PJM DERA Use Cases

DIRS

July 23, 2021

Purpose of Use Cases

- Stress test the DERA model
- Build understanding by filling in details
- Cohesive examples to use throughout compliance process
- Highlight technology-specific needs
- Ability to iterate and introduce alternatives

Proposal Disclaimer

- Use Case review reflect proposal items that have been revised or updated since the PJM Draft Proposal review in March 2021
  - Updated areas will be briefly reviewed in this presentation, with a more detailed review of updates in the proposal refresh at the August 2021 DIRS
  - PJM still welcomes comments and questions on updated proposal items during this presentation for consideration

Agenda

- Use Case Characteristics
- Use Cases Outlined To-Date
- Status Quo and Use Case Review
  - Will review the following use cases today: **Use Case 1** & **4**
- Next Steps

Use Case Characteristics

Composition	Whether multiple technologies and/or resource types exist within the DERA Homogenous: only one type is present Heterogeneous: multiple types are present
Configuration	Relation of the DER physical elements to retail load Front of the meter: not co-located with retail load Behind the meter: co-located with retail load
Resource Type	Specifies type of market participation Distributed Generation Resource (DGR): state interconnected generator Demand Response (DR): activity used to reduce load Energy Efficiency (EE)
Technology Types	Type of generation or load reduction in DERA DGR: Solar, Wind, ESR, diesel, electric vehicle w/ V2G, etc. DR: On-site load reduction, On-site generation for retail load reduction
Market Participation	All market services the DERA is technically capable of providing
Sites	Number of unique sites and relevant registration and modeling information
Tx Location	PJM node(s) to which an aggregate maps and how DERA will be priced

Use Cases Outlined To-Date

	Composition	Configuration	Technology Types	Market Participation	Sites	Tx Location	Demonstration Goals
1	Homogeneous	Front of the meter	Solar	Cap, En, An	One	Single Primary Node	• Demonstrate size requirements and their implications.
2	Heterogeneous	Front of the meter	Solar + ESR	Cap, En, An	Multiple	Single Primary Node	• Demonstrate how information is exchanged on an aggregate basis. • Highlight any impact to the utility review given multiple distribution feeders
3	Homogeneous	Behind the meter	ESR	Cap, En, An	One	Single Primary Node	• Demonstrate how ESR participates as behind the meter generation with injections in DERA
4	Heterogeneous	Behind the meter	DR + ESR	Cap, En, An	One	Single Primary Node	• Illustrate heterogeneous aggregates with a DR component, Illustrate ESR model within an aggregate.
5	Heterogeneous	Behind the meter	DR + Solar	Cap, En, An	One	Single Primary Node	• Illustrate a NEM component and its implications.

