California ISO

T-D Interface Coordination for the High-DER Future Grid

Presentation for New York Utilities –
Grid Operations Stakeholder Engagement Group

August 25, 2016

Participation models for DER, current and future.

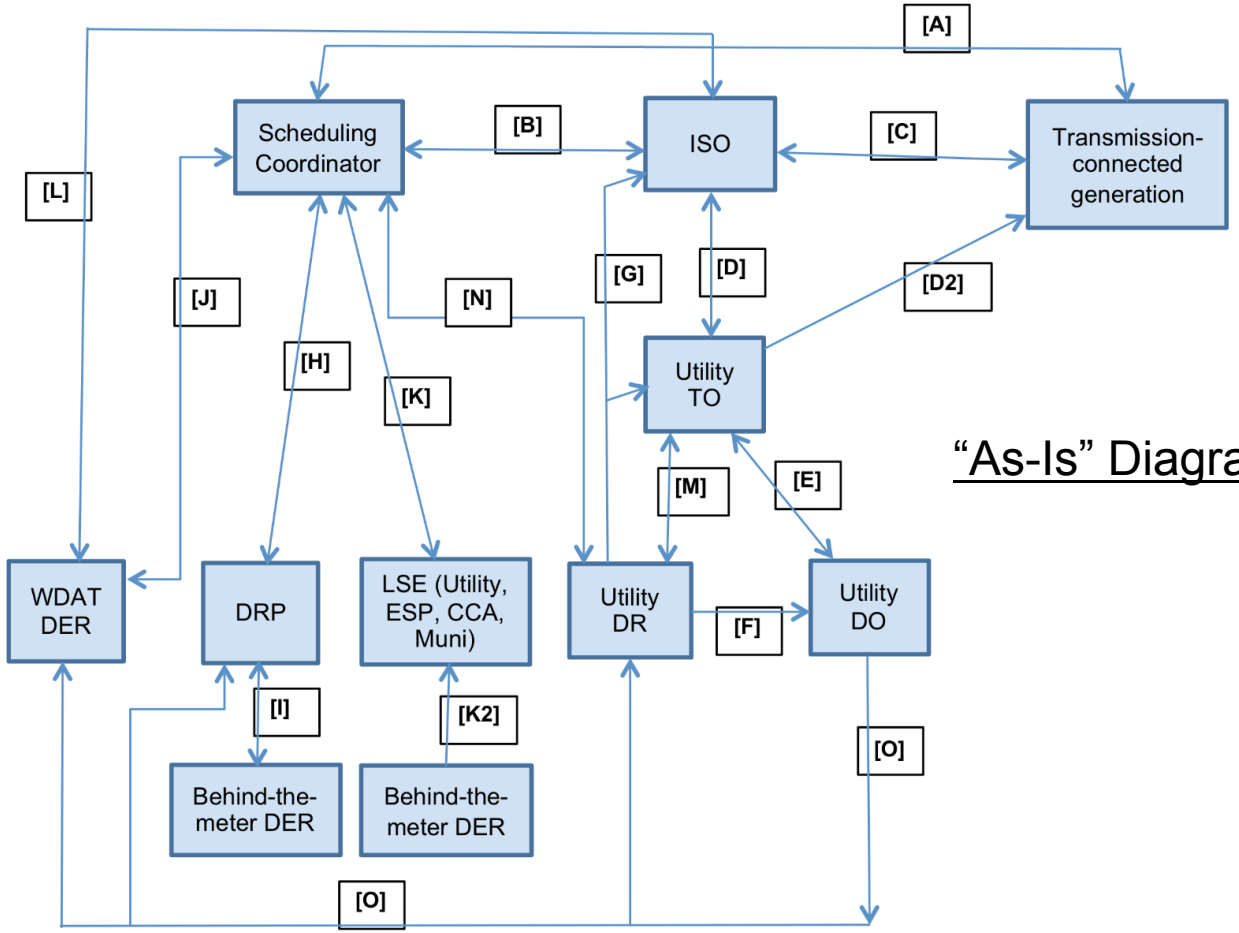
- Demand Response ("Proxy Demand Resource" or PDR)
  - May incorporate behind-the-meter (BTM) devices such as energy storage, but can only reduce load, cannot inject energy to the grid
  - Relies on baselines to measure performance
  - Allows sub-metering of BTM storage device for DR measurement
  - Visible to CAISO only when it bids in and is dispatched
  - Future: CAISO ESDER2 initiative developing rules for bi-directional dispatch and provision of regulation service
- "Non-Generator Resource" (NGR)
  - Designed for a resource like storage that will consume or inject energy at different times
  - Visible to CAISO and settled 24x7 (comparable to a generator)
  - Does not use baselines
- Distributed Energy Resource Provider (DERP)
  - Allows aggregator to create a virtual resource of mixed DER types
  - Resource will utilize NGR model

The high-DER grid requires rethinking distribution system operation and T-D interface coordination.

