Creating A Clean, Affordable, and Resilient Energy Future For the Commonwealth

SMART Energy Storage Working Group Meeting

Boston, MA
April 13, 2018

Agenda

1. Introduction (5 min)
2. Presentations (45min)
3. DOER Questions (30 min)
4. Public Comments (30 min)

Purpose of Today's Meeting

DOER will guide a conversation on clarifying the details of the *SMART Energy Storage Adder Guideline.* DOER's primary goal is to clarify the following the components of the adder in the Guideline:

1. How should DOER define "co-located"?
2. How should DOER enforce its requirement for Energy Storage Systems to discharge 52 complete cycle equivalents?
3. What format should DOER use to collect 15-minute interval data from Energy Systems as required under SMART?

DOER also plans to discuss how energy storage systems under SMART will interact with ISO-NE markets in order to ensure that benefits to ratepayers are maximized to the greatest extent possible.

SMART Storage Stakeholder Meeting

Ron Nelson

April 13, 2018

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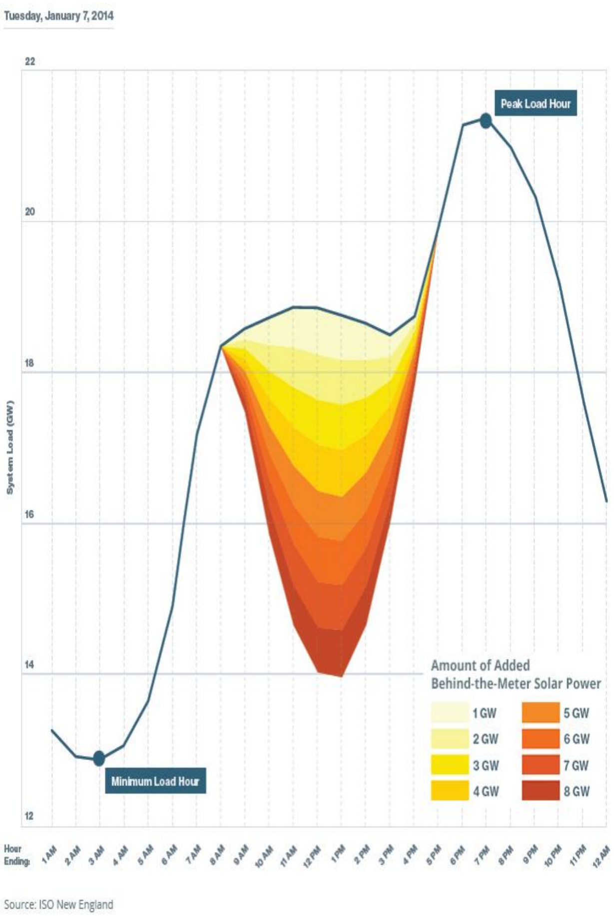
Operational requirement

- The operation requirement for energy storage systems participating in SMART is that it must have 52 complete cycle equivalents annually
- While ISO NE participation helps to align energy storage cycles with that of ratepayer benefits, no price signal is currently provided to avoid Regional Network Service (RNS) charges



Timing of cycles is critically important for ratepayer benefits

Source: [Energy Alabama]

Regional network service charges

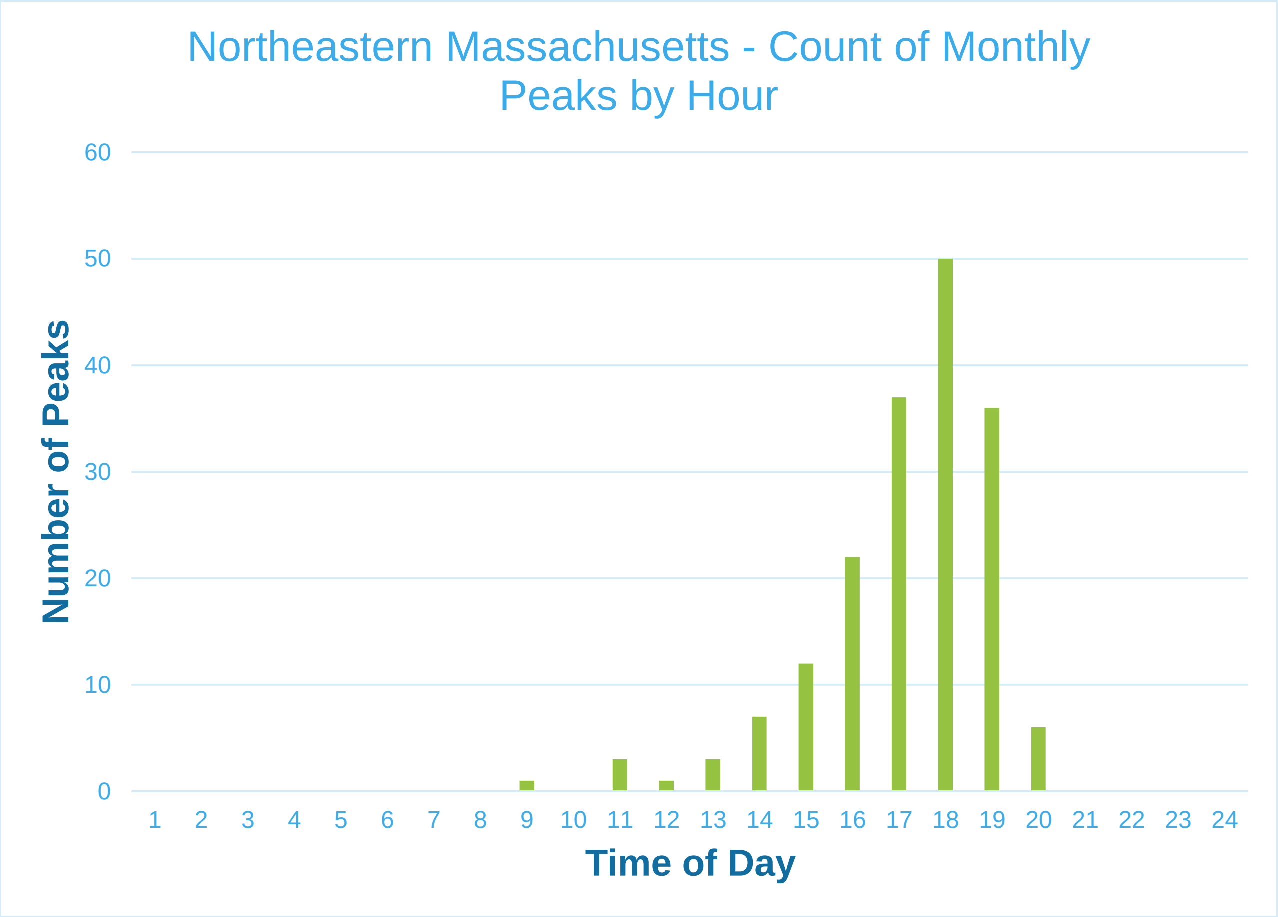
- Regional Network Load (RNL) costs as percent of total wholesale load costs