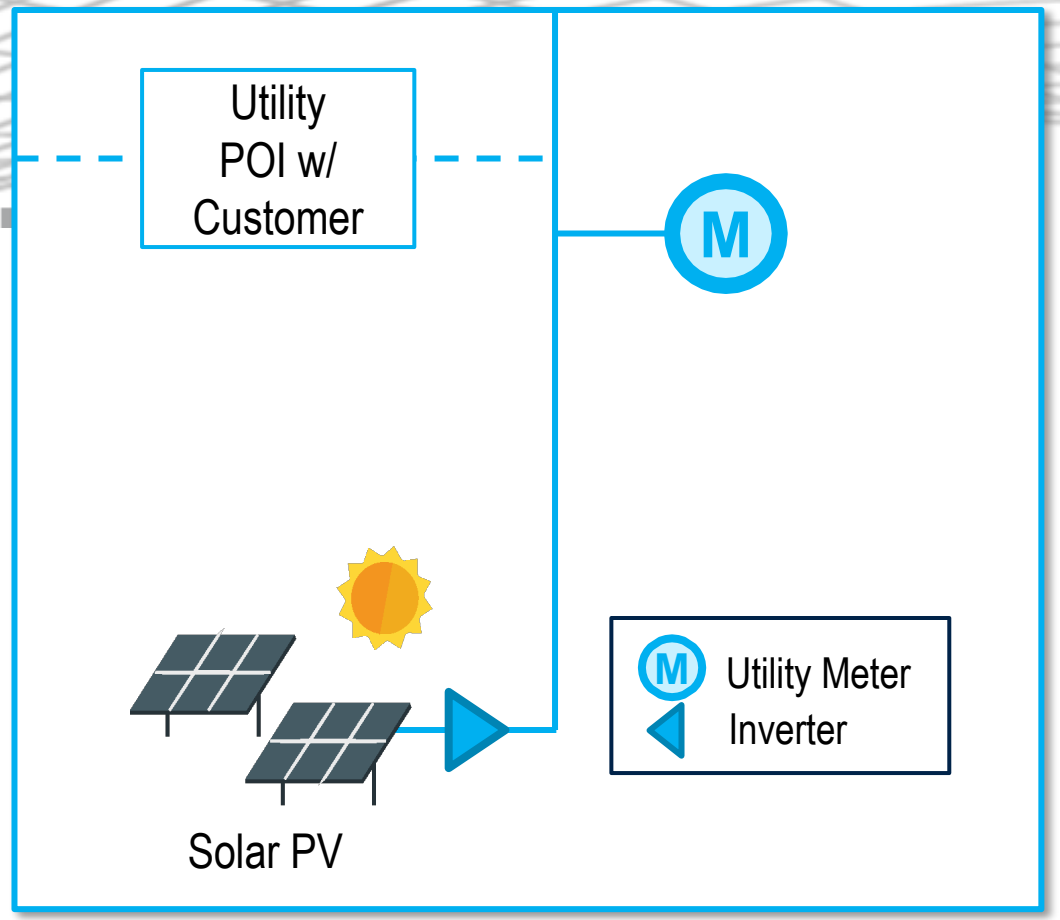
Use Cases Outlined To-Date

	Composition	Configuration	Technology Types	Market Participation	Sites	Location	Notes
1	Homogeneous	Front of the meter	Solar	Cap, En, An	One	Single Primary Node	• Demonstrate size requirements and their implications.
2	Heterogeneous	Front of the meter	Solar + ESR	Cap, En, An	Multiple	Single Primary Node	• Demonstrate how information is exchanged on an aggregate basis. • Highlight any impact to the utility review given multiple distribution feeders
3	Homogeneous	Behind the meter	ESR	Cap, En, An	One	Single Primary Node	• Demonstrate how ESR participates as behind the meter generation with injections in DERA
4	Heterogeneous	Behind the meter	DR + ESR	Cap, En, An	One	Single Primary Node	• Illustrate heterogeneous aggregates with a DR component, Illustrate ESR model within an aggregate.
5	Heterogeneous	Behind the meter	DR + Solar	Cap, En, An	One	Single Primary Node	• Illustrate a NEM component and its implications.

Today's Use Cases

Use Case 1

- A solar Distributed Generation Resource (DGR) participating under the DERA model as an aggregate of 1
- Not co-located with retail load

