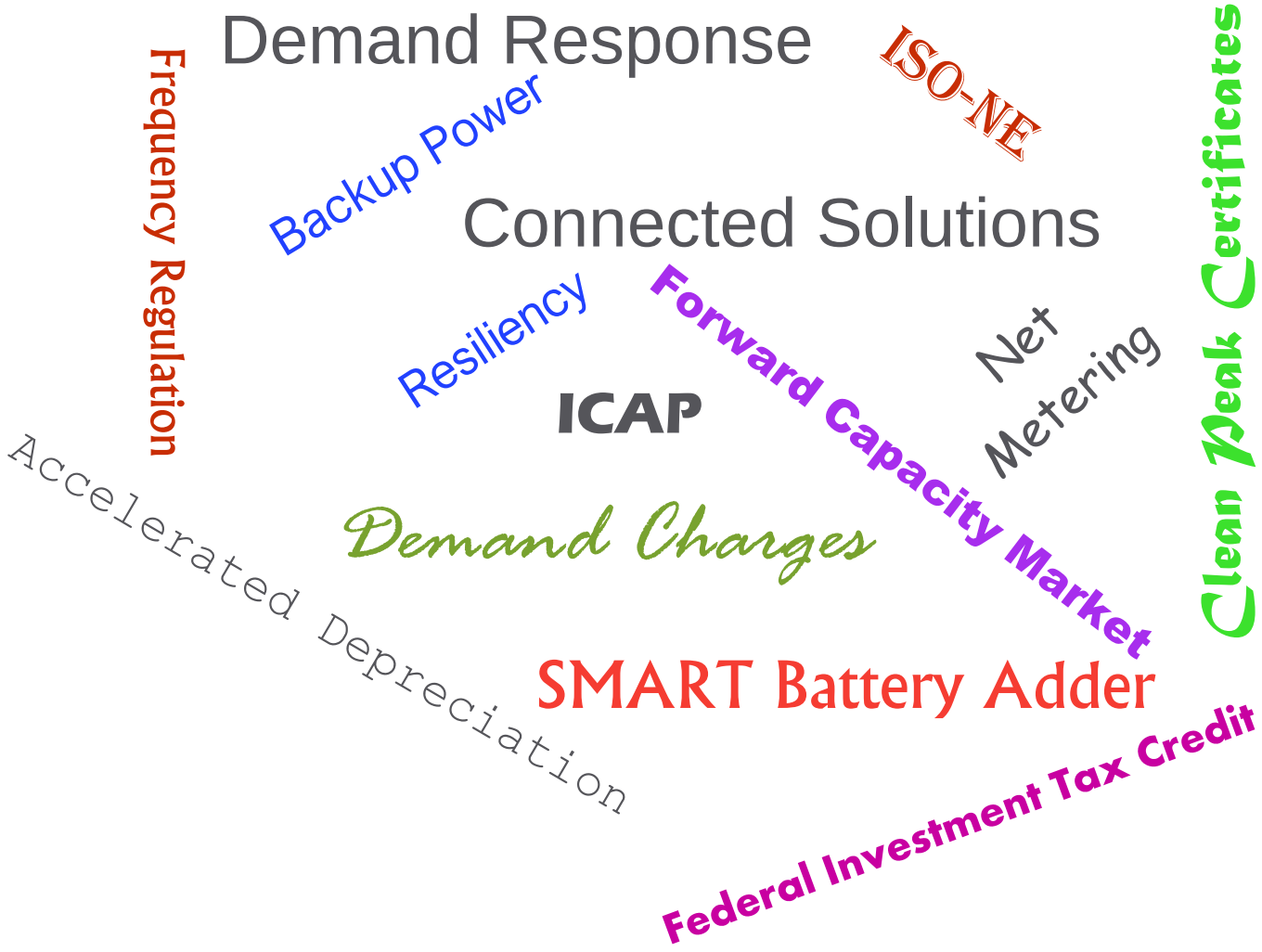
# Demand Response and Energy Storage

# AEE – New England

nationalgrid

# The Value Stack…



# Let's Put Some Numbers To It!

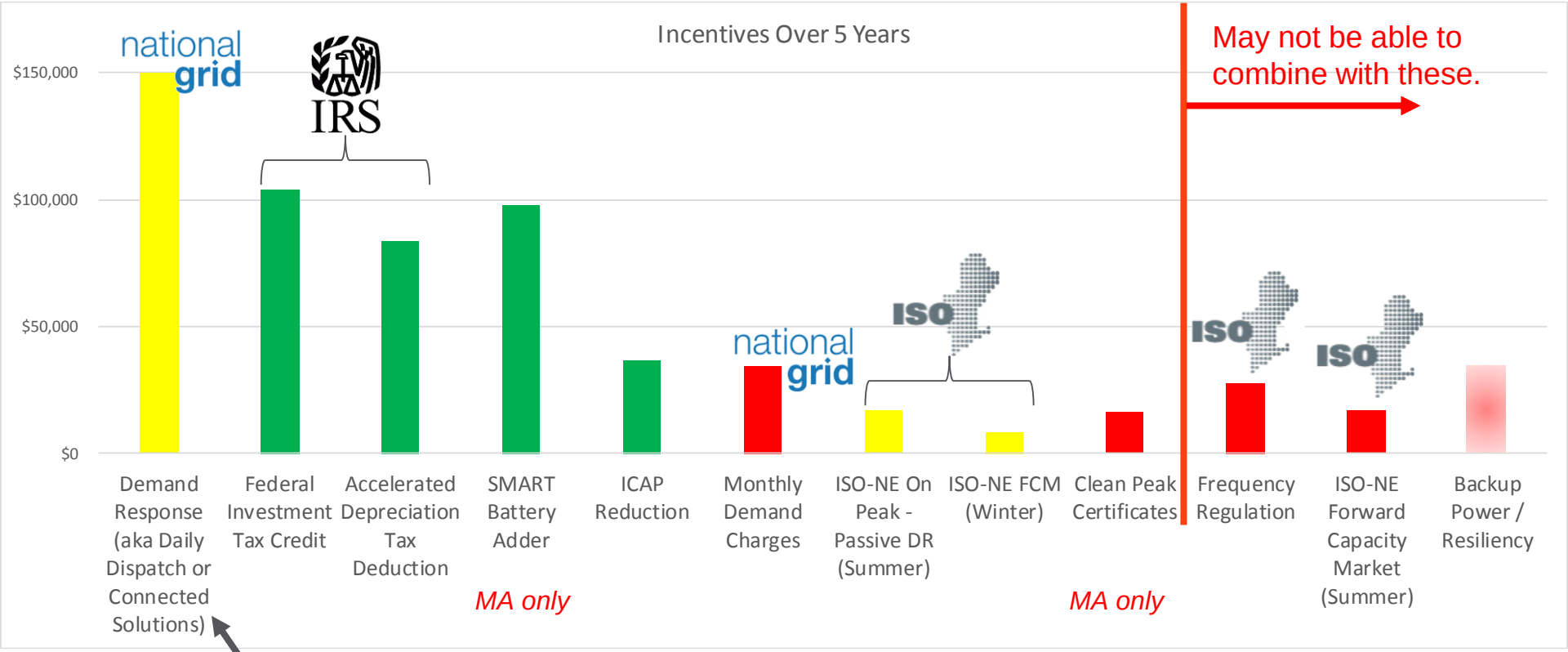
## 200kW/400kWh Example

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Demand Response (aka Daily Dispatch or Connected Solutions) | -Must discharge battery at peak times<br>-Pay for Performance<br>-2 to 3 hour events | $225/kW-year | $30,000 | Every Year | $150,000 | Medium |
| Federal Investment Tax Credit | -Must install solar<br>-Must charge (mostly) with solar<br>-Need a tax liability<br>-Drops down to 22% in 2021, then 10% in 2022 | 26% of Installed Cost | $104,000 | First Year | $104,000 | Easy |
| Accelerated Depreciation Tax Deduction | -100% Bonus Depreciation in year 1<br>-Phases down to 80% in 2023, can use 5-Year MACRS for the remainder<br>-Need Solar (7-yr MACRS w/o Solar) | 21% Reduction in Capital Costs | $84,000 | First Year | $84,000 | Easy |
| SMART Battery Adder | -Need Solar<br>-Depends on Size of Solar and Battery<br>-25% to 100% of Solar Capacity<br>-52 Full Cycle Discharges per Year | About $0.04/kWh-Solar | $19,622 | Every Year | $98,112 | Easy |
| ICAP Reduction | -Need a 3rd Party Supply Contract<br>-Need to "pass through" capacity charges | $55/kW-year | $7,378 | Every Year | $36,889 | Easy |
| Monthly Demand Charges | -Need to keep you demand down all month | $5.75/kW-month | $6,900 | Every Year | $34,500 | Hard |
| ISO-NE On Peak - Passive DR (Summer) | -Fixed discharge window of June, July, and August on 1pm to 5pm on weekdays.<br>-Can particiapte in summer only for 1/3 of the benefit | $37/kW-year | $3,443 | Every Year | $17,215 | Medium |
| ISO-NE FCM (Winter) | -Need to be an ISO-NE market participant or have a CSP<br>-CSPs typically get 20% - 40% of the ISO revenue<br>-December through March. Between 5pm and 7pm. | $18/kW-year | $1,721 | Every Year | $8,607 | Medium |