Month	Total RNL Costs ($)	Wholesale Load Costs ($)	Total Wholesale Load Costs ($)	RNL as % of Total
Dec-16	$178,633,679	$686,659,429	$865,293,109	20.6%
Jan-17	$176,648,352	$480,984,045	$657,632,398	26.9%
Feb-17	$165,361,192	$348,229,794	$513,590,985	32.2%
Mar-17	$159,787,640	$443,951,452	$603,739,092	26.5%
Apr-17	$143,605,821	$353,440,616	$497,046,437	28.9%
May-17	$180,989,615	$360,813,746	$541,803,361	33.4%
Jun-17	$229,397,231	$417,698,530	$647,095,761	35.5%
Jul-17	$226,419,366	$481,240,633	$707,659,998	32.0%
Aug-17	$217,919,604	$430,404,736	$648,324,339	33.6%
Sep-17	$203,092,432	$449,840,034	$652,932,466	31.1%
Oct-17	$165,793,702	$448,091,646	$613,885,348	27.0%
Nov-17	$164,768,910	$488,366,400	$653,135,310	25.2%
Dec-17	$198,804,851	$1,085,094,823	$1,283,899,675	15.5%

RNL costs for Northeastern Massachusetts have reached over $10,000/MW-Month

Source: ISO NE – Monthly Regional Network Load Cost Report December 2017

RNS charges (continued)



Over 80 percent of monthly peaks occurred between 3-8 pm

Strategen's proposal

- Objective: lower Regional Network Service (RNS) charges
- Approach: provide the EDCs with 2 call options per month for FTM storage
  - 24 hour notice
  - Limited duration
  - Only applies to front of the meter energy storage systems
    - Open to residential pilot with aggregator
    - C&I should have data collection
  - Participants can opt-out but face a reduced incentive (Lon's testimony has this value as 1 cent/kWh)
- Performance: the EDCs performance related to avoiding RNS charges would be monitored through an annual regulatory filing
  - Potential for shared savings

Targeting energy storage discharge during periods of high demand can provide benefits for ratepayers

Strategen's proposal (continued)

- Participation within ISO NE markets would not be impacted outside of the 2 call options per month
- Details still need to be finalized
  - Duration of call option
  - State of charge at the end of a called event
  - Penalties for non-performance during events

Details of the proposal are not finalized—feedback is welcome

Thank You

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DOER Workshop on SMART Energy Storage Adder Guideline

Department of Energy Resources

April 13, 2018

Definition of Co-located Storage

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- All of the definitions put forward for co-location – in the draft guideline, the SMART tariff proceeding and the SEIA, et al., comments need slight improvement to reflect the preferred interconnection infrastructure for all systems including large stand-alone solar + storage developments
- The SEIA definition, with additional edits underlined, could be supported by National Grid:
  - **"To be deemed co-located, the Solar Tariff Generation Unit and the Energy Storage System must be located on the same or adjacent parcels, and must be interconnected to the same common collector <u>located on the same parcel(s) on which the STGU and ESS facilities are located</u> (i.e. a<u>n electric service on such parcel(s) connected to an</u> independent circuit at nominal AC voltage or distribution element that serves no <u>other utility customers and no</u> load other than that associated with the parcels on which the Solar Tariff Generation Unit(s) and Energy Storage Unit are located)."**

Validation of ESS Cycling, Operation Data and Efficiency

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- The EDCs have procured the services of the Solar Program Administrator from CleaResult which include validating the eligibility of STGUs to receive their adders under the guidelines
- The SPA plans to set reporting requirements for all ESS to provide sufficient evidence of 52 cycle discharges per year, the required operational data collection and the evidence of efficiency
- The EDCs understand DOER intends to provide more guidance on the format of the data, timing of submission, and the time period and method over which to assess round trip efficiency (first year, life average, current year, etc.)

ISO-NE Participation and Connection/Metering - BTM

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- The EDCs will install and own separate meters on both the solar PV and ESS components of an STGU if they are, combined, equal to or greater than 60 kW
- The EDCs do not seek to separately meter ESS that are, combined with on-site solar, less than 60kW at this time
- For all Behind the Meter ESS facilities, National Grid would have option to bid them as Passive On-Peak Demand Resources or Settlement Only Resources
  - Energy from an POPDR ESS would remain with the owner, but the owner could not participate in the ISO-NE energy market