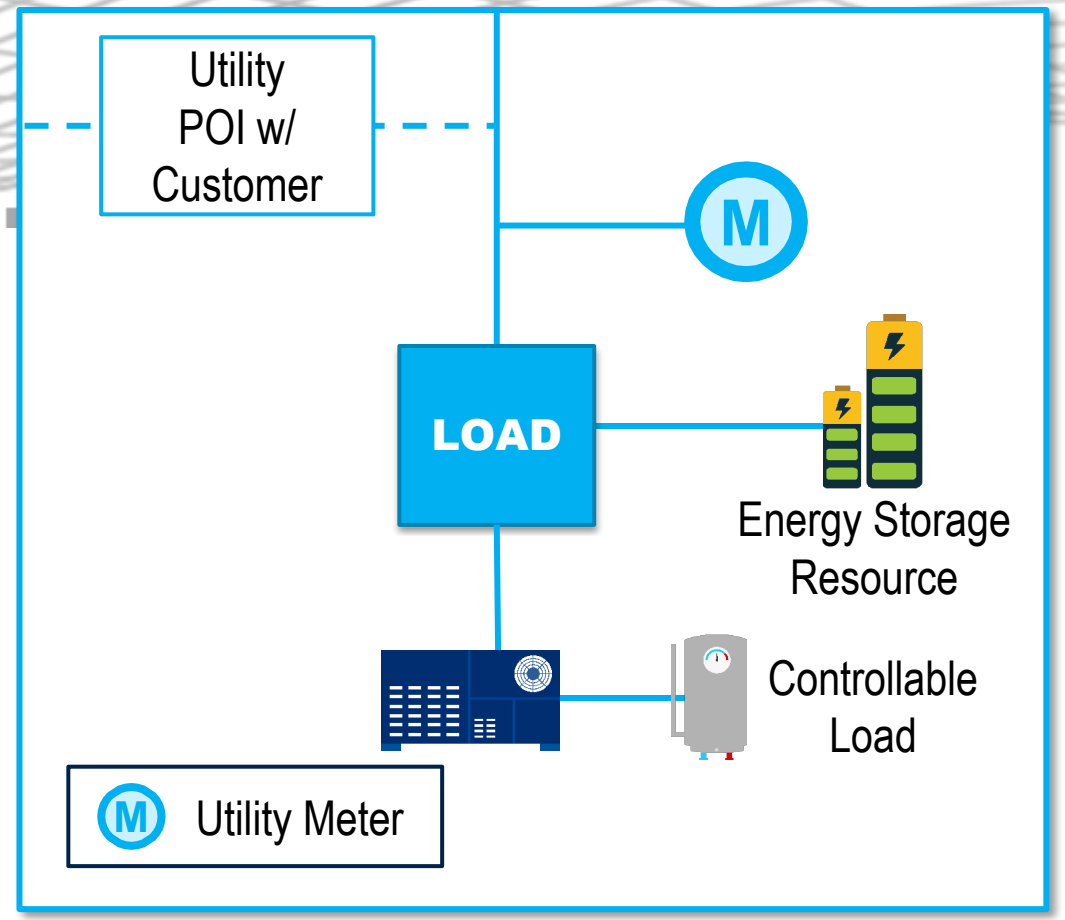


Note: This Meter represents status-quo utility interconnection, PJM telemetry or metering are discussed in a later slide.

Today's Use Cases

Use Case 4

- An ESR acting as a Distributed Generation Resource (DGR) and controllable load providing load reduction
- One Site, both co-located with retail customer load
- Site may inject



Note: This Meter represents status-quo utility interconnection, PJM telemetry or metering are discussed in a later slide.

Outline of Topic Areas

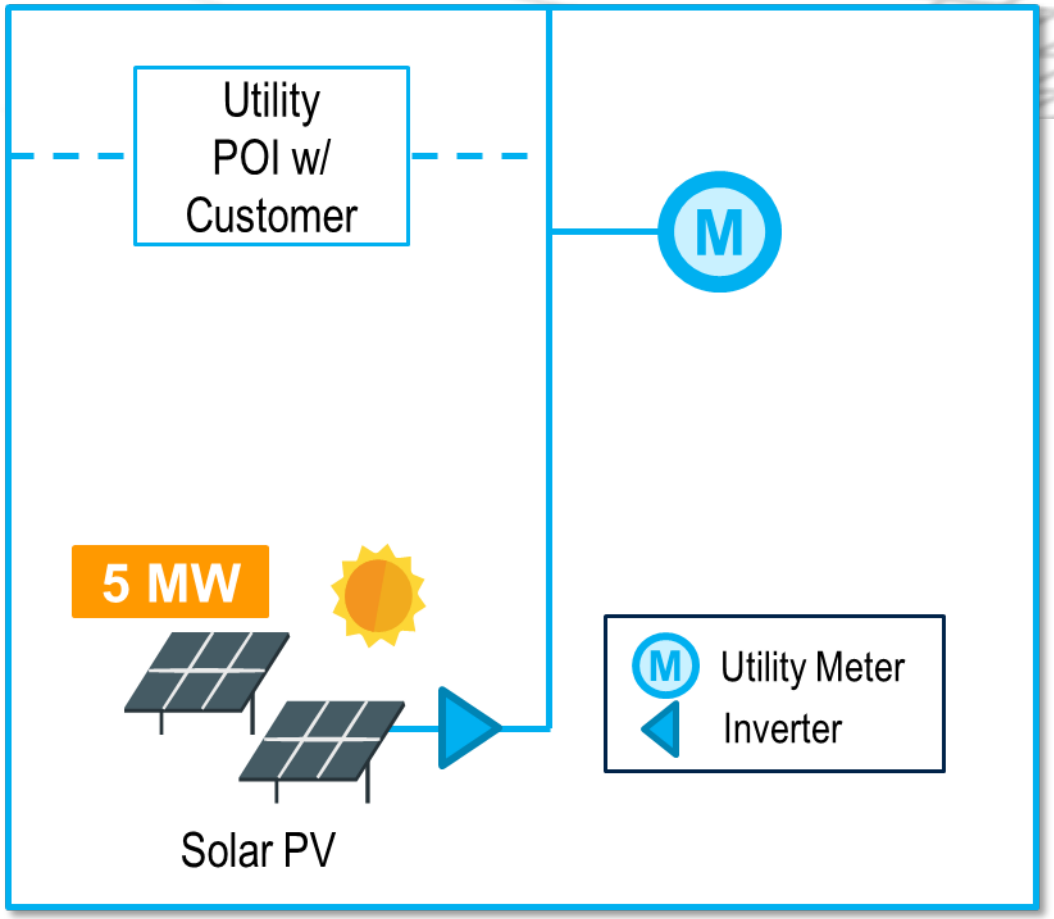
- Registration
- Size Requirements
- Locational and Weighting Factors
- Telemetry
- Market Participation Eligibility
- Cost-Based Offers
- Metering
- Performance & Settlements

