



Distributed Energy Resources Subcommittee: Education Session

January 26, 2018

Andrew Levitt—Senior Market
Strategist, Emerging Markets



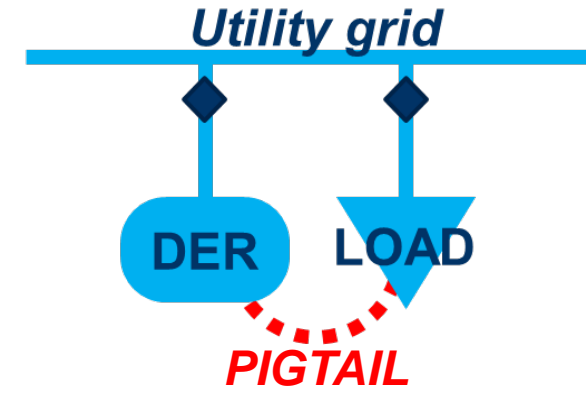
PJM W-DER Proposal Summary

1. W-DER: unique type of market participant (3rd ruleset as alternative to Generation & Demand Response) allowing sales of capacity, energy, and ancillary services to PJM.
2. W-DER proposal especially applicable for DER that inject, interact w/ retail customers, have multiple fuels, and/or are <100 kW.
3. W-DER rules build on substantial status quo of DER selling in PJM as Generators, borrowing some from Demand Response.
4. W-DER proposal can include both Front Of The Meter and Behind The Customer Meter DER.

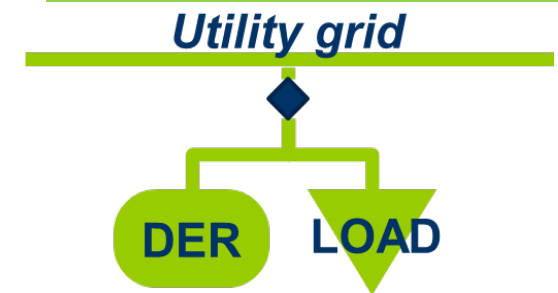
Examples of W-DER:

- A. Cogenerator behind a customer meter selling excess power.
- B. Aggregation of several residential batteries that can inject power.
- C. Front of meter solar+storage that can provide backup power to an adjacent retail load.

FRONT OF METER W-DER



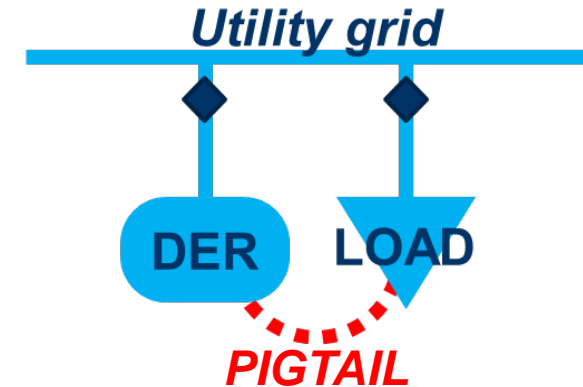
W-DER BEHIND THE CUSTOMER METER



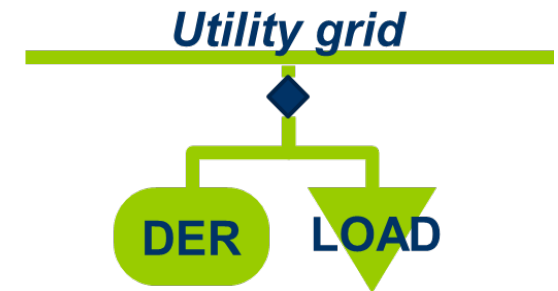
- Proposal recognizes the central role the Electric Distribution Company (“EDC”) plays in DER activity:
 - The EDC is central to the interconnection process for each DER under applicable regulatory oversight.
 - The EDC involved at each step of the aggregation process.
 - The importance of operational coordination with the EDC.

1. Who Can Provide: W-DER may be marketed by owner, third party incl. LSE, utility, etc.
2. Web tool for retail interactions: (esp. tracking end-user capacity accounting), w/ confirmation by distribution utility (similar to DR Hub for Demand Response).
3. Aggregation Option: W-DER may be aggregated to meet 100 kW market size.

FRONT OF METER W-DER

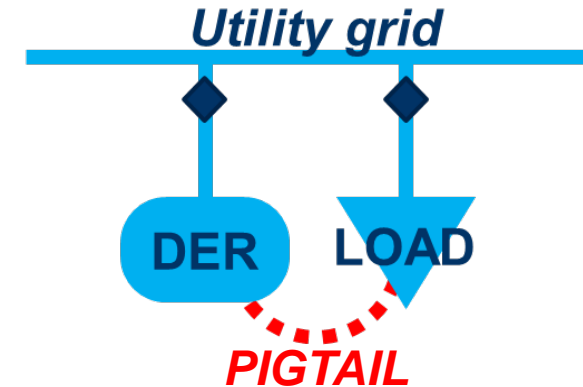


W-DER BEHIND THE CUSTOMER METER

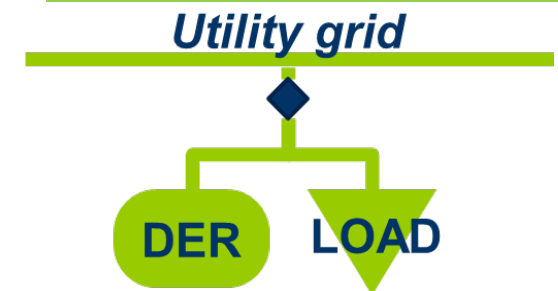


4. Rules default to Generation: Where not specified, W-DER rules (e.g., telemetry, bidding parameters, fuel cost policy) = Generation rules.
5. Interconnection as a Generator: W-DER requires interconnection approval from EDC, including PJM queue as per Generation status quo.

FRONT OF METER W-DER



W-DER BEHIND THE CUSTOMER METER





Market Proposal: Aggregation, Energy, & Ancillary Services

1. Aggregation across distribution utility to meet 100kW min market size (like DR).
2. Energy: compensation at LMP for excess sales at Point of Interconnection.
 - a) No compensation for load offsets from W-DER (however, open to stakeholder discussion). Proposal for co-located curtailments in Demand Response.
 - b) Scheduling will be on entire W-DER output, including load offsets.
 - c) Working internally on quantifying wholesale stored energy for storage with pigtail.
 - d) Option for PJM wholesale Ancillary-Services Only—no wholesale energy settlement (e.g., if customer sells energy output under PURPA or net metering).
3. Ancillary Services can be measured at POI or at DER with submeter.
4. Coordinate W-DER operations w/ distribution utility: day ahead schedules, etc.
5. Capacity market rules to be developed later in 2018.
6. Submeter (can be 3d-party owned) required for all W-DER > 25 kW, with “gross load” measurement used for PJM planning purposes and possibly other purposes.