ISO-NE Participation and Connection/Metering - FTM

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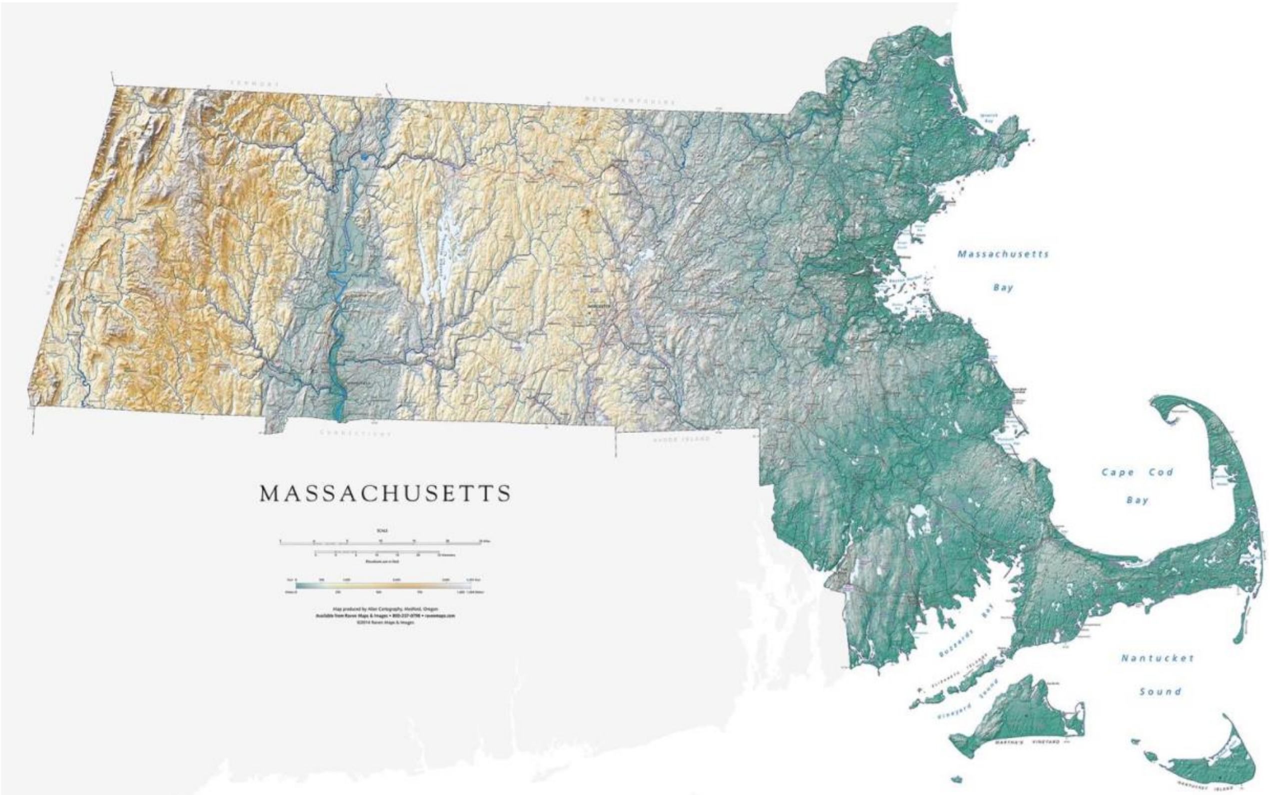
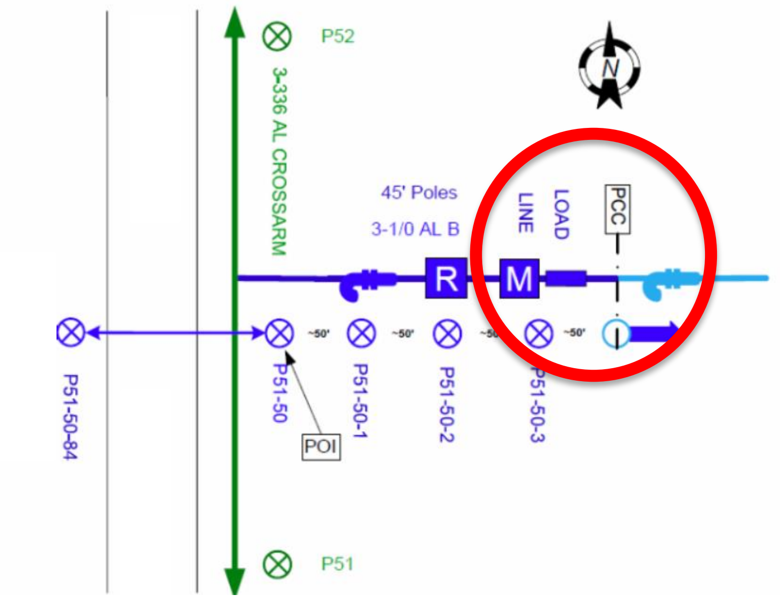
- The EDCs anticipate owning capacity rights of and having the option to participate in capacity markets with ESS facilities that are Front of the Meter (FTM), requiring meters on each resource
- The EDCs would encourage FTM ESS system owners to participate in the ISO-NE market as Active Generators whereby the units would be dispatched in the Day Ahead Energy Market, and could support performance as capacity resources in the FCM
- If such ESS were not active generators, the EDCs would seek for the owners to enroll such facilities as Settlement Only Generators, and would intend to register the facilities as Settlement Only Resources in the FCM if they meet the minimum size requirements in the FCM
  - Facilities that do not meet the minimum size requirements in the FCM would receive Performance Incentive payments if generating during Capacity Scarcity Conditions

MA SMART Energy Storage Guideline Technical Session



Topic #1 - Co-location

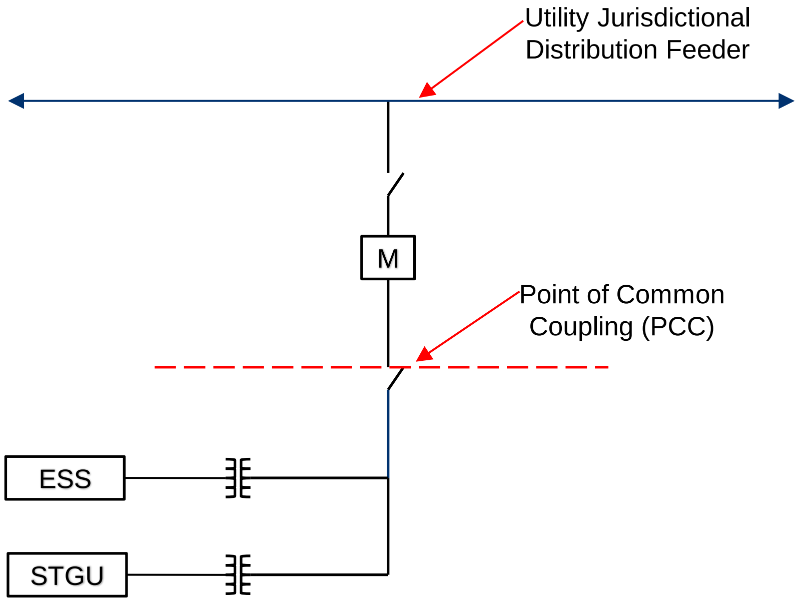
- Guideline specifies that the PV and ESS should share a “common point of coupling”
- “Point of Common Coupling” as defined in the interconnection tariff
  - *“Point of Common Coupling (PCC)” shall mean the point where the Interconnecting Customer’s local electric power system connects to the Company EPS, such as the electric power* ***revenue meter or Company’s service transformer.*** *The PCC shall be specified in the Interconnection Service Agreement.*