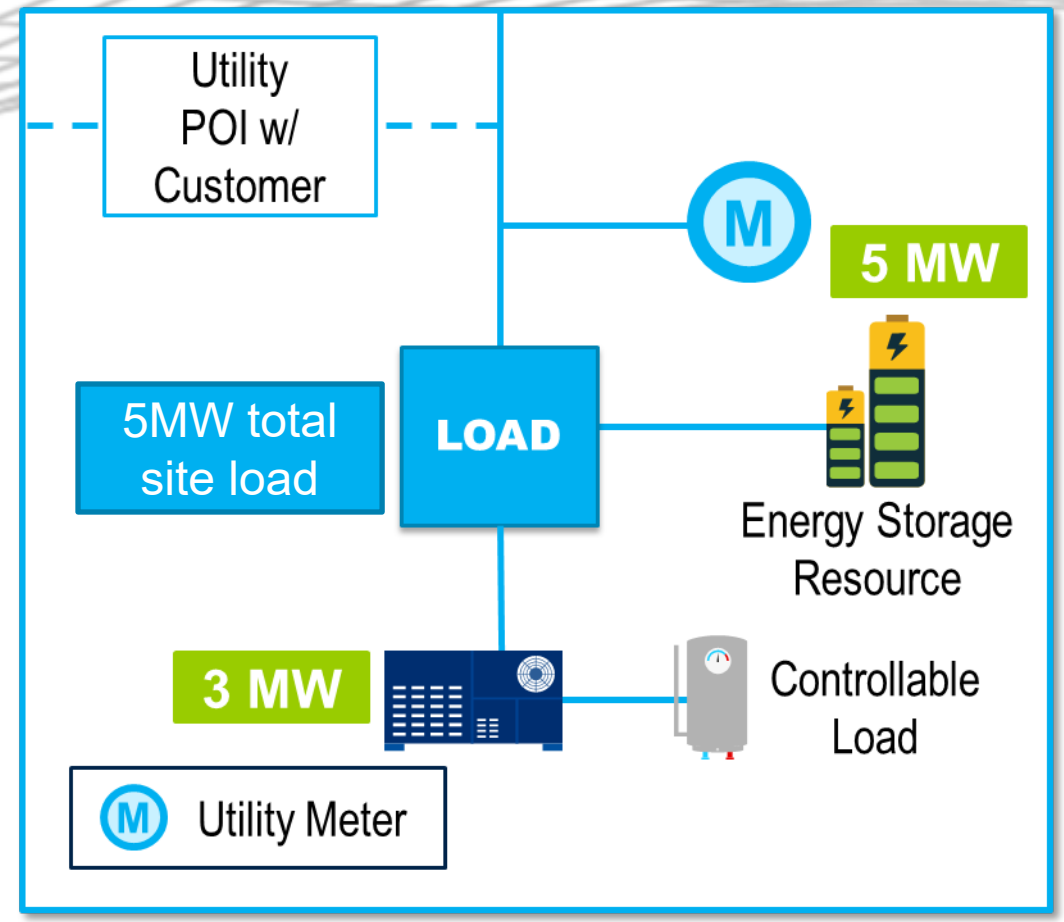
Not Covered in Today's Presentation:

Ops Coordination, Single vs. Multiple DER Aggregators, Double Counting, PAI Example

Registration

- MW values added to use cases to help illustrate registration process





Use Case 1: Registration

DERA Registration															
DERA	Start Date	End Date	Status	Site Resource Type	Name	Address	Markets	EDC	Transmission Zone	EDC Account Number	Max Load (kW)	Max Injection (kW)	Max En. Offer (kW)	Pricing Point	Agreements
DERA1	---	---	---	Distributed Generator	---	---	Cap, En, A/S	---	---	---	0	5000	5000	Node A	---

Distributed Generation Resource(s)	Load Reduction Method				
Generation (kW)	Refrigeration (kW)	HVAC (kW)	Lighting (kW)	Generator (kW)	Process (kW)
5000	N/A	N/A	N/A	N/A	N/A

5 MW PV

DERSP submits the data, EDC reviews
EDC provides the data
Procedural information

- Interconnection is handled by EDC—DERA do not enter the PJM New Services Queue
- Additional DGR data for PJM Planning will be required (inverter type, etc.) (more details in August DIRS)
- EDCs review information and provide approve/deny status

Use Case 4: Registration

DERA Registration															
DERA	Start Date	End Date	Status	Site Resource Type	Name	Address	Markets	EDC	Transmission Zone	EDC Account Number	Max Load (kW)	Max Injection (kW)	Max En. Offer (kW)	Pricing Point	Agreements
DERA1	---	---	---	DR with Injection	---	---	Cap, En, An	---	---	---	10000	5000	8000	Node A	---

Distributed Generation Resource(s)	Load Reduction Method				
Generation (kW)	Refrigeration (kW)	HVAC (kW)	Lighting (kW)	Generator (kW)	Process (kW)
5000	0	0	0	0	3000

