



# PJM Straw Proposal for DER in the Energy Market



Andrew Levitt  
Senior Market Strategist  
Special Markets Implementation  
Committee - Distributed Energy  
Resources  
October 2, 2017

Today's proposal does not apply  
to DER sited at wholesale  
customers—i.e. DER at most  
munis and coops.

Muni/coop proposal to follow.

- Energy market proposal: follow status quo for customer-sited wholesale generators wired-with-load on “sell excess” basis:
  - Energy injected to the distribution grid at the Point Of Interconnection (POI) is paid by PJM at wholesale LMP.
  - Energy withdrawn from the distribution grid at POI is settled by EDC at retail.
- To be eligible for wholesale energy settlement, customers must have unidirectional retail metering that records only withdrawals.
- Customers with retail meters that record injections, and customers that have retail compensation for injected energy, will **not** be settled at wholesale for injected energy.

*Ancillary Services + Energy + Aggregation = first draft of a standalone package.  
Consider this package a starting point for discussion.*



## For Today: Three Use Cases In, Four Use Cases Out

**We are starting “simple”, with the following use cases:**

- A. Single (i.e., not more than one DER at a site) wholesale DER unit “wired with load” (i.e., behind a customer meter) and selling injected (i.e., excess) energy at **wholesale**.
- B. Single wholesale DER unit “wired with load” and selling injected energy at **retail**.
- C. Single wholesale DER unit “wired separately” (i.e., standalone or “front of meter”) selling all energy output at wholesale or retail.

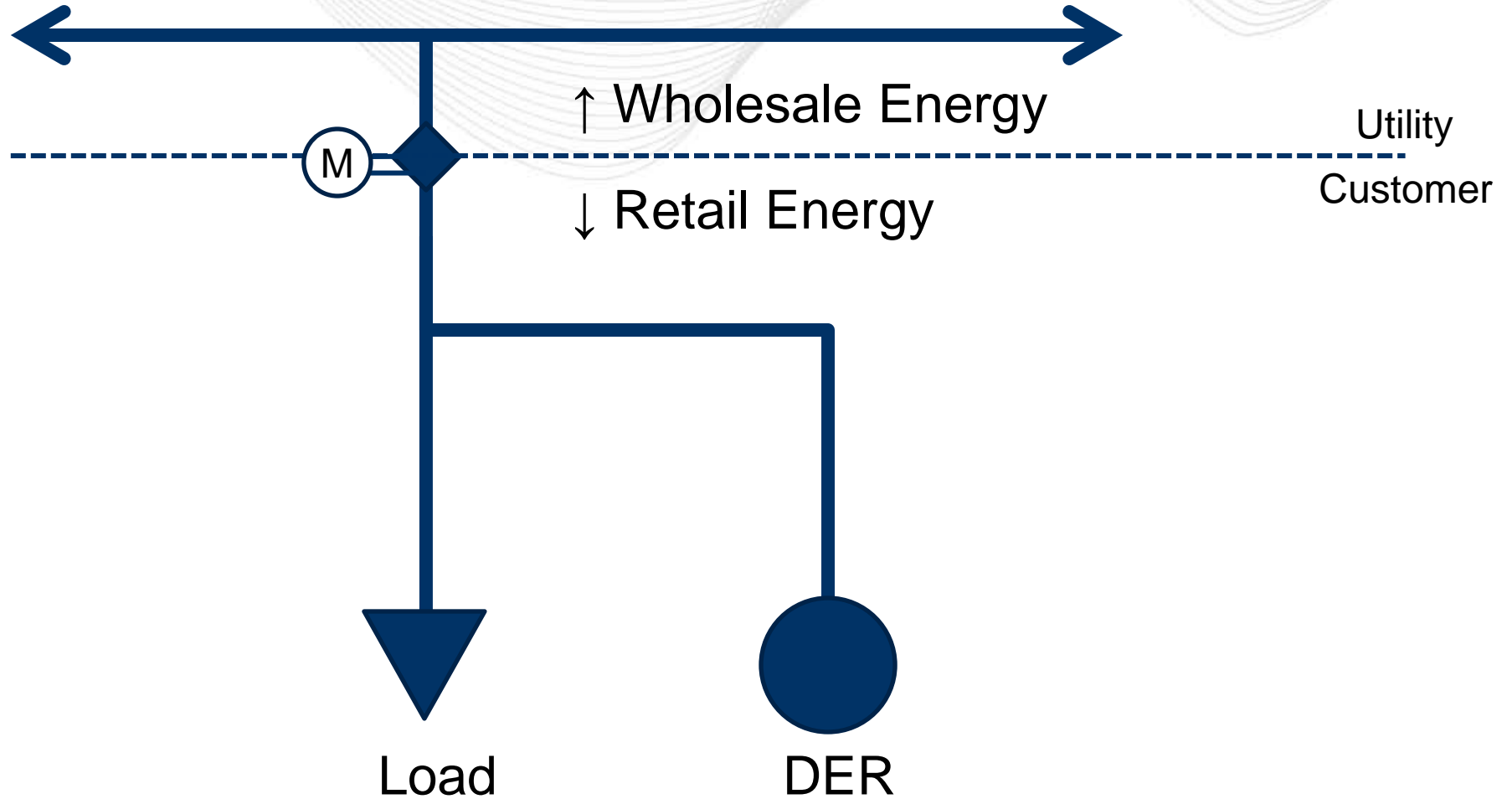
*--And also aggregations of the above single DER units--*

