CleanEnergyGroup

CleanEnergy States Alliance

Batteries 101, Part 2:

Benefits and Applications of Battery Energy Storage in Massachusetts

May 30, 2024

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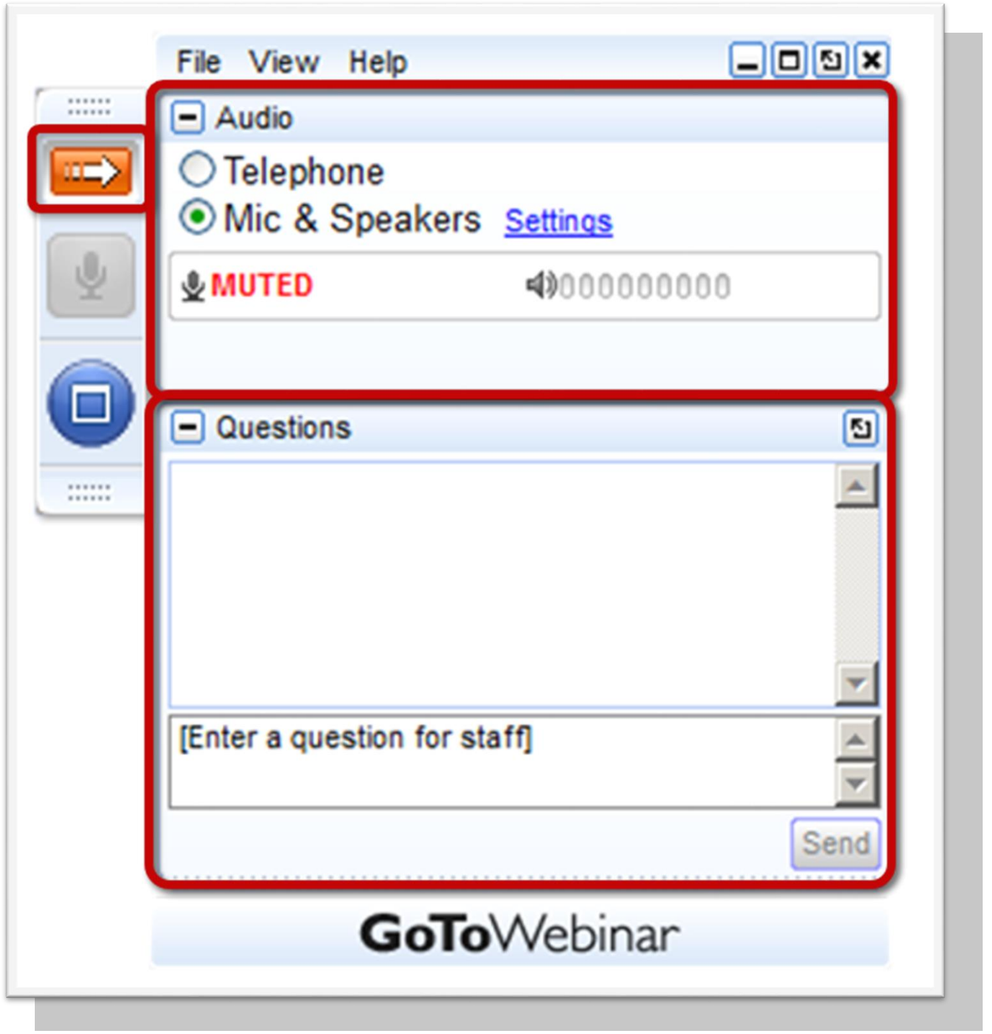

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Celebrating 20 Years of State Leadership

Clean Energy States Alliance

The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy.

CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

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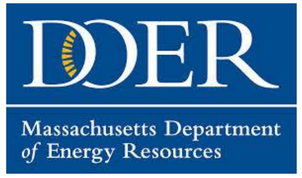

Webinar Speakers

Batteries 101, Part 2: Benefits and Applications of Battery Energy Storage in Massachusetts

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May 30, 2024

About This Webinar Series

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- Three Massachusetts agencies – Department of Energy Resources (DOER), Clean Energy Center (MassCEC) and the Department of Environmental Protection (MassDEP) – have been working together since 2011 as the Clean Energy Results Program (CERP).
- This webinar series is a collaboration between CEG/CESA and the three Massachusetts agencies working collectively as CERP.

About This Webinar Series

Today's webinar is #2 of a 4-part series

Webinar 2: Energy Storage Benefits and Applications

- Fossil fuel peaker plant replacement
- Energy and environmental equity
- Grid benefits
- Resilience

Webinar 3: Considerations for Battery Siting

- Fire safety
- Environmental considerations
- Security

Webinar 4: Municipal Considerations for Battery Installations

- Siting
- Permitting
- Planning
- Zoning
- Municipal best practices

NOTE: This webinar series is for informational purposes only.

We will answer as many questions as possible, prioritizing questions from Massachusetts residents or about Massachusetts-specific topics.

All webinars are recorded and will be available, along with the slides, on the CEG/CESA website.

Thank You

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Thank You

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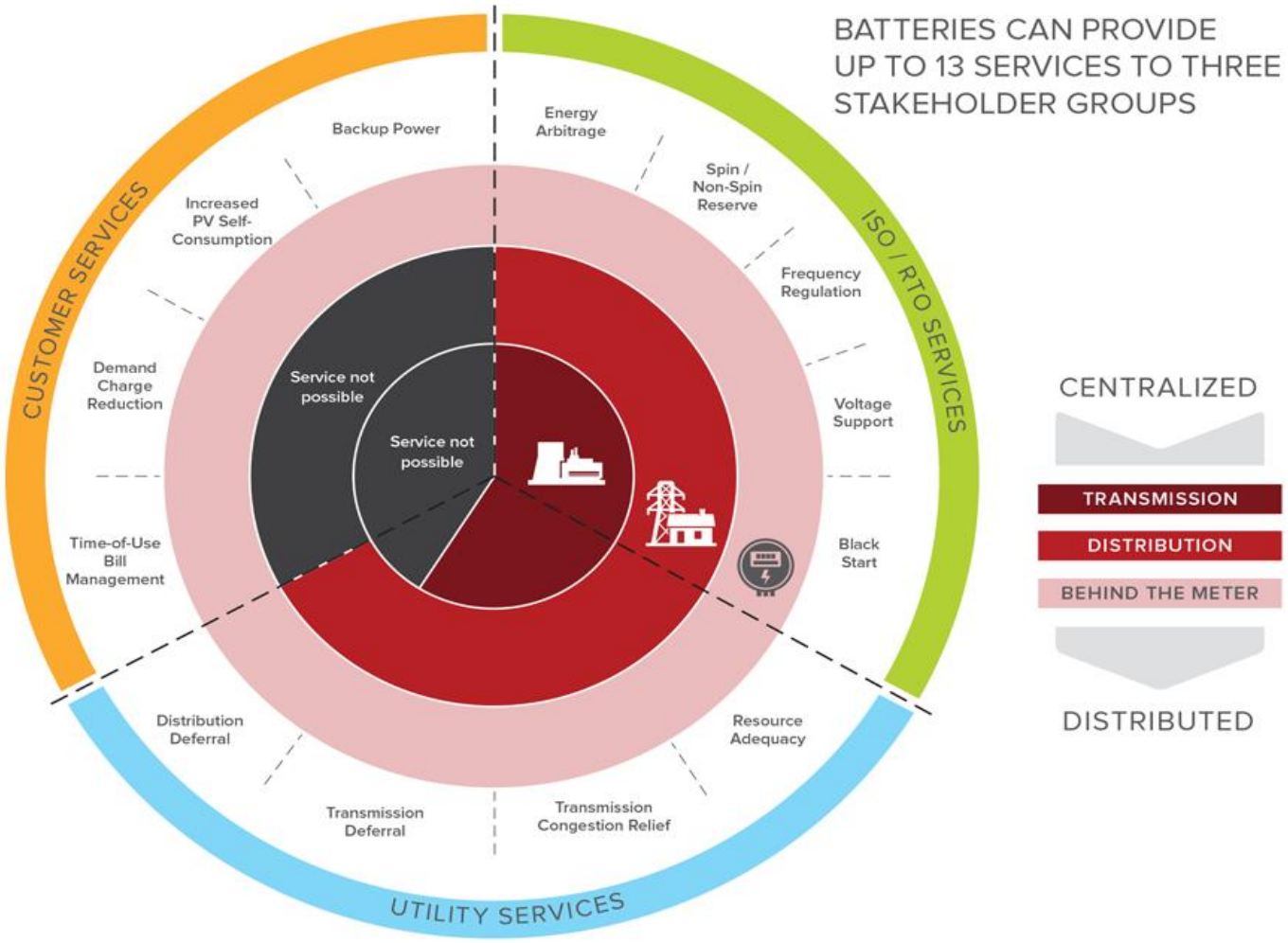
Why Storage Matters? – The Swiss Army Knife of the Grid



Source: *The Economics of Battery Energy Storage*, Rocky Mountain Institute, 2015

- To ensure **grid stability**, several energy market products were created
- Energy storage resources like batteries are dispatchable, meaning charging and discharging them can be controlled, unlike renewables. They are also able to quickly respond to charge/discharge signals. This means they are poised to **provide a variety of energy market products and integrate intermittent renewable energy sources**
- As we **further decarbonize** our electric grid, these energy market products, and therefore batteries, become ever **more valuable and critical** to the Commonwealth meeting its decarbonization mandates
- Additionally, energy storage can provide a variety of **customer services**, including **lowering electric bills** and **backup power**

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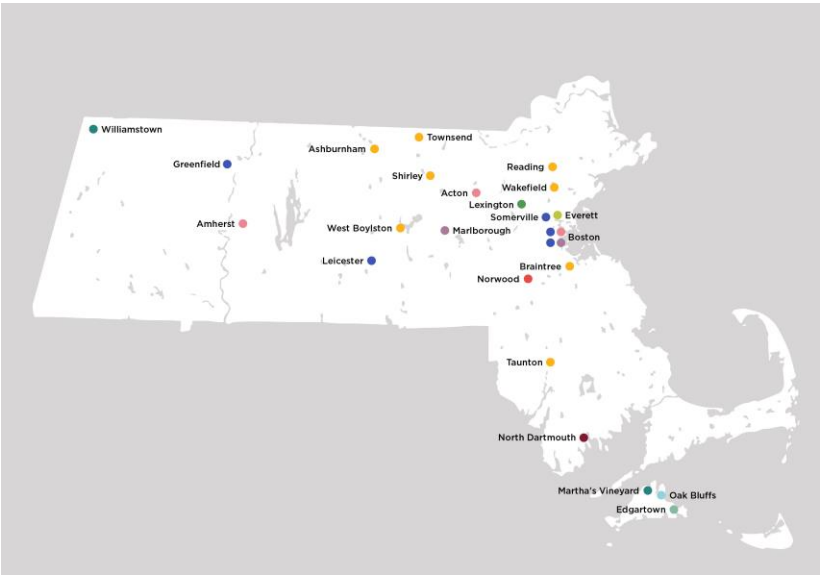
Massachusetts Department of Energy Resources

History of Energy Storage Programs in MA

- **Energy Storage Initiative (ESI)**
  - **2016**: Published *State of Charge* report, which firmly established the many value propositions of energy storage
  - **2017**: Created the $20M Advancing Commonwealth Energy Storage (ACES) program to fund pilot and demonstration projects for a range of energy storage use cases across the Commonwealth
  - **2018**: established a target of 1,000 MWh of energy storage by December 31, 2025
- **SMART Storage Adder (2018)**: Primarily a solar incentive program, includes an adder for energy storage paired with solar
- **ConnectedSolutions (2019)**: Demand response program offering incentives based on performance during calls. Administered by Mass Save®
- **Clean Peak Energy Standard (CPS) (2020)**: Incentivizes renewable generation dispatch during peak hours each season; storage that charges primarily from renewable energy qualifies
- ***Charging Forward* (2024)**: Report and underlying Study on the state of energy storage deployment, benefits, and use today and the potential roles of mid- and long-duration energy storage technologies (i.e., > 4 hr.) as we meet our decarbonization mandates and transform our electric grid.