5 MW Battery

3 MW Controllable Load

5 MW Co-located Residential Load
5 MW of ESR Charging

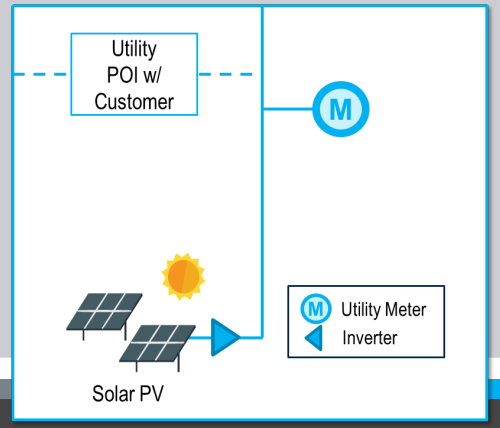
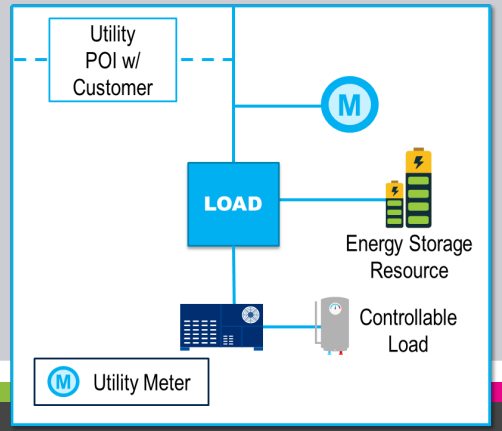
DERSP submits the data, EDC reviews

EDC provides the data

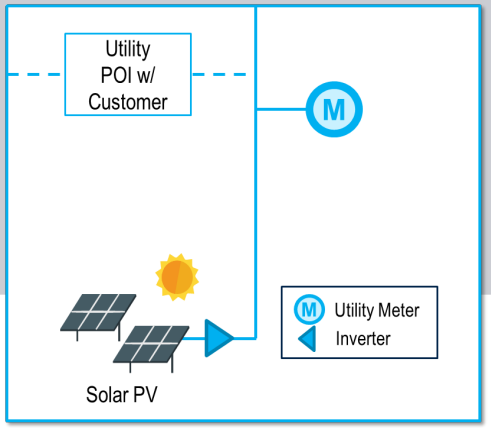
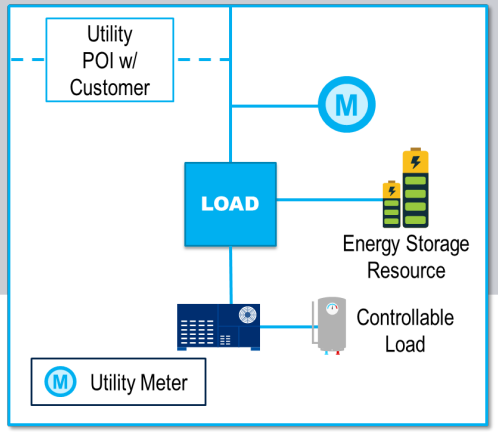
Procedural information

- Settlements needs explicit information on DR's portion of any heterogeneous aggregate, will be required upon Registration

Size Requirements

DERA Requirements (Draft)	Use Case 1	Use Case 4
DER with greater than 5MW of injection MW will not be eligible to participate in DERA	DER (Solar Resource) is less than or equal to 5MW MFO 	• No size restrictions on Demand Response • ESR must have less than or equal to 5MW injection • Aggregation sizing requirements under review 

Locational Requirements

DERA Requirements (Draft)	Use Case 1	Use Case 4
All DER participating in a DERA must be mapped to the same primary Tx node Resource that impacts multiple transmission nodes should be reflected in modeling review between EDC and PJM	• Single site, single resource • Verification with EDC on mapping node(s) *(See example upcoming)* 	• Single site, multiple resources, still share primary node • Verification with EDC on mapping node(s) *(See example upcoming)* 

Information needed for modeling - the “Factors”

- (input → registration process) **Capability Factors** (At DER level)
  - PJM will determine a capability factor, based on nameplate of DERs in a DERA. These will not be updated unless the aggregation changes and it is reviewed and approved by PJM/EDC.
- (input → registration process) **Locational Factors** (At the DER level)
  - This is the mapping that the EDC/Aggregator provides for transmission location(s) (all DERs in aggregation sharing primary node), during registration process. This will not be updated unless reviewed and approved by PJM/EDC.
- (operations/markets) **Modeling Impact Factor** (At the DERA level)
  - The factor to be used in pricing/dispatch. PJM will calculate from the capability factor and locational factor. There will not be a dynamic update of this value (hourly/daily) but can change over time if DERA changes occur (via registration process).
- (operations/markets) **Weighting Factors** (AKA “distribution factors” from Order 2222)
  - Defined as the breakdown of which DERs are responding to the dispatch signal – would be a RT update from the aggregator. Order ties this to multi-nodal aggregations.
  - Given PJM preference for a “single location” approach, we will **not require weighting factors** for initial implementation.