| Clean Peak Certificates | -Must Charge with Solar<br>-A lot of charge/discharges - Be sure to quantify the cost of decreased battery life | $16/kW-year | $3,225 | Every Year | $16,127 | Hard |
| Frequency Regulation | -4 second response time<br>-Must be able to charge and discharge<br>-Must be available all the time<br>-Need to be an ISO market participant, or go through a CSP | $0.02/kWh | $5,600 | Every Year | $28,000 | Not Compatable with any other program. |
| ISO-NE Forward Capacity Market (Summer) | -Need to be an ISO-NE market participant or have a CSP<br>-CSPs typically get 20% - 40% of the ISO revenue<br>-Has a 10-day baseline that would be wiped out with Demand Response | $37/kW-year | $3,443 | Every Year | $17,215 | Not Compatable with Demand Response |
| Backup Power / Resiliency | -Depending on the customer, may not be compatiable with any other revenue stream.<br>-Very site specific. | ??? | ??? | ??? | ??? | May not be compatable with others. |



**Upfront Cost of Battery:** $200kW \cdot \frac{\$2{,}000}{kW} = \$400k$

# In Perspective

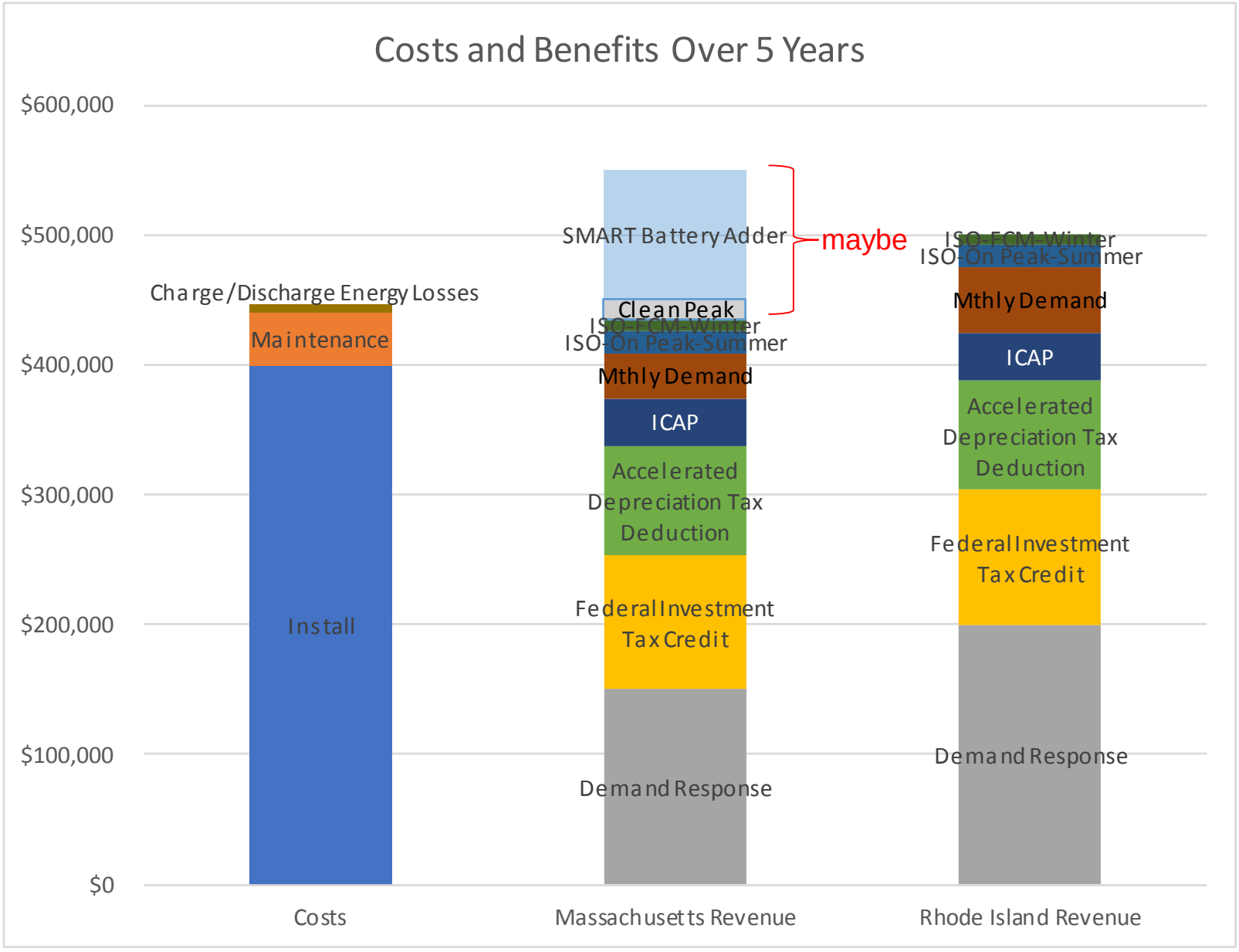



The Rhode Island Demand Response Incentive is even larger.

Difficulty

- Easy
- Medium
- Hard

# 5-Year Cost and Benefits



# Note on Storage and Net Metering

Massachusetts

Solar systems larger than 10kW are not eligible for net metering in MA. However, that is okay because they can get SMART incentives.

Rhode Island

Solar + Storage systems larger than 25kW are not allowed in the Net Metering Program in Rhode Island, and there is not other production incentive for solar.

This is a downer, and we are looking for ways to include larger batteries in Net Metering in RI.

However…

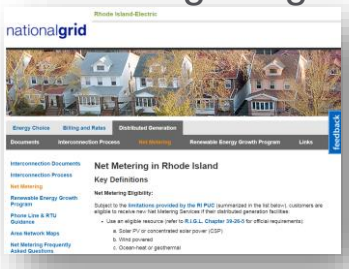
Many/most commercial facilities with solar rarely back feed to the grid, and don't get a benefit from Net Metering. If you opt out of Net Metering, there is no restriction on storage. Additionally, you may be able to still get ~$0.05/kWh for your back feeding by registering as a Qualified Facility.