**The below use cases: not included in today’s proposal, but PJM intends to address:**

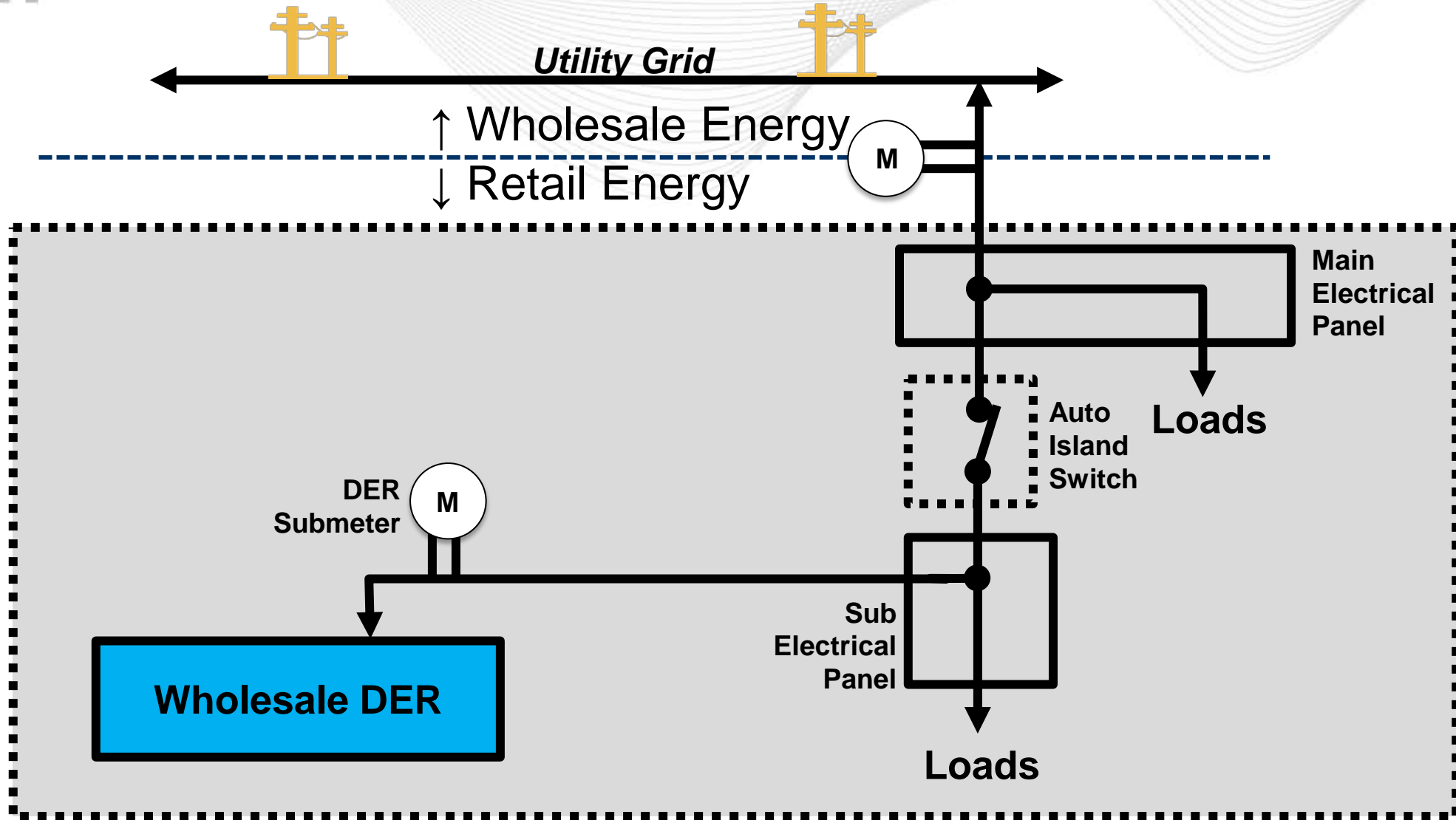
- 1. *The interaction of DER with co-sited load reductions (e.g., DER + grid-interactive water heaters or HVAC).*
- 2. *Multiple wholesale DER units at the same site*
- 3. *Wholesale DER + non-wholesale DER at the same site.*

**Not part of this proposal, but PJM is open to discussing later:**

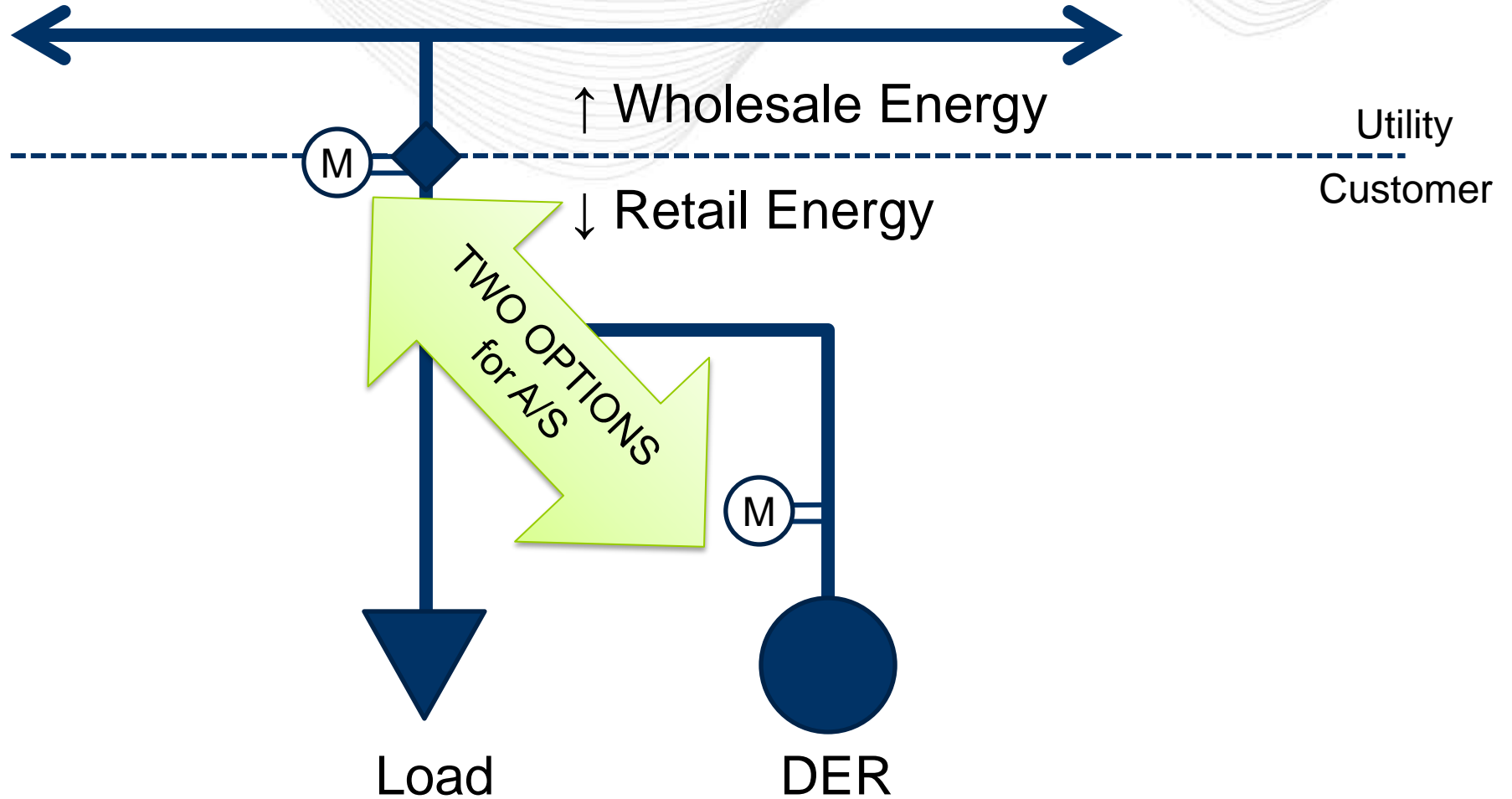
- 4. *Energy credit for load reductions from DER under new DER rules*