The current proposal does not apply to DER sited at wholesale customers—i.e. DER at most munis and coops.

Muni/coop proposal to follow.

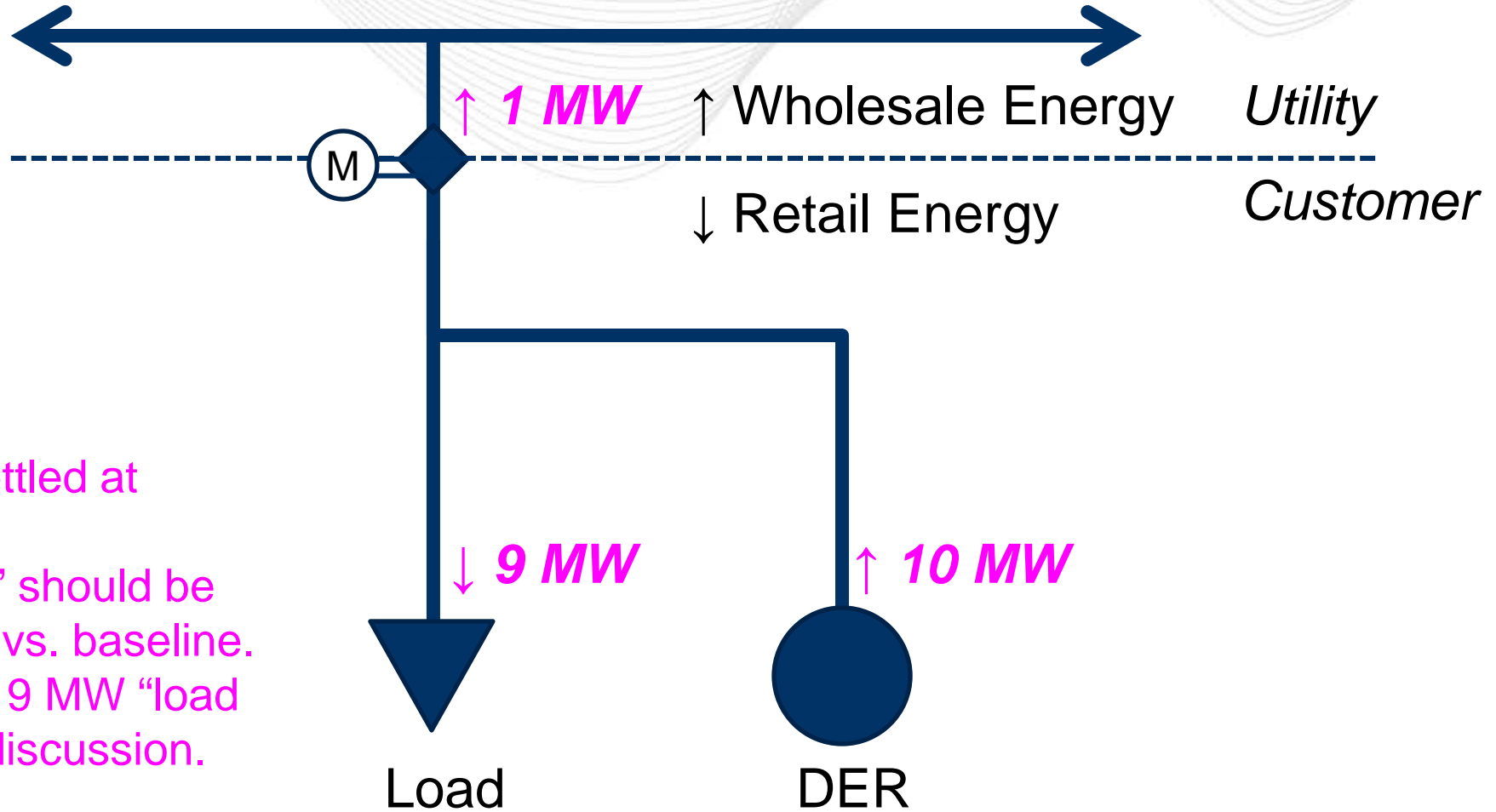


Energy

Straw Proposal for DER in the Energy Market

- Energy market proposal: follow status quo:
 - Energy injected to the distribution grid at the Point Of Interconnection (POI) is paid by PJM at wholesale LMP.
- For behind the customer meter DER, follow status quo of customer-sited wholesale generators wired with load on “sell excess” basis: :
 - Energy withdrawn from the distribution grid at POI is settled by EDC at retail.
 - Withdrawals are not accounted as station power. Station power must be metered separately from ordinary retail load.
 - To be eligible for wholesale energy settlement, customers must have unidirectional retail metering that records only withdrawals.
 - Customers w/ retail meters that record injections, & customers w/ retail compensation for injected energy, will **not** be settled at wholesale for injected energy.
 - New rule: scheduling for load offsets relative to baseline (but no compensation)