## Resources to Learn More:

Webpage about the MA Net Metering Program


https://www.mass.gov/guides/net-metering-guide

Webpage about the RI Net Metering Program




https://www9.nationalgridus.com/narragansett/home/energyeff/4_net-mtr.asp

Waiver for <25 kW Systems in RI


MA Net Metering Cap

# Demand Response Battery Demonstration

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Demand Response (aka Daily Dispatch or Connected Solutions) | -Must discharge battery at peak times<br>-Pay for Performance<br>-2 to 3 hour events | $225/kW-year | $30,000 | Every Year | $150,000 | Medium |

$$Incentive\ Amount = \frac{400\ kWh\ battery\ capiacity}{3h\ event\ duration} \cdot \frac{\$225}{kW - year} = \$30k\ per\ year$$

## Commercial

### Massachusetts

- 30 - 60 events per summer
- 2 - 3 hours per event
- Technology/Vendor Agnostic
- **$200/kW-performed-summer**
- **$ 25/kW-performed-winter**

### Rhode Island

- 30 - 60 events per summer
- 2 - 3 hours per event
- Technology/Vendor Agnostic
- **$300/kW-summer**

## Residential

### Massachusetts

- 30 - 60 events per summer
- 2 - 3 hours per event
- 5 Approved Battery Integrators
- **$225/kW-performed-summer**
- **$ 50/kW-performed-winter**

### Rhode Island

- 30 - 60 events per summer
- 2 - 3 hours per event
- 5 Approved Battery Integrators
- **$400/kW-summer**

## Resources to Learn More:

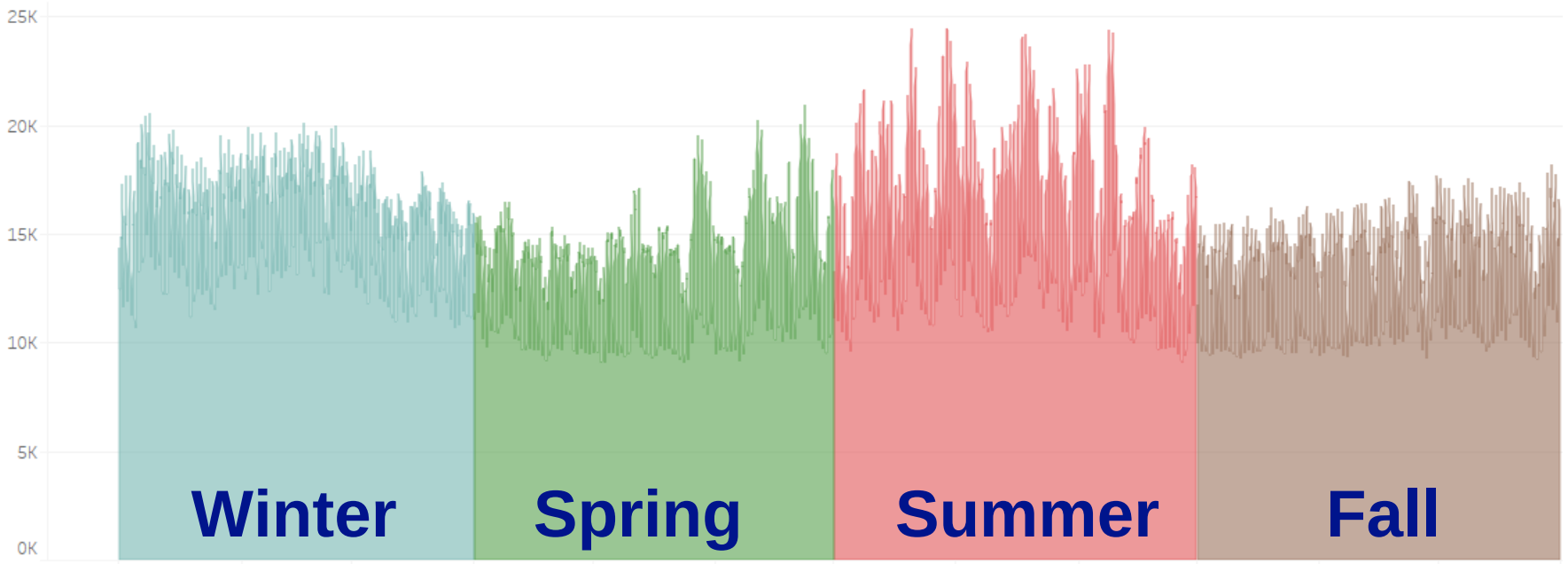
**https://www.nationalgridus.com/connectedsolutions**

**National Grid**

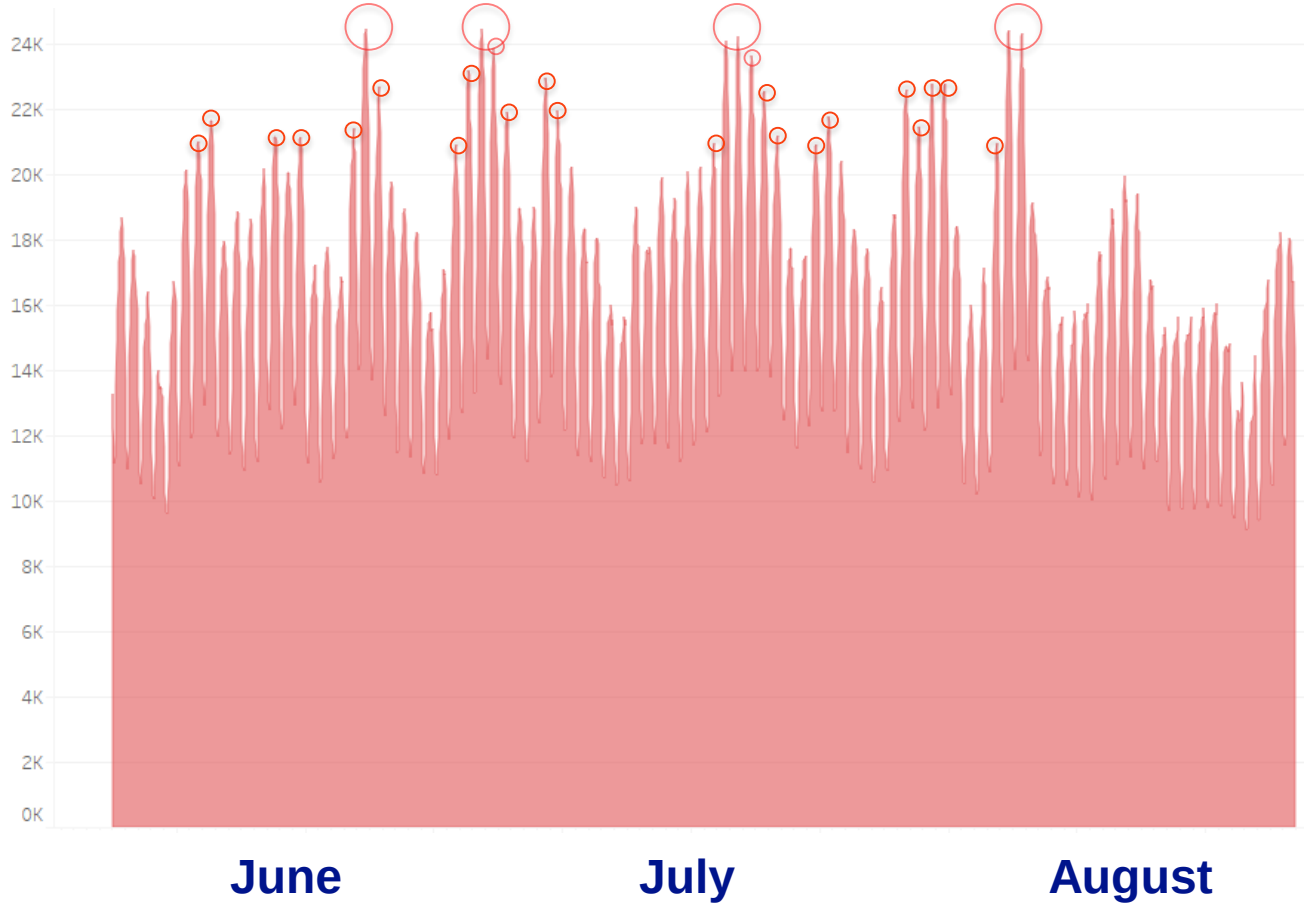
Utility Demand Response Program Managers

- Unitil – Tom Palma palma@unitil.com
- National Grid – Paul Wassink paul.wassink@nationalgrid.com
- Eversource - Roshan Bhakta roshan.bhakta@eversource.com
- CLC - Austin Brandt austin.brandt@capelightcompact.org

# What is Demand Response, and Why do We Do It?




The whole grid is sized to meet the peak.