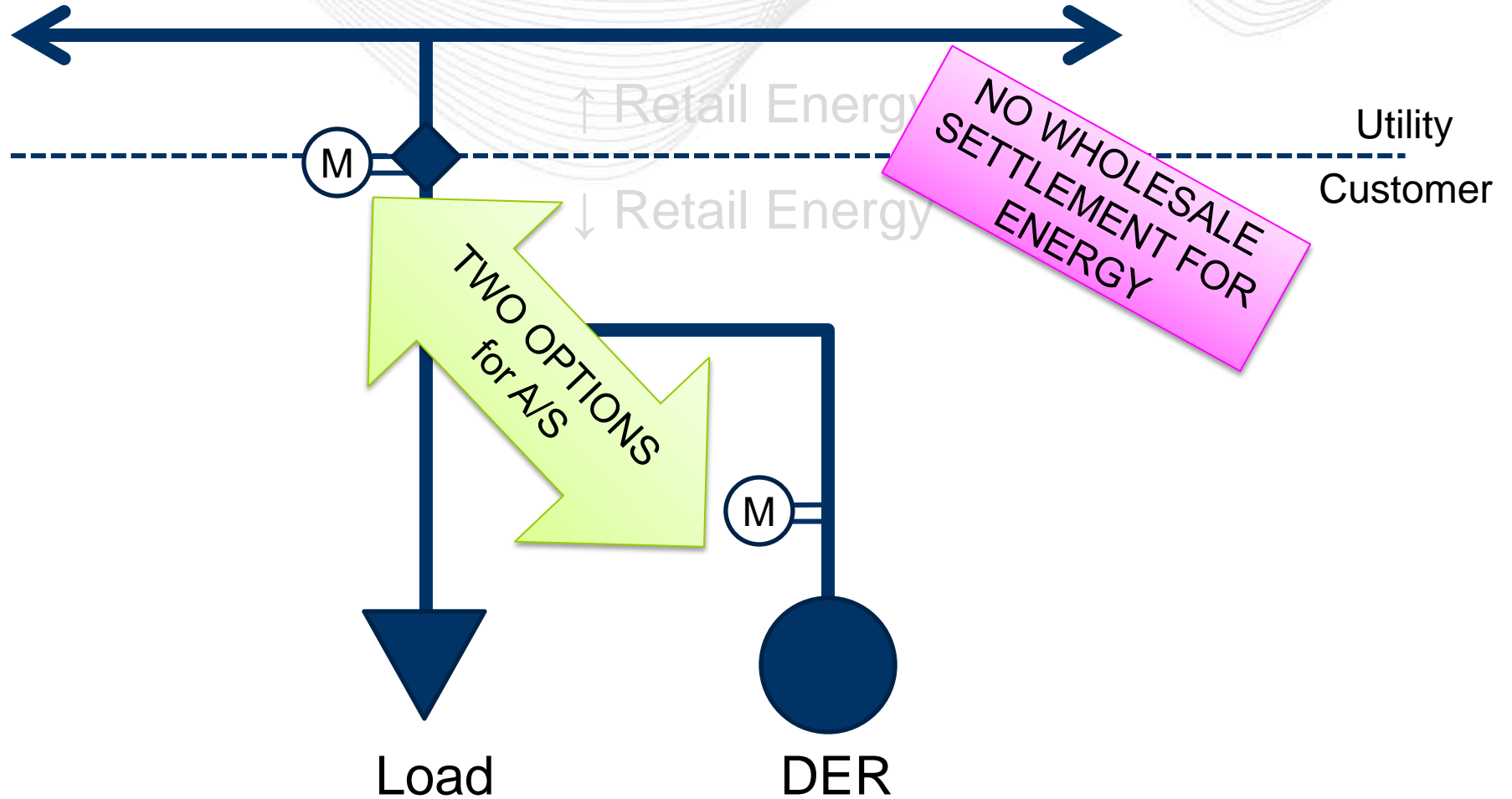
# Energy Concept: Wholesale “WIRED W/ LOAD” WHOLESALE DER



# Ancillary Services Performance Measurement Concept



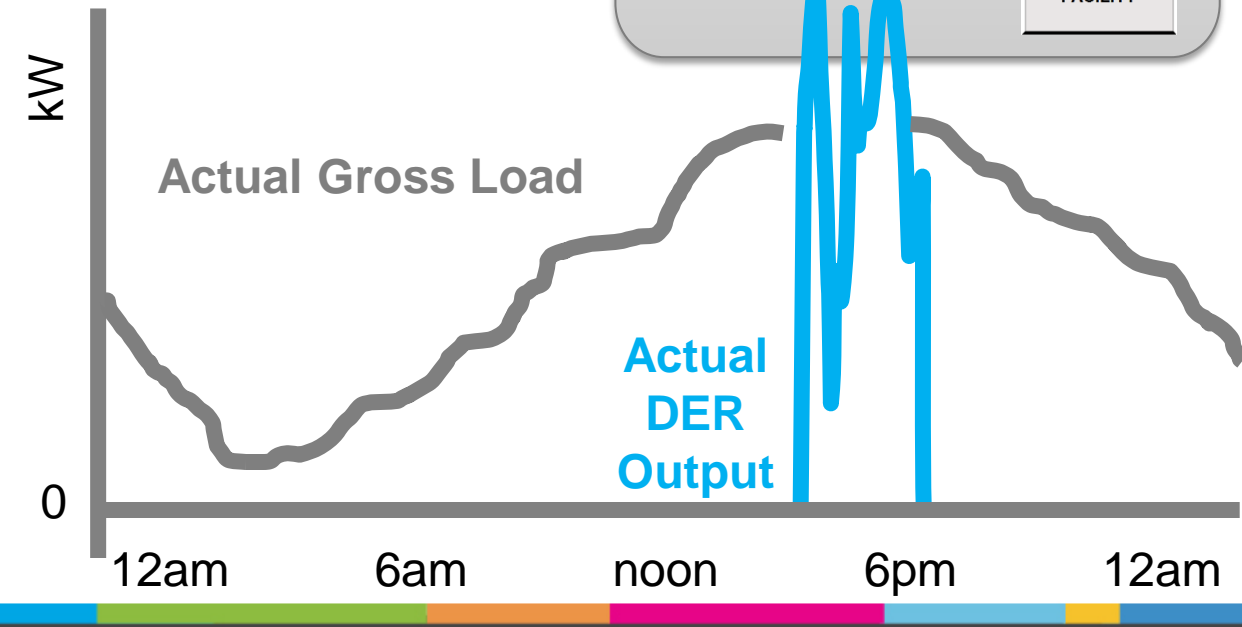
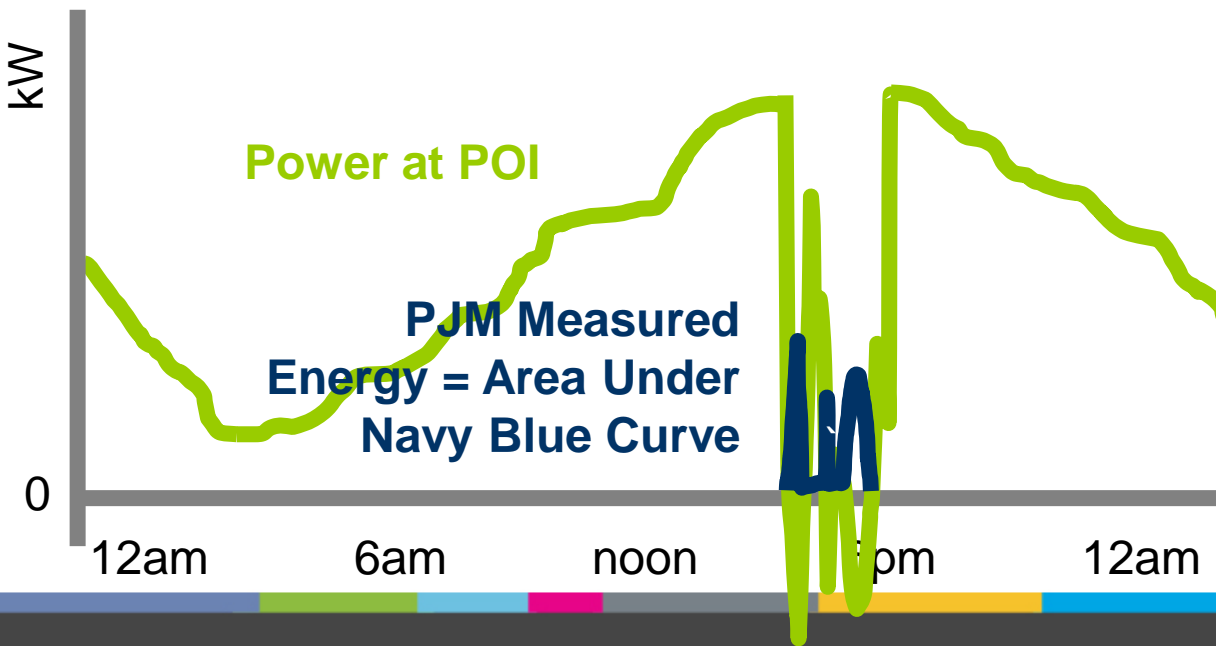
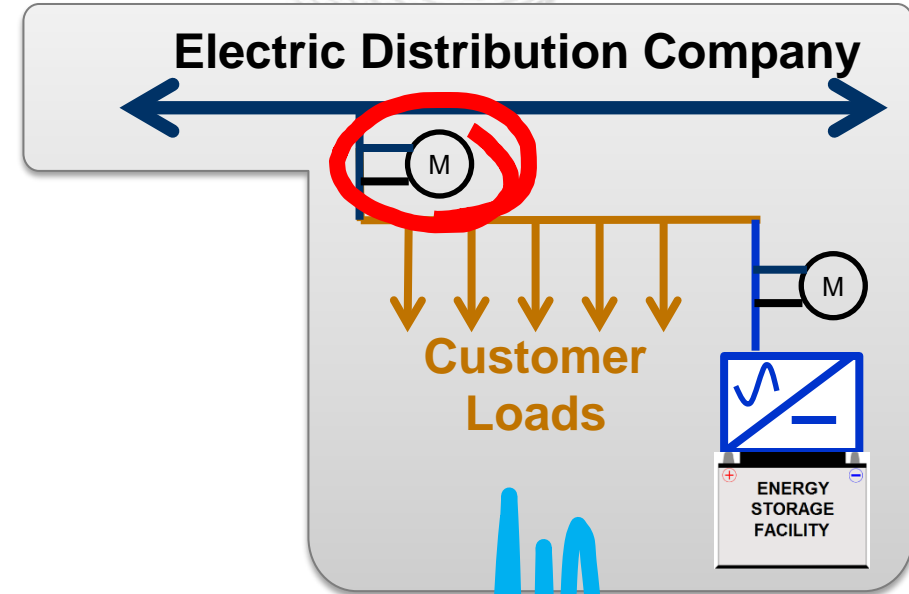
# “Ancillary Services Only” Concept