Proposed Energy Concept: W-DER Behind The Customer Meter



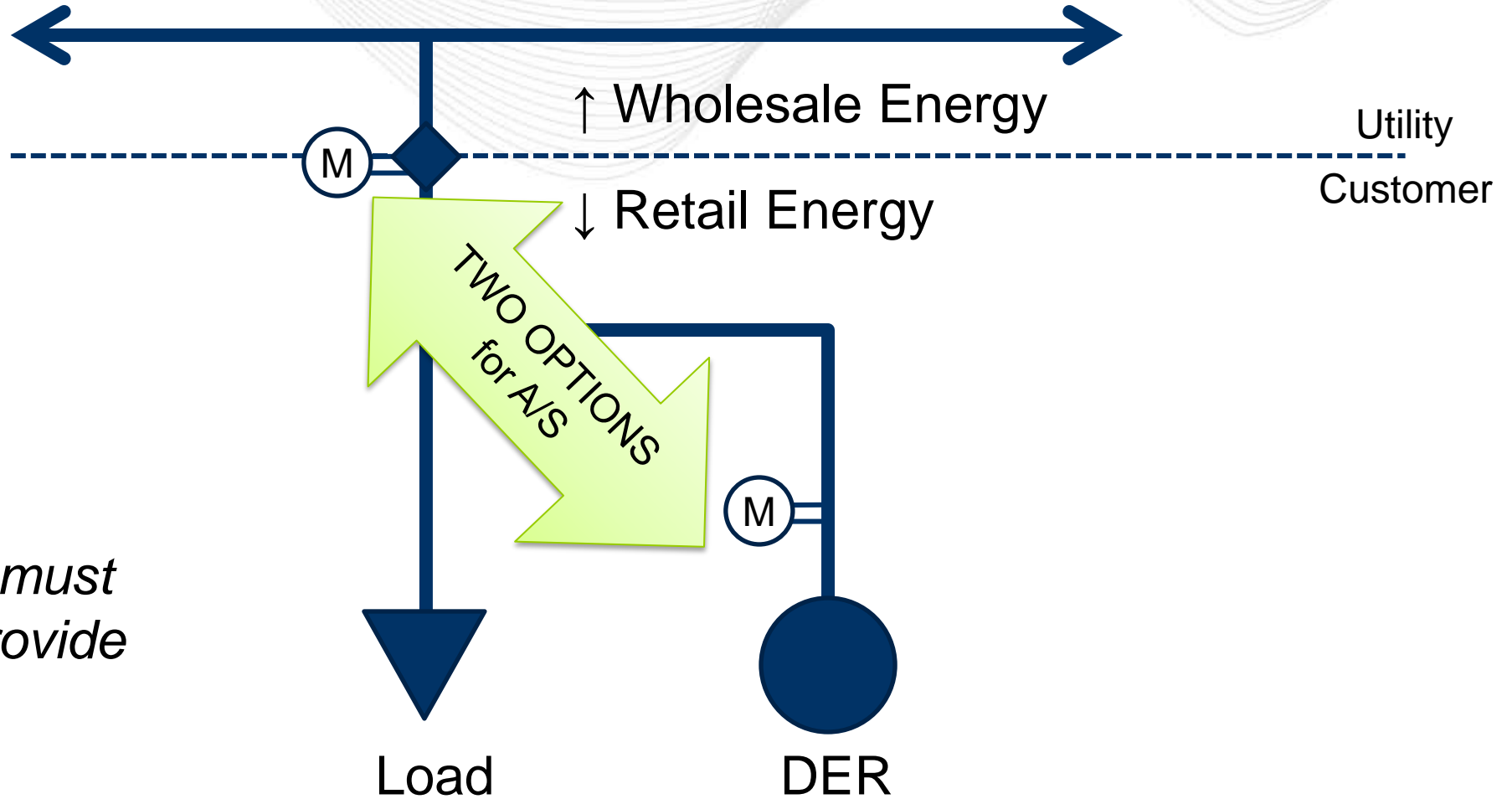
- 1MW excess is settled at wholesale at LMP.
- 9 MW “load offset” should be scheduled if delta vs. baseline.
- Compensation for 9 MW “load offset” still under discussion.

- 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.
- PJM has proposed to allow DR that is co-sited with W-DER to retain ability to participate in markets even when the W-DER is injecting.



