Tuesday, June 16, 2021
Medway Planning and Economic Development Board
SPECIAL MEETING
Medway Middle School – Presentation Room
45 Holliston Street.
Medway, MA 02053

Members	**Andy Rodenhiser**	**Bob Tucker**	**Tom Gay**	**Matt Hayes**	**Rich Di Iulio**	**Jessica Chabot**
Attendance	**X**	**X**	**X**	**X**	**X**	**X**

PRESENT:

- Susy Affleck-Childs, Planning and Economic Development Coordinator

PUBLIC COMMENTS:

- There were no public comments.

The representatives from Pacific Northwest National Laboratory providing the presentation included the following:

- Matthew Paiss
- Jeremy Twitchell

It was explained that Pacific Northwest provides technical assistance to help figure out where energy storage fits. The information in the presentation was made possible through funding provided by the U.S. Department of Energy Office of Electricity, through the Energy Storage unit under the direction of Dr. Gyuk.

The topics covered in the presentation included:

- What is energy storage?
- Where energy storage can be deployed?
- How energy storage relates to the considerations of local jurisdiction, and codes and safety standards.

See attached slides from the presentation.

The Board was informed that the U.S. electric grid operates on an alternating current at 60 cycles per second. The slightest variation of this can cause major damage to the grid and connected machinery. The goal is to maintain the power generation and balance the energy load demands. There are two things which define making storage unique. The first is that it is flexible. There needs to be a balance. A chart of the four quadrants of grid balance was shown. The second characteristic is that it needs to be scalable. Since it is flexible, energy storage investments accelerated in 2020. California was a leading source in this. There is a growing trend for energy storage. The recent boom in storage development has been driven by falling lithium-ion system costs. The cost for this has fallen by 85% over the last decade. Battery costs represent a fraction of overall installed costs. Energy storage systems, since they are flexible and scalable, can provide services throughout the grid and can be placed in distribution, transmission and generation areas. A customer can use it to demand change in reduction and as backup power. This is time-of-rate management. The storage is located and managed by who owns it and where it is stored. This could include utility, third party, and customer. This could also be a third-party hybrid owner. Energy storage is "Energy limited" if fuel is available. The storage does not produce energy and is limited to how much it can hold. The storage technologies are mechanical. This is stored as a potential energy that is later used to generate electricity. This could include examples which would be pumped storage hydro, compressed air energy storage and flywheels. Another storage technology includes electrochemical. This is stored in chemical and later released examples are lithium batteries, flow batteries and sodium batteries. The last storage technology is thermal. The electricity is stored by heating/cooling air or another medium for energy management or electricity production. An example of this includes ice thermal storage and concentrating solar.

The local jurisdictions need to consider the following:

- Environmental effects and associated mitigation
- Infrastructure utilization and enhancements (road infrastructure)
- Property values
- Tax base
- Local energy service reliability and resilience.
- Indirect benefits form grid scale improvements.

The Town would need to think about the indirect benefits from grid scale improvements which would include system performance, lower stack emissions, and least-cost deployment for electricity rate management. Research has been conducted on property values. Analysis has been done on energy infrastructure technology types and their influence on residential property values. There has been analysis done and a detailed review of the environmental review by the Monterrey County which provides a detailed environmental impact review under the State of California Environmental Quality Act.

The next section covered was the code and standards. One of the codes is the NFPA 1. The other is the NFPA 855. There was a chart which showed the standards and model codes hierarchy indicating where specific codes apply. This could include the built environment, installation/application/energy storage system and system components. The energy storage systems have the following codes: UL9540, ASME TES-1 and NFPA. There was a map which showed the IFC adoption of the International Fire Code (IFC). There is the intention of FY22 MA will be adopting the NFPA855. The current IFC Code is from 2021 and there is current work to update this for 2024. The recent changes will align with the NFPA 855. The NFPA 855 has the first edition published in 2020. This covers the design, commissioning, O & M, deflagration protection, emergency response, and decommissioning. This also requires that ESS listed to UL9540. This becomes enforces through reference. MA will adopt this it will reference UL9540. The State of MA has also committed to adopting NFPA1 Fire Code 2021 Chapter 52.

There are two options for explosion protection requirements. This includes the NFPA68 – deflagration venting and blow out panels to protect structure from explosion based on max gas production in cell tests. There is also the NFPA 69 deflagration prevention which has the exhaust system designed to keep below 25 % of LEL in area. The test method of UL9540A is to evaluate the fire characteristics and interpreting the test results and this can be challenging. The best design practices include the system design and exterior marking and visible alarm annunciation for the dedicated use at the buildings. There would be smoke and heat sensors for delayed detections post agent discharge. The warning systems would have the BMS which should remain powered and in communication with the monitoring systems. The incident pre-planning is to include the local responders plans and locations of ESS. They would need to plan for multiple scenarios including decommissioning and having clear signage of hazards with contact information. The incident management addressed life, property, and environment. There needs to be identification of a site manager to be liaison with the local responders. There needs to be an evacuation plan and shelter in place.

The meeting was next opened to questions from PEDB members.

<u>If a battery catches on fire, how long until it can be put out?</u>
- The duration is difficult to determine due to a variety of factors such as the specific battery which caught on fire since there are many different types.

<u>Where does the emergency discharge go back to?</u>
- It goes back to the grid.

<u>Has the MA Firefighters Association begun training on the passage of the new regulations?</u>
- The Fire Code official academy has a facility on their training site in Quincy. The consultant does not know the status of training at the academy. There are local support consultants who will help with training.

<u>There were two installations mentioned in California and a member of the public wanted to know how close those facilities are to residential neighborhoods?</u>
- Those are not close to homes, but the biggest exposure is a sensitive river. This is a 200 mg location. Most of the residences are pretty far away.

<u>What is the oldest battery storage system in the US?</u>
- It has been online back in 2007 and 2008, so probably 13 years. Those sites were noted in the presentation screen.

<u>The Consultant was asked to discuss the pros and cons of stacking the batteries versus in racks. Also pros and cons of housing the batteries in enclosed buildings versus outside:</u>
- The manufacturer of these does allow for a stacking and it has gone through fire testing to show there are no issues with stacking. It is recommended to not have these in buildings but instead outside.

<u>Are there any other environmental impacts the operation might have, particularly on water resources?</u>
- It depends on what the response plan would be and strategy employed which would be a defensive approach with sensitive water limits and those would need to be arranged with the system owner.

<u>In other states where these are installed, are there state level permits also involved versus local permitting. Is a state level permit needed from the energy facility siting board?</u>

- Several states have a conditional certificate to determine if there is a need.

<u>What is the approval for the components of the UL9540 mechanical systems?</u>

- There will be pages of listing requirements for the components which need to be submitted to the testing entity. The labs which perform the tests perform the certifications on the components. The quality of work done is hard to control. All that the lab does and is to make sure it is done with each component. The labs have accreditation requirements.

<u>What is the shelf life of these and how do you get rid of these?</u>

- The typical life cycle is 7 to 10 years. There is usually a contract for 10-15 years which could include extra supply of storage, and another could be for the repurchasing of capacity. There is also an agreement put in place about the recommissioning of these.

<u>Has there ever been an overload?</u>

- There has been overloading and can cause a fire.

<u>Is the Town of Medway compatible with a large-scale system?</u>

- The proposed system by Able Grid did go through the initial criteria, and it was determined that Medway is a viable location. The Consultant communicated that it is not their job to determine if this should be in the Town of Medway. This is for the town to determine.

<u>A question was asked about the noise from the HVAC units?</u>

- The Consultant responded that they do not know the decibel numbers since it depends on the equipment used. There would need to be a baseline determined for this.

<u>Describe the ideal site?</u>

- Great sites include where these can get the most energy and where the site is in close proximity to transmission areas. Most of large-scale systems area are built where there is infrastructure or substations.

<u>A question was asked if the consultant is aware of any communities which have written zoning language to address facilities like this that we should look at and study?</u>

- The Consultant will send a list of towns who have written bylaws. One of the examples was New York.

<u>What types of mitigation measures have been required of a developer?</u>

- The Consultant explained that this is something they do not make recommendation on. This should be addressed by the hired consultant when the proposed project is submitted. Possible mitigation could be funding for specifics within the Fire Department and also training for staff.