- Diverse end-use devices & resources with diverse owners/ operators will dramatically affect:
  - Net end-use load shapes, peak demands, total energy
  - Direction of energy flows, voltage variability, phase balance
  - Variability & predictability of net loads & grid conditions
  - Retail kWh volumes & traditional revenue streams
- High DER penetration has impacts in two directions:
  - From distribution to transmission: DER autonomous behavior & service provision to distribution affects the transmission grid => need for accurate RT forecasting and local management of DER variability
  - From transmission to distribution: ISO market sees DER at T-D substations, has no visibility to distribution grid conditions or impacts
- Result => need for new coordination framework between ISO, distribution operator (DO) and DER operators

Today's information exchanges have been diagrammed, focusing on DR as the main distribution-level resource participating in the ISO market.

The ISO and the utility distribution operator (DO) do not coordinate or exchange info today. (See notes next 2 pages.)



"As-Is" Diagram

Notes for “As-Is” diagram

Line	Description of Information Exchange
[A]	T-connected gen provides to SC: unit characteristics, bids, outage/derate information.
	SC provides to T-connected gen: market awards, settlements, ISO dispatch instructions, ISO exceptional dispatch/OOM instructions.
[B]	SC submits DA bids to ISO by 10am of day prior to operating day; submits RT bids to ISO by T-75 minutes for each operating hour.
	ISO provides DA energy schedules, A/S awards and commitment instructions to SCs by 1pm of day prior to operating day; ISO provides RT dispatches, A/S awards and commitment instructions at various times within operating day and within each hour.
[C]	T-connected gen executes PGA with ISO.
	ISO provides T-connected gen RT operating instructions/restrictions.
[D]	ISO provide to Utility TO: transmission operating instructions, outage schedules, emergency instructions (such as load curtailment), information on demand response called due to ISO emergency, and notice of dispatches of non-market utility DR resources.
	Utility TO provides the ISO: transmission outage requests, outage status, courtesy outage information of non-controlled ISO transmission, transmission outage/restoration coordination.
	[SCE only] Utility TO (Grid Communications Center or GCC) coordinates all information with the ISO. In addition, for non-market DR programs the Utility DR communicates current information directly to ISO per line [G]. (See SCE System Operating Bulletin 104.)
[D2]	Utility TO informs T-connected gen of outages/derates to transmission facilities.
[E]	Utility TO provides Utility DO: instructions during emergency load curtailment, coordination/approval on certain distribution outages that impact transmission or have other restrictions (e.g., fire management issues).
	Utility DO provides to the Utility TO: certain distribution outages, particularly where TO approval is needed.
[F]	[SDG&E only] Utility DR informs the Utility DO of non-market DR resource (same info as line [G]).
[G]	One-way to ISO only: For non-market utility DR, Utility DR provides the ISO DA and day-of forecast of scheduled and remaining available DR (before 0800 daily from May 1 through October 31 and monthly or when there is a utility-dispatched DR even from November 1 through April 30).
[H]	For market non-utility PDR, the DRP provides to SC the resource characteristics, bids, outage/derate information.
	SC provides to DRP for market PDR: notice of ISO market dispatches (SDG&E currently has no non-IOU DRP resources on its system).
[I]	DRP coordinates dispatch of individual sub-resources comprising a PDR.