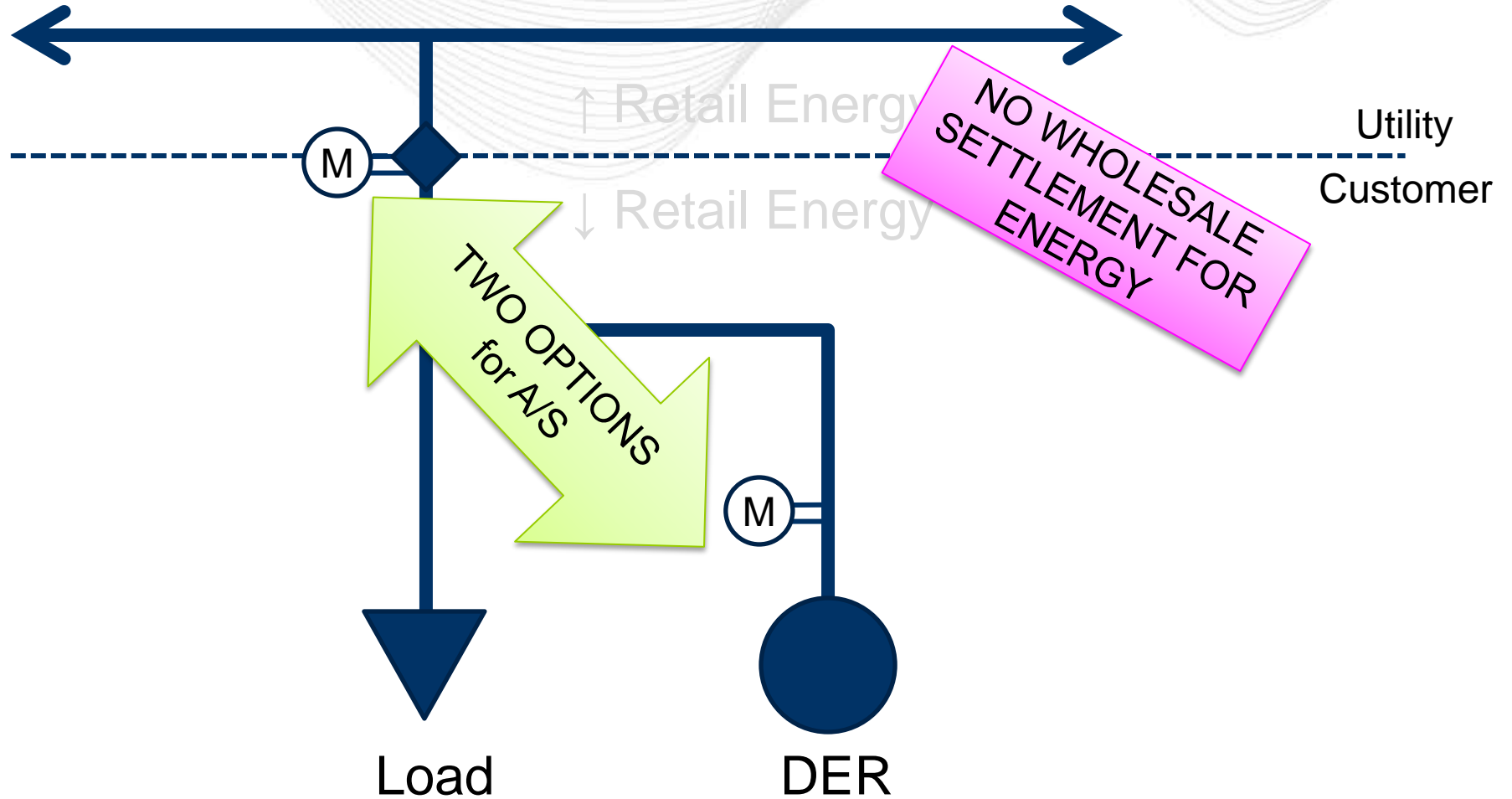
Ancillary Services

Ancillary Services Performance Measurement Concept



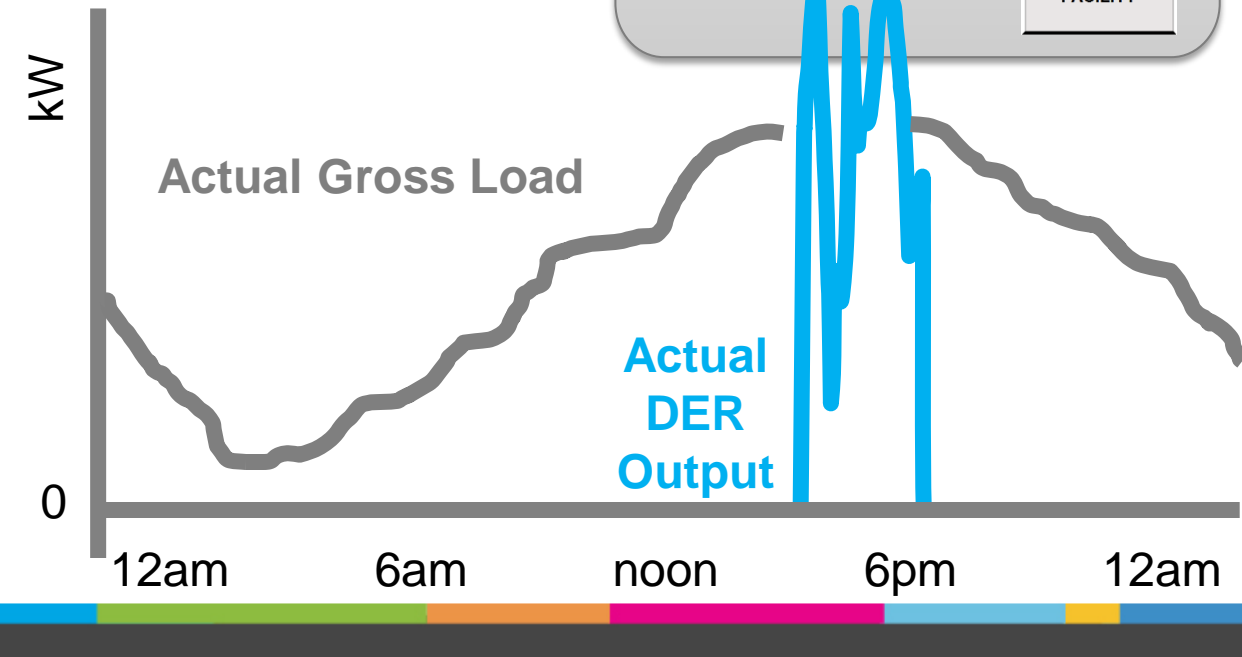
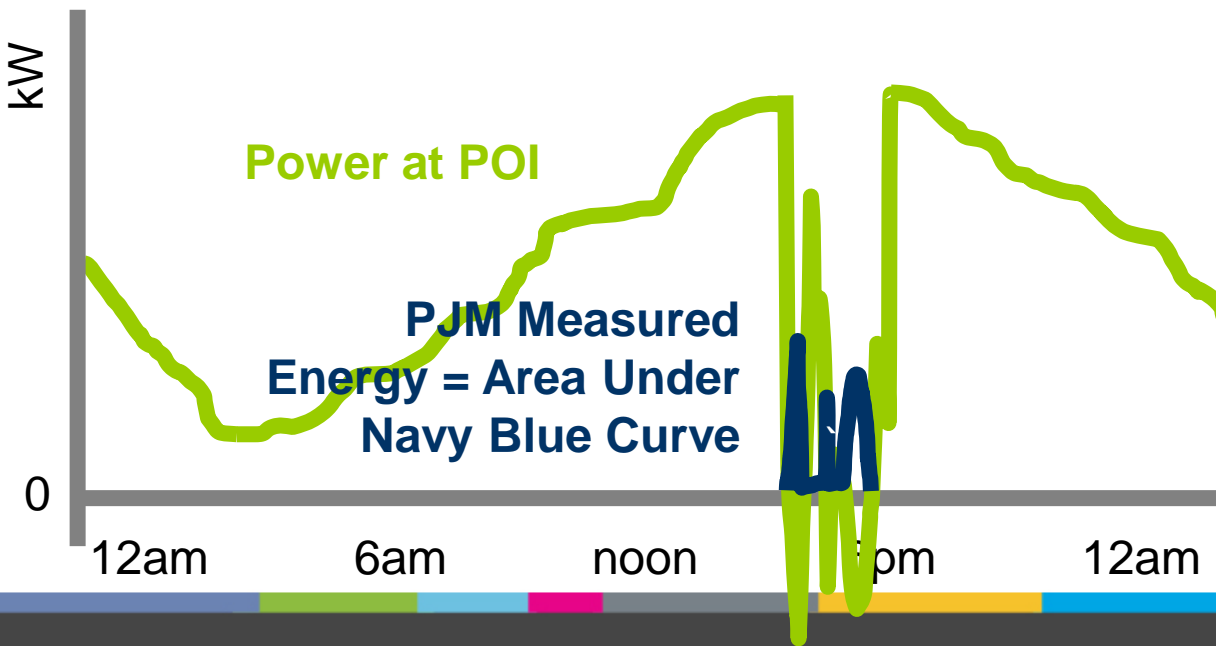
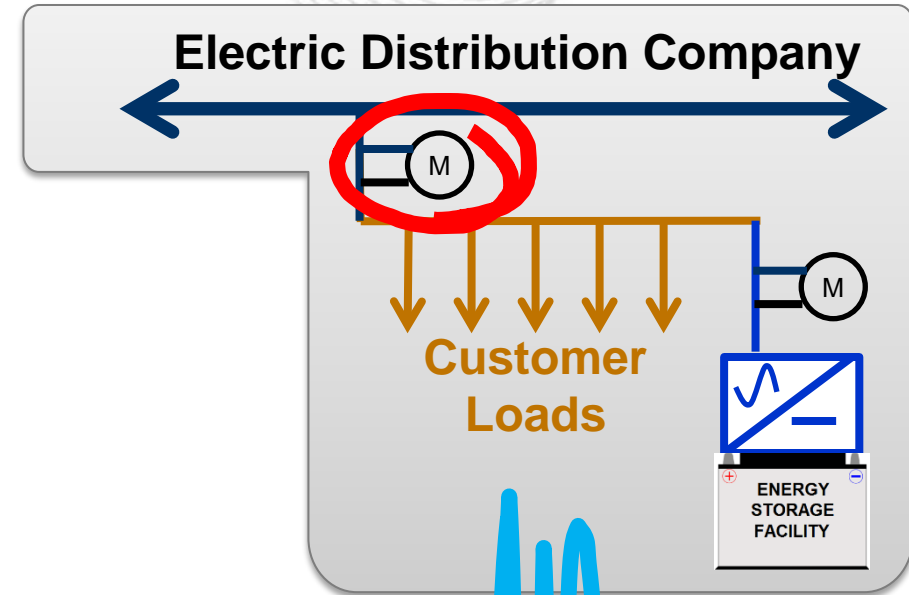
Note: W-DER must be online to provide Synchronous reserves