<u>What is the difference between a lithium battery and flow battery relative to safety?</u>

- The Consultant responded that they do not have experience in flow batteries.

A resident expressed her concern that property values will go down with this type of facility.

It was explained that the Town has created a master plan where one of the goals is to increase the commercial tax base to decrease the tax burden on residential properties. The Town has beautiful parks, trails, open space and great schools. This all costs money and by increasing the commercial base other Town improvements can take place.

The Board communicated that the next step is to continue to have meetings on this. The Town has allocated funds to hire consultants to study the issue and help the Board craft language for a bylaw by October 2021. This bylaw will be brought to town meeting for vote. The goal of the board is to provide the towns' people with as much information as possible. The Town probably wants to make the application for this be a Special Permit since it is currently by right. The Consultants were thanked for providing an educational presentation.

FUTURE MEETINGS:

- June 22 and July 13. 2021

ADJOURN:

On a motion made by Jessica Chabot and seconded by Matt Hayes, the Board voted to adjourn the meeting.

The meeting was adjourned at 9:15 pm.

Prepared by,
Amy Sutherland
Recording Secretary

Reviewed and edited by,
Susan E. Affleck-Childs
Planning and Economic Development Coordinator

Pacific Northwest
NATIONAL LABORATORY

Energy Storage 101

June 16, 2021

Matthew Paiss

Jeremy Twitchell

Rebecca O’Neil

Town of Medway

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

Acknowledgment

The work described in this presentation is made possible through funding provided by the U.S. Department of Energy's Office of Electricity, through the Energy Storage Program under the direction of Dr. Imre Gyuk.

Agenda

- Why energy storage is a unique resource
- Where energy storage can be deployed
- What energy storage is
- Considerations for local jurisdictions
- Codes and safety standards

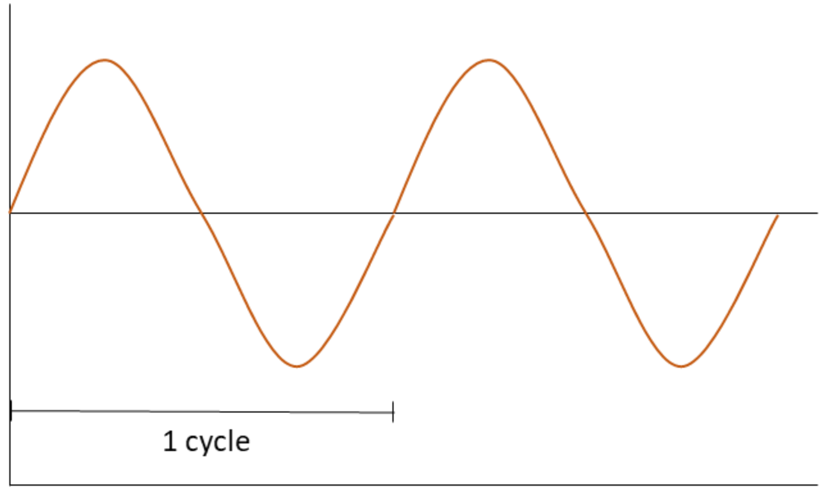
Why Storage is Unique

Pacific Northwest NATIONAL LABORATORY

Electric Grid Basics

The U.S. electric grid operates on an alternating current at 60 cycles per second

- Electric current is constantly alternating direction, giving it a wave form
- Even the slightest variations from 60 cycles can damage the grid and connected machinery

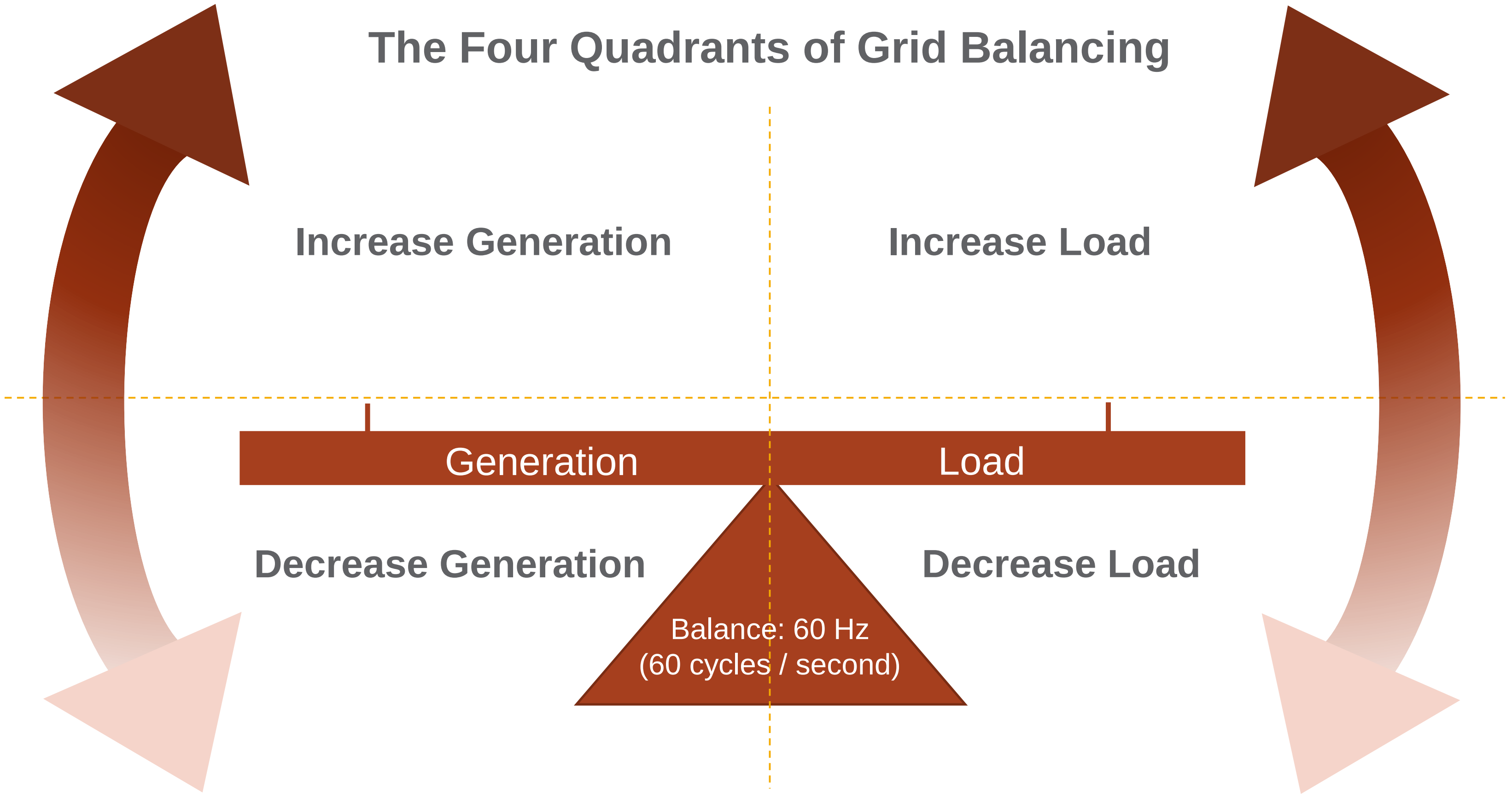


Frequency measures the balance of generation (supply) and load (demand)

- Maintaining generation and load in constant balance is the primary job of grid operators; ancillary services (targeted changes in generation or load) are the tool
- Growing variability introduced by renewable resources and changing customer usage patterns (distributed generation, electric vehicles, etc.) increases value of flexible resources that can rapidly respond to changing grid conditions