- These two terms are easily conflated
- We are interested in each of the utilities’ interpretation of “common point of coupling,” and whether that effectively means, “behind the same utility meter”
- Multiple use cases envisioned by State of Charge would potentially be constrained by a single-point of common coupling approach
- We encourage DOER to include sample diagrams in the guideline, and include a waiver process for configurations that aren’t evident today

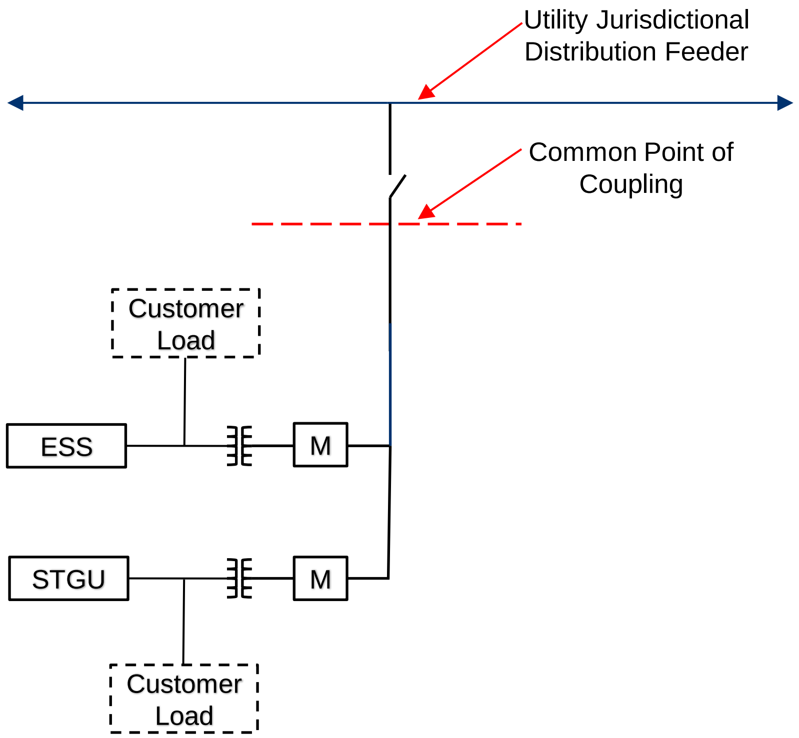
Topic #1 - Co-location

- Single-meter configuration use cases
- Behind the meter, C&I demand charge management (DCM) or resiliency use cases
- Behind the meter, residential DCM or resiliency/backup power
- Front of meter, renewables integration, interconnection impact mitigation, both AC- and DC-coupled



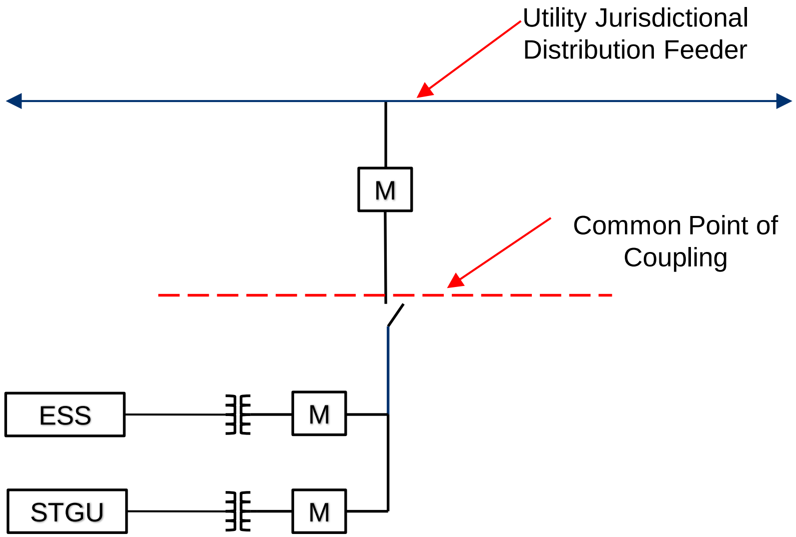
Topic #1 - Co-location

- Dual-meter configuration use cases
- Behind the meter, C&I demand charge management (DCM) ESS + FTM PV
- Behind the meter, campus-style arrangement with ESS & PV behind separate meters
- Front of meter, wholesale market participation
  - STGU and ESS can be brought to the wholesale market as separate assets
- “common point of coupling” could refer to a common distribution element that serves no load other than the customer and/or PV+ES station service



Topic #1 - Co-location

- Three-meter configuration use cases
- Master meter + sub-meters
- Functionally similar to dual-meter FTM case
- Front of meter, wholesale market participation
  - STGU and ESS can be brought to the wholesale market as separate assets
- Has been proposed by utilities in recent PV+ES ISA's



Topic #2 – Discharge and Cycling Requirements

- Degradation and Depth of Discharge (DoD) will vary between technologies, chemistries, and use cases
- **Cycle Equivalent** = Rated energy capacity of the ESS at 100% depth of discharge (same as California SGIP program)
  - Example: The cycle equivalent of a 1MW/2MWh battery is 2MWh, regardless of technology
- Annual minimum discharge for ESS adder compliance should be determined in Year 1
  - (Annual minimum discharge) = 52 * (Rated Energy Capacity)
  - Example: 1MW/2MWh ESS, annual min discharge = 52 * 2MWh = 104MWh
- **DoD Restrictions:** Chemistries with DoD restrictions will need to cycle > 52 times
  - Example: 1MW/2MWh ESS with a 95% DoD restriction achieves 1.9MWh per cycle, and will need to cycle 54.75x to meet the 104MWh annual minimum requirement
- **Degradation:** The ESS should meet its annual minimum requirement for the full term of the adder
  - Example: 1MW/2MWh ESS with 1.5% annual degradation (see table)