ACES Installations



SMART and Energy Storage

- **Has driven deployment of solar-plus-storage systems throughout the Commonwealth**
- Launched in 2018, SMART has promoted cost-effective solar development
- Declining block structure that pays owners fixed $/kWh for solar energy produced

Energy Storage Adder

- Storage adder increases $/kWh paid for solar energy produced if storage meets following criteria
  - At least 2 hours duration
  - At least 65% Roundtrip Efficiency
  - At least 25% of the capacity of the solar its paired with
  - At least 52 cycles per year
- Value of storage adder based on a formula that provides more value to systems with higher rated power and/or energy capacities, to a point
- Estimated ~400 MWh energy storage participating. Been a key incentive for storage deployment to date in the Commonwealth
- Incentive focuses on deploying storage, not on operations like CPS

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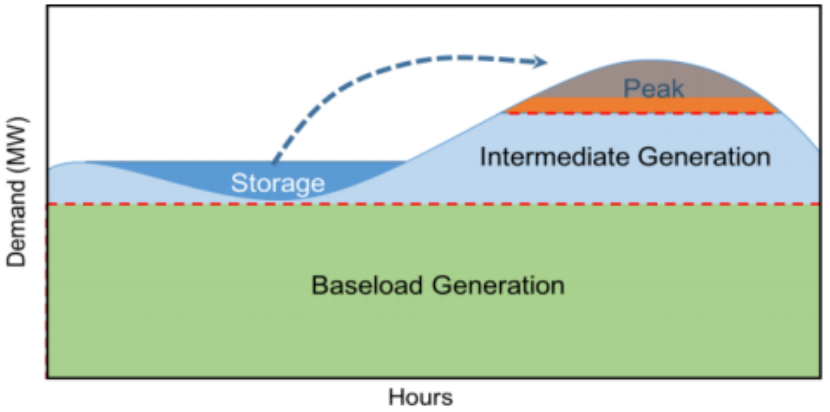
Clean Peak Energy Standard (CPS)

- **Objective**: Reduce cost and emissions impacts of peak demand through renewables, energy storage, and demand response
- **Mechanism** – **Market-based**
  1. Eligible resources that generate, dispatch or discharge energy during **Seasonal Peak Periods** will generate **Clean Peak Energy Certificates (CPECs)**
  2. All retail electricity suppliers must annually purchase a certain number of Clean Peak Energy Certificates (CPECs) relative to their load served
- **Seasonal Peak Periods** – Late afternoon to evening
  - **Winter** (Dec. 1 – Feb. 28): 4pm – 8pm
  - **Spring** (Mar. 1 – May 14): 5pm – 9pm
  - **Summer** (May 15 – Sept. 14): 3pm – 7pm
  - **Fall** (Sept. 15 – Nov. 30): 4pm – 8pm



Existing CPEC Multipliers

Mainly meant to further incentivize certain behaviors and deployments

- **Seasonal Multiplier:** Seasonal multipliers are established for each Clean Peak Season to reflect the level of emissions and magnitude of peak demands in a season
  - **4x** Summer/Winter
  - **1x** Spring/Fall
- **Actual Monthly System Peak Multiplier:**
  - **25x** for performance coincident with highest single hour of demand in the month
- **Resilience Multiplier:**
  - **1.5x** provided to resources that increase resilience to outages
- **Existing Resource Multiplier**
  - **0.1x** applied to existing renewable resources
- **Contracted Resource Multiplier**
  - **0.01x** applied to state contracted renewable resources
- **SMART ES Resource Multiplier**
  - **0.3x** applied to SMART energy storage resources
- **Distribution Circuit Multiplier – Rolled out December 5, 2023**
  - **2x** applied to resources that interconnect to specific highly loaded circuits on the distribution system

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CPS Participating Resources – March 2024

Technology	Qualified Systems	Capacity (MW)
Energy Storage	62	186
Demand Response	260	62
RPS Resources	73	31
Total	**395**	**279**

- **Energy Storage**: Largely < 5 MW batteries paired with solar through SMART
- **Demand Response**: Has mainly been building load curtailment, but this past year has begun to see system aggregations of EVs and smart thermostats qualify and participate
- **RPS Resources**: Comprise PV, onshore wind, and anaerobic digesters. Largest capacity is a 5.6 MW PV system.

2024 CPS Program Review

- **Goal: To drive more participation in the program, both by existing and new CPS resources, and lower collected ACP**
  - When market is undersupplied and there aren't enough CPECs for electric suppliers to meet Minimum Standard obligation, alternative compliance payments (ACP) must be made by suppliers to make up the difference
  - DOER uses this ACP to create programs to drive more storage deployment, participation in CPS, and hopefully help lower ACP collections in future years

- CPS Regulations - 225 CMR 21.00
  - Beginning in 2024, and not less frequently than **every four years** thereafter, DOER shall review:
    - The CPEC Multipliers
    - The Minimum Standard
    - The ACP Rate
  - DOER may modify the three aforementioned CPS elements following stakeholder review and input
  - The Regulations do not preclude DOER from reviewing other aspects of CPS

- Key considerations in DOER's review will include:
  - An examination of the effectiveness of the program in meeting its policy goal of reducing the cost and emissions associated with peak demand
  - The program's ability to incentivize Clean Peak Resource deployment, particularly energy storage

- On May 3, stakeholders responded to a DOER request for public comment on the CPS Program Review. DOER's review of their feedback is ongoing

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2024 Is Charging Forward: New Energy Storage Study

Required by legislature with analyses led by consulting firm E3, study released on January 4, 2024 addresses three broad questions:

1. **What is the current state of energy storage in the Commonwealth?**

   Example Sub-Questions Investigated

   - *What are the costs and benefits of current use cases for energy storage?*
   - *What barriers exist to further deployment and use, and what are the recommended mitigation actions by the state?*

2. **What are potential applications of mid- and long-duration energy storage?**

   - *How can mid- and long-duration energy storage (M/LDES) contribute to reliability in a decarbonized system?*
   - *What are the emission benefits of M/LDES technologies?*

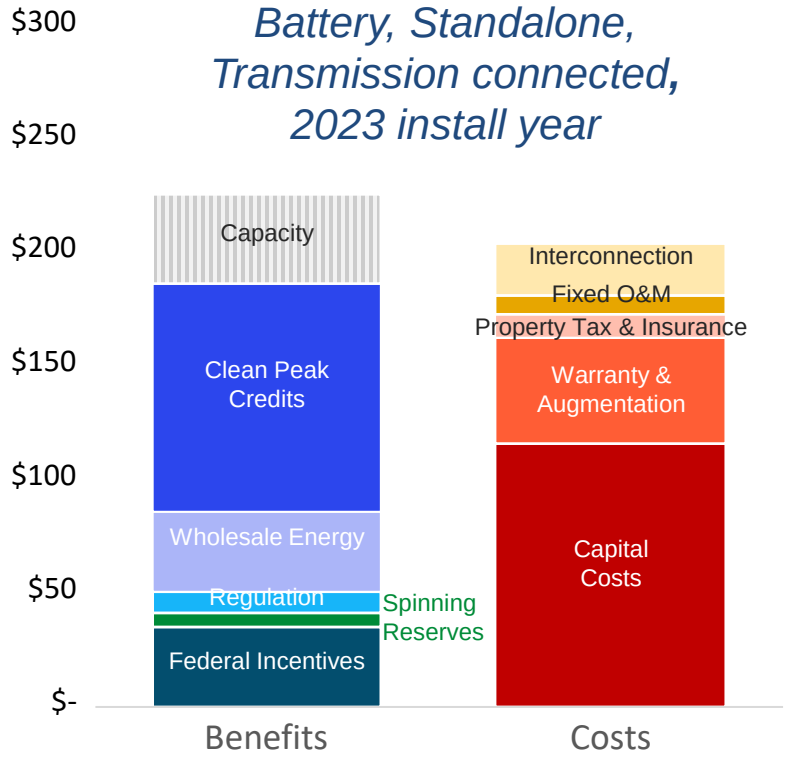
3. **What is the market outlook for emerging mid- and long-duration energy storage (M/LDES) technologies?**

   - *What is the level of maturity for various emerging M/LDES technologies?*

Cost-Benefit Analysis (CBA): Tx-connected standalone

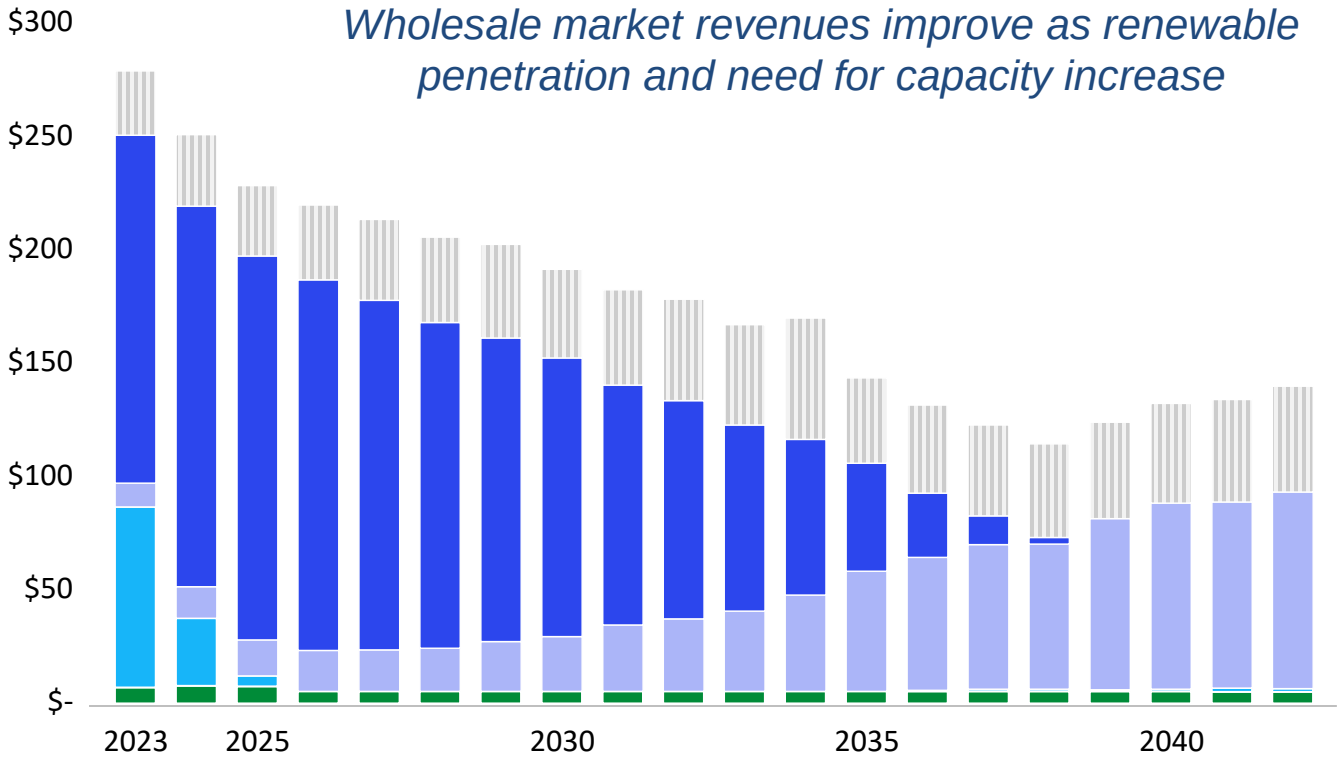
Levelized revenues & costs - developer view
($2022/kW-yr.)