Two defining characteristics make storage unique

First, it is **flexible:**



Two defining characteristics make storage unique

Second, it is **scalable:**

InsideEVs

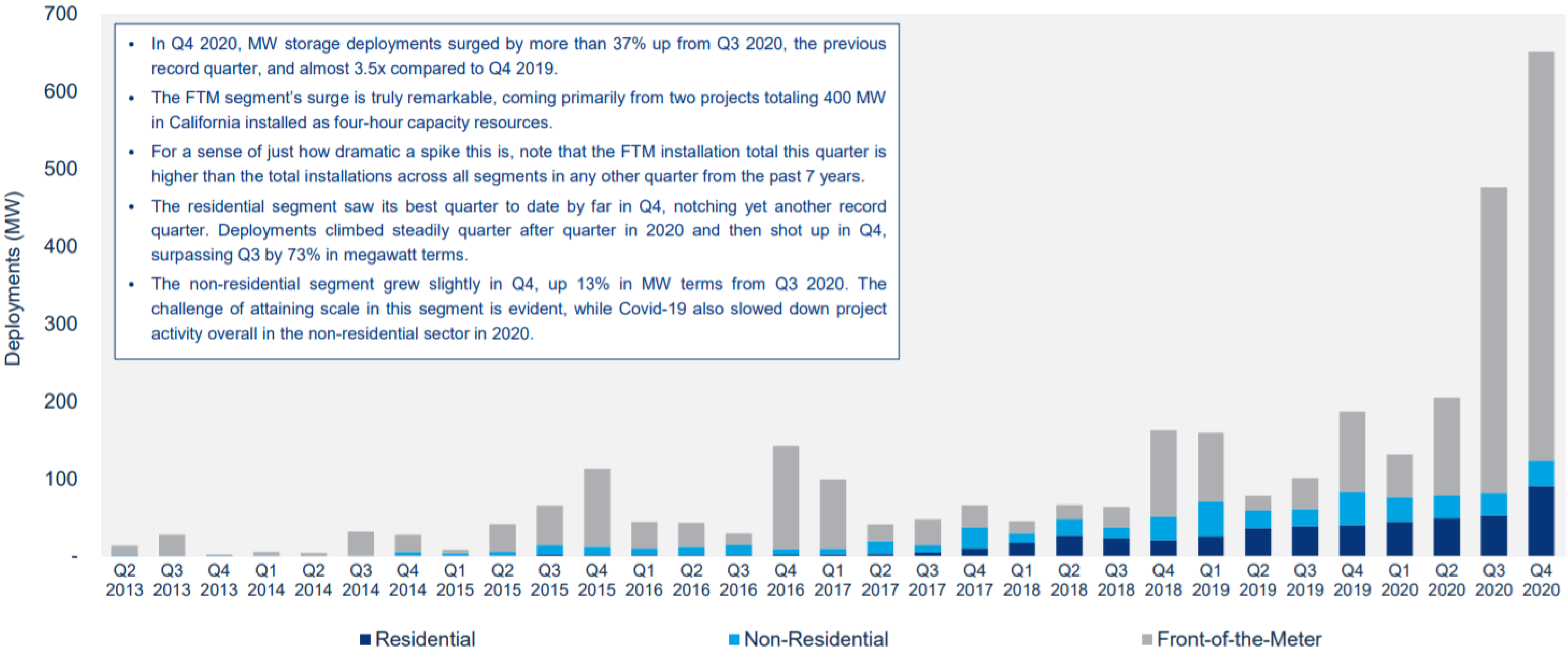
At 300 MW/1200 MWh, the Moss Landing energy storage project (Monterey County, CA) is the largest battery storage facility in the world.

And anything in between

Tesla

At 5 kW/13.5 kWh, a Tesla Powerwall can power an average home for a few hours and is small enough to be mounted on a wall.

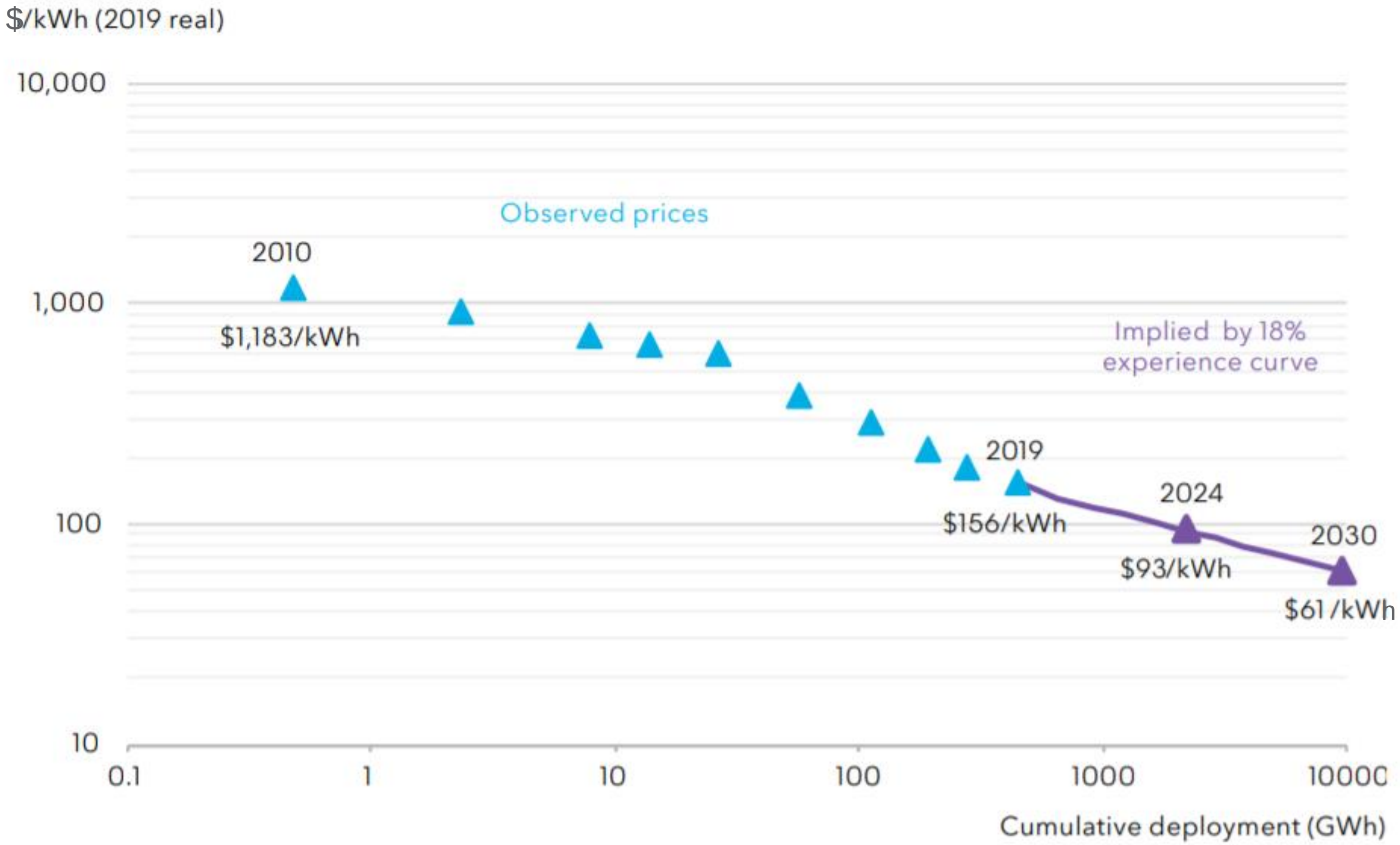
Energy Storage Investments Accelerated in 2020



U.S. Energy Storage Monitor, Q1 2021 (Energy Storage Association/Wood Mackenzie).

Recent boom in storage developments driven by falling lithium-ion system costs

Lithium-ion battery costs fell by 87% over the last decade and are forecast to fall another ~60% over the next decade.