"Ancillary Services Only" Concept



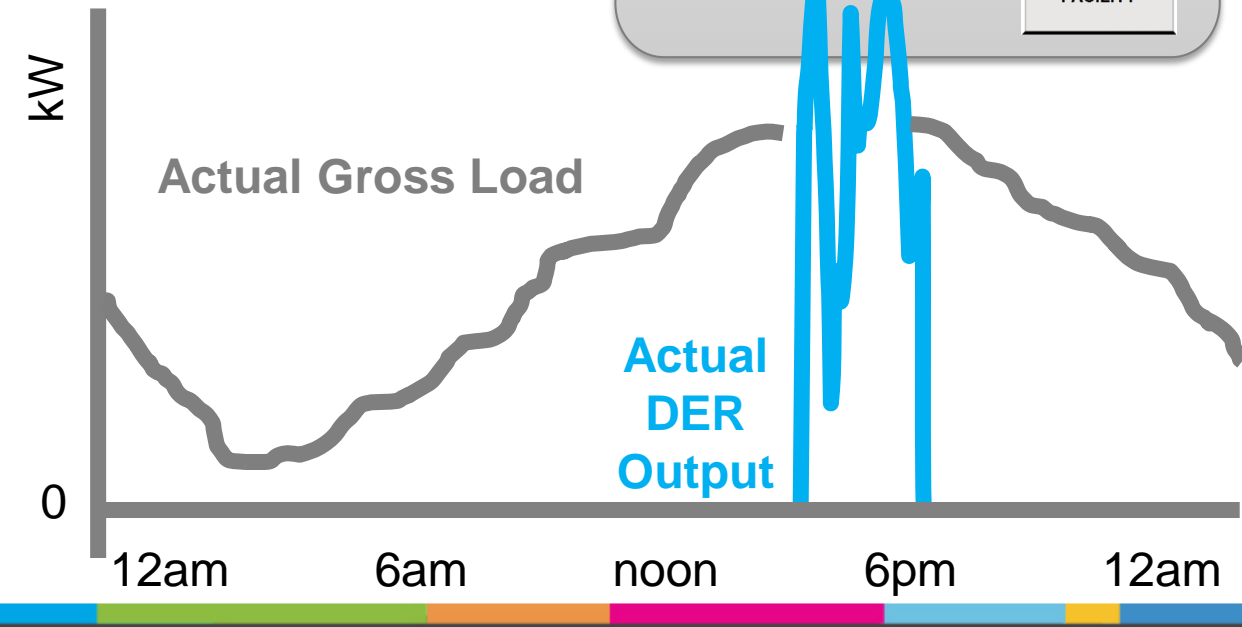
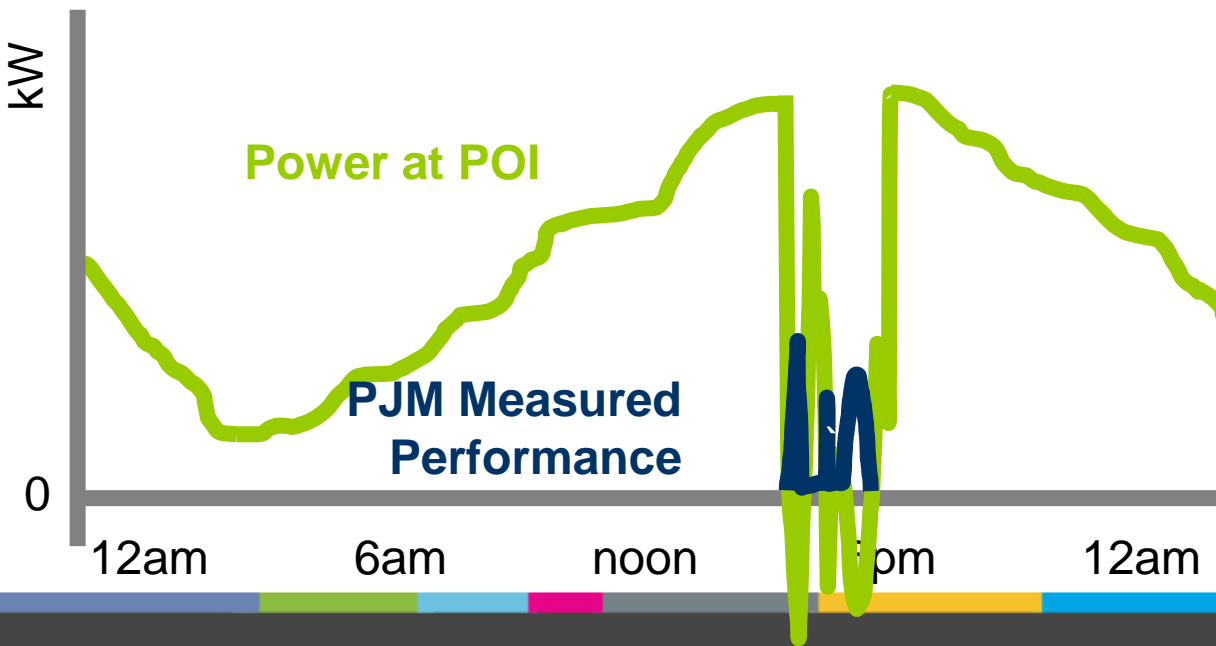
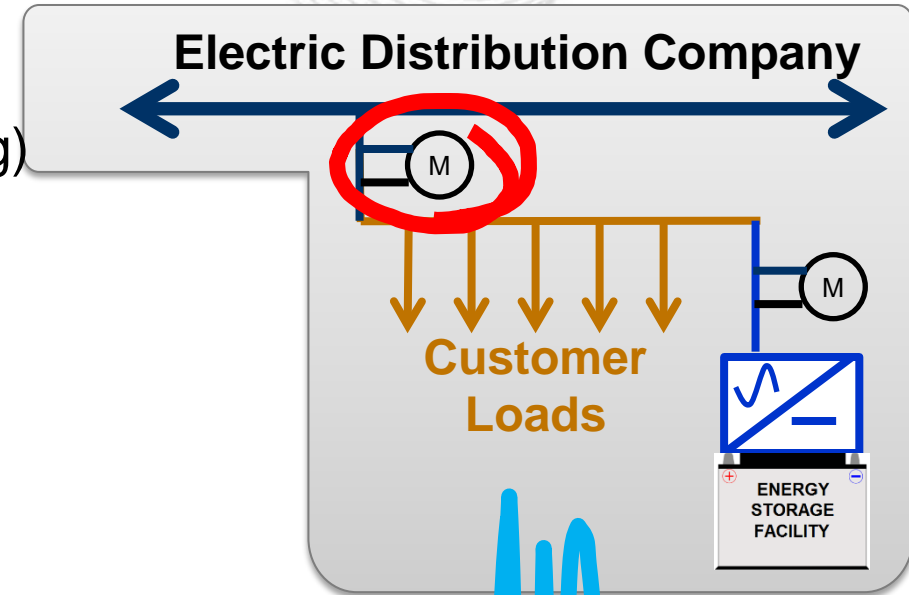
DER Measurement for Energy Must Be POI Meter