Year	Energy Capacity (kWh)	Required Cycles/yr
1	1900	54.74
2	1872	55.57
3	1843	56.42
4	1816	57.28
5	1789	58.15
6	1762	59.03
7	1735	59.93
8	1709	60.85
9	1684	61.77
10	1658	62.71
11	1633	63.67
12	1609	64.64
13	1585	65.62
14	1561	66.62
15	1538	67.64

Topic #2 – Discharge and Cycling Requirements – Additional Considerations

- Reporting requirements for discharge and cycling should not favor some PV+ES architectures over others
  - Example: AC-Coupled system could comply with a utility-grade metering requirement, whereas the availability of 'utility-grade' DC meters may be limited
  - For DC-coupled systems, DOER should accept discharge and cycle reporting from the power conversion system or inverter's native metering
- Dispatch requirements introduced through the SMART docket or guidline should not interfere with the ESS' core economic use cases or prejudice certain ESS configurations
  - Example: An ESS performing ancillary services, renewable smoothing, or DCM may receive a utility dispatch signal that conflicts with those operations
  - DOER should not impose additional dispatch requirements for behind-the-meter systems due to complications with onsite load interactions.
  - A 1MW/2MWh ESS cannot respond to a four-hour utility dispatch signal without reducing its power capacity to 500kW for the duration of that discharge cycle;
    - Depth of Discharge restrictions and degradation over time are also important to keep in mind if discharge signals are going to be required
  - Removal from SMART for alleged failure to respond to dispatch signals should be subject to fair hearing provisions and reasonable *force majeure* exceptions.

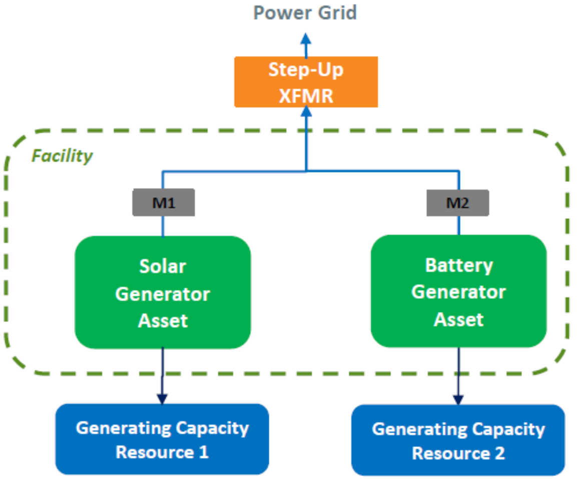
Topic #2 – Discharge and Cycling Requirements – Additional Considerations

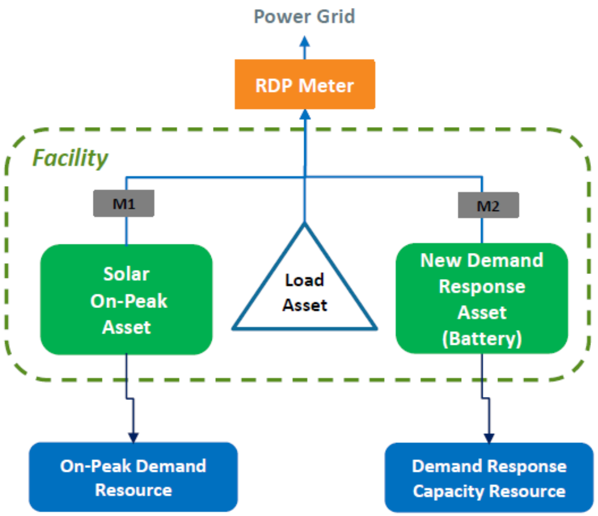
- Potential conflict with ISO rules if utility dispatch is authorized
  - Regardless of the hours of utility dispatch, the asset owner, not utility, should have "first call" on the asset, and/or the ability to set the asset’s availability for utility dispatch.
  - This is needed to ensure ISO system reliability and ability to meet ISO-NE obligations.
  - This should not jeopardize distribution level reliability as any restrictions relating to distribution level reliability are set forth in the ISA.
- Potential conflict between operational requirements within utility ISA and dispatch rules/signals
  - ISAs include numerous restrictions focused on reliability and safety
  - ESS should not be expected to violate ISA in order to satisfy SMART requirements

Topic #3 – ISO-NE & Wholesale Market Participation

- Participation models for PV & ES under current ISO-NE asset classifications
  - FTM: Dual-meter (or three-meter) configuration, registered as a **Generator**. Access to Capacity, Regulation & Reserves
  - BTM: Three meter configuration, registered as a **Passive Demand Response** or **Demand Response Capacity Resource**

- In FTM Generator model, ISO requires "separate interconnection rights" for PV & ES
  - Does this mean separate ISA's? Separate Points of Interconnection?
  - ISO-NE has indicated that for all Energy Storage applications seeking to participate as a Generator, the Interconnection Request should be submitted through ISO-NE's Interconnection Request Tracking Tool (IRTT), and follow the Schedule 23 process





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Maximizing Ratepayer Benefits from SMART

April 13, 2018

SMART Objectives

- Reduce peak demand, system losses, the need for investment in new infrastructure, and distribution congestion

- Increase grid reliability; improve public health and safety; and diversify the Commonwealth's energy supply

Use the 52 Cycles Strategically to Align with these Objectives and Reduce

- Require storage owners to cycle through one or more of the following mechanisms; each mechanism delivers benefits to all ratepayers; give owners flexibility to choose, as long as they can demonstrate compliance;