50 MW, 4-hr Li-Ion Battery, Standalone, Transmission connected, 2023 install year



Annual revenues - developer view
($2022/kW-yr.)

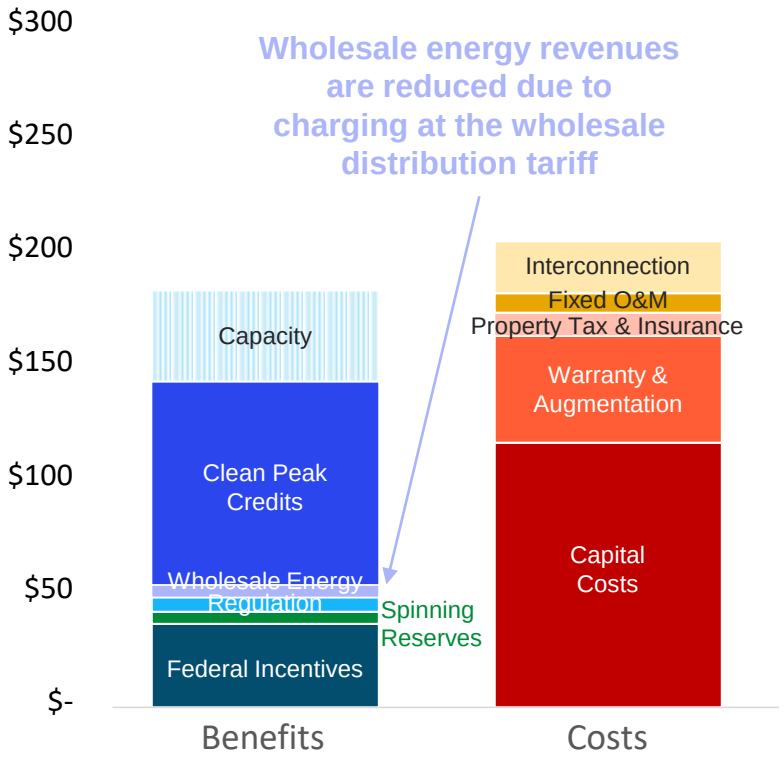
Wholesale market revenues improve as renewable penetration and need for capacity increase



- **Challenge**: Lack of long-term certainty in CPS challenges benefit realization

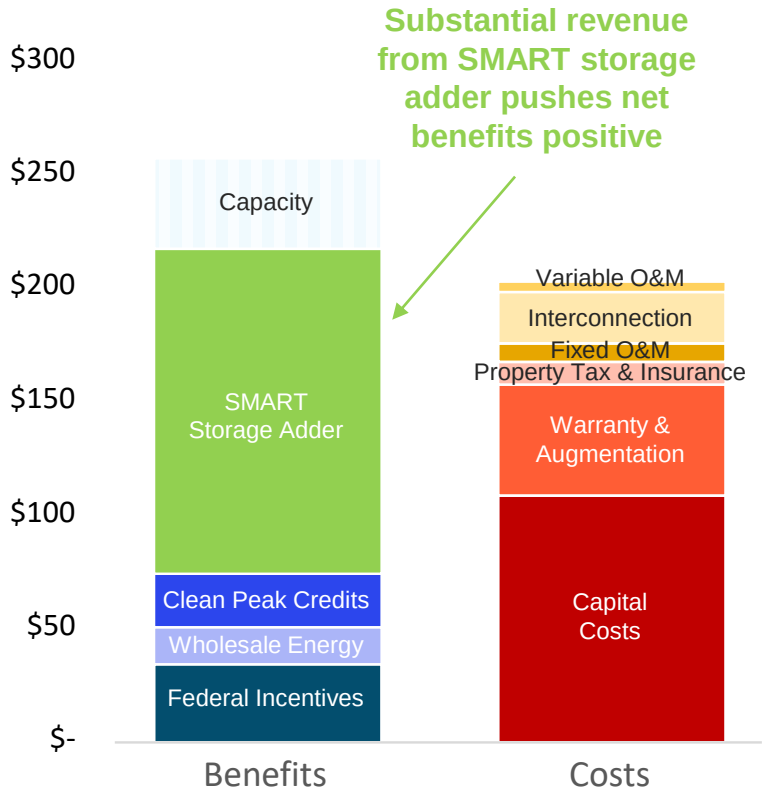
CBA: Dx-standalone and Dx-solar+storage

Levelized revenues & costs - developer view
($2022/kW-yr.)



*5 MW, 4-hr Li-Ion Battery, **Standalone**, Distribution connected, 2024 install year*

Levelized revenues & costs - developer view
($2022/kW-yr.)



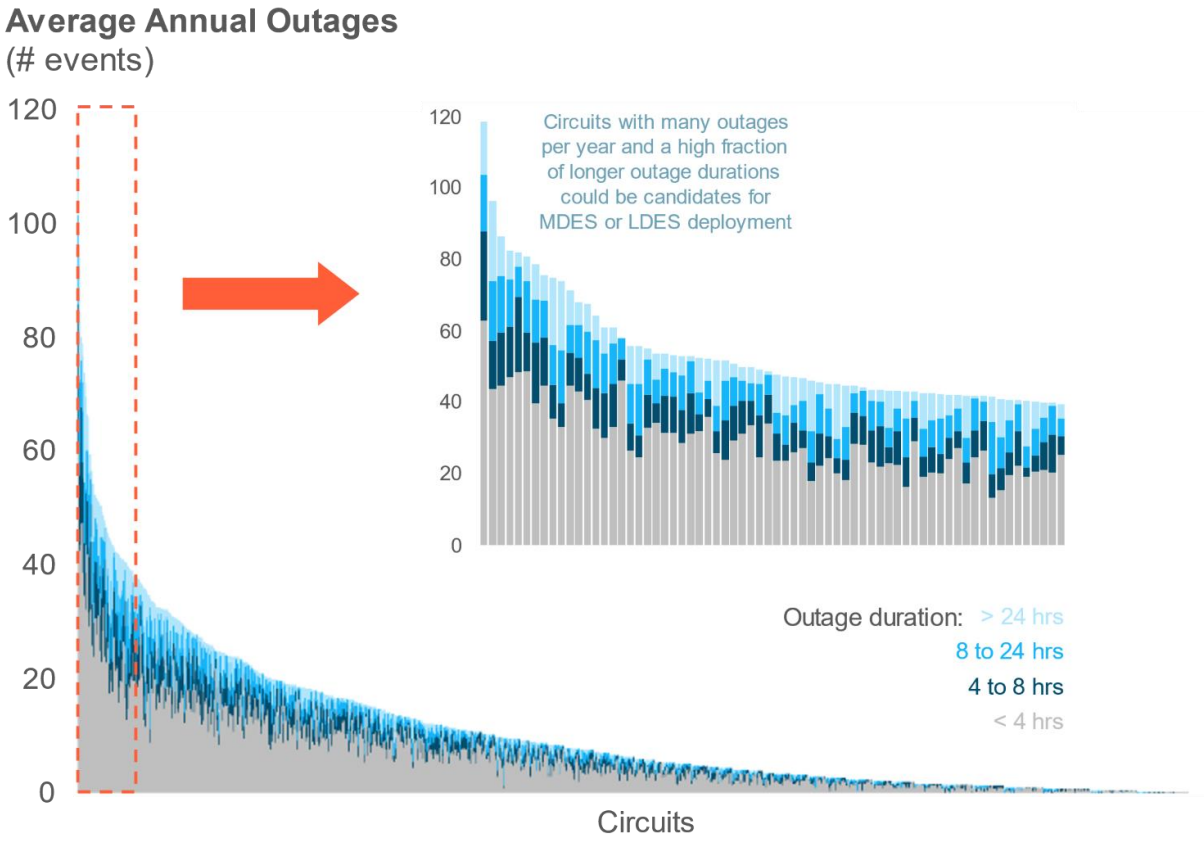
*1 MW, 4-hr Li-Ion Battery, **Paired with 4 MW solar***, Distribution connected, 2024 install year*

*Costs/benefits shown are incremental costs/benefits of storage component of solar+storage installation

Key Findings: Energy Storage's Large Resiliency Value

- **Resiliency can make up a major part of the value stack for energy storage, particularly for critical facilities**
  - Characteristics shared by resiliency-focused deployments:
    - High Value of Lost Load (VOLL)
    - Frequent loss-of-load events
    - Unavailable or unfavorable alternative solutions (e.g., fossil-based backup generators)