## C&I Daily Dispatch

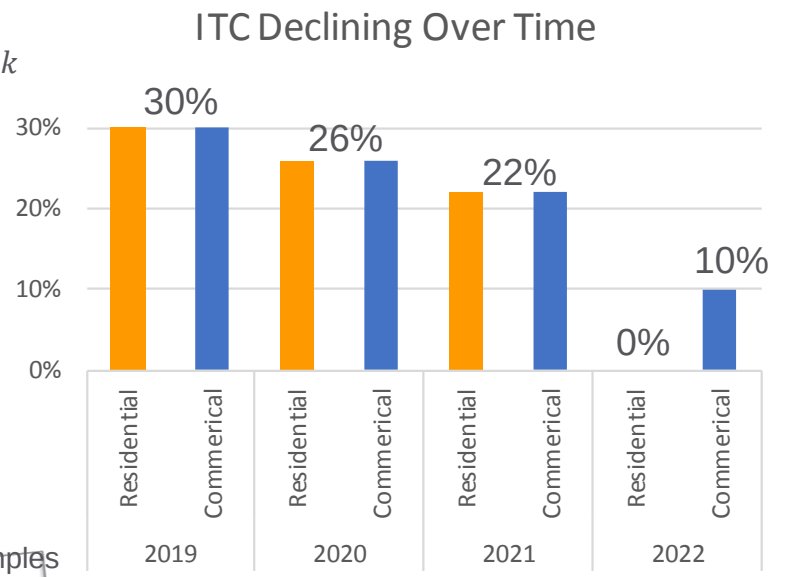
## Residential Batteries

# Federal Investment Tax Credit

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Federal Investment Tax Credit | -Must install solar<br>-Must charge (mostly) with solar<br>-Need a tax liability<br>-Drops down to 22% in 2021, then 10% in 2022 | 26% of Installed Cost | $104,000 | First Year | $104,000 | Easy |

$$Incentive\ Amount = 200kW\ battery\ system \cdot \frac{\$2{,}000}{kW\ -installed} \cdot 26\% = \$104k$$

Tax credits directly reduce the amount of taxes owed.



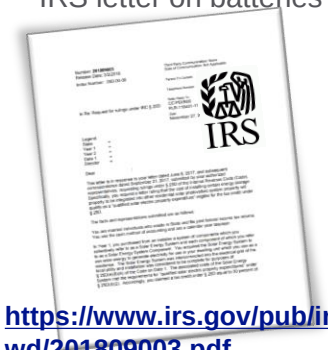

## Resources to Learn More:

Tax Advisor

**Dan Audette**
**Energy Tax Savers®**
144A Jackson Avenue
Syosset, NY 11791
Phone: 516-364-2630
Fax: 516-706-4122
www.energytaxsavers.com |

Energy Tax Savers, Inc.
The EPAct 179D Experts

IRS letter on batteries




https://www.irs.gov/pub/irs-wd/201809003.pdf

NREL Tax Examples


https://www.nrel.gov/docs/fy18osti/70384.pdf



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# Accelerated Depreciation Tax Deduction

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Accelerated Depreciation | -100% Bonus Depreciation in year 1<br>-Phases down to 80% in 2023, can use 5-Year MACRS for the remainder<br>-Need Solar (7-yr MACRS w/o Solar) | 21% Reduction in Capital Costs | $84,000 | First Year | $84,000 | Easy |

$$Incentive\ Amount = 200kW\ battery\ system \cdot \frac{\$2{,}000}{kW\ -installed} \cdot 21\% = \$84k$$

Typical Corporate Tax Rate

Tax deductions reduce how much income is subject to taxes.

## Resources to Learn More:

Tax Advisor


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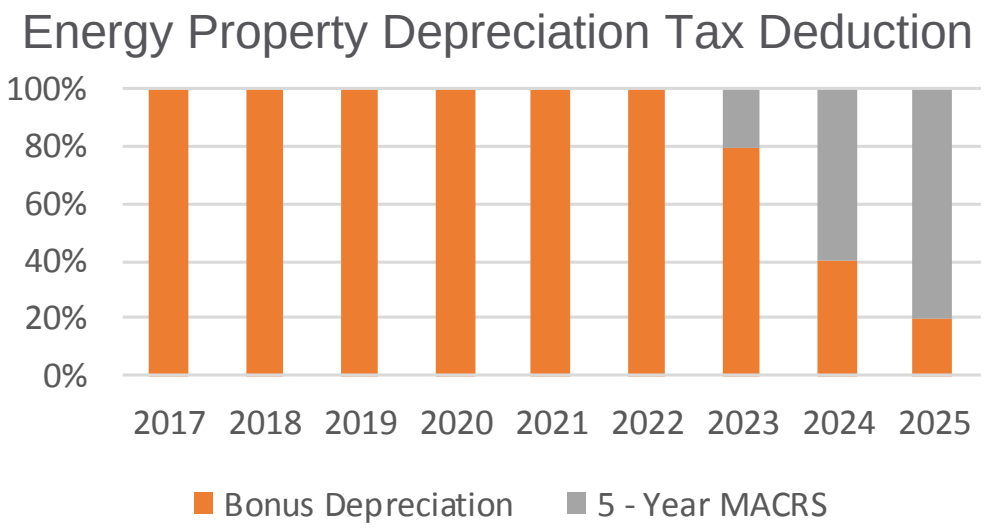
The EPAct 179D Experts







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# SMART Battery Adder

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| SMART Battery Adder | -Need Solar<br>-Depends on Size of Solar and Battery<br>-25% to 100% of Solar Capacity<br>-52 Full Cycle Discharges per Year | About $0.04/kWh-Solar | $19,622 | Every Year | $98,112 | Easy |

$$Energy\ Storage\ Adder = \left[\frac{\left(\frac{ESkW}{PVkW}\right)}{\left(\left(\frac{ESkW}{PVkW}\right) + \exp\left(0.7 - \left(8 * \left(\frac{ESkW}{PVkW}\right)\right)\right)\right)}\right] * \left[0.8 + \left(0.5 * \ln\left(\frac{ESkWh}{ESkW}\right)\right)\right] * Base\ Adder$$

Battery Size

Solar Size

Typically about $0.15/kWh if you can get it…

**LARGE PROJECTS (>25 kW AC)**

| Electric Distribution Company | Accepting Applications for Block |
|---|---|
| Eversource MA East | 2 of 8 |
| Eversource MA West | Waitlist |
| National Grid (MA Electric) | Waitlist |
| National Grid (Nantucket) | 1 of 2 |
| Unitil | Waitlist |

The DOER is starting meetings in September to review the SMART program. Maybe they will add more blocks. ?

