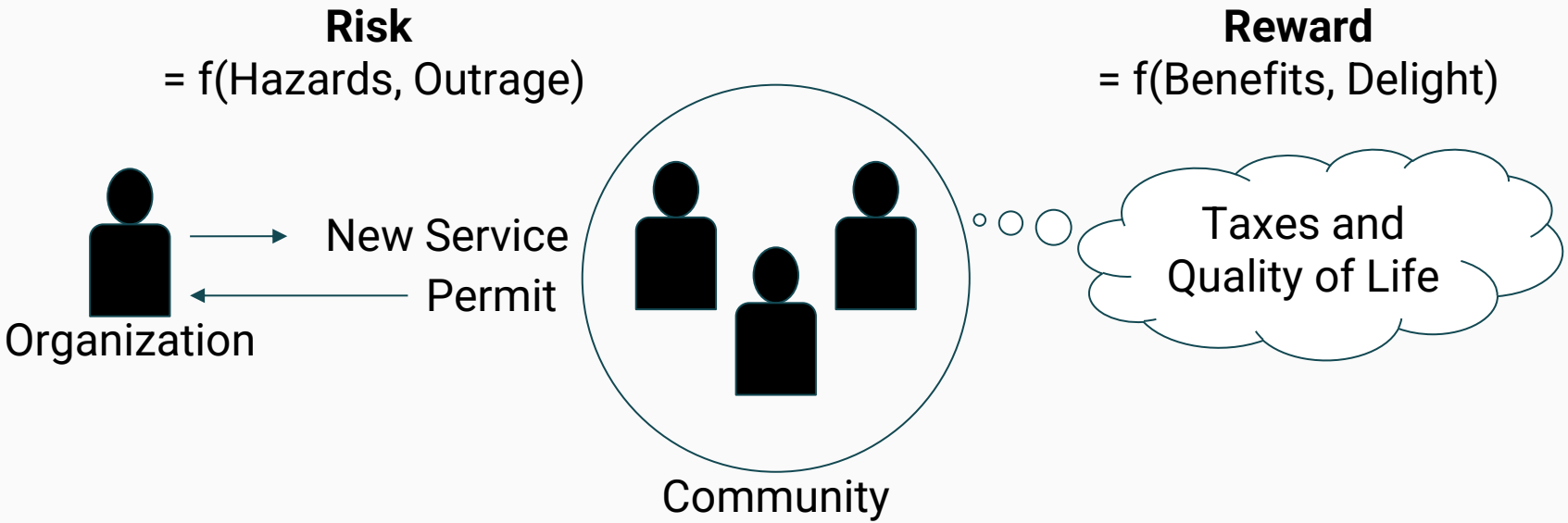
Individual B

Perceived Risk/Reward

Community

Perceived Risk/Reward

How we live includes the Risk and Reward decisions that others make for us



Q: What defines Community?
Q: Who represents the Community?
Q: Simple majority or unanimous consensus?

Economic Loss from a BESS

No data is available on how BESS neighboring properties have had market value impacted as few BESS sites exist within NYS.

Perhaps some comparison can be made to residential properties that border cell towers or transmission wires.

Intuitively, living next to anything that has a failure risk would negatively impact the neighboring property market value, but it would likely be diminished or eliminated as distance increases or failure rates become low.