Eversource and National Grid historical outages (2019-2022) by circuit

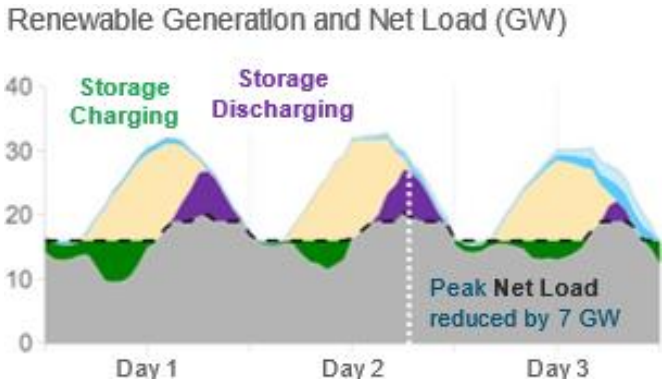


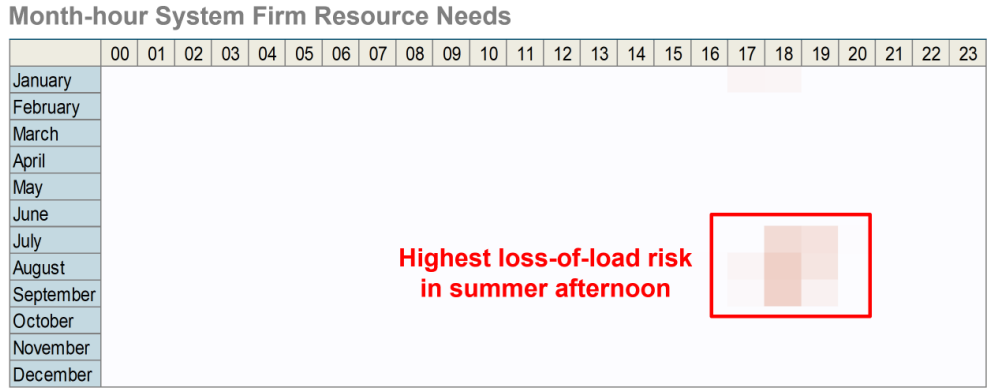
- Study found most resiliency needs at circuit level could be met with current 4 hr. energy storage technology

Key Finding: Evolving Reliability Risks

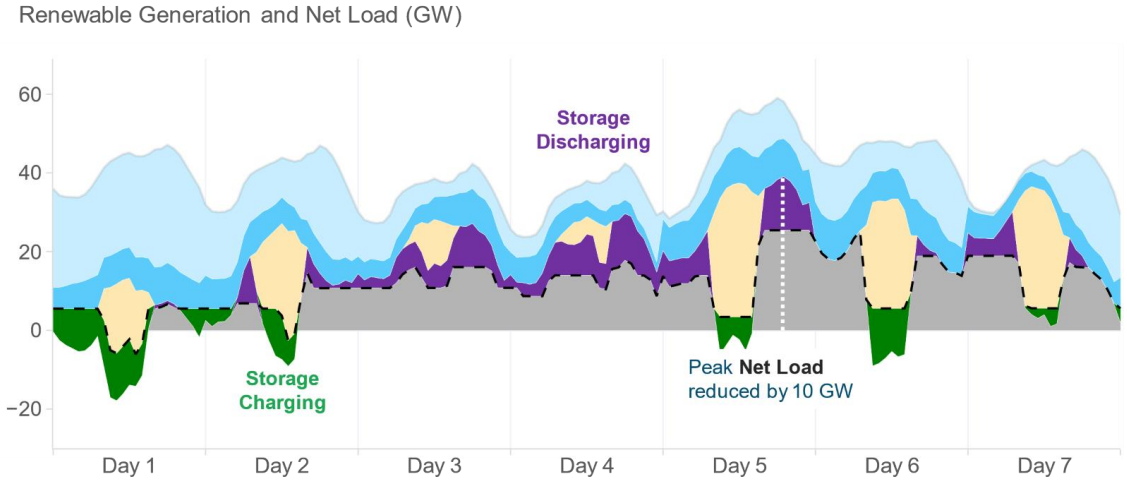
- **Energy storage of varying durations can mitigate the Commonwealth's grid reliability risks as it decarbonizes through 2050**
  - Over time, reliability challenges increase in duration and move from summer to winter

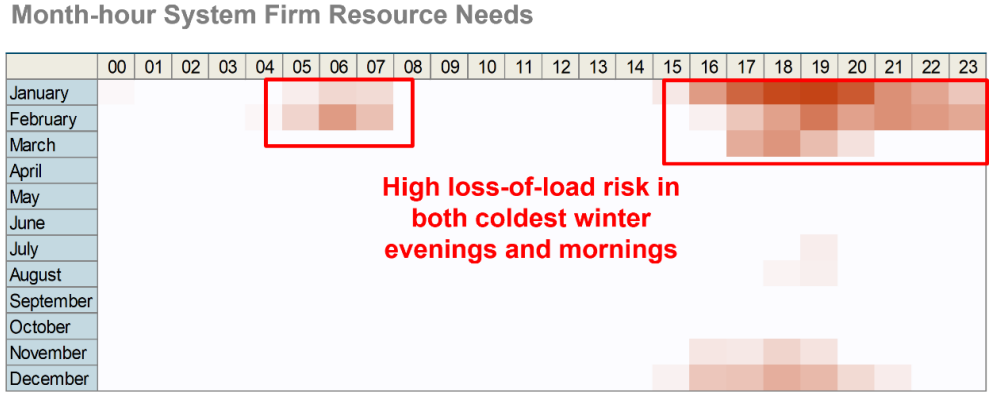
2030





2050





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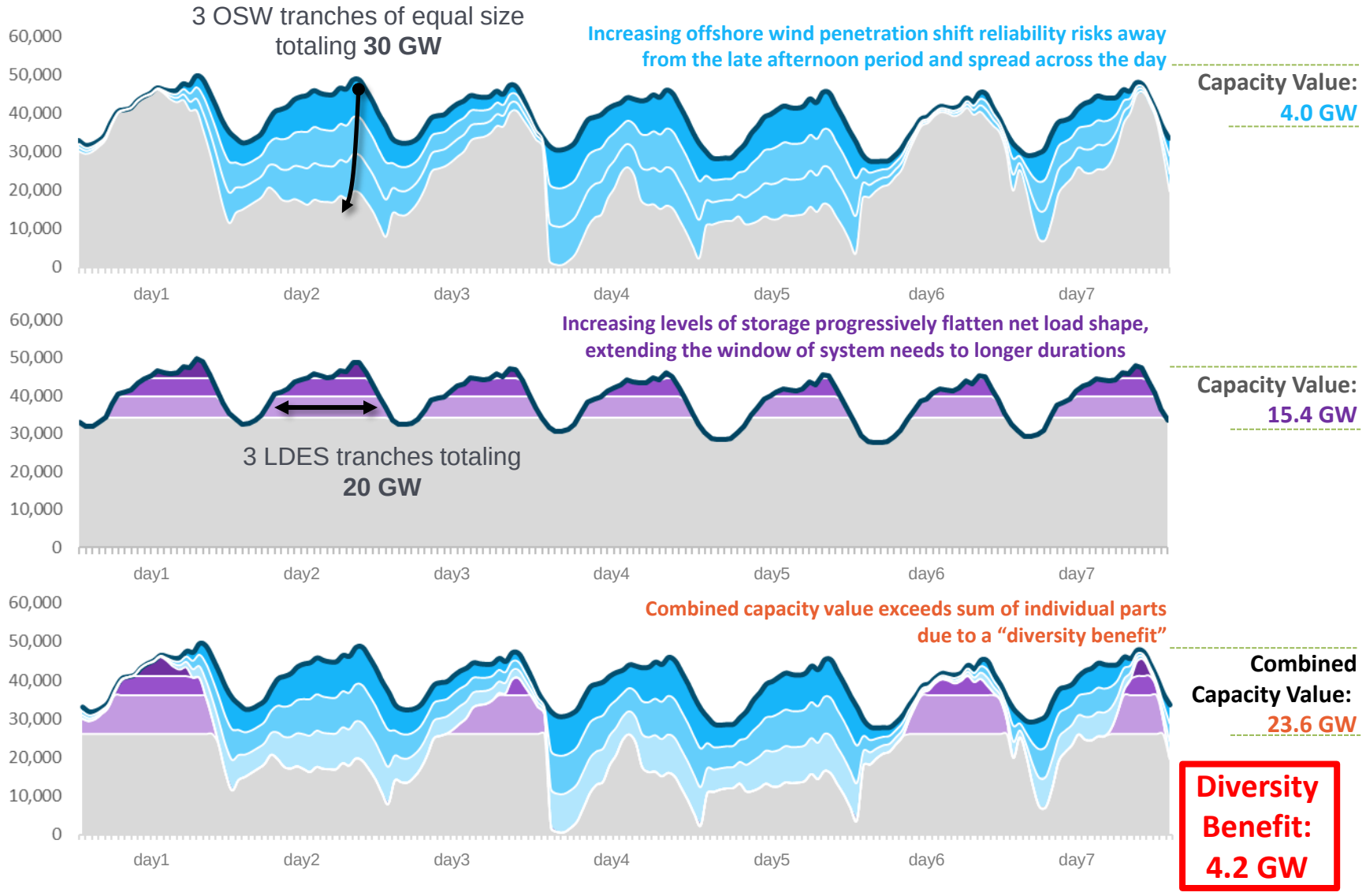
Key Finding: Diversity Benefits for Renewables + Storage

- The complementary interaction between renewables and energy storage resources can create diversity benefits where total capacity value is greater than the sum of its parts
- Diversity benefit between **Offshore Wind** and **Long-duration energy storage (i.e., duration > 10 hrs.)** is a main driver of LDES capacity value, especially at high penetrations of both resources



DOER Recommendations Based on Study

- $50 million in program funding targeted toward deploying specific use cases of storage today and to lower commercialization barriers for mid- and long-duration energy storage (i.e., durations > 4 hrs.);
- Procurements or other mechanisms for incentivizing storage deployment;
- Creating refined interim targets for energy storage deployment that connect the targets to renewable generation deployment;
- Reviewing existing programs that incentivize storage, including the CPS; and
- Continued stakeholder collaboration on other issues impacting energy storage deployment (e.g., interconnection, rate design).

Behind the Meter Load Reduction

A Municipal Use Case

MMWEC
MASSACHUSETTS MUNICIPAL
WHOLESALE ELECTRIC COMPANY
Public Energy Partners

Grid Scale Energy Storage, It's Not New

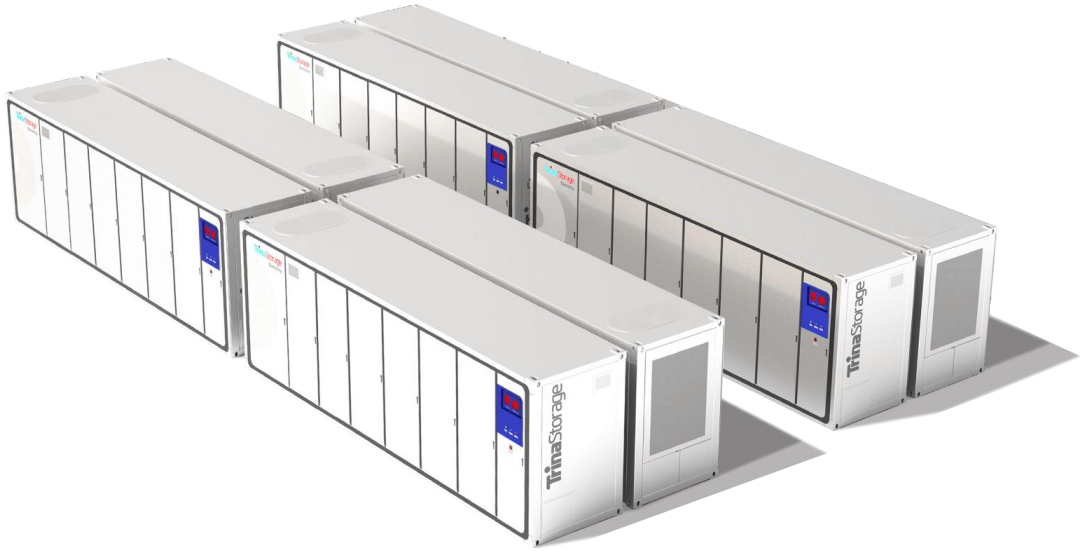
Northfield Mountain (1200MW)
Northfield, MA (1972)