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



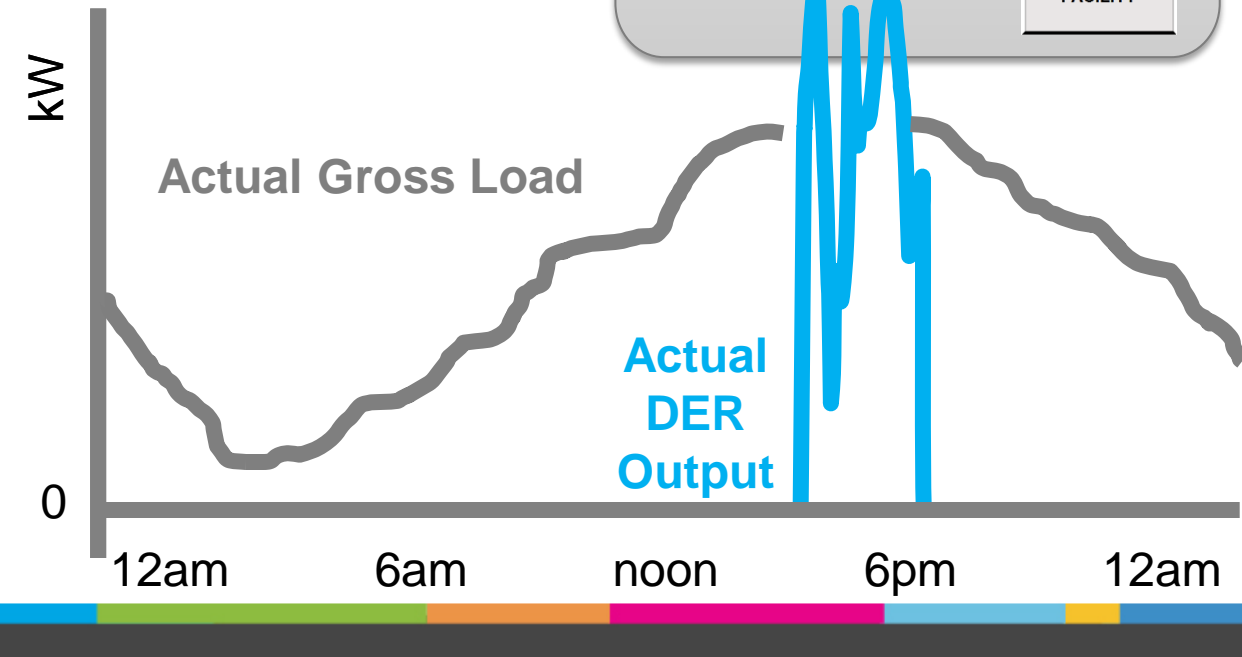
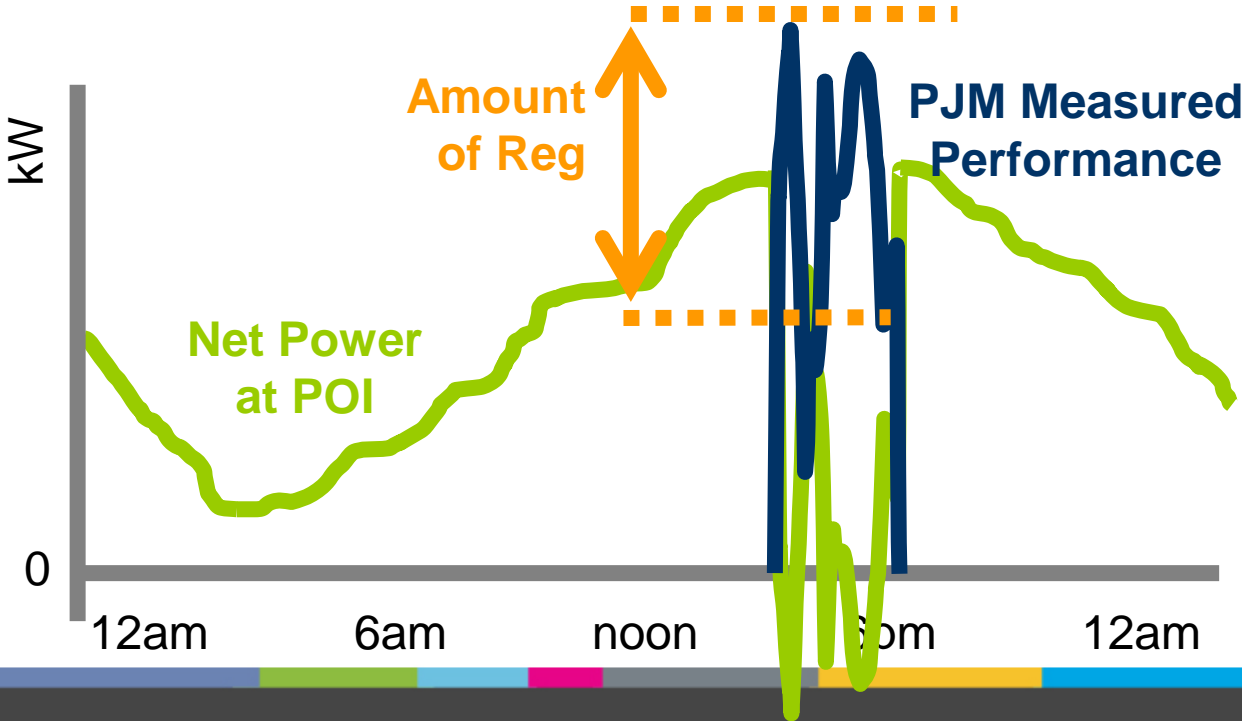
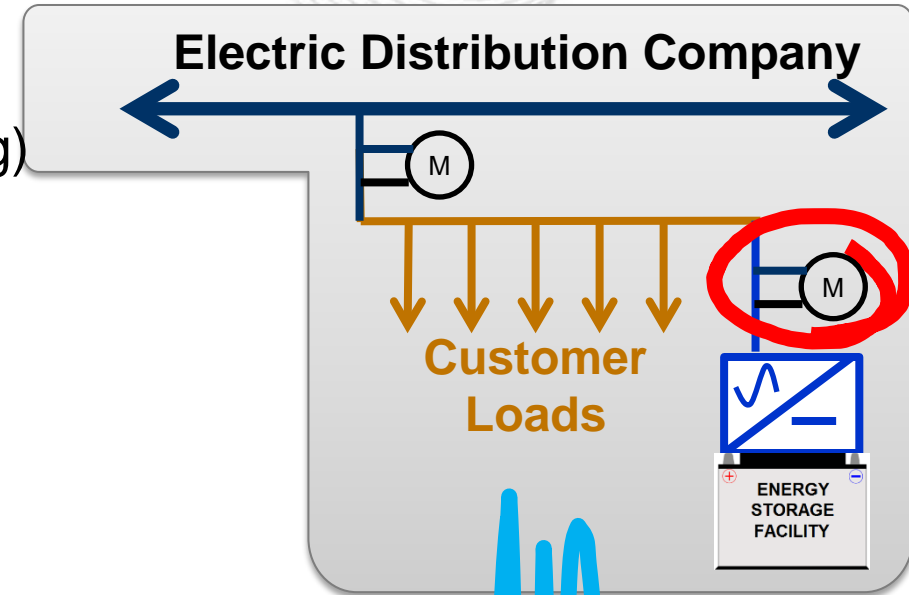
DER Performance for Regulation: **POI Meter** option