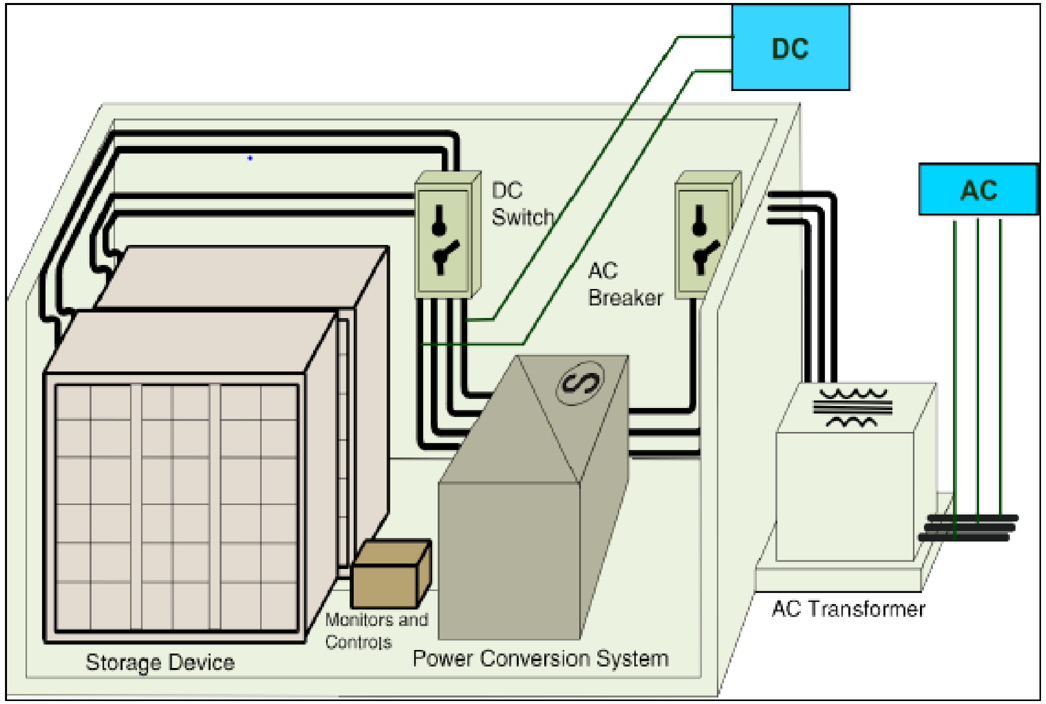
Source: BloombergNEF

Battery costs represent a fraction of overall installed costs

Battery storage prices are generally given based on the battery itself, but interconnecting the device to the grid and allowing for control and interoperability requires additional infrastructure (and cost):

Balance of Plant (controls, switches, HVAC, etc.):
$432/kW
($108/kWh)

Battery capacity:
$174/kWh
($696/kW)



DOE/EPRI 2013 Electricity Storage Handbook in Collaboration with NRECA

Construction & Commissioning:
$516/kW
($129/kWh)

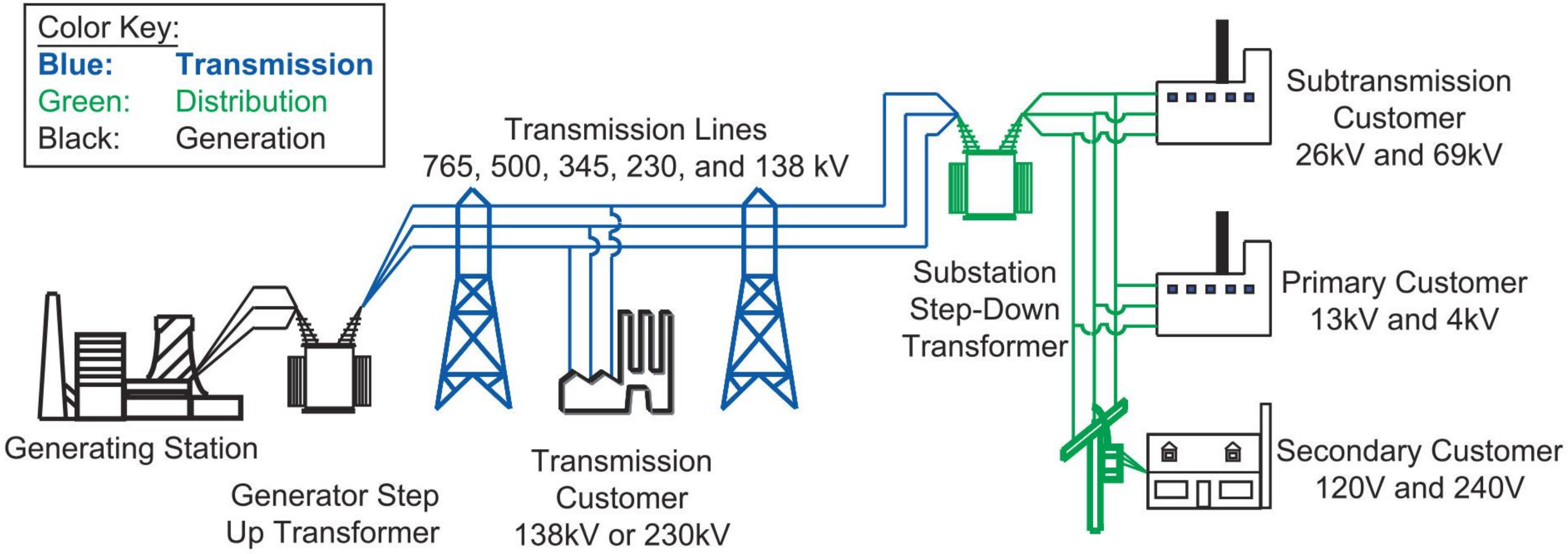
Cost data for a 10 MW/40MWh lithium iron phosphate system from the 2020 Grid Energy Storage Technology Cost and Performance Assessment by Mongird et al.

Total all-in cost for a 4-hour li-ion battery: $411/kWh, $1,644/kW

Battery represents about 40% of total system costs.

Where Storage Can be Deployed

Because storage is flexible and scalable, it can provide services throughout the grid



Generation
- Capacity
- Energy
- Ancillary services
  - Regulation
  - Frequency response
  - Spin/non-spin reserve
  - Etc. …

Transmission
- Thermal management
- Congestion relief
- Infrastructure deferral

Distribution
- Voltage support
- Conservation voltage reduction
- DG integration/hosting capacity
- Thermal management
- Infrastructure deferral

Customer
- Time-of-use rate management
- Demand charge reduction
- Backup power

Where Storage is Located and Who Owns it Shapes How it is Used

Front of Meter | Behind the Meter | ● Readily provided | ◐ Conditionally provided | ○ Cannot be provided

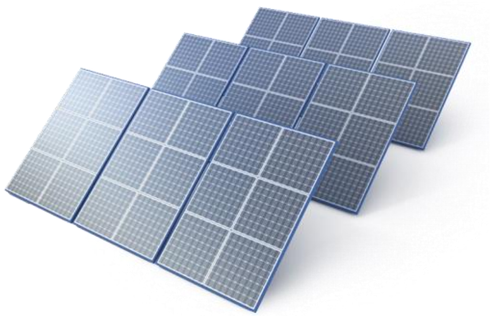
Location	Owner	Resource Adequacy	Peak Reduction	Ancillary services	Renewables Integration	Customer Rate Management	T&D Services	T&D Deferral	Resilience	Decarbon-ization
Front of Meter	Utility	●	●	●	●	○	●	●	●	◐
Front of Meter	Third Party	●	●	◐	●	○	◐	●	●	◐
Front of Meter	Utility/Third Party Hybrid	●	●	●	●	○	●	●	●	◐
Behind the Meter	Utility	●	●	◐	●	●	●	●	●	◐
Behind the Meter	Customer	◐	◐	◐	●	●	◐	◐	●	◐
Behind the Meter	Utility/ Customer Hybrid	●	●	◐	●	●	●	●	●	◐
Behind the Meter	Third Party/ Customer Hybrid	●	●	◐	●	●	◐	◐	●	◐

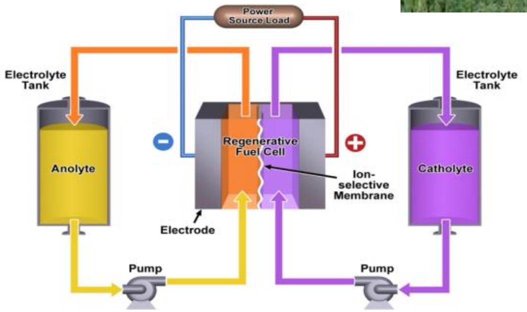
What Energy Storage Is

Energy storage costs: Background information

Unlike energy generation resources, energy storage is “energy limited.” What that means:







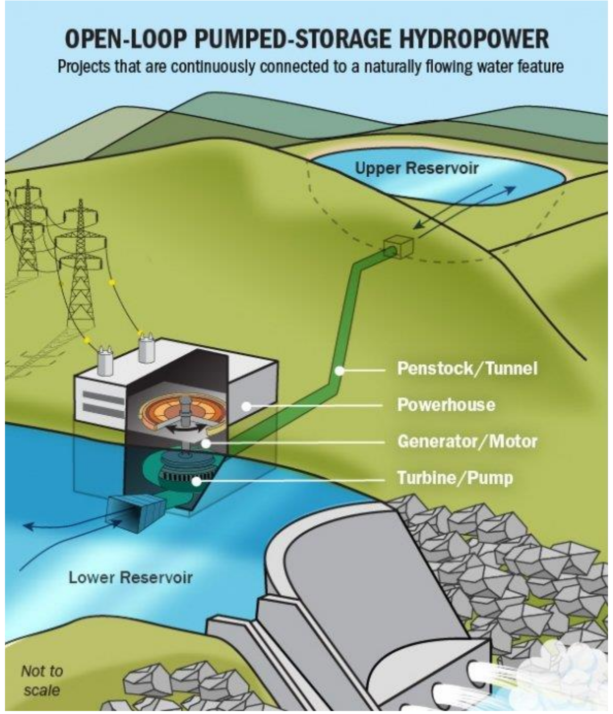
- Generators: if fuel is available, energy production is basically unlimited
- Costs a function of asset’s maximum potential output: $/kilowatt (kW) or $/megawatt (MW)

- Storage does not produce energy and is limited in how much it can hold
- Costs a function of the size of the asset’s reservoir: $/kilowatt-hour (kWh) $/megawatt-hour (MWh)

Storage Technologies: Mechanical

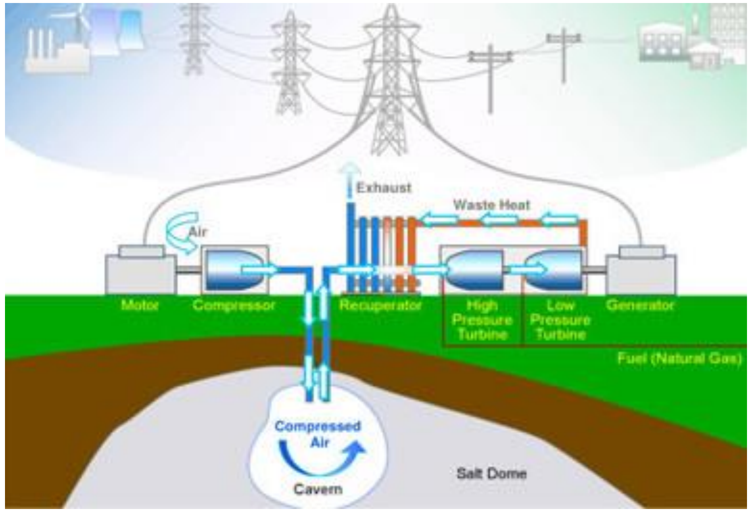
Electricity is stored as potential energy that is later used to generate electricity.

Pumped-Storage Hydro (PSH)



- Long duration (8+ hours)
- Good round-trip efficiency (RTE) – 80%
- Cycle life: 15,000 (40+ years)
- Limited flexibility

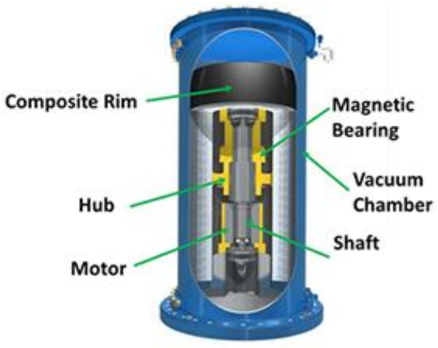
Compressed Air Energy Storage



Ridge Energy Storage & Grid Services LP

- Long duration (8+ hours)
- Low RTE (~50%)
- Cycle life: 10,000 (~25 years)
- Limited flexibility

Flywheels



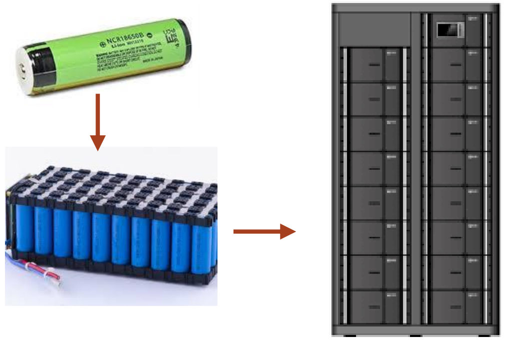
Source: Beacon Power, LLC

- Short duration (~15 min)
- Very good RTE (~85%)
- Cycle life: 200,000 (~20 years)
- Highly flexible

Storage Technologies: Electrochemical

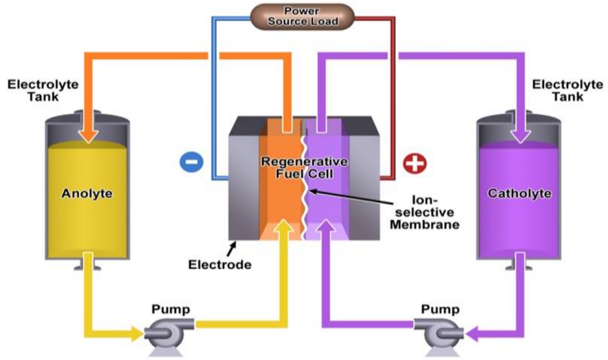
Electricity is stored in chemical bonds and later released.

Lithium-ion Batteries



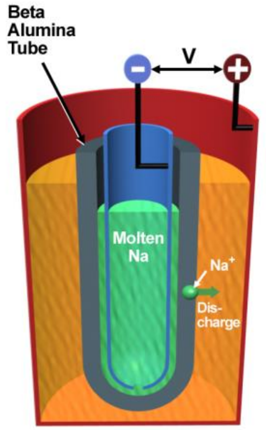
- Short to mid-range duration (0.5 - 4 hours)
- Very good round-trip efficiency (RTE) – 86%
- Cycle life: 3,500 (7-10 years)
- Highly flexible
- Developed supply chain
- Safety concerns
- Recycling challenges

Flow Batteries



- Moderate durations (4-8 hours)
- Moderate round-trip efficiency (RTE) – 70%
- Cycle life: 10,000 (15-20 years)
- Highly flexible
- Improved safety
- Highly recyclable
- Mechanical challenges

Sodium Batteries

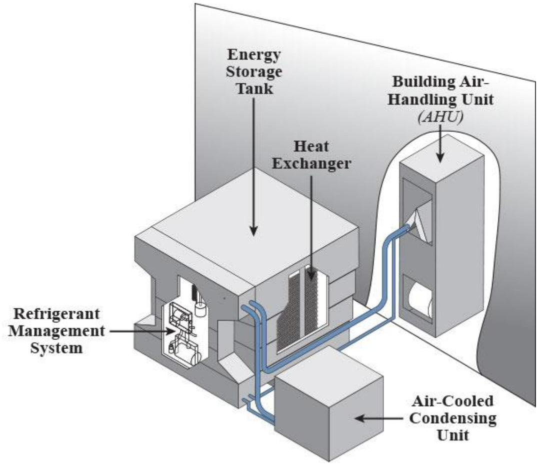


- Moderate durations (4-6 hours)
- Good round-trip efficiency (RTE) – 75%
- Cycle life: 4,000 (10-13 years)
- Highly flexible
- High-temperature ops

Storage Technologies: Thermal

Electricity is stored by heating/cooling air or another medium for energy management or electricity production.