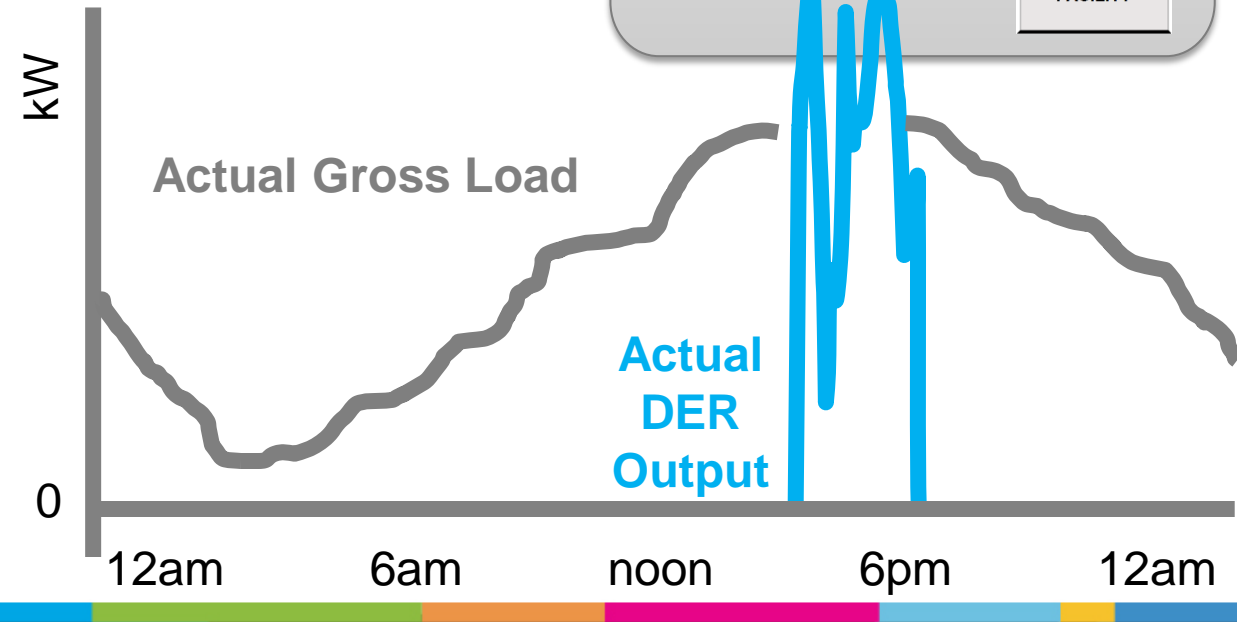
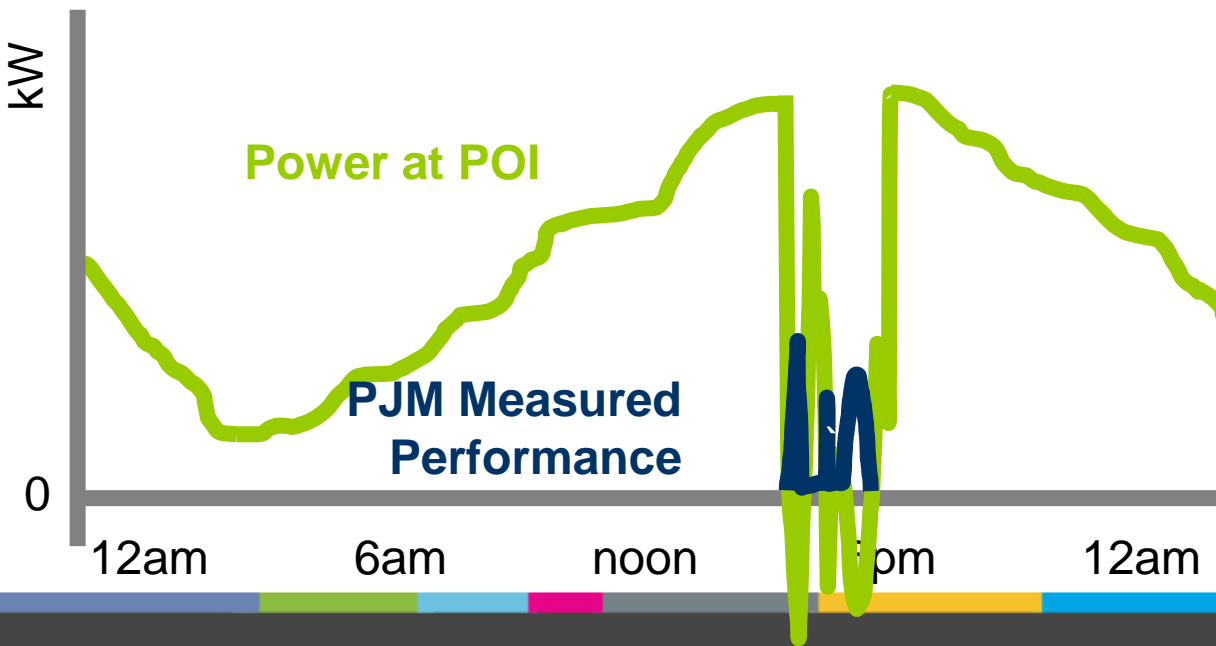
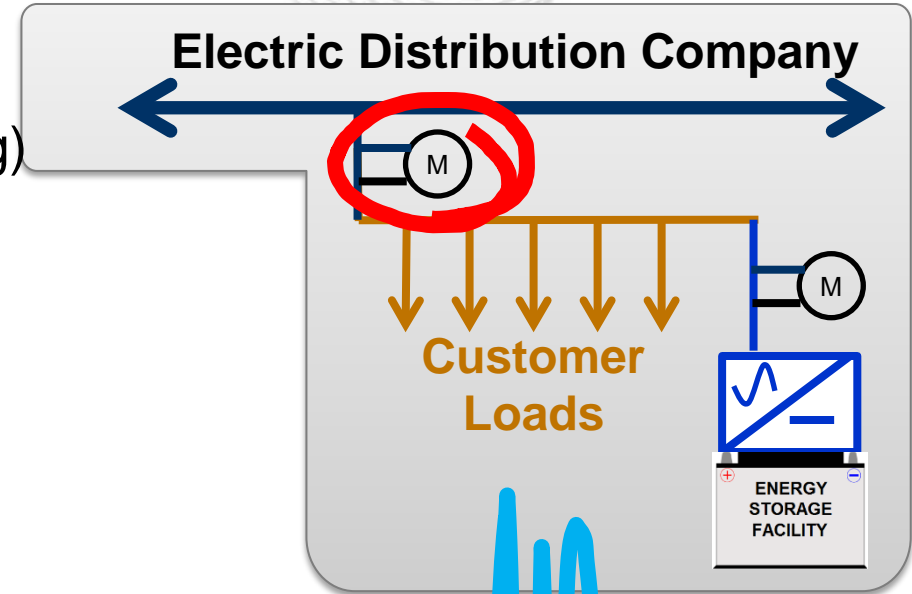
# DER Measurement for Energy Must Be POI Meter

