Opportunities:
Electrification & Battery Storage

Kate Crosby, Energy Manager
Acton-Boxborough Regional School District
“Last Thursday, one of the biggest coal units in Australia, Loy Yang A 3, tripped without warning...with the sudden loss of 560MW and causing a slump in frequency on the network.

“What happened next has stunned electricity industry insiders....Even before the Loy Yang A unit had finished tripping, the [Tesla battery] had responded...

“Data...shows that the Tesla big battery responded four seconds ahead of the generator contracted to provide FCAS (frequency control and ancillary services)...pretty much instantaneous.

“Tesla weren’t officially playing in that market, but just wanted to show what they could do. And they did.”

The plan calls for the construction of a **409 MW/ 900 MWh** battery installation...

“For context, the largest battery installation in the world was built by Tesla...in South Australia [with] a capacity and power rating of **100 MW / 129 MWh**.”
“The Los Angeles Board of Water & Power Commissioners is expected to approve a 25-year contract that will serve 7% of the city's electricity demand at 1.997¢/kwh for solar energy and 1.3¢/kwh for power from batteries.

“...the lowest solar-photovoltaic price in the US...the largest and lowest-cost solar + storage project in the US and we believe in the world today,’ said the agency's manager for strategic initiatives.

“...half the estimated cost of power from a new natural gas plant.”
Solar, Wind and Battery Prices Falling
BloombergNEF Levelized Cost of Energy

$800 per MWh

2009 2019

Battery storage

400

Solar (no tracking)

300

Wind (offshore)

200

Solar (tracking)

100

Wind (onshore)

Source: BloombergNEF. Note: The global benchmark is a country weighted-average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale Li-ion battery storage system with four-hour duration running at a daily cycle and includes charging costs assumed to be 60% of wholesale average power price. Data as of October 22, 2019.
High demand costs → opportunities

- Participate in Demand Response programs to generate revenue

![Graph showing demand reduction](image)

- Reduce demand charges by “snipping peaks” on your electricity account(s)

![Graph showing demand profiles](image)

Source: An Introduction to Demand Charges (Clean Energy Group/NREL)
Solar arrays do **not** provide steady protection from 15-minute demand charges because generation is variable.

*Source* How to Estimate Demand Charge Savings from PV on Commercial Buildings (NREL)
*Source* Massachusetts Energy Storage Initiative: State of Charge (MA DOER, MA CEC)
Solar + Storage: “Time Shift” of Renewables & Peak Load Reduction

Source: Massachusetts Energy Storage Initiative: State of Charge (MA DOER, MA CEC)
“Value Stack” – Battery Economics

REVENUE:
- Demand Charge Reduction
- Resource Adequacy (Forward Reserve Market = reserve capacity)
- Frequency Regulation
- Load Following/Arbitrage

COSTS:
- Capital
- O&M & Charging

Source: The Economics of Battery Energy Storage (Rocky Mountain Institute)
ACES (Advancing Commonwealth Energy Storage)

2MW/4MWh battery storage array (on central school campus)
Dec. 2017 = grant award
Dec. 2020 = commissioning
ABRSD Central Campus Storage Project

Revenue Projection

Sources of Battery Revenue and Savings over Time

+ ISO-NE Frequency Regulation (ATRR)
+ ISO-NE Reserves
+ Capacity DR Programs
+ ICAP Savings
+ Demand Charge Management

$\text{(revenue & cost savings)}$

2019 2020 2021 2022 2023 2024 2025 2026 2027 2028

Demand Charge Management ICAP Savings Capacity DR Programs ISO-NE Reserves ISO-NE Frequency Regulation (ATRR)

Plus new Clean Peak Standard
ABRSD Douglas & Gates School Building Project

Douglas & Gates Elementary Schools
Acton-Boxborough Regional School District
Acton, Massachusetts

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ABRSD Douglas & Gates School Building Project

- 177,000 s.f.
- EUI target 28 kBtu/sf – currently modeling at 23.6 kBtu/sf
- Zero Net Energy
- Geothermal heating/cooling + backup electric boiler
- All-electric (diesel emergency backup generator)
- Solar+Storage (1MW/2MWh battery array)
- Rainwater collection to greywater system
STRATEGIC ELECTRIFICATION

- $70,000 “Electrification Roadmap” grant (MA MVP)
  - 10 responses to RFP – now underway
- $15,000 Municipal Energy Technical Assistance grant (MA DOER)

“Ithaca, New York votes to decarbonize every building in climate change fight”
APS = Alternative Energy Portfolio Standard (similar to RPS)
AEC’s = Alternative Energy Credit (similar mechanism to REC’s)
Intermediate and Large Renewable Thermal

- DOER is soliciting feedback from stakeholders on potential metering schemes for intermediate and large Generation Units
- Metering schemes must calculate Useful Thermal Energy and include the ability to net out:
  - Parasitic load and grid electricity
  - All cooling energy
  - Any heating energy from heat recovery

Useful Thermal Energy

1. Meter the heat energy coming off the heat pumps. For geothermal: meter the inlet and outlet water temp and it shows as BTUs...temp differential tells you how much heat was created thru GSHP. Calculate as BTU, and then convert to kWh (MWh).
2. Then subtract the electricity input into the GSHP system (kWh) to run the pumps, etc.
3. That calculation = net thermal energy from the system (in kWh) >>> you receive AECs.