Example: Developing Modeling Impact Factors

DER	Capability Factor	Aggregation Definition	Locational Factors	Modeling Impact Factors
DER1	0.25	DERA 1	100% Node A	0.25 – node A
DER2	0.25	DERA 1	100% Node A	0.25 – node A
DER3	0.25	DERA 1	80% Node A 20% Node B	0.20 – node A 0.05 – node B
DER4	0.25	DERA 1	70% Node A 30% Node D	0.175 – node A 0.075 – node D
DER5	1	DERA 2	70% Node B 30% Node A	0.70 – node B 0.30 – node A
DER6	1	DERA 3	100% Node C	1.0 – node C

DERA 1
0.875 – Node A
0.050 – Node B
0.075 – Node D

DERA 2
0.70 – Node B
0.30 – Node A

DERA 3
1.0 – Node C

Locational Requirements Example

- Assumes resource maps solely to 1 transmission node, based on distribution system normal configurations
  - Switching and distribution configuration changes will be covered in more detail at August DIRS

DER	Capability Factor	Aggregation Definition	Locational Factors	Modeling Impact Factors	Primary Node
DER1	1.0	DERA 1	100% Location A	100% Node A	Node A

Notes
CF based on size and capability of each DER. LF determined by location and electrical impact of each DER, including CF. MIF determined by LF "in aggregate," using CF alongside LF takes into consideration other DER within the DERA.

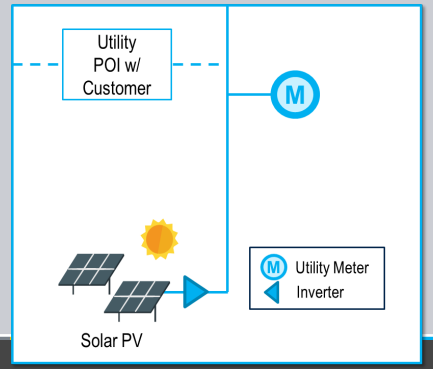
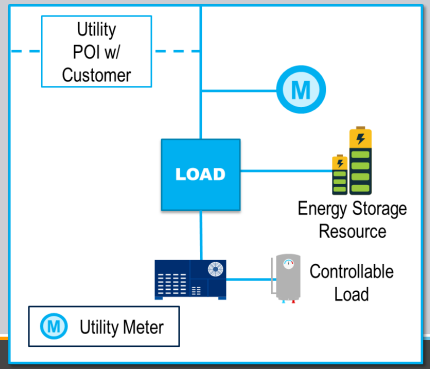
Locational Requirements Example 2

- Assumes resource maps to 2 transmission node, based on distribution normal configurations
  - Switching and distribution configuration changes will be covered in more detail at August DIRS

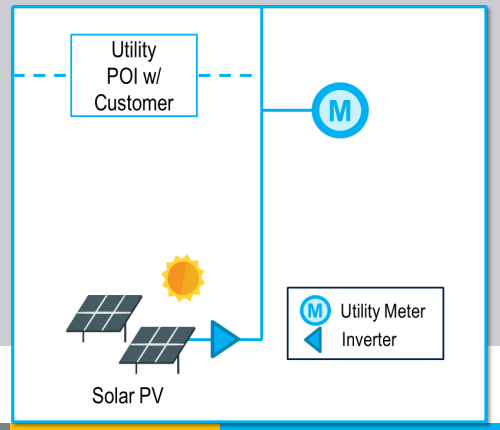
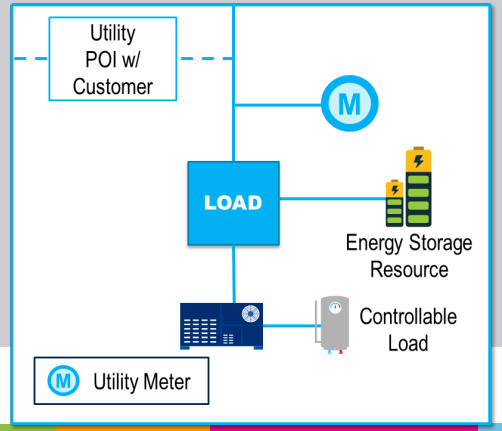
DER	Capability Factor	Aggregation Definition	Locational Factors	Modeling Impact Factors	Primary Node
DER1	1.0	DERA 1	75% Location A 25% Location B	0.75 Node A 0.25 Node B	Node A

Notes
CF based on size and capability of each DER. LF determined by location and electrical impact of each DER, including CF. MIF determined by LF "in aggregate," using CF alongside LF takes into consideration other DER within the DERA.