- DER proposal requires metering at the POI for energy.
- Or: option to not take any wholesale energy settlement.



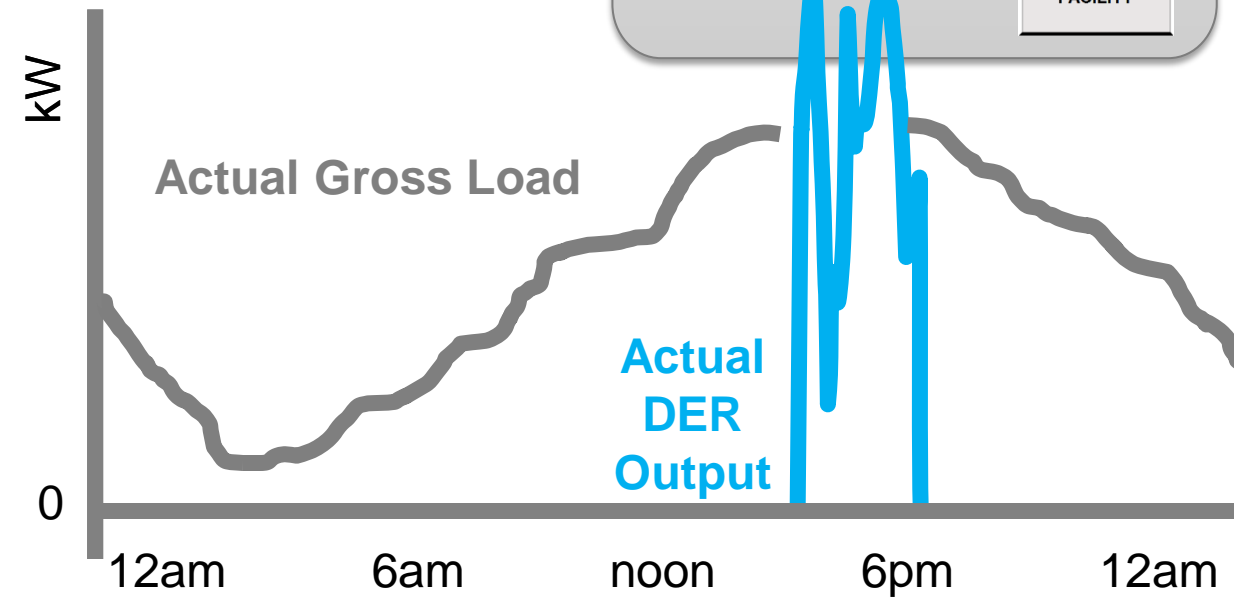
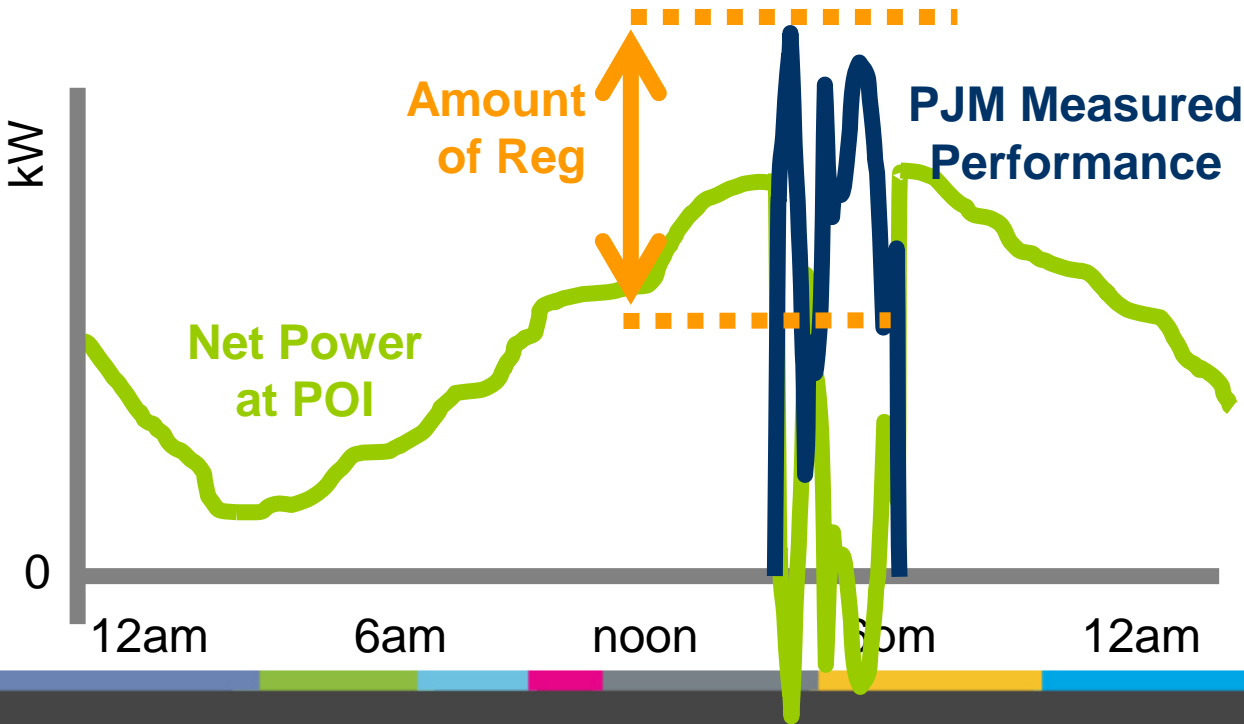
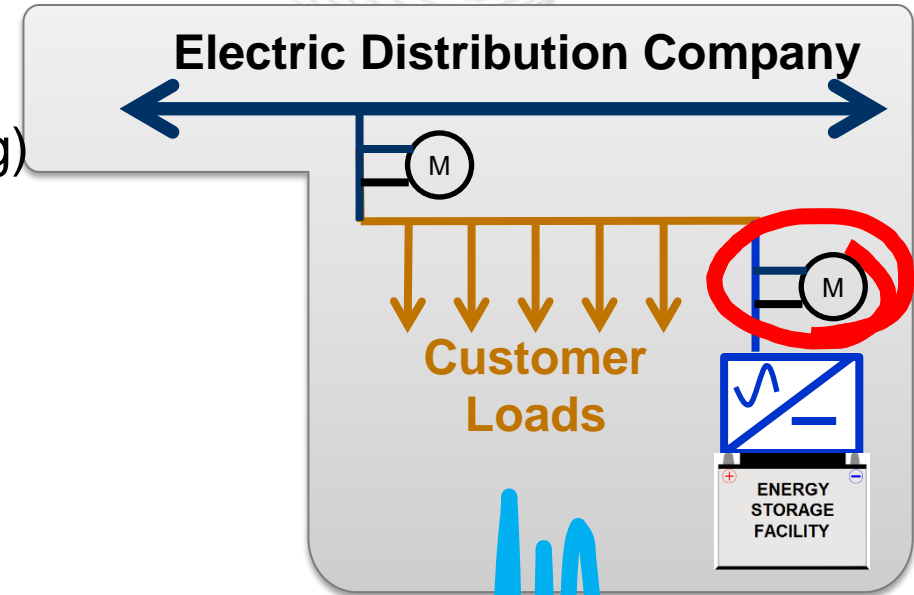
# DER Performance for Regulation: **POI Meter** option