Resources to Learn More:

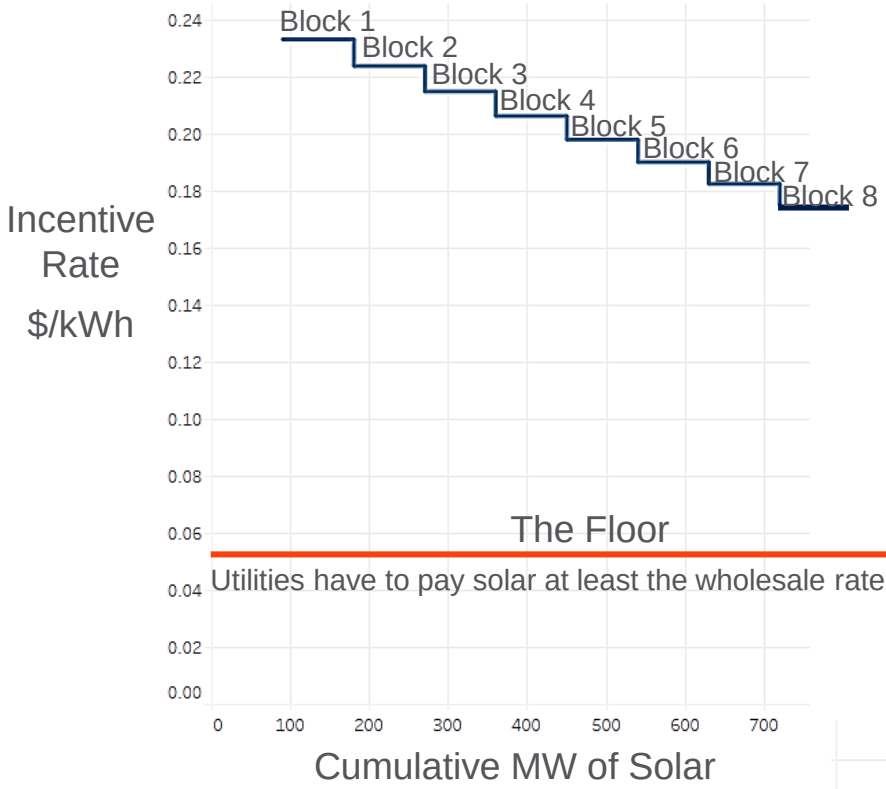
**http://masmartsolar.com/**

Energy Storage Calculator

**Utility SMART Program Managers**

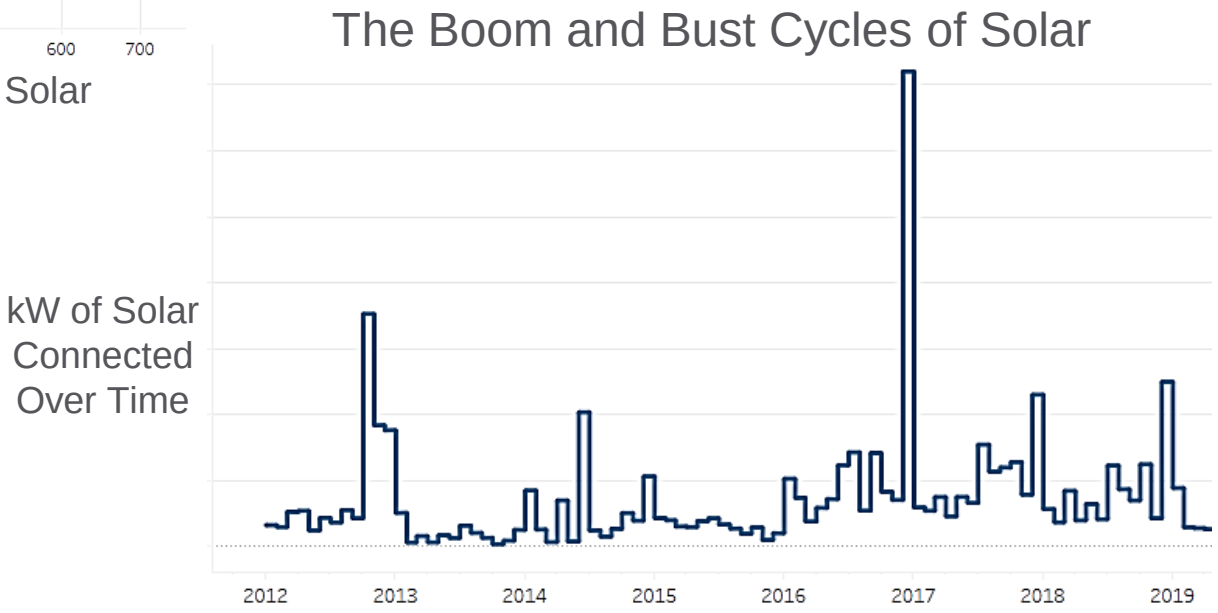
- Unitil – Jessica Emerson emerson@unitil.com
- National Grid – Tara Reisner Tara.Reisner@nationalgrid.com
- Eversource – Andy Belden Andrew.belden@eversource.com

# Declining Blocks of MA SMART Incentives




? *Coming this Fall?*

Utilities have to pay solar at least the wholesale rate for solar under PURPA.



# ICAP Reduction – Reduction of 3rd Party Supply Costs

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| ICAP Reduction | -Need a 3rd Party Supply Contract<br>-Need to "pass through" capacity charges | $55/kW-year | $7,378 | Every Year | $36,889 | Easy |

**Fixed Rate**

**If the customer pays a fixed (all –in) rate, the ICAP charge is baked into the $/kWh. The customer could still lower their demand on the ICAP hour to negotiate a lower charge with his/her supplier or to get a better rate when the supply contract is over.**

VS.

**Capacity Pass-Through**

**In this type of contract the customer gets all of the benefit (and risk) of their ICAP tag. If the customer reduces their demand during the ICAP hour, they will see lower a lower capacity charge next June, when capacity charges are reconstituted.**

ISO new england

| Summer | ICAP Tag Value |
|---|---|
| Summer 2016 | $36/kW-year |
| Summer 2017 | $81/kW-year |
| Summer 2018 | $109/kW-year |
| Summer 2019 | $84/kW-year |
| Summer 2020 | $64/kW-year |
| Summer 2021 | $56/kW-year |
| Summer 2022 | $46/kW-year |

# Monthly Demand Charges

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Monthly Demand Charges | -Need to keep you demand down all month | $5.75/kW-month | $6,900 | Every Year | $34,500 | Hard |

$$Incentive\ Amount = \frac{400\ kWh\ battery\ capiacity}{3h\ event\ duration} \cdot \frac{\$5.75}{kW - month} \cdot \frac{9\ months}{year} = \$6.9k\ per\ year$$

*Assumes just focusing on demand response for July and August, and you might not hit every other month.*

| Utility | Service Area | Rate Code | $/kW every month |
|---|---|---|---|
| nationalgrid | Massachusetts | G-3 Rate | $5.75 |
| | Rhode Island | G-32 Rate | $8.47 |
| EVERSOURCE | Boston | G8 | $11.46 winter<br>$20.11 summer |
| | Cambridge | G-3 | $12.65 |
| | South Shore | G-2 | $8.23 |
| | Western MA | T-5 | $4.62 |
| | | T-2 | $6.47 |

A facility's peak load is not necessarily (or usually) coincident with the system peak.

# ISO-NE Winter Forward Capacity Market

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| ISO-NE Forward Capacity Market (Winter) | -Need to be an ISO-NE market participant or have a CSP<br>-CSPs typically get 20% - 40% of the ISO revenue<br>-December through March. Between 5pm and 7pm. | $18/kW-year | $1,721 | Every Year | $8,607 | Medium |

Average FCA price over the next 3 years x 1/3 for winter only

$$Incentive\ Amount = \frac{400\ kWh\ battery\ capiacity}{3h\ event\ duration} \cdot \frac{\$18}{kW-year} \cdot \frac{70\%}{Customer's\ Share} = \$1.7k\ per\ year$$

## Pre-Approved Curtailment Service Providers in Connected Solutions

| | |
|---|---|
| CPower | 1 (844) 996-4743<br>NGRID@CPowerEnergyManagement.com |
| enel X | 1 (617) 535-7482<br>NationalGridNE@enernoc.com |
| IPKeys SECURE TECHNOLOGY INTEGRATION CONSULTING & SOFTWARE | 1 (855) 475-3970<br>NGSales@ipkeys.com |
| voltus LESS ENERGY • MORE CASH | 1-415-463-4236<br>NGridNE@voltus.co |

ISO new england

Forward Capacity Auction Clearing Prices

| Summer | FCA Clearing Price |
|---|---|
| Summer 2016 | $36/kW-year |
| Summer 2017 | $81/kW-year |
| Summer 2018 | $109/kW-year |
| Summer 2019 | $84/kW-year |
| Summer 2020 | $64/kW-year |
| Summer 2021 | $56/kW-year |
| Summer 2022 | $46/kW-year |