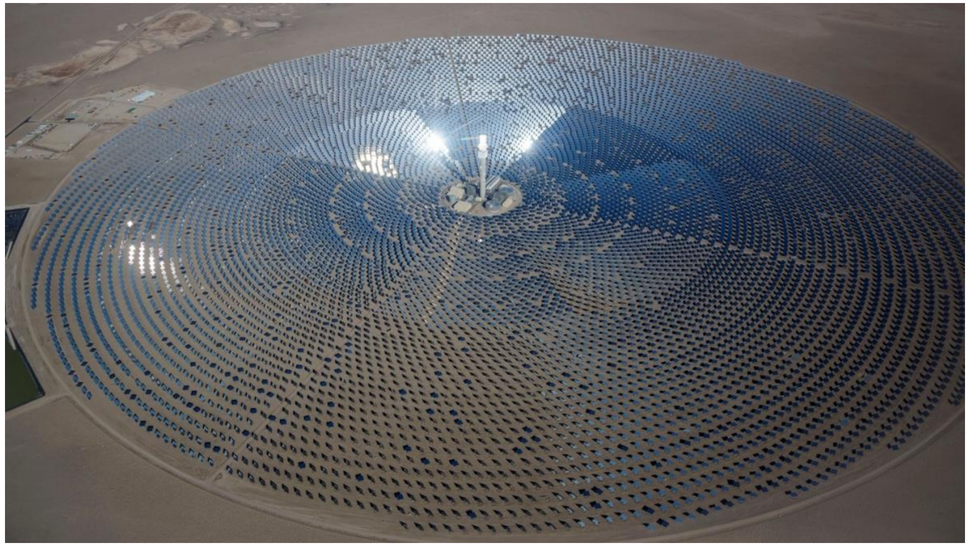
Ice thermal storage



Ice Energy, Inc.

- Moves energy through time, but does not inject electricity into the grid
- Moderate duration (4-6 hours)
- Can shift up to 95% of HVAC loads to off-peak

Concentrating Solar



U.S. DOE

- Longer duration (6-12 hours)
- Very good RTE – 86% (Hameer and Van Niekerk 2016)
- Moderate life (20-30 years)
- Moderately flexible (turbine generator)

Considerations for Local Jurisdictions

Local Effects and Interactions

- Environmental Effects and Associated Mitigation
- Infrastructure Utilization and Enhancements (roads, facilities)
- Property Values
- Tax Base
- Local Energy Service Reliability and Resilience
- Indirect Benefits from Grid-Scale Improvements
  - System performance
  - Lower stack emissions
  - Least-cost deployment for electricity rate management

Property Values

- Many analyses of energy infrastructure technology types and their influence on residential property values. Meta-analyses across technology types available
  - Catherine Brinkley, Andrew Leach, Energy next door: a meta-analysis of energy infrastructure impact on housing value, Energy Research & Social Science, Volume 50, 2019, Pages 51-65, ISSN 2214-6296,
  - https://doi.org/10.1016/j.erss.2018.11.014.
  - https://www.sciencedirect.com/science/article/pii/S2214629618300495
- Common for existing storage deployments to be within substation or industrial footprints
- Standalone storage most similar to substations or utility-scale solar PV installations (not rooftop)
  - Recent study shows residents estimate a "zero" impact on property values, with some exceptions for very large installations or very close proximity.

Moss Landing BESS
Environmental Review Documents

- Monterrey County performed a [detailed environmental impact review under the state California Environmental Quality Act.]
- Itemizes potential interactions similar to NEPA, including rating the level of impact and proposing mitigation measures

The environmental factors checked below would be potentially affected by this project, as discussed within the checklist on the following pages.

☒ Aesthetics	☐ Agriculture and Forest Resources	☒ Air Quality
☒ Biological Resources	☒ Cultural Resources	☐ Energy
☒ Geology/Soils	☒ Greenhouse Gas Emissions	☒ Hazards/Hazardous Materials
☒ Hydrology/Water Quality	☒ Land Use/Planning	☐ Mineral Resources
☒ Noise	☐ Population/Housing	☐ Public Services
☐ Recreation	☒ Transportation/Traffic	☒ Tribal Cultural Resources
☒ Utilities and Service Systems	☐ Wildfires	☒ Mandatory Findings of Significance

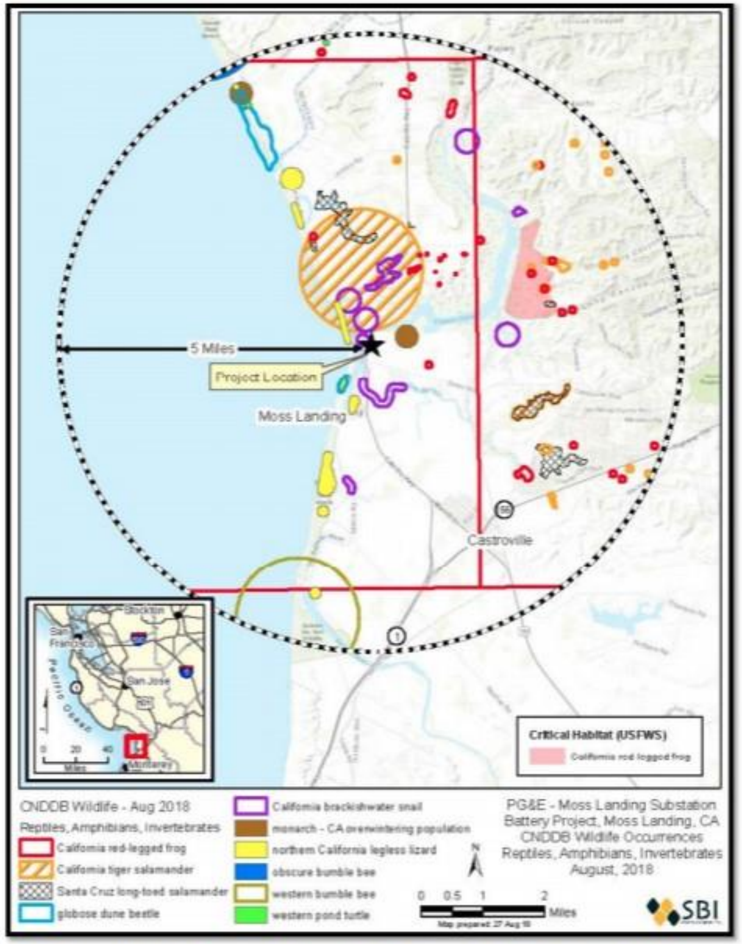
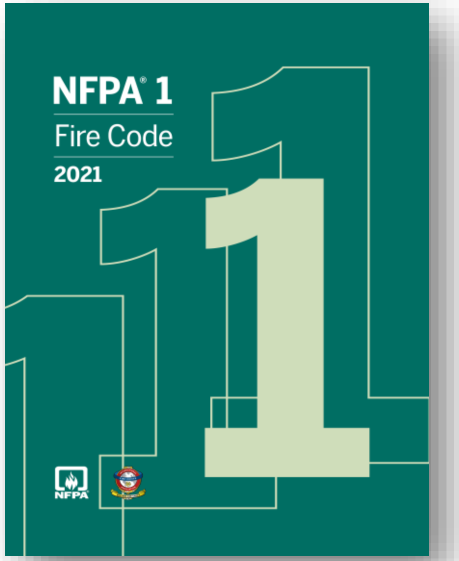
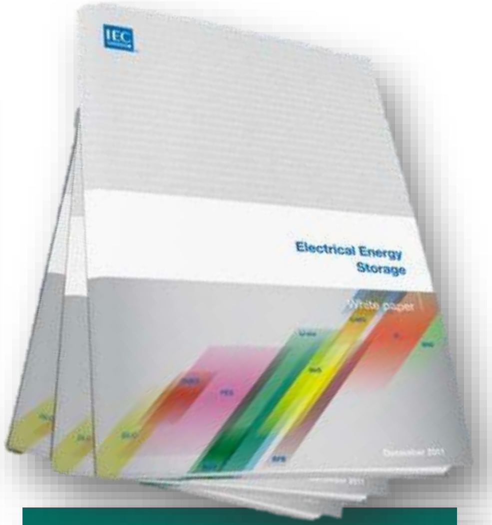


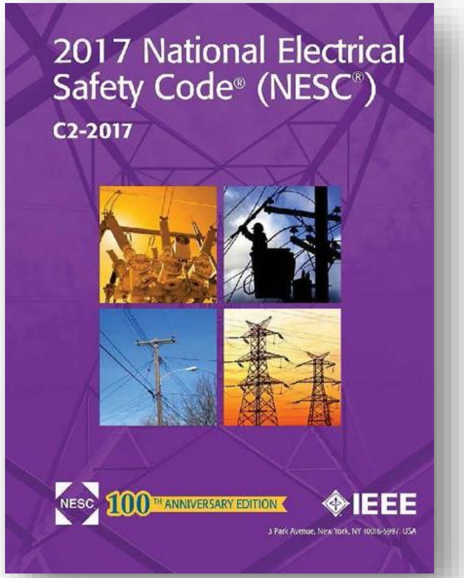
Figure 8 – CNDDB Map of Amphibian, Reptile, and Invertebrate Records within a 5-mile Buffer