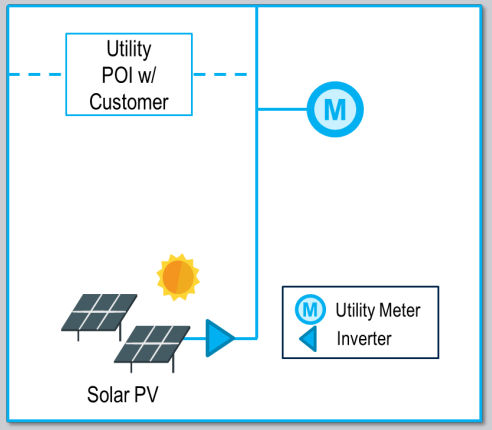
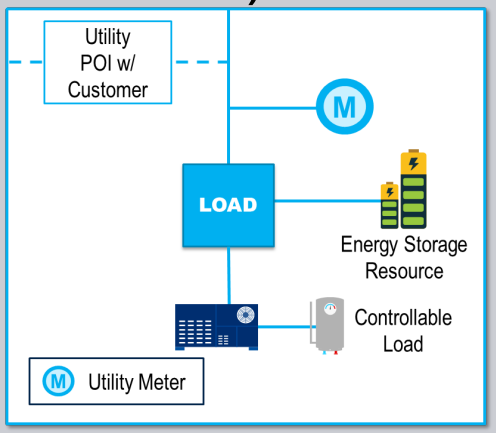
Telemetry Requirements

DERA Requirements (Draft)	Use Case 1	Use Case 4
Telemetry provided for DERA (not individual DERs) Telemetry required for all DERA >=0.1MW	PJM is not proposing to send curtailment flags to DERAs regardless of underlying technology types Solar telemetry will inform the solar forecast 	PJM is still determining whether the full load reduction + injection MW, or just the injection MW, should be sent to PJM. 

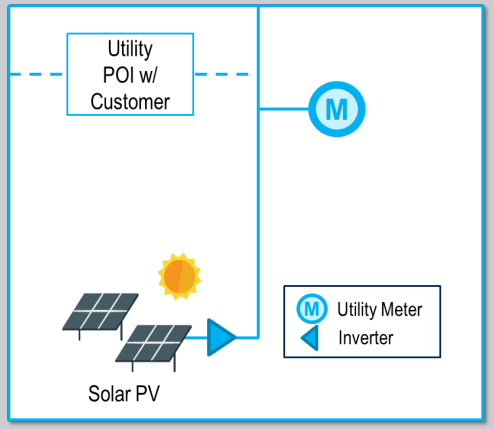
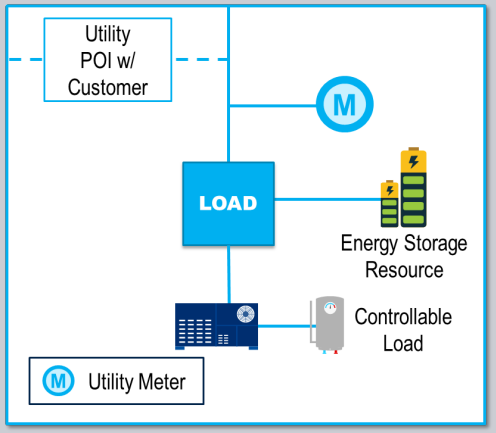
Market Participation Eligibility and Aggregation

DERA Requirements (Draft)	Use Case 1	Use Case 4
DERA eligible for Capacity, Energy and Ancillary Services, where technically capable Additional 'grouping' of aggregations for performance available consistent with existing rules	Eligible for all markets, where technically capable 	• Eligible for all markets, where technically capable and no double counting present with retail programs • Underlying storage will have access to participating under the ESR model to reflect charging 

Metering Requirements

DERA Requirements (Draft)	Use Case 1	Use Case 4
Meter data submitted to PowerMeter by 4 PM next business day Meter data submitted for aggregation (DERA)	Status quo 	Individual DER data will need to be provided by ESR and DR - ESR data needed for “charging energy” accounting, if applicable - DR data is needed for DR (Order 745 Settlements) 

Cost Based Offers

DERA Requirements (Draft)	Use Case 1	Use Case 4
DERA will participate in Energy under a no-commitment, no-dispatch model – **No cost offer required** DERA will participate in Energy under a no-commitment model, PJM dispatch available - **Cost Offers Required** - Homogenous DERA follows M15 rules - Heterogeneous DERA must offer $0	Status Quo 	• DERA must offer $0 

- Examples are simplistic as a starting point.
- Highlight the necessary settlement process bifurcation when load response is present within an aggregate
- Iterations on settlement calculations to be provided at future DIRS to demonstrate additional settlement scenarios (PAI, overrides, ESR charging, etc.)
  - Welcome suggestions on settlement scenarios or details that are important to explore further