# ISO-NE On Peak – Passive DR Program

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| On Peak - Passive DR | -Fixed discharge window of June, July, and August on 1pm to 5pm on weekdays.<br>-Can particiapte in summer only for 1/3 of the benefit | $37/kW-year | $3,443 | Every Year | $17,215 | Medium |

Average FCA price over the next 3 years x 2/3 for summer only

$$Incentive\ Amount = \frac{400\ kWh\ battery\ capiacity}{3h\ event\ duration} \cdot \frac{\$37}{kW-year} \cdot \underset{Share}{70\%\ Customer's} = \$3.4k\ per\ year$$

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| Summer 2022 | $46/kW-year |

# Clean Peak Program Certificates

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Clean Peak Certificates | -Must Charge with Solar<br>-A lot of charge/discharges - Be sure to quantify the cost of decreased battery life | About $18/kW-year | $4,000 | Every Year | $20,000 | Hard |

$$Incentive\ Amount = \frac{400\ kWh\ battery\ capiacity}{3h\ event\ duration} \cdot \frac{\$18}{kW - year} = \$4k\ per\ year$$

The program design is NOT finalized yet, but they have given some preliminary indications of what it might look like…

Incentivizes charge/discharge every day of the year, but gives a higher rate to peak days.

-When charging/discharging so often, be sure to look at decreased battery life

$$\frac{Cost\ of\ decreased\ battery\ life}{} = \frac{Energy\ Discharge\ from\ battery_{kWh}}{Energy\ Capacity\ of\ battery_{kWh}} \cdot \frac{Cost\ of\ replacing\ battery\ at\ the\ end\ of\ useful\ life}{Usefull\ life\ of\ battery_{complete-charge/discharge-cycles}}$$

-When accounting for decreased battery life, it is may be better to just chase Clean Peak Credits on Peak Days, not 365 days per year.

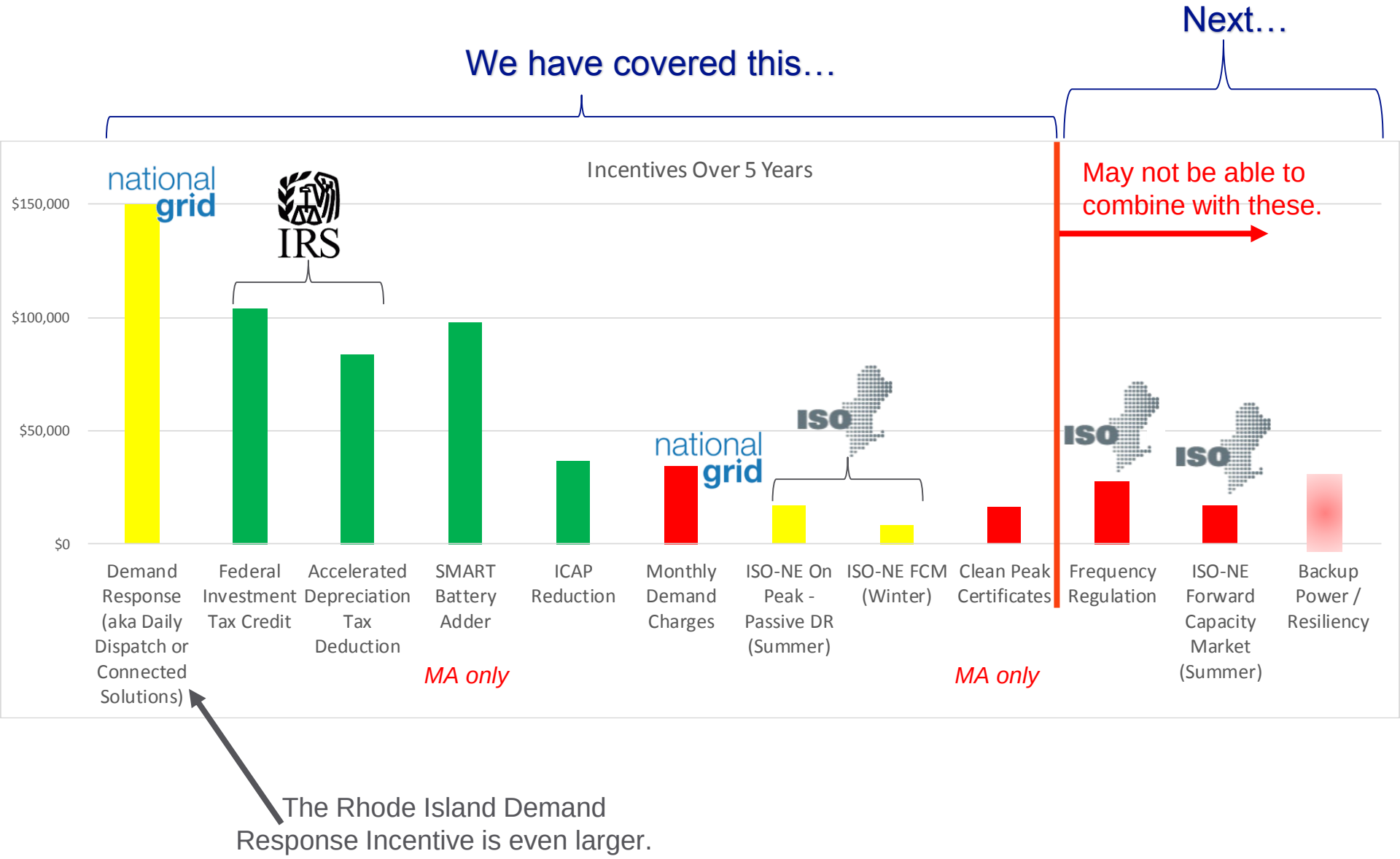
Resource to Learn More:

https://www.mass.gov/service-details/clean-peak-energy-standard

Quick Calc for CPS

Microsoft Excel Worksheet

# Where are we in this presentation?



# Frequency Regulation (aka Ancillary Services)

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Frequency Regulation | -4 second response time<br>-Must be able to charge and discharge<br>-Must be available all the time<br>-Need to be an ISO market participant, or go through a CSP | $60/kW-year | $4,800 | Every Year | $24,000 | Not Compatable with any other program. |

$$Incentive\ Amount = 400\ kWh\ battery\ capacity \cdot \frac{\$0.02}{kWh} \cdot \frac{1000hr}{year} \cdot \frac{70\%}{Customer's\ Share} = \$5.6k\ per\ year$$

Hours per year frequency regulation is typically called on

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ISO new england

Resource to Learn More:

https://www.iso-ne.com/markets-operations/markets/regulation-market/

# ISO-NE Summer Forward Capacity Market

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Average FCA price over the next 3 years x 2/3 for summer only

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| Summer 2020 | $64/kW-year |
| Summer 2021 | $56/kW-year |
| Summer 2022 | $46/kW-year |

# Backup Power / Resiliency

| Program | Strings | Incentive Rate | Incentive Amount | When | 5-Year Incentive | Difficulty |
|---|---|---|---|---|---|---|
| Backup Power / Resiliency | -Depending on the customer, may not be compatiable with any other revenue stream.<br>-Very site specific. | ??? | ??? | ??? | ??? | May not be compatable with others. |

The value of backup power is customer specific.