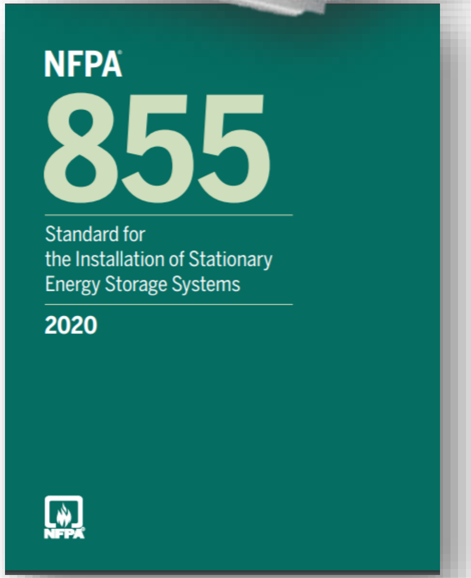
PG&E Co. (Elkhorn Battery Storage Facility) Initial Study *Page 29*
PLN180371

Codes & Standards

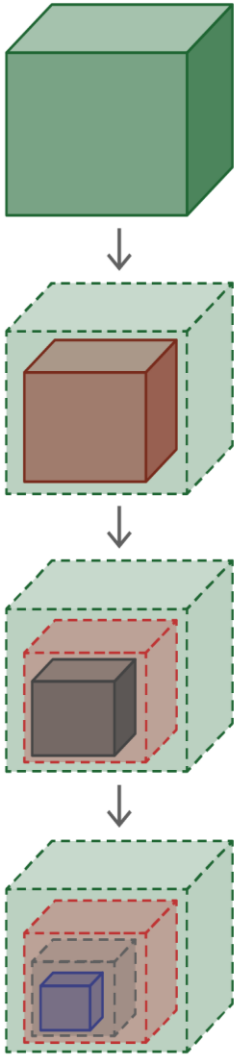








Standards and Model Codes Hierarchy



BUILT ENVIRONMENT

- ICC IFC, ICC IRC, ICC IBC
- NFPA 5000
- NFPA 1

INSTALLATION / APPLICATION

- NFPA 855
- NFPA 70
- UL 9540 A

- IEEE C2
- IEEE 1635/ASHRAE 21
- IEEE P1578

- DNVGL GRIDSTOR
- FM GLOBAL 5-33
- NECA 416 & 416

ENERGY STORAGE SYSTEMS

- UL 9540
- ASME TES-1
- NFPA 791

SYSTEM COMPONENTS

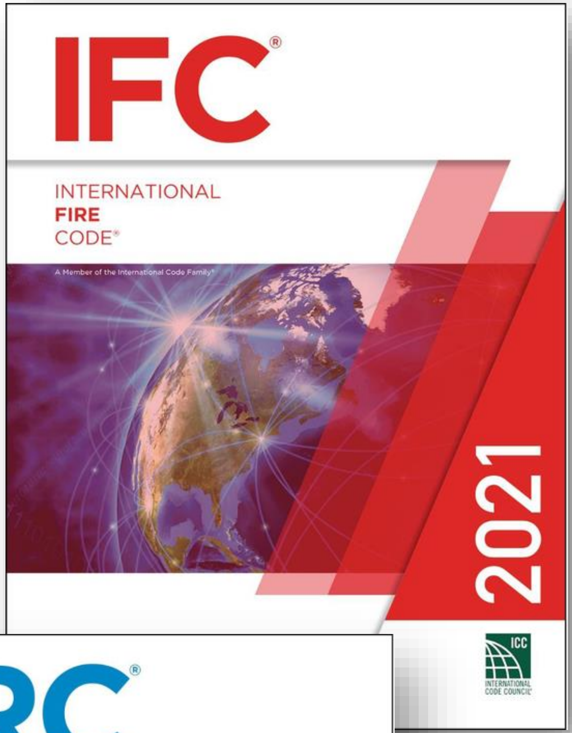
- UL 1973
- UL 1974
- UL 810A
- UL1741

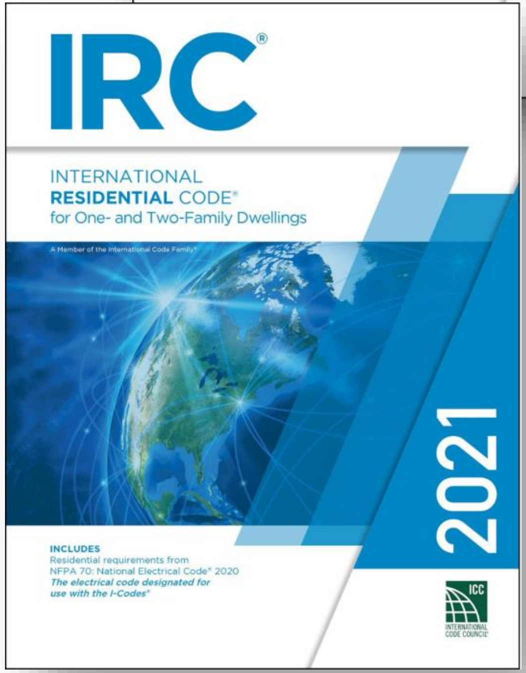
- CSA 22.2 No. 340-201
- IEEE 1547
- IEEE 1679 Series

IFC Adoption Map

IFC

- 2021 International Fire / Residential Code
  - IFC Section 1207 – IRC Section 327
  - Changes from 2018
    - ✓Harmonizes with NFPA 855
    - ✓Requires listing to UL9540
    - ✓Scope ads O&M, retrofit, commissioning, decommissioning
    - ✓Exemption for telecom using Pb & NiCd @ < 60VDC
    - ✓Suppression system based on 9540a
    - ✓Explosion control: NFPA 68 or 69
    - ✓Post-Fire Mitigation Personnel
    - ✓Emergency Response Plan & Training





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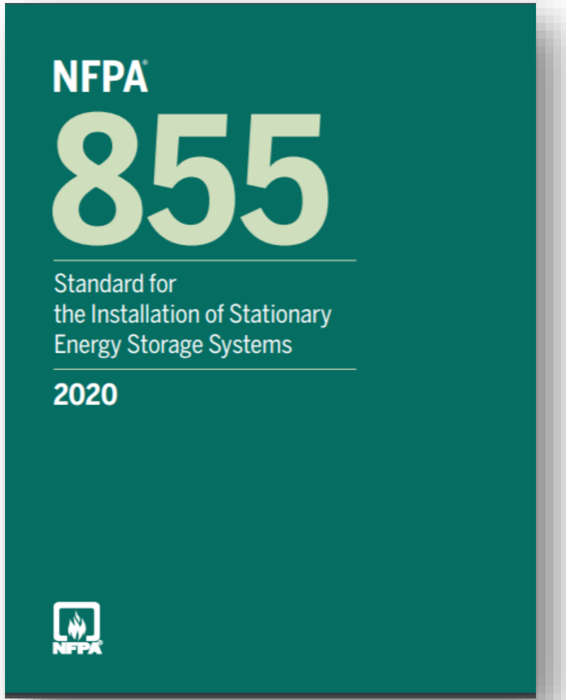
NFPA 855