Bear Swamp Reservoir(600MW)
Rowe, MA (1974)

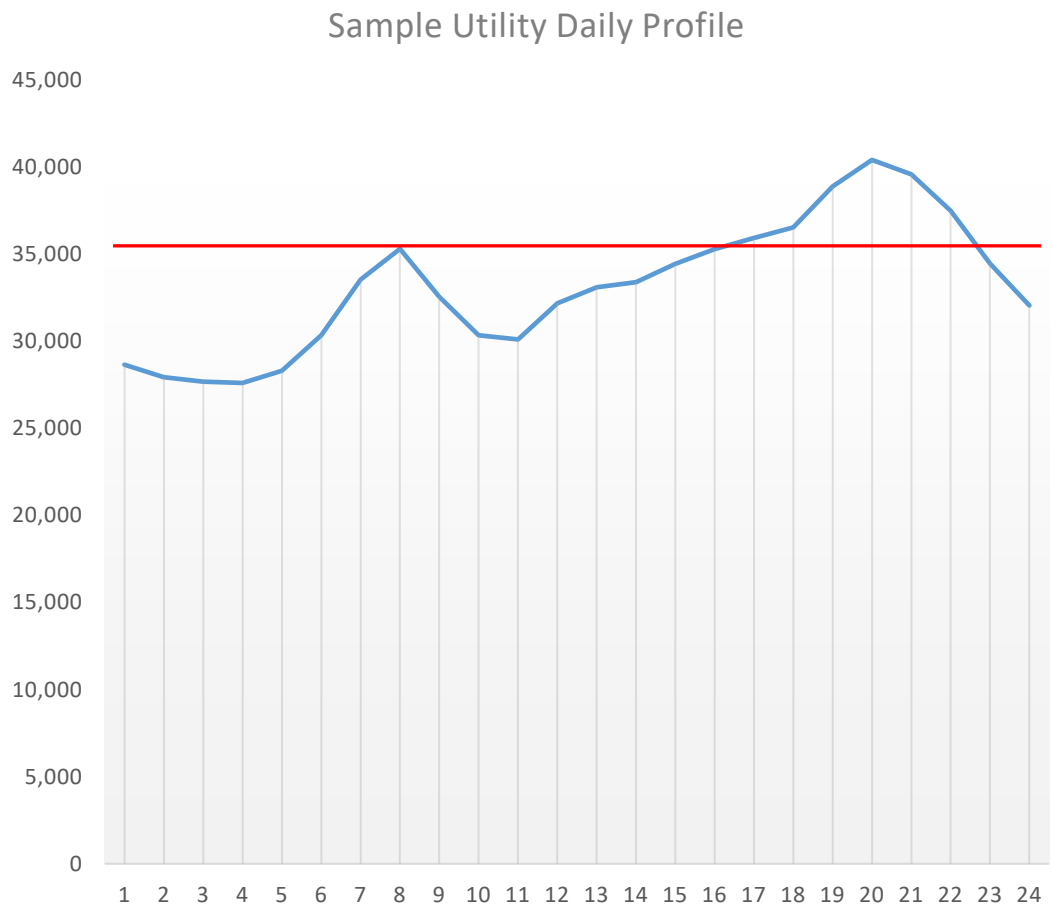
First Project in US Was in 1930 in New Milford CT

What is Behind The Meter Energy Storage?

- Behind The Meter Energy Storage, is an energy storage systems located behind a customer or distribution utility's meter, reducing the amount of energy that is drawn during certain periods of the day



Why is Energy Storage Important?



- Energy usage is not uniform throughout the day. Demand drops off overnight and is supplemented by solar mid day.
- More than 50% of an MLP's wholesale power costs are driven by peak demand (the highest hour per month/year).
- By shifting power and storing it from low use periods for use during peaks, MLPs can help stabilize rates their customers.

How Municipal Utilities Deploy BTM Storage

Wakefield

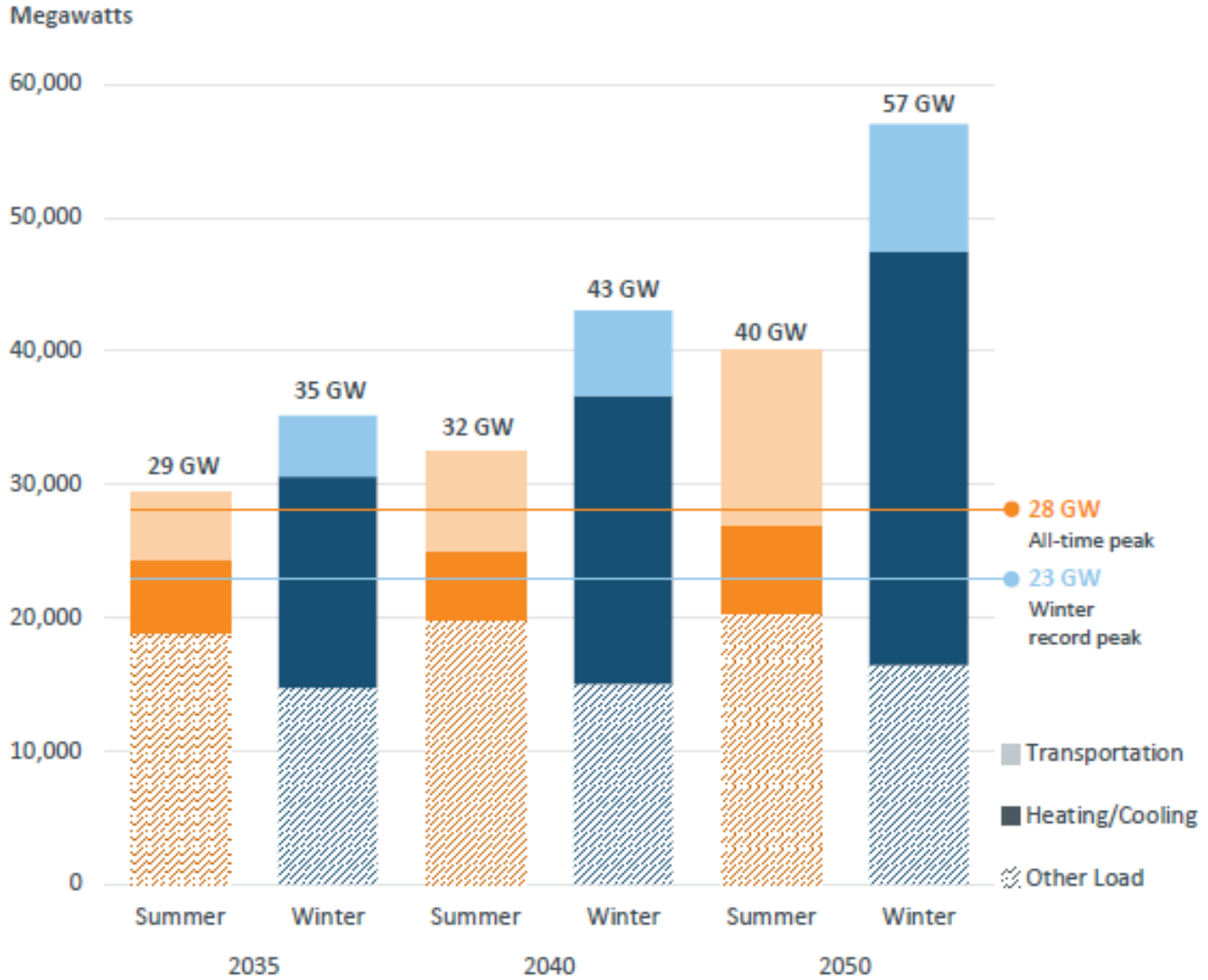
3.2MW/5.3MWH

Templeton

1.6MW/3.5MWH

MMWEC
Public Energy Partners

Why Peak Load Management Matters



Source: ISO New England 2050 Transmission Study

How Peak Management Can Reduce Costs

Timeframe	Average Cost Per Year	Total Costs
2002-2023	$0.73 Billion	$15 Billion
2024-2050 (51GW Peak)	$0.62 Billion to $0.65 Billion	$16 Billion to $17 Billion
2024-2050 (57GW Peak)	$0.88 Billion to $1.00 Billion	$23 Billion to $26 Billion

Source: ISO New England 2050 Transmission Study

Plans for the Future

- MMWEC working with 10+ MLPs to deploy upwards of 50MW/200MWH of energy storage in 2024-2025
- Focus is on peak load reduction with longer storage duration (4+ hour system as opposed to 2 hour)
- (2) projects are leveraging benefits of storage to provide automatic microgrid and resilient backup to schools.
- Continued focus on peak load management to manage the impacts of electrification. This is done concurrently with MMWEC's demand management and efficiency program NextZero

Massachusetts Municipal Wholesale Electric Company (MMWEC) is a non-profit, public corporation and political subdivision of the Commonwealth of Massachusetts created by an Act of the General Assembly in 1975 and authorized to issue debt to finance a wide range of energy facilities. MMWEC provides a variety of power supply, financial, risk management and other services to the state's consumer-owned, municipal utilities.