- DER proposal allows metering at either i) POI or ii) direct at the DER for Ancillary Services (both Synch and Reg)
- Submetering works because at any point on the grid:
  - a) reductions (increases) in withdrawal, and
  - b) increases (reductions) in injection
 are effectively equivalent for providing ancillary services.



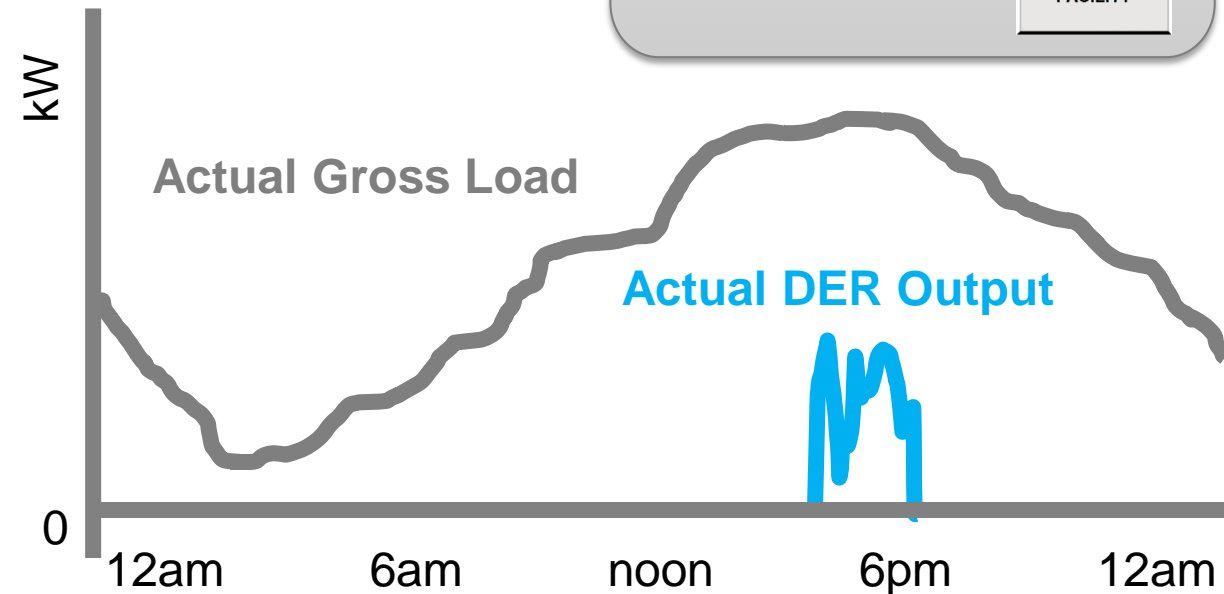
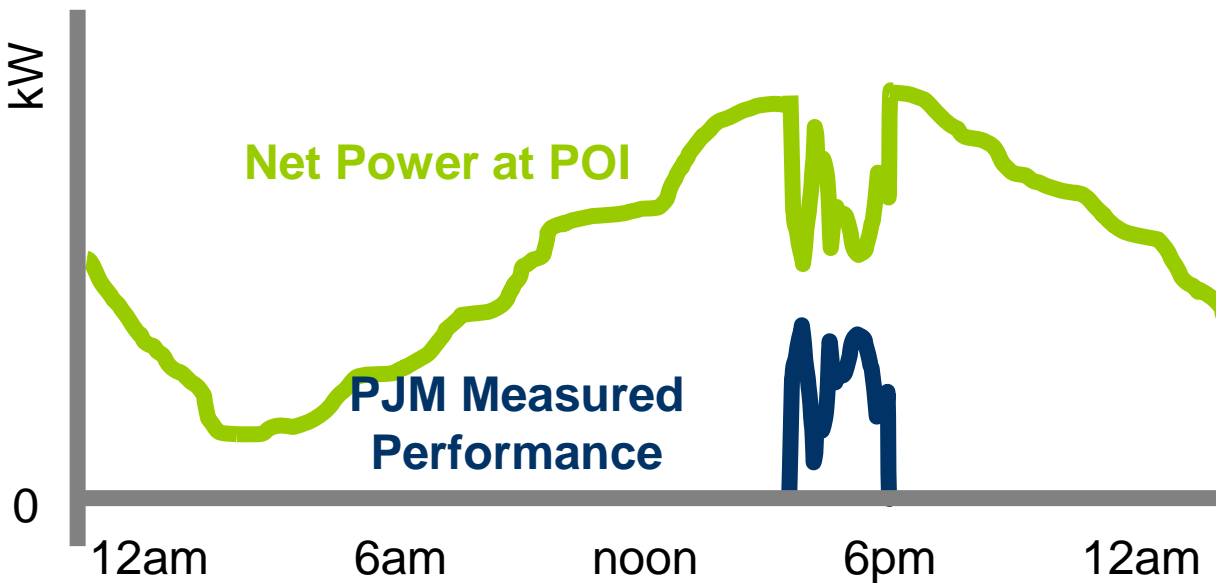
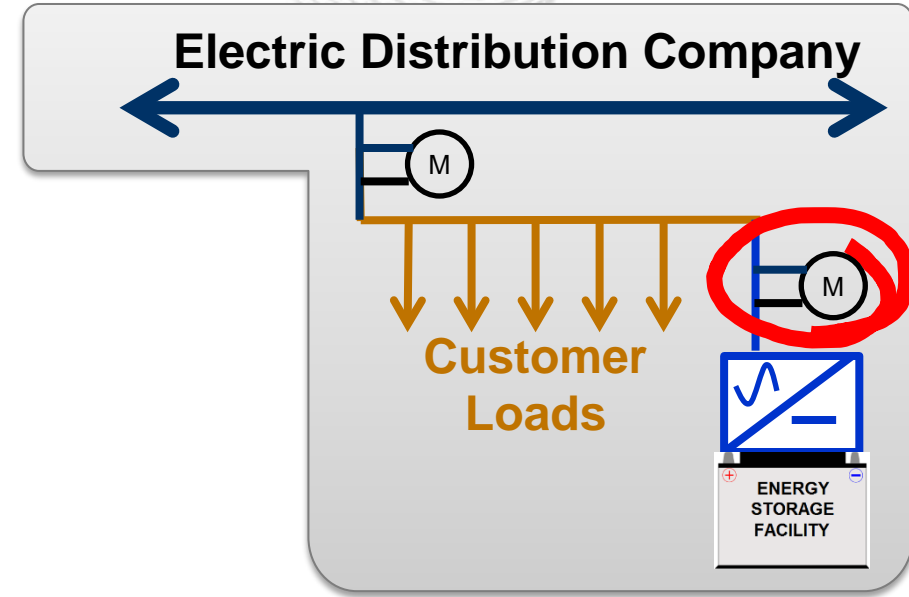
# DER Performance for Regulation: **Submeter** Option