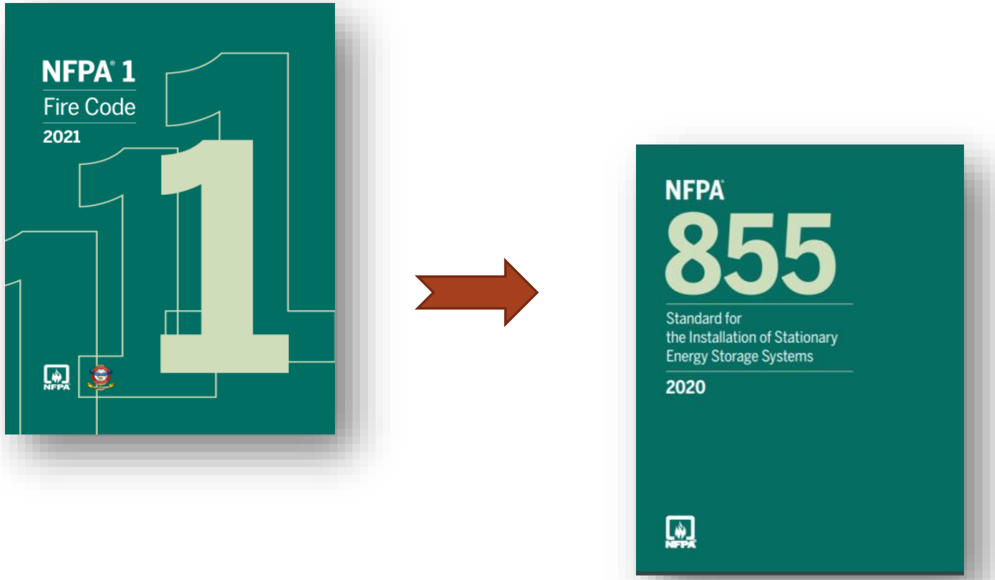
- 2020 NFPA 855 Standard for the Installation of ESS
  - 1st Edition published
  - Requires ESS Listed to UL9540.
  - Covers
    - ✓ Design
    - ✓ Commissioning
    - ✓ O & M
    - ✓ Deflagration Protection
    - ✓ Emergency Response
    - ✓ Decommissioning



2021 NFPA1 Fire Code

Chapter 52

- Direct pointer to NFPA 855
- The MA Board of Fire Prevention Regulations has an established ESS working group that is currently reviewing NFPA 855 in anticipation of adopting NFPA 1 2021 edition this year. It will likely be adopted and promulgated around January 1, 2022.



UL 9540 Listing

- This is a SYSTEM listing, not for components.
- Includes a UL1973 listed battery & UL1741 listed inverter
- Construction & Performance
- Mechanical & Environmental Tests
- Communications Systems
- Functional Safety
- HVAC
- Includes requirements for UL9540a fire testing

JOINT CANADA-UNITED STATES NATIONAL STANDARD

ANSI/CAN/UL 9540:2020

STANDARD FOR SAFETY

Energy Storage Systems and Equipment

ANSI/UL 9540-2020

Standards Council of Canada
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Explosion Protection

Two options for meeting requirement:

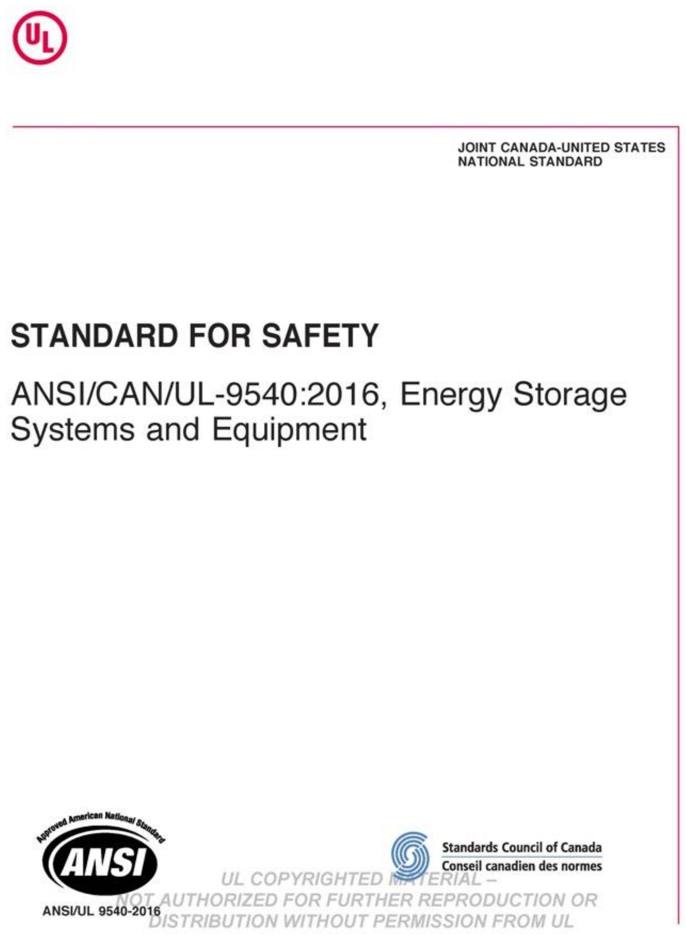
1. NFPA 68 – Deflagration Venting.
   - Blow-out panels to protect structure from explosion based on max gas production in cell tests.

2. NFPA 69 – Deflagration Prevention.
   - Exhaust system designed to keep below 25% of LEL in area.

UL 9540A Test Method

Scope

- Evaluate fire characteristics of a battery ESS that undergoes thermal runaway.
- Artificially forces cells into thermal runaway (if possible)
- Evaluates/documents the resulting fire/explosion characteristics
- Test results used to determine fire and explosion protection required for an installation


JOINT CANADA-UNITED STATES NATIONAL STANDARD

STANDARD FOR SAFETY

ANSI/CAN/UL-9540:2016, Energy Storage Systems and Equipment

ANSI/UL 9540-2016

Standards Council of Canada
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UL 9540A Test Methodology

- Evaluating/interpreting test results can be challenging

Credit: FM Global

Cell Level

↓

Module Level

↓

Unit Level

↓

Installation Level

Design Best Practices

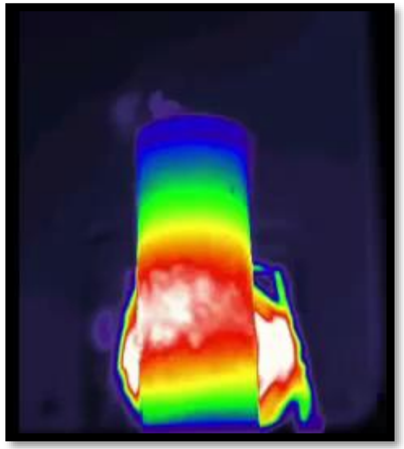
- Design Best Practices
- System Design
- Warning Systems
- Incident Pre-Planning
- Incident Management

System Design
(dedicated use buildings)

- Exterior marking & visible alarm annunciation
- Gas detection
- 2-stage suppression (clean agent + water)
- Smoke & heat sensors for delayed detection post agent discharge
- Auto exhaust w/ sprinkler activation (exterior manual option available)

Warning systems

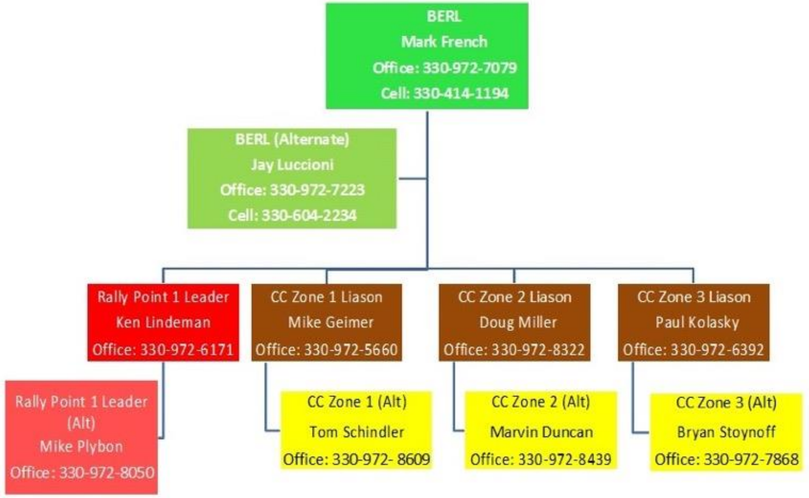
- BMS should remain powered and in communication with monitoring systems.
- Maintaining “eyes” on incident for long duration critical.
- Cell/module temperature & gas monitoring = key metrics



Incident Pre-Planning

- Provide local responders plans & locations of ESS.
- Plan for multiple scenario including decommissioning (detailed table-top exercises).
- Clear signage of hazards, disconnect locations, and contact info.

Emergency Contact List Phone Tree



Incident Management

- Life, property, environment are priorities.
- Rapid notification of 911
- Evacuate/shelter in place notifications as appropriate
- Identification of site manager to liaison with responders
- Decom/EOL, Emergency energy discharge

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Thank you

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