MMWEC
MASSACHUSETTS MUNICIPAL
WHOLESALE ELECTRIC COMPANY
Public Energy Partners

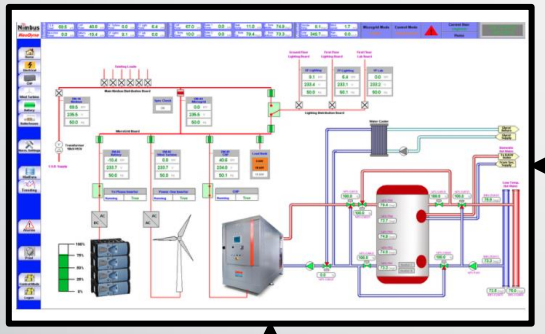
WMGLD Energy Park

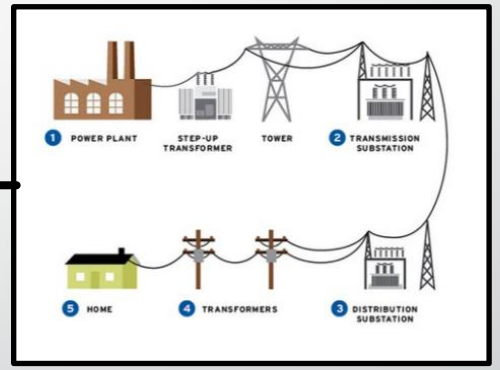
A multi-purpose, innovative, modern microgrid in Wakefield, MA

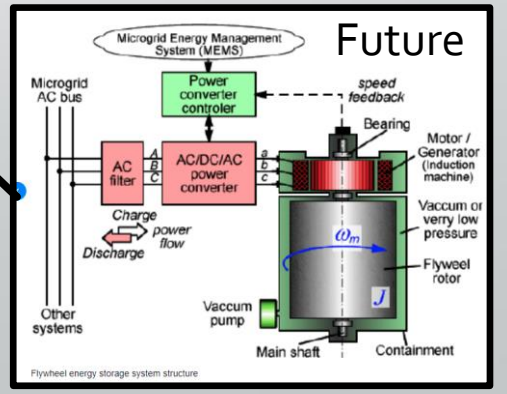
"A project designed to support Wakefield residents, WMGLD rate payers and the environment"

Batteries 101 – Benefits and Applications of Energy Storage in Massachusetts

Energy Park started as a concept in 2021





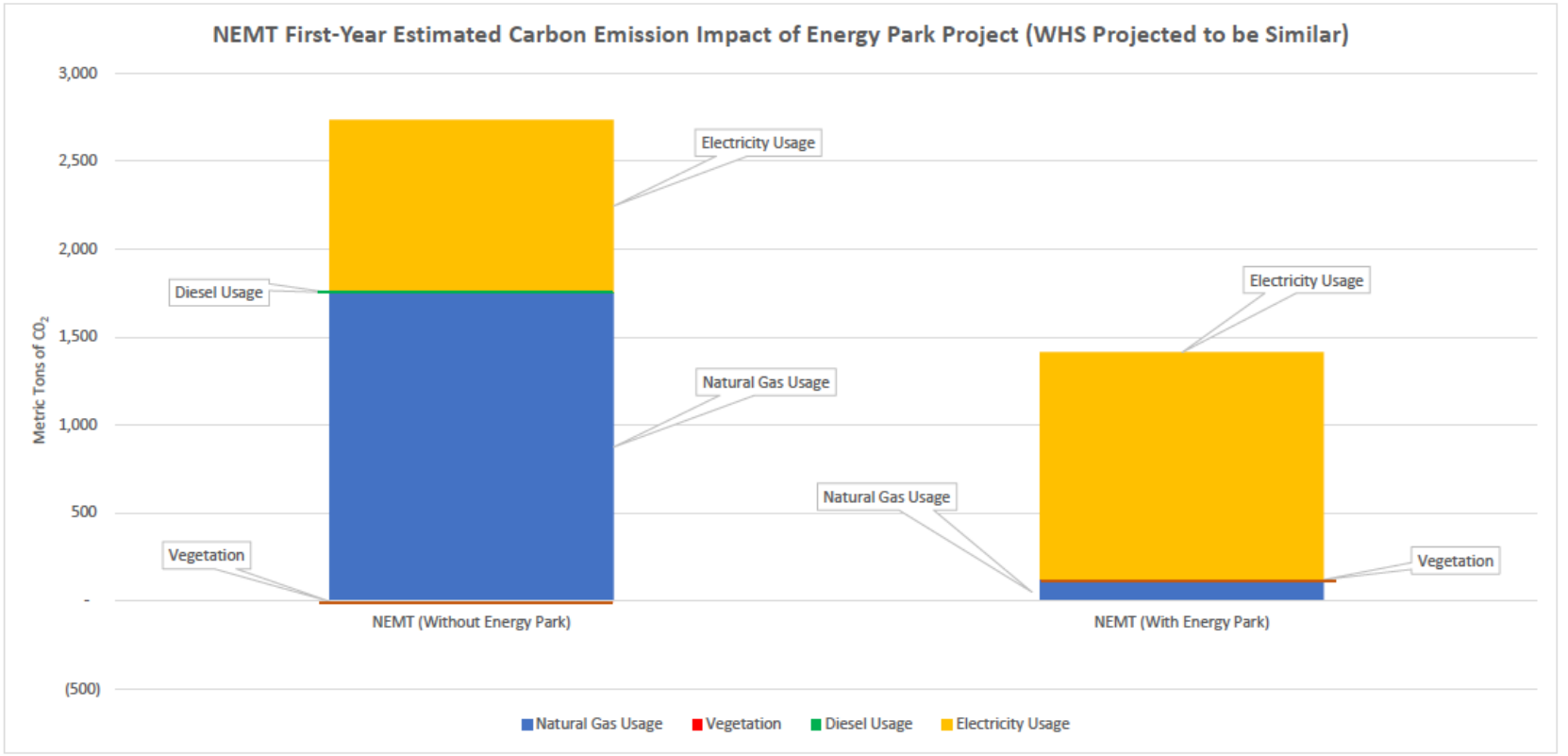


What is the Energy Park?

- The Energy Park will be a microgrid interconnected to WMGLD's electric system, the new Northeast Metro Tech (NEMT), and the proposed Wakefield High School (WHS)
- Both schools will have:
  - All-electric heating and cooling
  - Roof-mounted solar arrays owned by WMGLD
- The Energy Park site, located on Hemlock Rd in Wakefield, between the two new schools and will include:
  - 5Mw / 20MWh battery storage unit that will be charged via the solar arrays
  - Single natural gas generator replacing two diesel generators
  - Switchgear to enable the entire site to function as a microgrid
- The battery (with help from generator and solar arrays) will serve as the emergency power source for both schools and can serve as the primary power source during a rare extended outage
- The battery will provide Peak Shaving benefits for the ratepayers

Video Link:
https://vimeo.com/chamberpg/review/768700083/45d55ddob7

Promotes electrification, reduces carbon emissions moves towards the State's net-zero 2050 goal

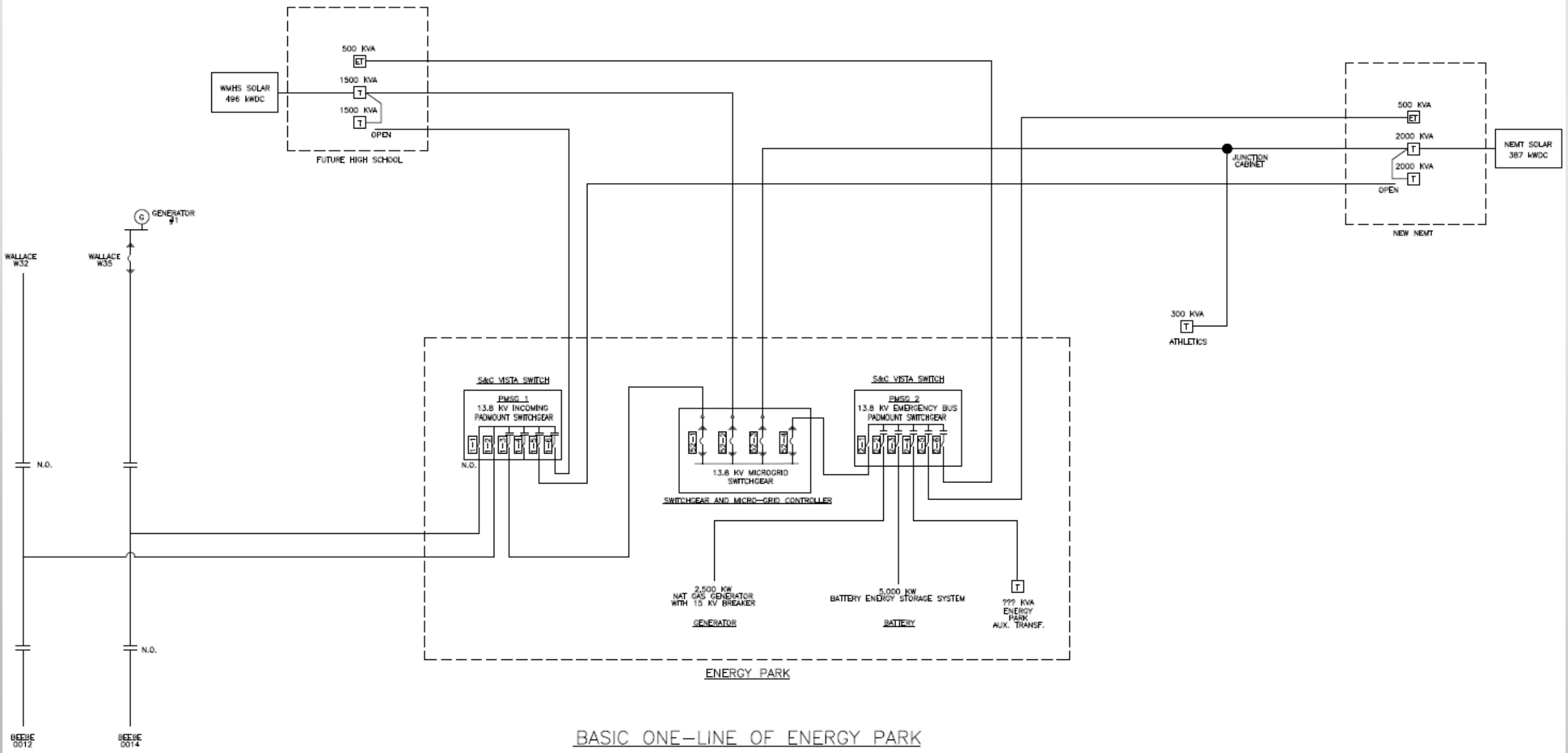


	Without Energy Park (Metric Tons of CO_2)	With Energy Park (Metric Tons of CO_2)
Electricity Usage	980	1,290
Diesel Usage	5	-
Natural Gas Usage	1,750	120
Vegetation	-3	3
Total	2,732	1,413

Reduction of 1,319 Metric Tons of CO_2 Equivalents (NEMT)

WMGLD
WAKEFIELD MUNICIPAL GAS AND LIGHT DEPARTMENT

Energy Park at Hemlock Road



BASIC ONE-LINE OF ENERGY PARK

Microgrid Controller

Real Time Automation Controller (RTAC)

- The Energy Park is designed to operate in multiple modes, depending on the availability of the utility supply and the state of charge of the BESS system. The intent is to transition seamlessly and without outage between modes.
- In the event there is loss of utility supply, the microgrid control will detect the failure and isolate the system, switch the BESS to grid forming operation and utilize BESS to power the critical loads at the schools.
- Monitoring BESS State of Charge. If the BESS State of Charge drops below a predetermined value, the 2.5 MW generator will start and recharge the BESS.
- Once the utility feeder is restored to service and remains energized for sufficient time to ensure it's viable, the microgrid will be restored to normal operation with a closed transition to avoid customer outage.