- DER proposal allows metering at either i) POI or ii) direct at the DER for Ancillary Services (both Synch and Reg)
- Submetering works because at any point on the grid:
  - reductions (increases) in withdrawal, and
  - increases (reductions) in injection
 are effectively equivalent for providing ancillary services.



# DER Performance for Regulation: Submetering

- Submetered DER in Ancillary Services also works even if DER is only reducing load.





# ENERGY EXAMPLES





## Ex 1. Storage + Load: Wholesale Energy and Regulation

- Summer peaking commercial site. Summer daytime load 3.0-5.0MW depending on weather, non-summer 3.0-3.5MW, nighttime load about 1.5MW lower.
- 2MW of storage wired with the load.
- Regulation and Synch: submetered at battery, **full battery range is credited** towards performance regardless of injections vs. load reductions.
- Energy: any injections can be settled retail OR wholesale, but not both. **No wholesale energy credit for load reductions under current proposal.**
- Assume customer chooses **wholesale energy** settlement for injections: (in addition to Regulation credits) receives nodal LMP at wholesale for MWh that are

Temp	Gross Load	Regulation Net Hourly Energy	Net Load (MWh)	Allowed Regulation Range	Wholesale Energy Credit	Retail Energy Charge
Warm	3.5	1 (gen)	2.5	1.5 to 5.5	-	2.5 MWh
Hot	5	1 (gen)	4	3.0 to 7.0	-	4 MWh
Mild	0.5	1 (gen)	-0.5	-1.5 to 2.5	0.7 MWh	0.2 MWh





## Ex 2: Storage + Load: Retail Energy and Wholesale Synch

- 2MW of storage wired with the load.
- Assume customer already has **retail energy** credit for injections, and so chooses not to have wholesale energy credit.
- (Retail-energy-settled DER are proposed to be ineligible for estimated Tier I Synch)
- Wholesale payments only include Synch Tier II clearing price, not wholesale energy.
- Discussion point: if resource overperforms during Synch event, should it be eligible to receive Tier I credit for the overperformance? Or does Tier I credit include an “energy” component which would constitute double payment?

Temp	Gross Load	Synch Net Hourly Energy	Net Load (MWh)	Allowed Synch Range	Wholesale Energy Credit	Retail Energy Charge/Credit
Warm	3.5	1 (gen)	2.5	1.5 to 3.5	-	2.5 MWh charge
Hot	5	1 (gen)	4	3.0 to 5.0	-	4 MWh charge
Mild	0.5	1 (gen)	-0.5	-1.5 to 0.5	-	0.5 MWh (credit)

## 1. Solar + storage + commercial load

*PJM intends in the near future to address multiple wholesale DER at the same site, as well as wholesale DER + non-wholesale DER at the same site.*





# Icetek Example 2: Hospital With Gas Engine

- Hospital with load 4.0 – 4.5MW summer, 3.0-3.5MW winter.
- 4MW of gas engine generator. Generator can provide 500kW of regulation in range 3.5MW +/- 0.5MW.

Season	Gross Load	Gen Base point	Allowed Net Regulation Range	Regulation Net Hourly Energy	Wholesale Energy Credit	Retail Energy Charge
Summer	4.0	3.5	0.0 to 1.0	0 MWh	-	0.5 MWh
Winter	3.0	3.5	-1.0 to 0.0	0 MWh	0.5 MWh	-

3. Generator + DR from HVAC load drop
4. Cogen + DR from industrial curtailment
5. Storage + DR from industrial curtailment

*PJM intends in the near future to address the interaction of DER with co-sited load reductions (e.g., grid-interactive water heaters or HVAC).*

- Three 50 kW microturbines connected together with various small commercial customers are aggregated into a single DER Entity for wholesale participation.
- Each is submetered for Regulation.
- Each takes wholesale settlement for excess energy.

Gross Load (kW)	Regulation Net Hourly Energy (kWh)	Net Load (kWh)	Allowed Regulation Range (kW)	Wholesale Energy Credit	Retail Energy Charge
50	20 (gen)	30	0 to 100	-	30 kWh charge
10	20 (gen)	-10	-40 to 60	15 kWh injection for the hour	5kWh withdrawal = charge
20	-Offline-	20	-Offline-	-	20 kWh charge
Aggregate DER Entity:				15 kWh credit	

- Three 50 kW batteries connected together with various small commercial customers are aggregated into a single DER Entity for wholesale participation.
- Each is submetered for Regulation.
- Each takes wholesale settlement for excess energy.

Gross Load (kW)	Regulation Net Hourly Energy (kWh)	Net Load (kWh)	Allowed Regulation Range (kW)	Wholesale Energy Credit	Retail Energy Charge
30	20 (load)	50	-20 to 80	5kWh injections for the hour	55 kWh charge
10	20 (load)	30	-40 to 60	15 kWh injections for the hour	45 kWh charge
20	-Offline-	20	-Offline-	-	20 kWh charge
Aggregate DER Entity:				20 kWh credit	

- Will add-backs be needed to reconstitute gross load for any wholesale cost allocation or for Planning purposes? If so: what are the associated submetering requirements? Are there size thresholds?
- Considerations for wholesale DER that (in addition to serving their own load) also sell energy directly to an adjacent site under retail “On-site Generator” rules.
- For energy settlement of aggregations:
  - Is nodal weighting for energy settlement based on ex post actual or on ex ante schedule? What if component nodal LMPs diverge widely?
  - Should all DER in aggregate share the same injected energy settlement track (wholesale vs. retail)?