- DER proposal allows metering at either i) POI or ii) direct at the DER for Ancillary Services (both Synch and Reg)



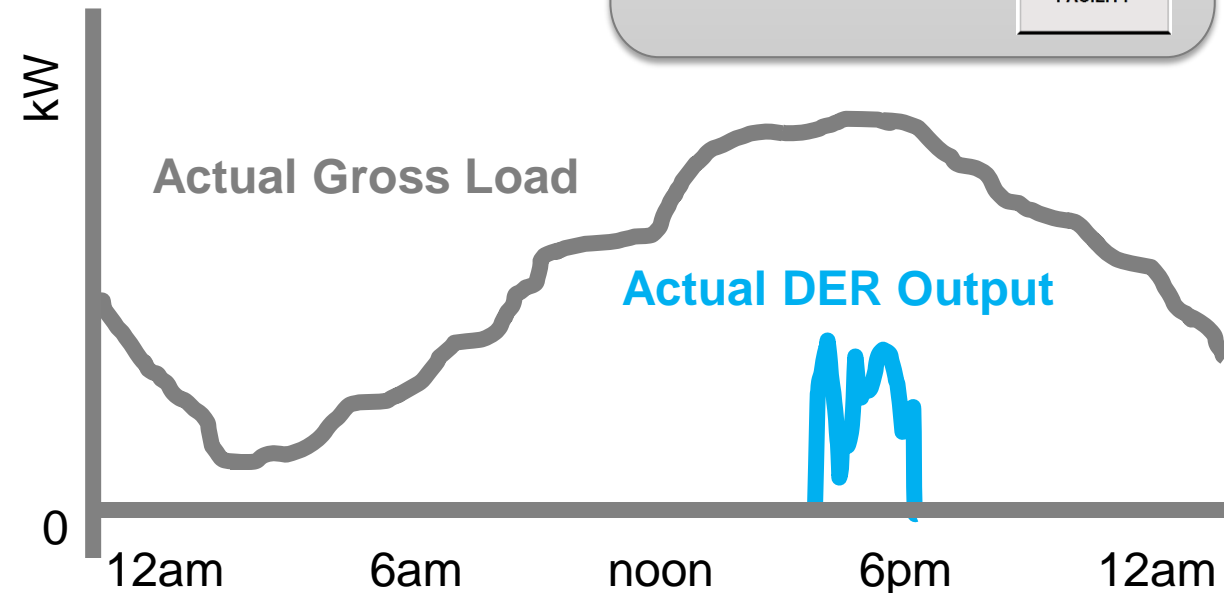
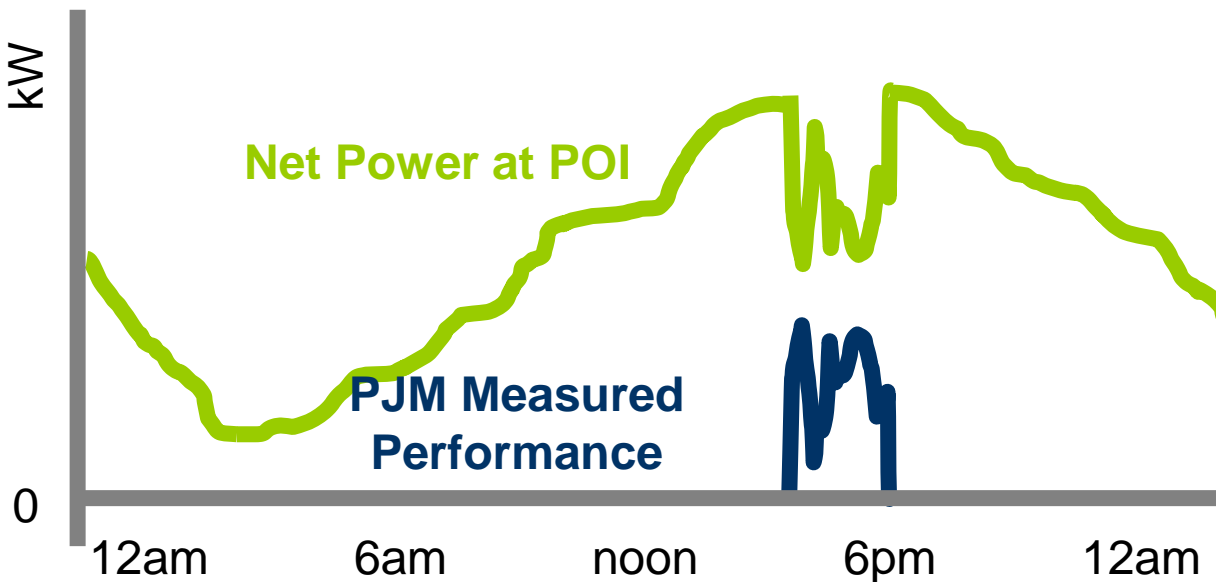
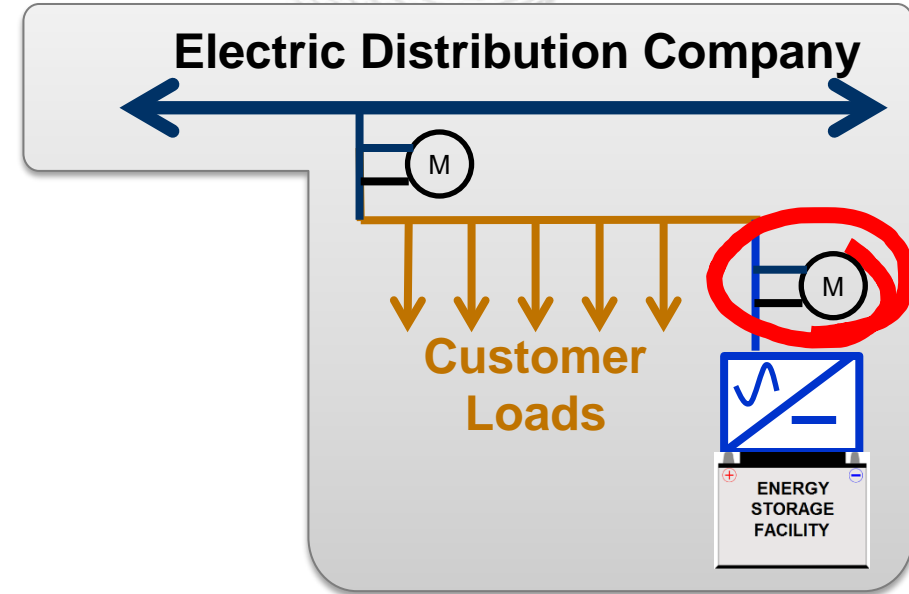
DER Performance for Regulation: **Submeter** Option