Grants & Education

- WMGLD received the maximum awarded amount of $125,000 from American Public Power Association (APPA) under the Demonstration of the Energy & Efficiency Developments (DEED) funding for the ***"Energy Park and Educational Project".***
  - The DEED board stated, "the project is unique, innovative, and ambitious"
  - Funding will be used to support an educational programs and training in energy management and distributed generation (DG) technologies as part of STEM and Vocational programs at WHS and NEMT
- WMGLD is also evaluating funding opportunities through:
  - The "Inflation Reduction Act" (IRA)
  - The American Rescue Plan Act (ARPA)
  - Mass Department of Energy Resources (MA-DOER)
  - Mass-DEP - MassEVIP for Public Access Charging Stations

Rooftop Solar and EV Chargers

WMGLD will manage, own and operate the solar on both schools

NEMT Approximately 387 kWDC

WMHS Approximately 496 kWDC

Some buildings are built "solar ready" (just to meet Leeds standards) but may never have solar installed. **These schools will be built with solar from the start, guaranteeing savings**

Any excess solar energy not used by the schools will charge the emergency battery at the Energy Park and flow back to the Wakefield system

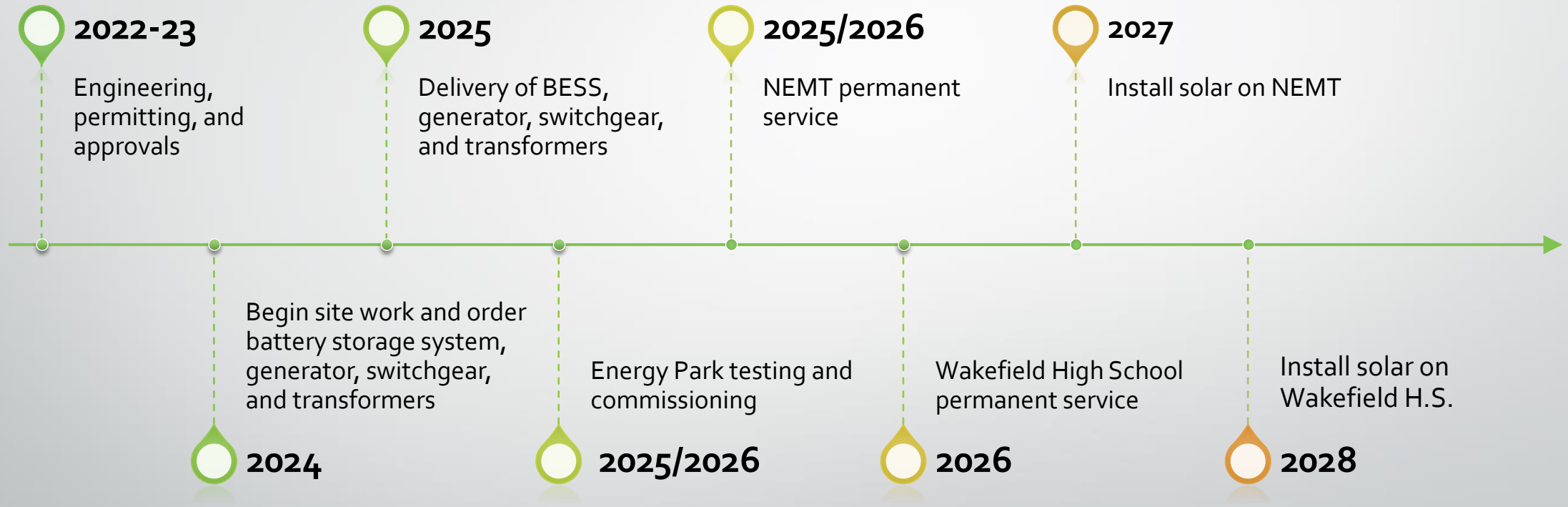
WMGLD will provide each school with electric vehicle chargers from the beginning instead of simply being "EV Ready"

AERIAL VIEW – Energy Park

Benefits of the Energy Park Project for Wakefield

1. Supports maintaining low electric rates for all rate payers by adding peak shaving capabilities with Solar and Battery Energy Storage System (BESS). Estimated capacity and transmission savings of $1.0 million per year
2. Promotes electrification, reduces carbon emissions, and moves towards the State's net-zero 2050 goal
3. Reduces construction costs for NEMT and WHS by eliminating the need for **two** diesel generators, saving each school ~$1.2 million
4. Reduces operation costs for NEMT and WHS by installing solar to greatly reduce electric costs through partnership with WMGLD
5. Provides energy management and environmental education opportunities for NEMT and WHS students
6. Provide 5 electric vehicle charging station to each school (2 EV connections per station)

Energy Park, NEMT and WMHS Schedule



Redevelopment of West Springfield Station

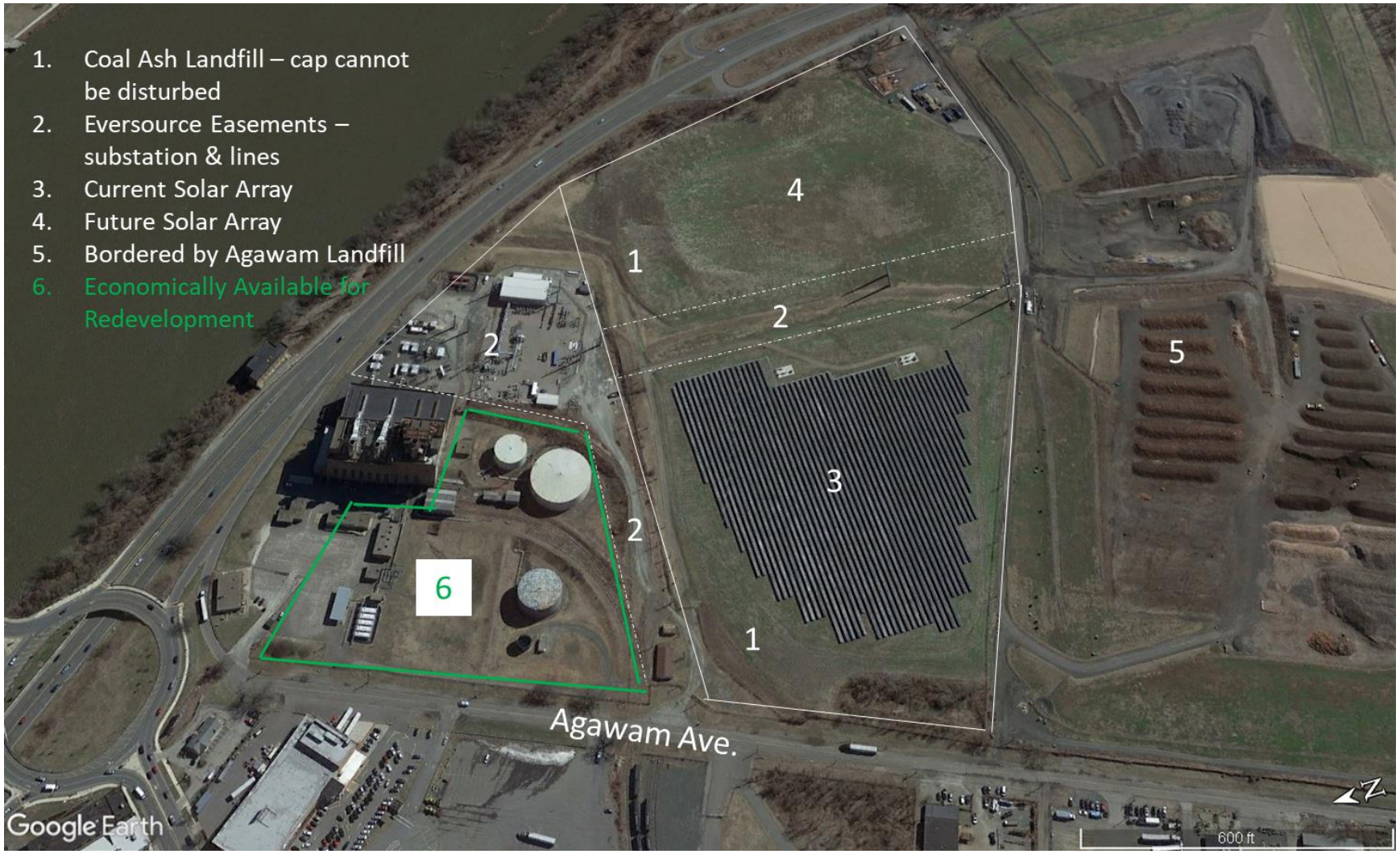
Station can "transition" to help ensure local grid reliability and reduce peak prices

- 1949 Coal fired Units 1 & 2 48 MW each
- 1957 Coal fired Unit 3 107 MW
- 1960s converted to heavy fuel oil
- 1969 small "jet" added 20 MW
- 1990s natural gas available
- 2002 Units 1 & 2 replaced with "aeroderivative" combustion turbines
- 2021 Unit 3 retired
- 2021 Redevelopment begins
- 2022 Units 1 & 2 and the jet deactivated

- As the industrial economy evolved away from heavy power use the station increasingly became needed only for peak energy use periods and eventually only for reliability
- The station's electrical interconnection to the New England grid and existing infrastructure makes it an advantageous location for energy transition resources

Power Station Area Today

Relatively small area available for redevelopment, but sufficient for up to 150 MW