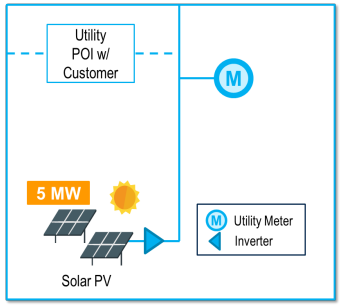
Use Case 1: Performance & Settlements

Generator LMP Charge Summary

RT PJM Energy Price	150
PNODE RT Congestion Price	0.3
PNODE RT Loss Price	-1.25

EPT Hour Ending	DA Scheduled MWh	DA PJM Energy Price ($/MWh)	DA Spot Market Energy Charge ($)	PNODE DA Congestion Price ($/MWh)	DA Transmission Congestion Charge ($)	PNODE DA Loss Price ($/MWh)	DA Transmission Loss Charge ($)	RT Generation (MWh)*	Bal Generation (MWh)	Bal Spot Market Energy Charge ($)	Bal Transm. Congestion Charge ($)	Bal Transm. Loss Charge ($)
11	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
12	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
13	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
14	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
15	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0
16	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0
17	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0
18	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0

- Generator portion of aggregate billed as such



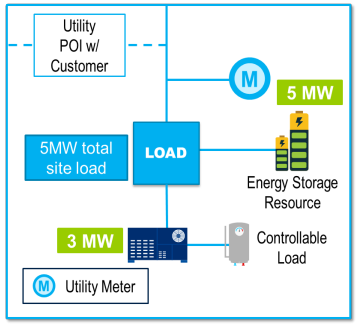
Use Case 4: Performance & Settlements

RT PJM Energy Price	**150**
PNODE RT Congestion Price	**2.5**
PNODE RT Loss Price	**1.25**

Generator LMP Charge Summary

EPT Hour Ending	DA Scheduled MWh	DA PJM Energy Price ($/MWh)	DA Spot Market Energy Charge ($)	PNODE DA Congestion Price ($/MWh)	DA Transmission Congestion Charge ($)	PNODE DA Loss Price ($/MWh)	DA Transmission Loss Charge ($)	RT Generation (MWh)*	Bal Generation (MWh)	Bal Spot Market Energy Charge ($)	Bal Transm. Congestion Charge ($)	Bal Transm. Loss Charge ($)
11	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
12	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
13	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
14	5	100	-500	0.25	-1.25	-1.5	7.5	4	-1	150	2.5	1.25
15	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0
16	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0
17	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0
18	5	100	-500	0.25	-1.25	-1.5	7.5	5	0	0	0	0

- Generator portion of aggregate billed as such



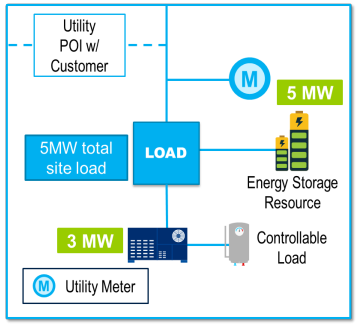
Use Case 4: Performance & Settlements

RT PJM Energy Price	150
PNODE RT Congestion Price	2.5
PNODE RT Loss Price	1.25

Load Response Summary

EPT Hour Ending	DA Load Response MWh	DA LMP ($/MWh)	DA Retail Rate Used ($/MWh)	DA Load Response Credit ($)	DA Load Response Charge ($)	CBL (MWh)	Metered Load (MWh)	Load Response Loss Factor	EDC Loss De-ration Factor	RT Load Response MWh	RT LMP ($/MWh)	RT Retail Rate Used ($/MWh)	RT Load Response Credit ($)	RT Load Response Charge ($)
11	3	100	0	300	0	5	2	1.01	0.01	2.9997	150	0	-0.045	0
12	3	100	0	300	0	5	4	1.01	0.01	0.9999	150	0	-300.015	0
13	3	100	0	300	0	5	3	1.01	0.01	1.9998	150	0	-150.03	0
14	3	100	0	300	0	5	2	1.01	0.01	2.9997	150	0	-0.045	0
15	2	100	0	200	0	5	2	1.01	0.01	2.9997	150	0	149.955	0
16	2	100	0	200	0	5	4	1.01	0.01	0.9999	150	0	-150.015	0
17	2	100	0	200	0	5	5	1.01	0.01	0	150	0	-300	0
18	2	100	0	200	0	5	5	1.01	0.01	0	150	0	-300	0

- DR portion of aggregate billed as load reduction
- Load Response Loss Factor set at registration—static value



Next Steps

- Receive feedback on currently outlined Use Cases
- Review other Use Cases in a similar format
- Incorporate remaining items for Use Cases
  - *Ops Coordination, Single vs. Multiple DER Aggregators, Double Counting, PAI Example*

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DERA Use Case Development