If all you need is backup power, consider a generator…

| Battery | Back Up Generator |
|---|---|
| Relatively High Upfront Cost | Relatively Low Upfront Cost |
| Relatively Low Running Cost | Relatively High Running Cost |
| Typically can run for hours | Typically can run for days |

# Things Could Change at the ISO…

- FERC Order 841 requires all ISOs and RTO to update their markets to better integrate battery storage.
- ISO-NE is expected to request market changes this fall.
- What the price point will be for all this is still unknown.
- However, nothing we have discussed so far in this presentation is expected to change. (**Only Upside**)

ISO-NE Preliminary
Storage Market Design


https://www.iso-ne.com/static-assets/documents/2019/02/20190221-csf.pdf


MA Energy Storage Overview
stem
Energy Superintelligence™

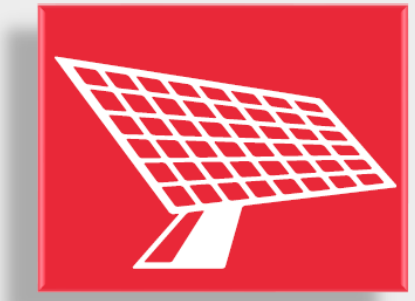
# Storage enables a modern, sustainable grid

### Enable distributed energy

Networking distributed storage enables the transition to a smart grid. It is the fastest, cheapest, and cleanest way to solve distribution-level challenges.

### Reduce peaker plants

Energy storage on the grid is a clean, flexible alternative to expensive gas-fired peaking power plants operating only a few hours per year.



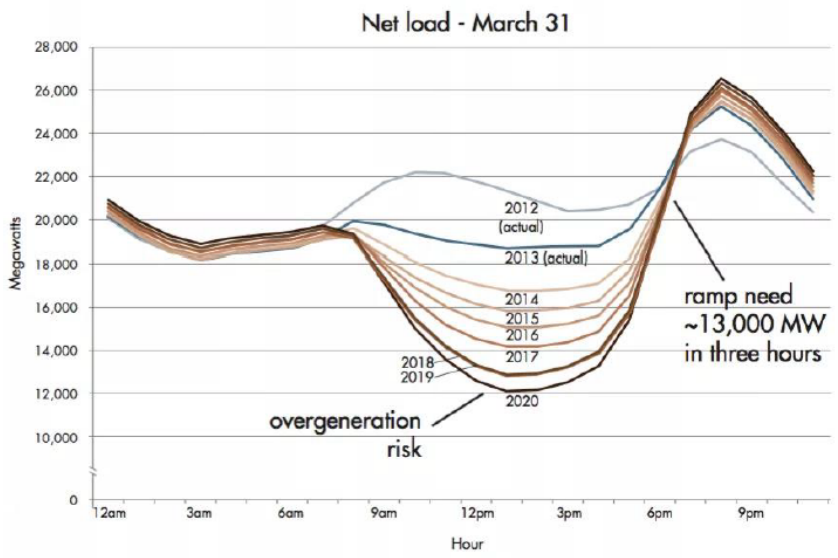
### Increase renewable energy

Smoothing the volatile output of solar and wind keeps the grid stable at high penetration levels, enabling widespread adoption of renewable energy.

# MA SMART solution for BTM + IFM

- "Duck Curve" is used to show how renewable energy production does not match consumer consumption of energy
- Daytime production can exceed demand causing negative energy pricing
- Nighttime demand can't be matched with 100% renewable Energy
- Will need ESS to timeshift

**Figure 2: The duck curve shows steep ramping needs and overgeneration risk**



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# Growing support for BTM energy storage in MA

**Jun 2017**
DOER sets energy storage target of 200 MWh

**Dec 2017**
- DOER awards $20M in ACES grants for energy storage pilots
- Eversource procures 5 MWh of battery energy storage for Demand Reduction Demonstration

**Nov 2018**
SMART launched with adder for solar projects paired with storage

**Jun 2019**
ConnectedSolutions launches, opening up BTM storage market

**Policy** → **Pilots** → **Programs**


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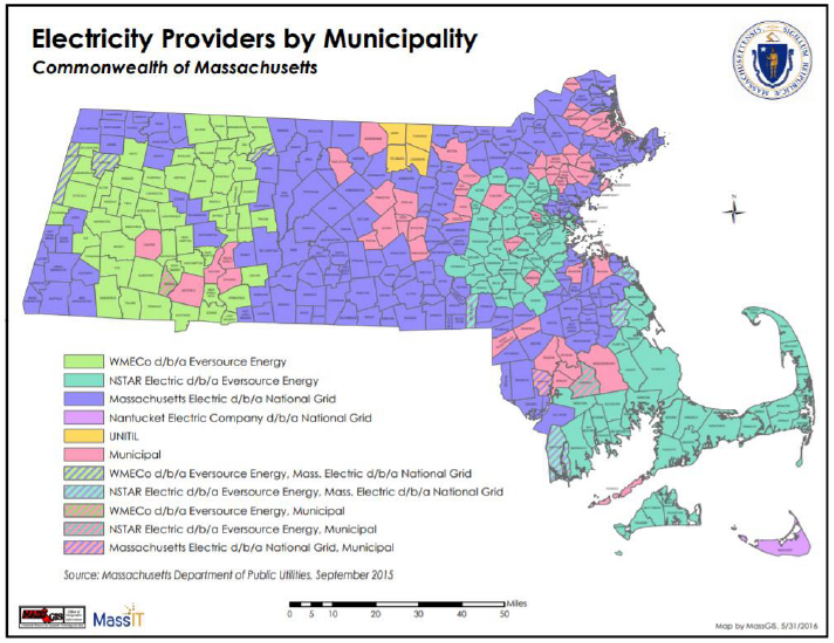
# MA SMART Solution for BTM + IFM




- MA is a top ten solar state with over 2.2GW of PV installed
- The state wants to adopt more solar but utilities are having challenges with ‘grid penetration’
- State government instituted new policy “MA SMART”
  - Want to have 1.6GW of additional PV on the grid
  - Mandates that utilities must purchase solar + storage energy from independent power producers at a fixed rate for 20 years
  - Rate is enhanced by the addition of storage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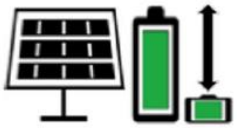
# MA SMART

## Storage Requirements:

52 cycle-equivalent discharges per year


2-6 hour systems (incentivized for up to 6 hours, and sub-2-hour must de-rate kW)



Rated power capacity ≥ 25% of the PV $kW_{DC}$ array capacity
(Systems only incentivized up to 100% of PV capacity)

Roundtrip efficiency > 65%

Must be operational for > 15% of any 12-month rolling period

Must provide 15-minute interval data for the first year, and upon request for the first five years



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# ConnectedSolutions

- Demand Response (DR): Customers are paid to reduce load when called on by their utility
- Open enrollment for customers of National Grid and Eversource
- Goal of ConnectedSolutions is to reduce daily, monthly, and annual coincident peaks
- Technologies that reduce demand on a “daily” basis earn enhanced incentive rate
- Incentive rates are locked in for 5 years from the time a customer enrolls