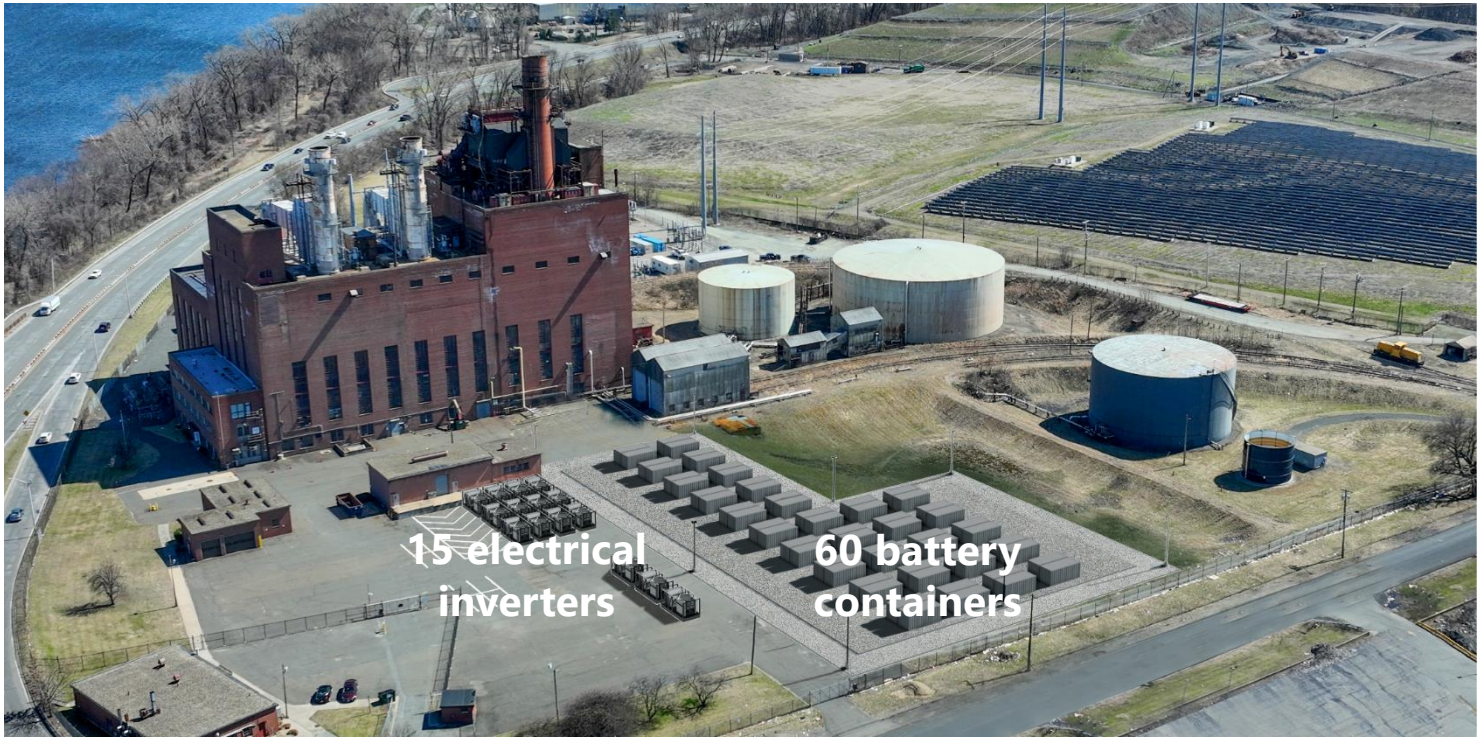


Redevelopment Potential

Former coal yard, now oil & water tanks, can be repurposed to host BESS

Project Description

45 MW – 180 MWh (4-hour duration) to supply MA *Clean Peak Standard* program



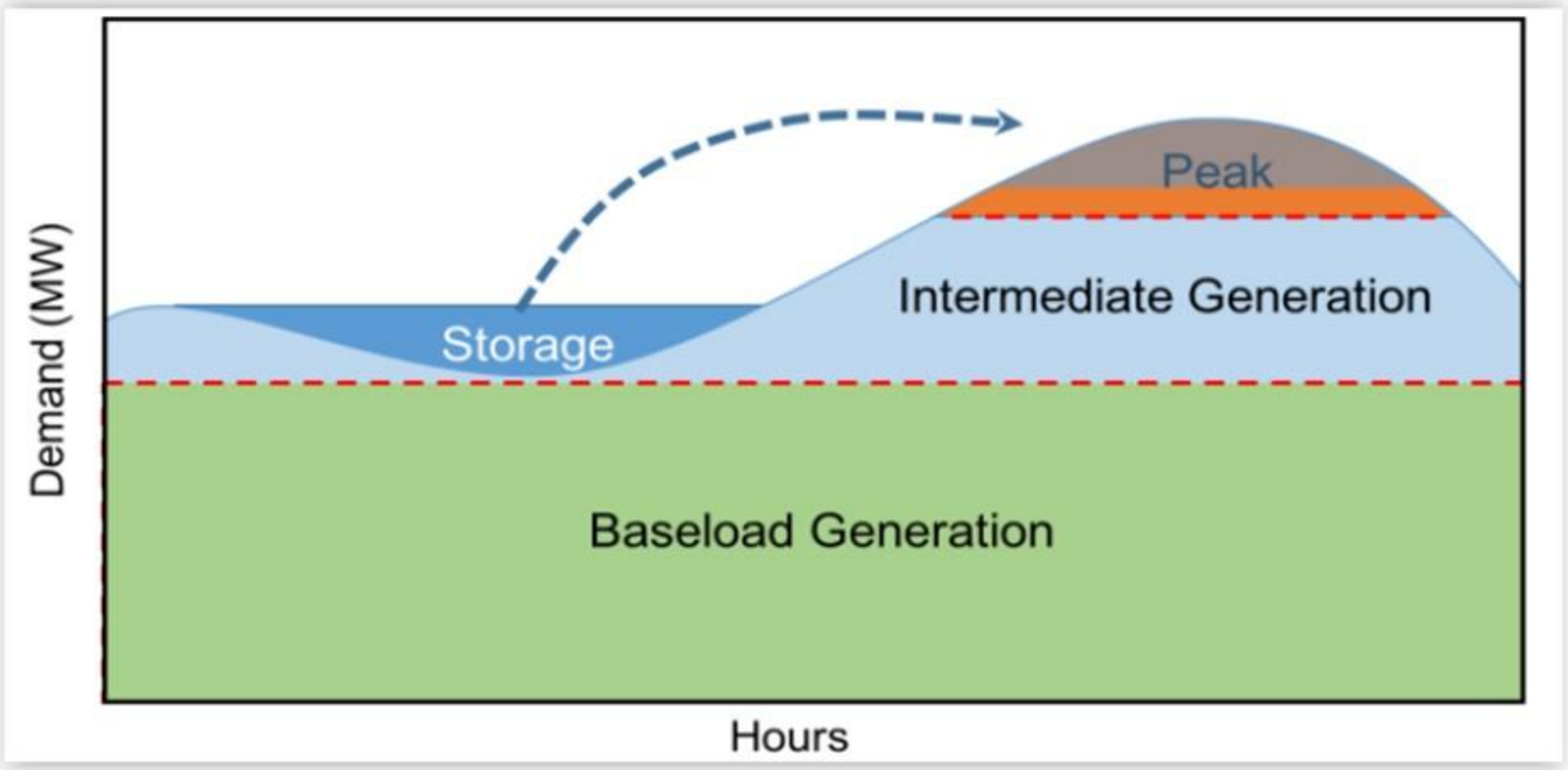
- Battery containers set on concrete pads; containers are fully enclosed, but cannot be entered
- Batteries are lithium iron phosphate (LFP) technology
- Interconnection will be via existing transformer (formerly that for Unit 2)
- Minimal site work except for crushed stone and concrete pads
- Site work could start during winter 2024/2025, containers could start arriving mid 2025

Project Thesis

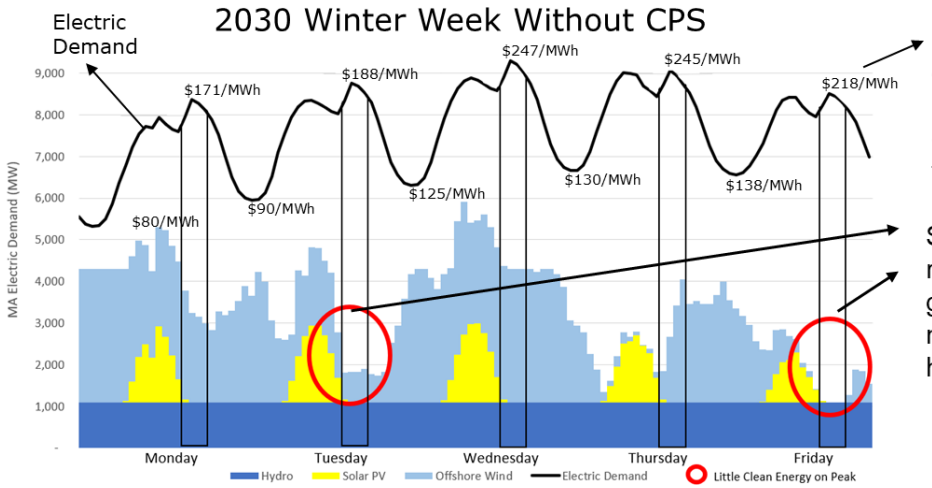
Project will serve the Massachusetts ***Clean Peak Standard (CPS)*** program, a first in the nation program to deliver low-cost renewable energy when energy market prices are the highest

Periods of the greatest solar or wind energy are not the periods of the highest energy use or cost

The CPS program incentivizes battery projects to shift solar and wind energy from the non-peak hours when it is generated to the peak hours when it is needed the most



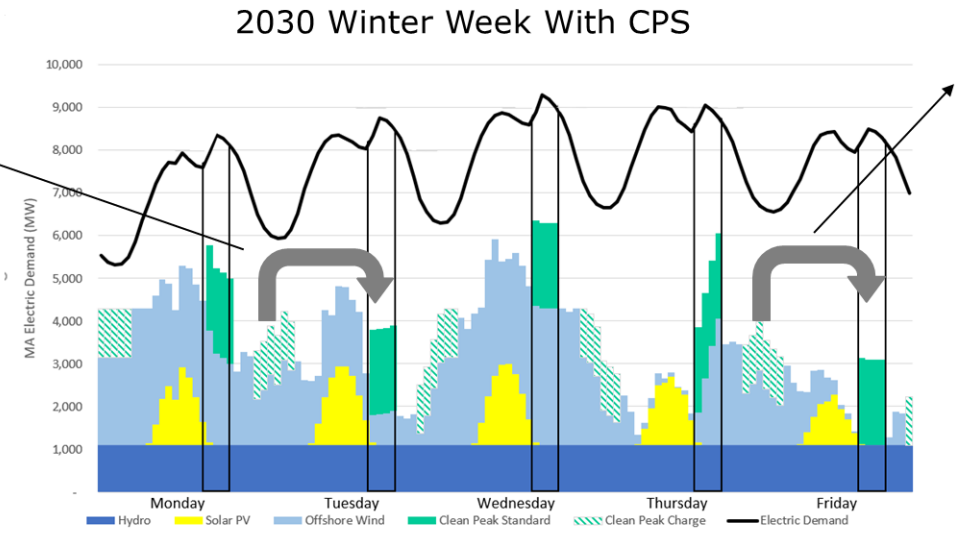
Benefits of the Clean Peak Standard



Pricing differentials reflect higher oil and gas use to meet peak

Significant renewable generation, but not during peak hours

Production profile for 1,090 MW Hydro, 3,200 MW Offshore Wind, 5,000 MW Solar PV



Opportunity to shift clean energy to peak periods through storage

CPS shifted wind energy generated overnight when prices and demand are lower to evening peak when demand is high

Production profile for 1,090 MW Hydro, 3,200 MW Offshore Wind, 5,000 MW Solar PV

Schedule

Goal is for BESS to be in commercial service from 2026

- Finalize interconnection process with ISO NE
- Discussions with West Springfield
- Initiate detailed engineering design
- Preliminary permitting activities

- Containers arrive at station
- BESS installation and connection
- Commissioning & commercial operation

June - December

January - December

January - June

- Engage with vendors and site related contractors
- Obtain final funding commitments
- Finalize supply agreement with BESS suppliers
- Begin on-site work

Beneficial changes to help promote clean energy development

Institutions are obligated to adhere to tariffs and regulations designed for conventional resources

- Storage in the northeast is not economically viable with only wholesale market revenue from the RTOs
  - Credit markets require significant revenue streams to be contracted for term
- Peaking resources have a low-capacity factor and underutilized injection rights.
  - Regulators should consider allowing clean energy additions to existing facilities to benefit from existing and underutilized injection rights
- The existing interconnection rules and injection rights anticipate a static generating resource for 20 to 40 years
- Existing generating resources have valuable interconnection rights that terminate upon the retirement of the existing resource
  - Regulators should consider extending the existing injection rights for the development of qualified clean energy resources
  - Such a change would provide significant cost savings and a meaningful reduction in the development schedule
- State brownfield provisions should focus on mitigation of site conditions and streamlining permitting for clean energy