Mechanism/Purpose	Dispatch Trigger	Ratepayer Benefit
ISO-NE wholesale market participation	ISO-NE dispatch control	Reduced wholesale prices; reliability
Peak shaving (summer or winter); transmission & distribution cost reduction	Dispatch at 96% of forecasted utility peak (trigger for current NGrid peak shaving)	Lower T&D costs and mitigate LMP spikes; system efficiency - (top 1% causes 8% of costs)
Reduce wholesale cost allocation for MA	Near single hour ISO-NE system peak or local non-coincident monthly peaks*	Lower capacity and transmission costs for MA ratepayers

* As
utili

SMART PV + Storage Co-Location Scenarios

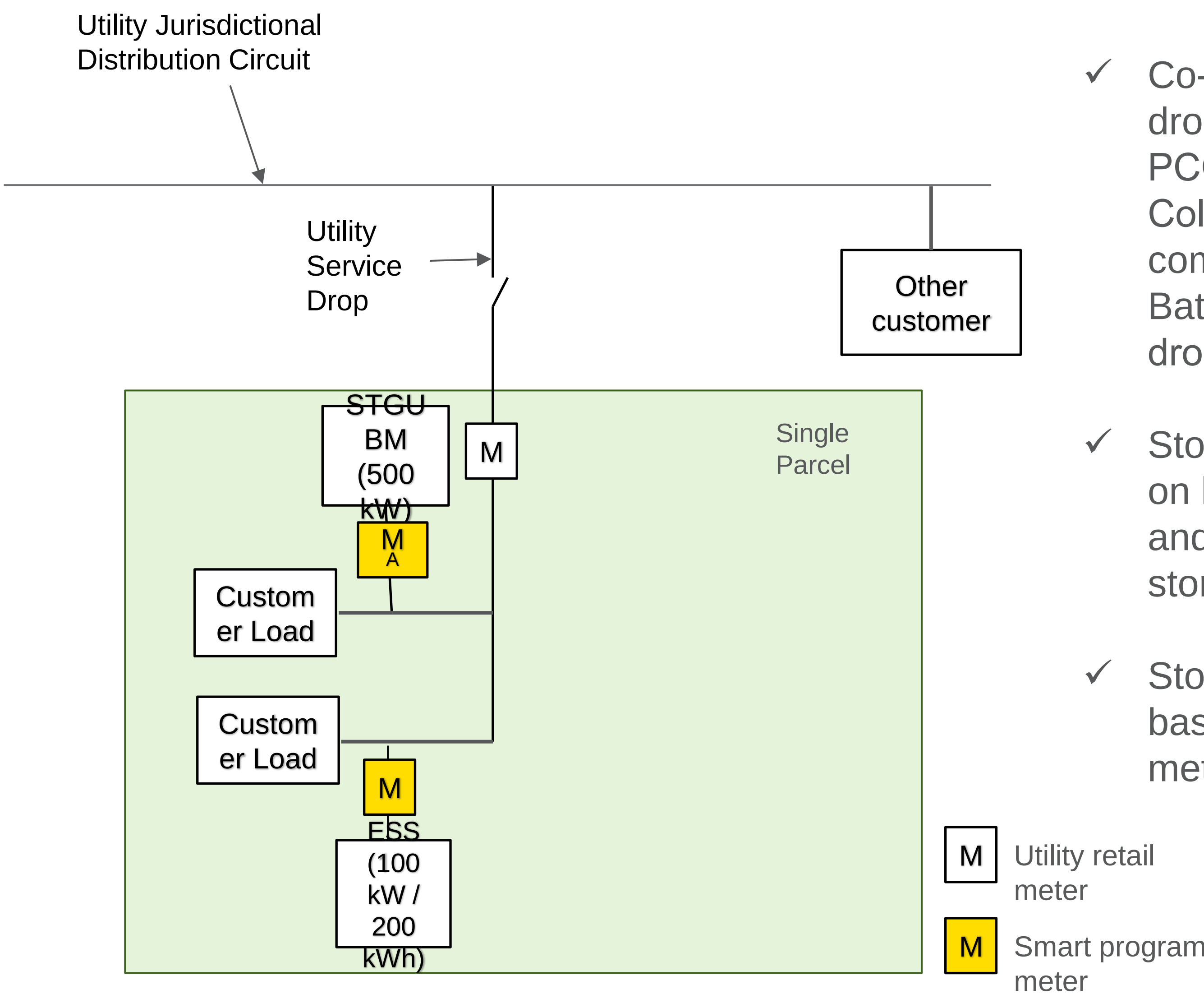
Becky Gallagher | April 13 2018

PV + Storage – Co-location & Incentive Issues

1) Determination of “Colocation”
2) Calculation of storage adder rate
3) PV kWh production applied to storage adder