# IMPORTANT CONSIDERATIONS





# A Selection of Three Types of Energy Withdrawals

1. End use energy withdrawals – purchased at retail.
2. Station power energy withdrawals can be “self supplied” or “purchased”. Self supply of station power involves special accounting.
  - When station power energy is purchased, it is retail.
  - Some retail tariffs allow station power energy to be self supplied by generators using monthly netting and fleet netting.
  - If station power is self supplied, there is no purchase.
  - Net energy withdrawals in any interval due to station power self supply are accounted for by PJM as negative credits at LMP.
  - Note: fleet netting for self supply also involves a PJM transmission fee.
3. Wholesale storage energy withdrawals for later release are “energy time shifting”, not end use of energy.
  - Pumped hydro and Energy Storage Resources that are drawing energy for later release are performing “wholesale energy time shifting”.
  - Wholesale storage energy withdrawals for later release: accounted by PJM w/ negative credits at LMP.
  - Recall that a battery that performs any non-wholesale service does not meet the criteria to be an “Energy Storage Resource”



- Recall that station power energy is either self supplied, or purchased at retail.
- Station power self supply → netting across each month and the owner's fleet.
- Self supply energy withdrawals: accounted for by PJM as negative credits at LMP.
- Status quo for customer-sited PJM “sell excess” generators today: unlike typical generators with bidirectional metering:
  - All energy imports are assumed to be non-station power loads (i.e., normal retail accounting).
  - PJM can apply station power energy accounting for appropriate loads for customers who work with EDC to separately meter energy for station power loads if it is allowed under local jurisdiction.
- PJM's proposal for DER is to follow this status quo.
- Note certain battery charging energy can qualify as station power.



- Recall that energy withdrawals for qualified wholesale storage are accounted for by PJM as negative credits at LMP.
- For discussion:
  - For DER wired with load: should PJM apply Energy Storage Resource or pumped hydro accounting for appropriate withdrawals for customers who work with EDC to separately meter withdrawals for Energy Storage Resources or pumped hydro resources, if it is allowed under local jurisdiction?
- Note certain battery charging can qualify for Energy Storage Resource accounting.
  - Recall that a battery that performs any non-wholesale service does not meet the criteria to be an “Energy Storage Resource”.

- Demand Response rules currently prohibit participation during intervals with injections from the site.
- This limits ability to co-locate DER (wholesale or otherwise) with DR.
- Propose to defer this question to future.
  - Note interaction with Demand Response Subcommittee.



## What if the retail metering records are based on the net over an interval?

- In order to ensure proper accounting (and avoid double counting), the retail function of the energy metering system should only record withdrawals and not account for exports (via netting or otherwise).
  - (Unless the customer opts not to have wholesale energy settlements.)
- For discussion: who has the responsibility to establish that retail energy metering meets this standard?
  - Initial response: the customer as confirmed by the EDC.
- Likewise, the wholesale function of the energy metering system should only record injections and not account for imports.
- A single metering device could theoretically be able to meet this standard and serve both purposes, separately recording withdrawals and injections.

# What if the retail and wholesale settlement intervals are different?

- Recall proposal that retail metering must only record withdrawals, wholesale must only record injections.
- Different settlement intervals should not be a problem given that the retail and wholesale metering systems are each unidirectional.
- Thought experiment: wholesale metering = unidirectional 5-minute interval meter under 5-minute wholesale energy settlements:
  - Example 1: retail metering = a unidirectional electromechanical meter that is read once a month.
  - Example 2: retail metering = unidirectional hourly interval meter.

## **Can a Single Grid Connection Serve Both Retail Energy and Wholesale Energy?**

- Consistent with today's proposal, implemented for some customers today.
- There is no PJM rule prohibiting this nor does PJM currently propose one.
- An important principle is coordination with retail regulation.
- The retail connection is under state jurisdiction.
- For most DER: the wholesale connection (as part of the interconnection process) is also under state jurisdiction.

## **Can a Single Energy Metering System Measure Both Retail Energy and Wholesale Energy Settlements?**

- This should be technically achievable in principle.
- There is no PJM rule prohibiting this nor does PJM currently propose one. PJM rules focus on technical requirements of accuracy et cetera.
- An important principle is coordination with retail regulation: local rules may prohibit this.

## **The EDC plays a central in configuring both retail customer energy metering and wholesale energy metering for DER:**

- The retail energy metering configuration is under state jurisdiction.
  - The method the customer will use to achieve PJM’s DER requirement (where applicable) for “unidirectional retail energy metering that records only withdrawals” is therefore subject to state jurisdiction.
- Furthermore, the Interconnecting Transmission Owner typically plays a central role in validating the configuration of metering that will be involved in generator energy submissions used for wholesale settlements (this will also apply to DER). This validation is done under FERC jurisdiction. In many cases, wholesale metering configuration requirements are specified in TO technical manuals.
- PJM sets the metering technical requirements and oversees the wholesale metering configuration validation process as part of the market “set up” process.



# ANCILLARY SERVICES DETAILS





- **Tier II** Synch Reserve is assigned directly to resources that clear the SR market.
- Tier II resources are paid the Synch Reserve Market Clearing Price for intervals in which they offer and clear, regardless of whether there is an event or not.
- Underperformance of Tier II resources during an event is penalized with a “refund” mechanism.
- Overperformance of Tier II resources during an event is typically compensated using a Tier I credit tied to a formula based on LMP and a premium.
- No Tier II Synch clears unless there is insufficient Tier I. There is often sufficient Tier I.
- Estimated **Tier I** Synch resources are estimated based on available headroom from online generators otherwise providing energy. Tier I is estimated because it is not explicitly assigned to resources through a market clearing mechanism.
- During intervals without an event, Tier I credits are often zero.
- Tier I performance during an event is compensated using a Tier I credit tied to formula based on LMP and a premium





# List of Interactions Energy <> Ancillary Services

- DER that pass the respective qualification tests can choose to offer Regulation and/or Synch Reserves.
- DER must be online when providing Synch and otherwise follow the rules of Generators in Synch, including resource-specific rules for availability for Tier I estimates.
- Recall that DER can choose Ancillary Services performance measurement either at POI or at DER submeter.
- Some complexity for DER that choose to submeter for ancillary services vis-à-vis energy scheduling/offers:
  1. Mismatch between measurement points for **POI-metered energy** and **submetered ancillary services**.
  2. Recall that Ancillary Services are generally (but not always) co-optimized with energy for each unit.
  3. Scheduling/offering injected energy may be infeasible for submetered DER in Regulation (consider: net energy injections under Regulation are not going to be stable).
    - If so, there would be no energy offer for the DER and no Lost Opportunity Cost in Regulation offer.
    - Note: injected energy would still be settled at wholesale (unless DER has retail offtake).
  4. Submetered Synch Reserve may also interact with energy scheduling/energy offers and LOC.
- No Estimated Tier I Synch for submetered DER. (They may offer as a Tier II Synch resource).
  - Because Tier I Synch is based on energy basepoint via energy settlement point.
- DER that have retail energy settlement for injections have no energy offer and cannot self schedule to sell energy, and are not eligible to be Estimated Tier I Synch. (They may offer as a Tier II Synch resource).
- Discussion point: should Tier I Synch credits be available for surplus performance of retail-settled DER?