- 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.



Aggregation and Registration

Note: aggregation here does not mean “DER market participation”. It means “bringing together multiple separate units into one resource”.

1. Purpose of aggregation: **allow small DER to meet 100 kW min size threshold***.
2. Multiple DER units may aggregate in order to reach 100 kW minimum size.
3. DER aggregates on same or adjacent feeders must be approved by EDC.
4. DER cannot aggregate beyond a single EDC.
5. Aggregates implemented as aggregate-nodal (like composite combined cycle units today), not zonal.
6. Maximum aggregate size limit of 1 MW.
 - No more than a single “anchor” DER > 100 kW per aggregate.
7. Rules for cost-based offers and offer parameters are as-per Generation.
 - Should all DER in aggregate share the same injected energy settlement track (wholesale vs. retail)?

**PJM position: aggregation for managing risk in complying w/ performance requirements should be identical for DER & Generators.*

- Managing initial DER set up and updates.
- **“DER Unit” vs “DER Market Resource”**.
- **DER Unit** details:
 - Physical: address, owner, etc.
 - Retail: account number, compatibility with wholesale energy settlement.
 - Also list of any adjacent retail customers that can be fed through a “pigtail”
 - Interconnection approval and reference.
- **DER Market Resource** details:
 - List of one or more associated DER Units (aggregated or individual).
 - Wholesale market-related details.
- Initial set-up is subject to approval process.
- Parameters can be updated in DER Hub subject to (possibly different) approval process.

- DER Unit:
 - EDC interconnection approval required, either via WMPA (under state jurisdiction) or ISA (under FERC jurisdiction). Note PJM queue study of transmission impacts also required for either case.
 - EDC: 2 weeks confirmation of retail account number and other basic details.
 - For wholesale energy settlements coordination: 2-week EDC confirmation that retail load metering is unidirectional (i.e., only measures consumption).
 - EDC: 30 day reliability approval for DER that provide Regulation, and that have not been explicitly given the right to do so in the interconnection process.
- DER Market Resource:
 - If resource is aggregated, and if any DER units in the aggregate are on the same or adjacent feeders: EDC to confirm no reliability impacts from coordinated activity of DER units.

Proposal for Operational Coordination with EDC

- Sharing of DER DA schedule with EDC.
- Sharing of telemetry If the EDC does not already.
- List and basic details for W-DER in EDC territory is made available to EDC.

APPENDIX: OTHER CONSIDERATIONS

1. Intraday Unit Commitment: automatic (like Economic DR) or manual (like Gen?)
2. For aggregates:
 - a) Is telemetry for the entire aggregate or per-unit?
 - b) Is the MW weighting across the aggregate: fixed, or adjustable per interval, or based on historical values, or something else?
 - c) No Lost Opportunity Cost for aggregates?
 - d) Is nodal weighting for energy settlement based on ex post actual or on ex ante
 - e) Should all DER in aggregate share the same injected energy settlement track (wholesale vs. retail)?
3. Measurement of wholesale energy at front of meter energy storage DER with pigtailed that can directly serve other on-site retail load.
4. Rules for DER at wholesale customers (e.g., most munis and coops).

- 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.)
- Under the proposal, the EDC has responsibility to confirm that that retail energy metering meets this standard.
- 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.



APPENDIX: 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?