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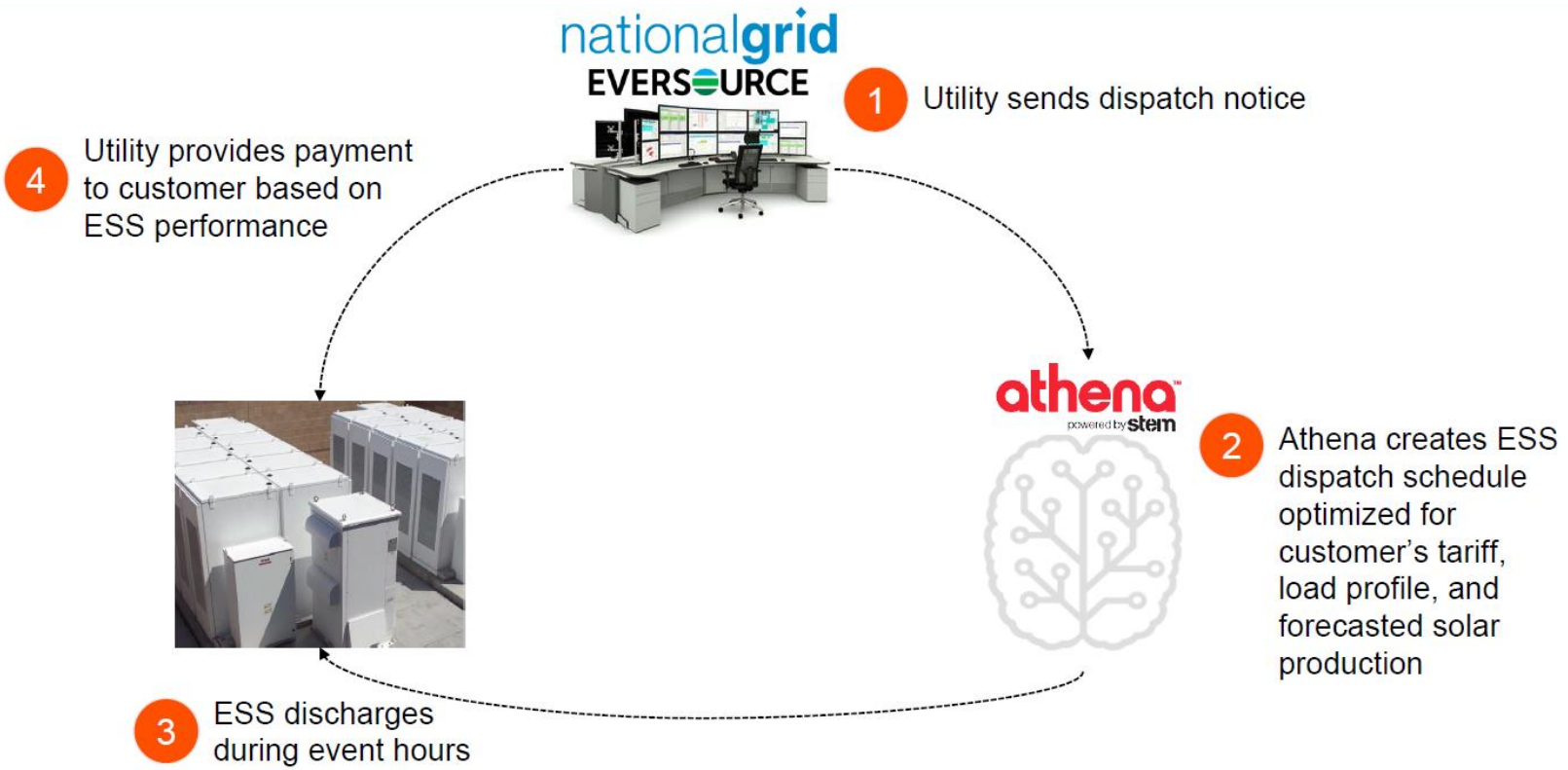
# ConnectedSolutions dispatch process

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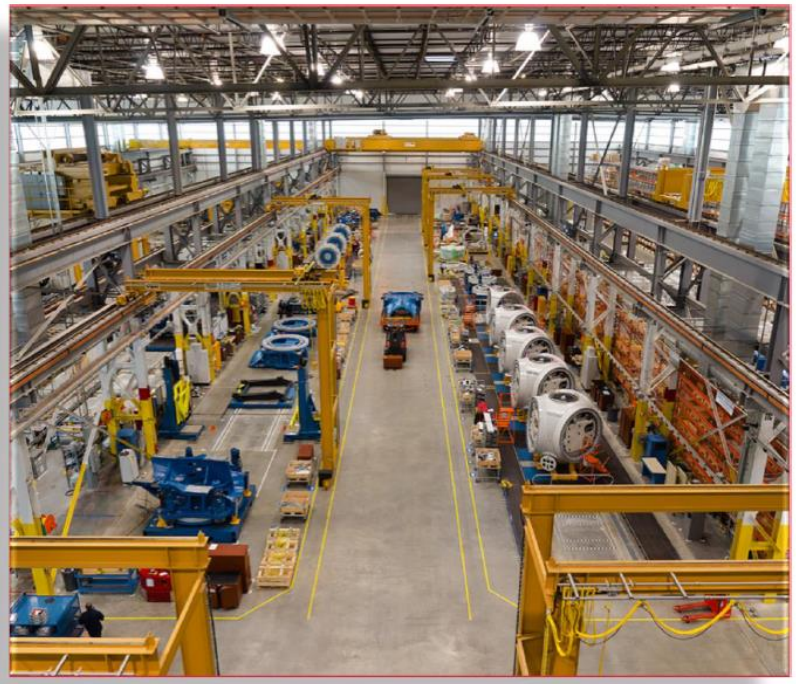
# No change to operations



- Storage system is 100% automated.
- Requires no extra staff time or disruption to normal operations.
- Participate in demand response without lifting a finger.

"The Stem system is invisible to our guests and our staff. It's simply a great way to save on energy costs. In addition, the software provides us with a clear view of electricity usage and activity."

**Larry Fichuk**, Director of Energy and Sustainability, Extended Stay America

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# Installation Process & Timelines

| Deployment Stage | Design & Interconnection | Construction Approvals | Installation | Validation & Inspection | Optimization & Testing | System Live |
|---|---|---|---|---|---|---|
| Estimated Timeframe | 6-8 Weeks | 8-10 Weeks | 3-6 Weeks | 2-4 Weeks | 2-4 Weeks | Immediate |

# Siting Considerations

- Distance to tie-in: Minimize AC Runs
- Clear of underground utilities
- Physical space for all equipment
- Installation access (crane, forklift)
- Illumination required
- If near public access/sight, screening may be required by AHJ/customer
- If near vehicular traffic, bollards required

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# Clearance and Access Requirements

- Fire and Electrical Code
  - Standard NEC and OSHA 3'+ clear space in front
  - 5' off buildings, 5' off property lines, 10' away from emergency egress paths
  - Consult local AHJ and Fire Authority
- Serviceability
  - 6' (Tesla) or 4' (Sungrow) front clearance
    - Removable bollards acceptable
  - 3' overhead clearance (structures and trees)
  - Walkable path to equipment for rolling carts/service units
  - Elevated locations need ramp, lift, and/or elevator

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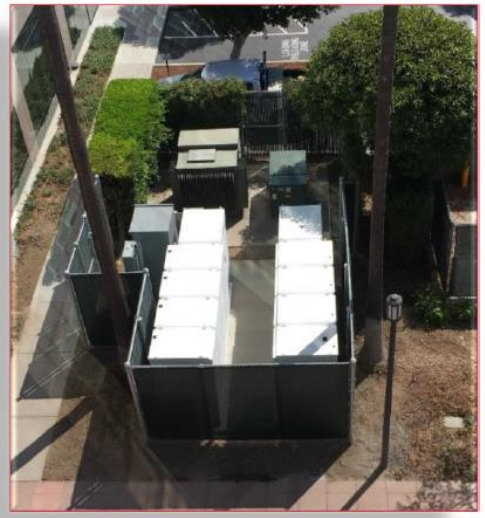
# Sample Layouts

- Select configurations to accommodate site constraints
- Balance code requirements, aesthetics and clearances



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# Key considerations regarding a storage solution

**Software Co-optimization & Value-stacking**

The value of your energy storage solution is directly tied to how effectively your system is operated. A successful energy storage solution will need to simultaneously manage multiple value streams at once. Be sure your partner has the ability to deliver on all of the available value streams for your specific use case.

**Experience and Expertise**

There are many complexities to enabling a successful energy storage project. Be sure your partner has active projects in MA and has a full understanding of the complexities that go into bringing a solution online in MA. Given the new programs an incentives in MA, many providers have rushed into the state without a full understanding of all the considerations involved.

**Ongoing Operation and Optimization**

You should expect that the value streams available for your system will continue to shift and change over time. Be sure to ask specific questions about how your partner's ability to ensure your system is optimized throughout its lifecycle. In addition, system downtime will erode the projected value of your system so ask your partner about how their maintenance and optimization is managed.

**Hardware and Safety**

Not all storage hardware is created equal. There are a number of different battery technologies and a host of hardware providers that carry different levels of efficiency and durability. Be sure the hardware that is part of your solution comes from a top-tier supplier and that your solution provider proactively monitors and maintains your equipment.


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# Questions?


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