Notes for “As-Is” diagram (continued)

Line	Description of Information Exchange
[J]	WDAT DER provides to SC: unit characteristics, bids, and outage information/derates.
	SC provides to the WDAT DER: market awards, settlements, ISO dispatch instructions, ISO exceptional dispatch/OOM instructions.
[K]	LSE (all types) provides to SC DA demand bids.
	SC provides to LSE DA market schedules.
[K2]	LSE (all types) may have retail customers with behind-the-meter DER that should be taken into account when the LSE forecasts its load and formulates its demand bids to the wholesale market.
[L]	ISO provides to WDAT DER: RT emergency instructions.
	WDAT DER executes PGA with ISO.
[M]	Utility DR informs the Utility TO of non-market DR resource (same info it provides to ISO on line [G]).
	Utility TO conveys the ISO dispatch instruction to the non-market utility DR resource.
[N]	For market utility DR such as PDR, Utility DR uses a SC, comparable to non-utility DRP [H] and other participating resource types.
[O]	Utility DO provides information on planned and unplanned outages to the Utility DR and DRP. WDAT DER executes interconnection agreement with Utility DO.
	[SCE only] SCE uses line [O] to provide system condition information on an exception basis to WDAT DER. Utility DO provides to WDAT DER day-ahead operating restrictions due to D/T issues; RT instructions (e.g., reduce output) if needed for distribution reliability.
[Not Shown]	For SCE’s A/C cycling programs under RDRR, the Utility TO sends instructions/signals directly to end-use participants. For PG&E’s LMRDR programs, the Utility DR sends instructions to the end-use participants.

No entity directly involved in DER wholesale market participation has sufficient info to assess feasibility of DER response to ISO dispatch.

- Four entities are directly involved in operational aspects of DER wholesale market participation:
  - ISO
  - Utility transmission operator (Utility TO)
  - Utility distribution operator (Utility DO)
  - DER operator or aggregator (DERP)
- Today, none of these entities possess complete info on the ISO dispatch "life cycle":

  DER bid ➡ ISO dispatch ➡ DER response
- Absent new info exchanges, each entity may be without sufficient info to meet their respective responsibilities or objectives.

Who knows what today

Information Type	ISO ("TSO")	Utility TO	Utility DO (UDC)	DERP
Bids from DER/DERP	X			X
DER Installed Capacity	X		X	X
"T" topology and conditions	X	X		
"D" topology and conditions			X	
"T" feasibility of schedules	X			
"D" feasibility of schedules				
DA schedules	X			X
RT schedules	X			X
Revenue meter data	X			X
Generation Telemetry	X (10 MW)		X (1 MW)	
System Telemetry		T system (highly consistent across the system)	D system (not so highly consistent)	

Notes:

- A blank cell does not necessarily need to be filled.
- Which information gaps need to be filled depends on what info is needed for each entity to achieve its **responsibilities or objectives** (see next slide).

The responsibilities or objectives of each entity determine which information gaps must be filled.

- ISO needs
  - Predictability or confidence regarding DER responses to dispatch instructions at the T-D interface or pnode.
- UDC needs
  - Visibility to the current behavior and predictability of the upcoming behavior of DERs on its distribution system.
  - Ability to modify the behavior of DERs via instructions or controls as needed to maintain reliable operation.
- DERP needs
  - Ability to participate, in a non-discriminatory manner, in all markets for which it has the required performance capabilities.
  - Ability to optimize its choice of market opportunities and manage its risks of being curtailed for reasons beyond its control.

What coordination activities & information exchanges are needed for the high-DER future grid?

- Take As-Is diagram as a starting point and enhance as needed
- Focus on ISO – DO – DER operator/provider
- Use each entity's responsibilities or objectives as guide to define needed enhancements
- Consider three main DER scenarios:

  A. [1st and most basic] DER and DER aggregations only participate as resources in ISO market

  B. [2nd] DER serve needs of end-use customers and/or DO and do not participate in ISO market, but their behavior has effects at the T-D interfaces

  => Short-term forecasting becomes crucial

  C. [3rd] DER and DER aggregations provide services to DO and participate in ISO market

How does the design of the high-DER future DO affect the coordination activities we would specify?

Model 1: Suppose the future DO maintains its current role, only to ensure reliable operation of the distribution system

- How to specify the needed coordination for the three scenarios?

Model 2: Suppose the future DO has a greatly expanded role, e.g., to operate distribution-level local markets, to balance supply-demand in the local area, to maximize DER responses to ISO dispatches and minimize potential impacts to the transmission grid

- How to specify the needed coordination for the three scenarios?

Question: If it's premature to know which future DO model to aim for, what "least regrets" near-term enhancements should we make to the As-Is coordination framework?

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