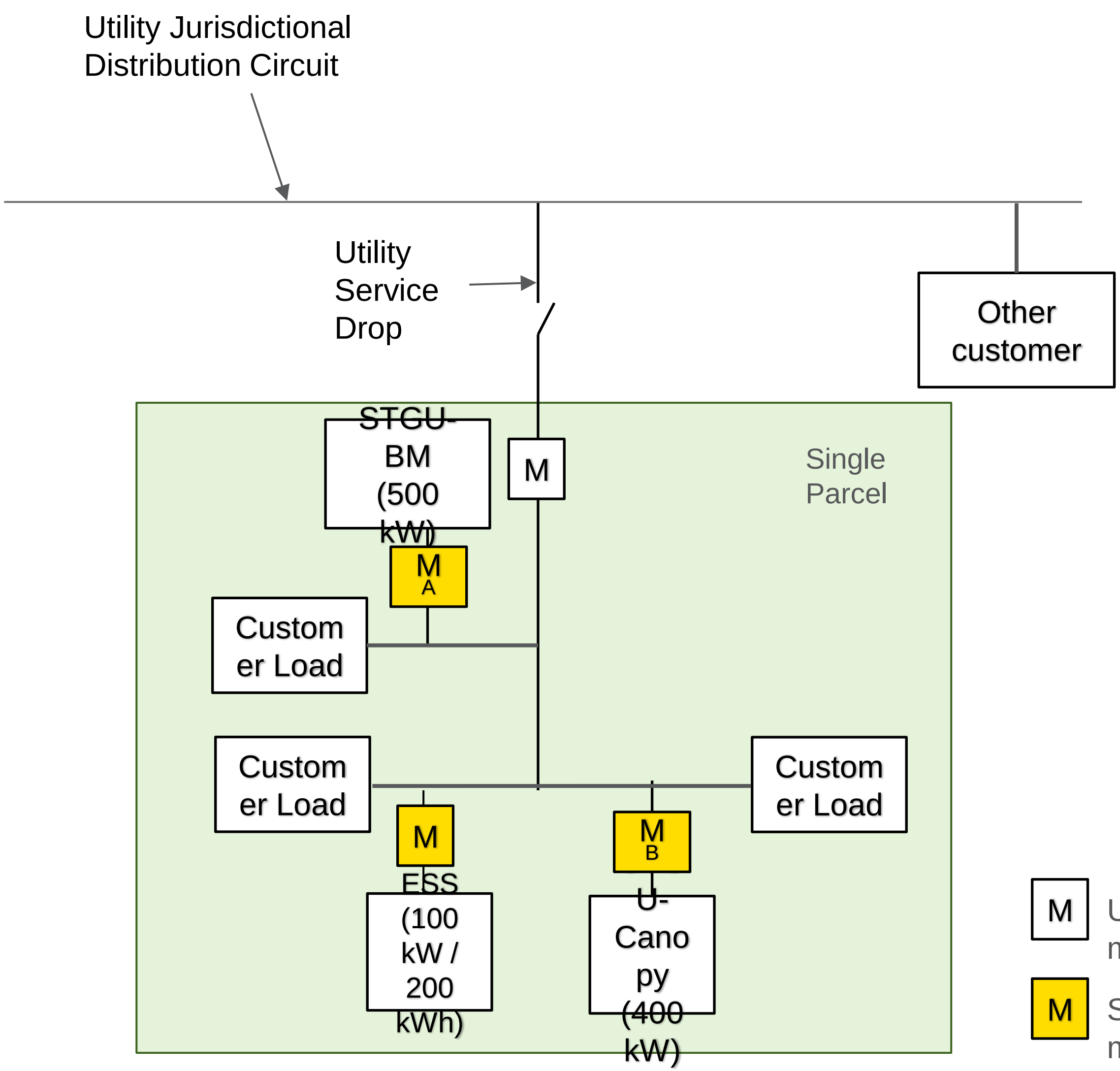
Recommendation: “Co-location” definition incorporate concept of “behind meters associated with same utility account” for **behind the meter projects** and reflect that in the SQA process.

Example 1: One customer meter, single utility service drop, single STGU



- ✓ Co-Location: Utility service drop meets definition of (a) PCC and (b) “Common Collector” language in comments. All PV and Battery behind that service drop are “Co-Located”
- ✓ Storage Adder Rate: based on kW of STGU A (500 kW) and 100 kW / 200 kWh of storage
- ✓ Storage Adder Payment: based on total production metered at M^A

Example 2: One customer meter, single utility service drop, multiple PV products

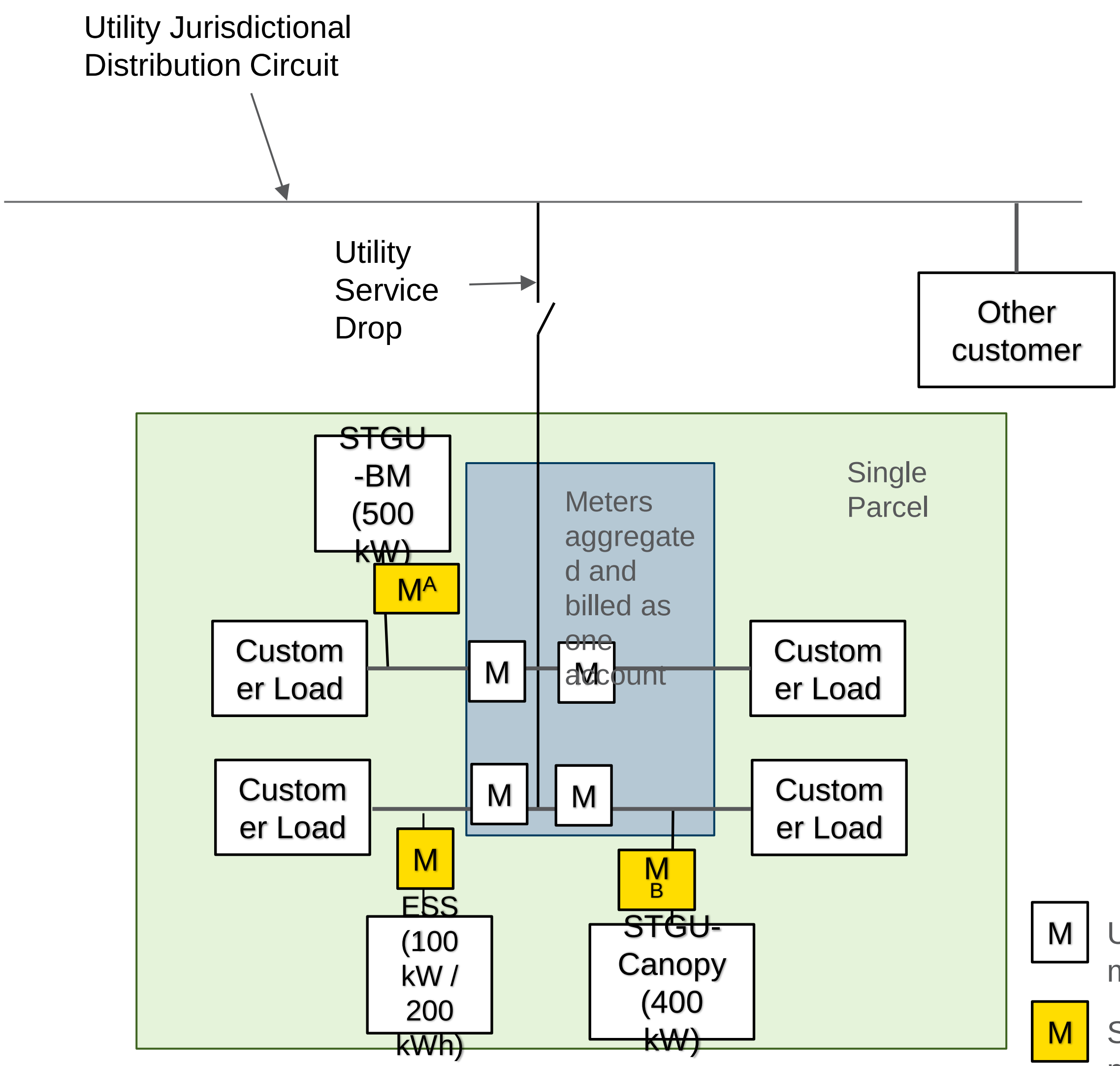


- ✓ Co-Location: Utility service drop meets definition of (a) PCC and (b) “Common Collector” language in comments. All PV and Battery behind that service drop are “Co-Located”
- ✓ Storage Adder Rate: based on total kW of STGU-BM & STGU-Canopy (900 kW) and 100 kW / 200 kWh of storage
- ✓ Storage Adder Payment: based on total production metered at M^A and M^B

M Utility retail meter

M Smart program meter

Example 3: Multiple customer meters, single account, single utility service, multiple PV products



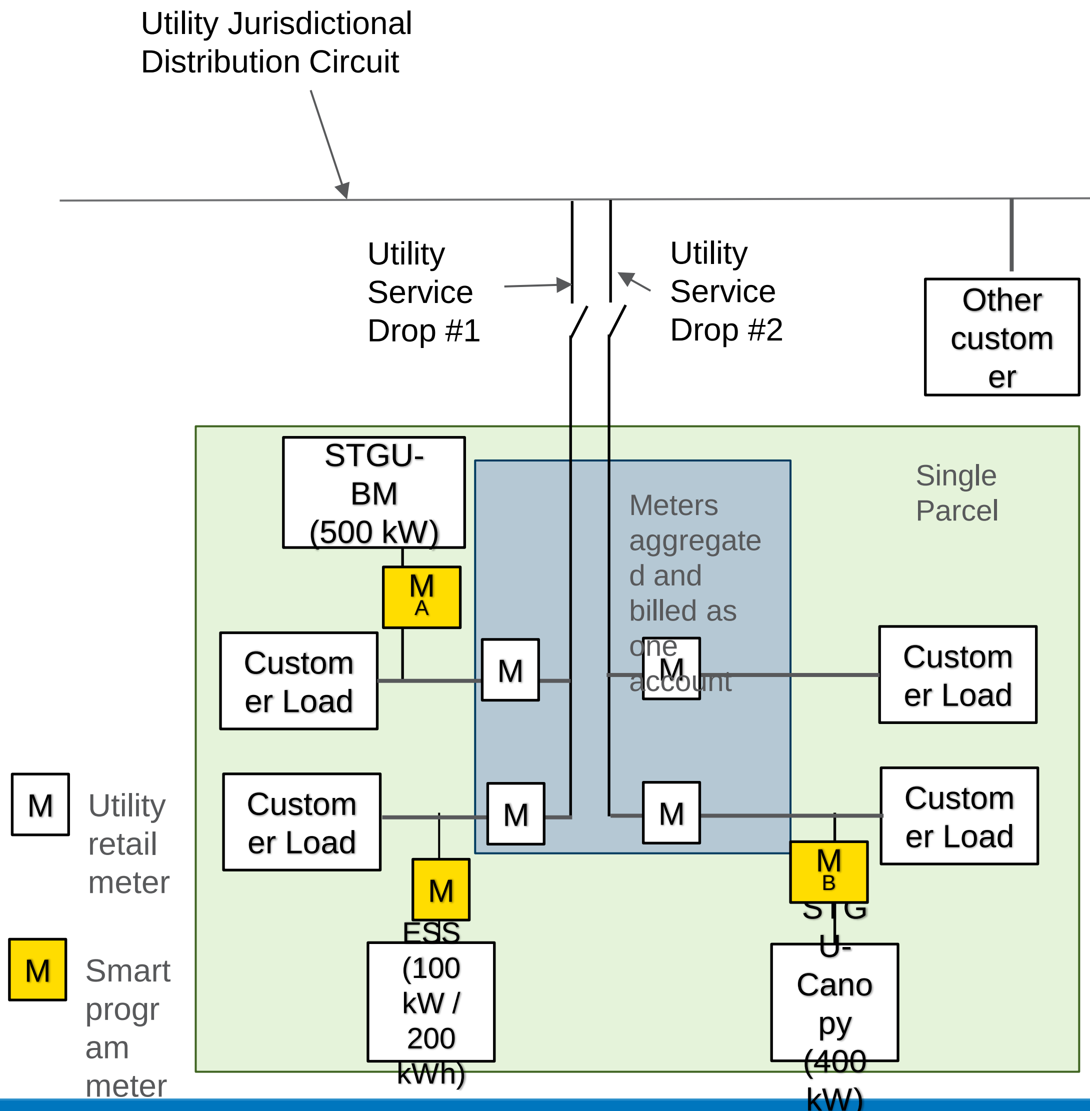
M Utility retail meter

M Smart program meter

- ✓ Co-Location: Utility service drop meets definition of (a) PCC and (b) "Common Collector" language in comments. All PV and Battery behind that service drop are "Co-Located"
- ✓ Storage Adder Rate: based on total kW of STGU-BM & STGU-Canopy (900 kW) and 100 kW / 200 kWh of storage
- ✓ Storage Adder Payment: based on total production metered at M^A and M^B

Example 4: Multiple customer meters and service drops, single account, multiple PV products

Not Uncommon for Behind-the-Meter sites



→ **For behind the meter projects, we encourage DOER to consider "Co-located" to encompass SGTUs and storage assets behind meters associated with same utility account.**

Then, customer economics would not negatively impacted if utility service config doesn't happen to match customer billing config.

- Storage Adder calculation would be based on kW of *both* STGU-BM & STGU-Canopy, and
- Storage adder would be paid based on total production metered at M^A and M^B
- This has administrative implications for how SQAs are submitted and evaluated.
  "Master" SQA?