T-D Interface Working Group Use Cases

Including Application of Use Cases to 2017 Work Plan Action Items 3, 4 and 5

Background:

The T-D Interface Working Group is focusing on real-time system operation, to develop a coordination framework between the ISO, the distribution operator (DO) and DER providers to provide for reliable and efficient integration of high volumes and diversity of DERs and DER aggregations (DERAs) into California's electricity system.

In support of this purpose, the Working Group is pursuing three action items:

> *3. Develop example use-cases reflecting likely DER integration scenarios to ground discussion in practical implications. Consider how future pilot proposals may stem from identified use cases.*
>
> *4. Specify potential real-time coordination procedures to manage potential conflicts between DO needs and ISO dispatches. Begin with scenario approach and then broaden as needed.*
>
> *5. Identify principles for a DO approach to DER curtailment resulting from distribution level constraints.*

What follows represents the Working Group's *DRAFT* approaches on these three action items.

Use-Cases (Action Item 3) and Real-Time Coordination Procedures (Action Item 4)

To begin, the group set the goals of developing uses cases that are a) as simple as possible while b) helping to identify specific coordination activities to support reliable T-D operation. The Working Group agreed complexity should be layered in from the simplest use-cases, to the more sophisticated. The following six use-cases were identified.

Use Case	Configuration	Grid Services Provided
A	Single Resource	Wholesale (only)
B	Aggregated Resource – consider single-feeder and multi-feeder sub-cases	Wholesale (only)
C-1	Single Resource	Wholesale + Distribution using separate portions of capacity for each (Multiple Use Application)
C-2	Single Resource	Wholesale + Distribution using the same capacity
D-1	Aggregated Resource – consider single-feeder and	Wholesale + Distribution using separate portions of capacity for each (Multiple Use Application)

Use Case	Configuration	Grid Services Provided
	multi-feeder sub-cases	
D-2	Aggregated Resource	Wholesale + Distribution using the same capacity
E	Single Resource	Wholesale + Distribution: enhanced DO/DSO functionality
F	Aggregated Resource	Wholesale + Distribution: enhanced DO/DSO functionality

Characteristics common to all use cases:

- DERs are located below a single T-D interface substation, either on the end-use customer side of the meter or on the utility side of the meter.[1]
- DERs can inject power into the grid (i.e., not pure demand response (DR) resources). This means that the DER or DERA participates in the ISO market using the non-generator resource (NGR) participation model. Under the NGR model a DER or DERA is a 24x7 wholesale market resource, and therefore its withdrawal of energy from the grid or injection of energy into the grid in each settlement interval is metered and settled through the ISO settlement process irrespective of whether the resource was following an ISO schedule or dispatch instruction. It also means that if a DER participating as NGR is physically located behind an end-use customer meter, the DER must have a separate revenue quality meter so that it appears, in effect, as if it were interconnected on the utility side of the meter, and its metered consumption or output can be logically removed from the end-use customer meter data in order to measure the true load at the customer site.
- These use cases do not consider DERs or DERAs operating as demand response (DR) resources because the coordination issues of interest to this working group do not arise absent injection of energy into the grid by the resources. The DR construct (i.e., PDR) requires that there be no injection of energy onto the distribution system. Even if DER such as solar generation or storage is installed behind the end-use customer meter and participates in the wholesale market as DR, its energy output must be less than the end use load at the site. This simplifies the coordination issues substantially and therefore DR need not be addressed as a separate use case.
- For use cases A-D the objectives of ISO, DO, and DER Provider are:
    - ISO needs predictability of DER responses to dispatch instructions
    - A DO must understand the current and predicted behavior of the DERs on its system, and be able to send curtailment or control instructions to the DER if needed to maintain reliability and safety.
    - A DER can participate in all markets for which it has the required performance and measurement capabilities, and can reasonably manage curtailment risk. In

[1] While use cases B and D could include multi-pnode aggregations, such scenarios add an additional level of complexity and will be considered later.

addition, behind the meter DER providers can provide customer service (e.g., demand charge reduction).

- Use-cases are agnostic to the DER technology and size, except for the 0.5 MW minimum total capacity of a DER aggregation for ISO market participation.

Defining Grid Services

Wholesale Grid Services may include: energy, regulation up, regulation down, spinning reserve, and non-spinning reserve. Detailed service definitions at http://www.caiso.com/participate/Pages/MarketProducts/Default.aspx.

In addition DER/DERA may be eligible to provide system, local or flexible resource adequacy capacity (RA). Designation of a DER/DERA for RA entails must-offer obligations (MOO) under the ISO tariff to participate in the markets for these wholesale grid services.

Distribution Grid Services may include: energy (up/down), capacity (up/down), and voltage/volt ampere reactive (VAR, up/down). Detailed service definitions in CPUC Decision 16-12-036.

Local Balancing grid services are introduced in use cases C-3 and D-3.

Use Case A (Focus of Working Group in 2016)

This use case anticipates a single DER providing wholesale grid services (only). For example, this DER could be a 2 MW solar PV plus storage facility connected directly to the DO's distribution system, or it could be a commercial "smart building" that looks like a single resource/customer at a single point of interconnection, but has rooftop PV, workplace charging for employee vehicles, internal thermal storage for cooling, and an electronic control system for maintaining building services and responding to ISO dispatch signals.

Currently, the ISO's systems see a participating DER as if it is electrically connected at the T-D substation, not at its actual location on the distribution system. The DO knows the installed capacity and other characteristics of each DER from its interconnection process. However, existing processes and procedures do not inform the DO of a DER's bids or ISO dispatches, nor are there procedures to inform the ISO or the DER of current distribution system conditions that could inhibit the DER from fully responding to an ISO dispatch instruction. Thus none of the key parties – the ISO, the DO or the DER operator or its scheduling coordinator – has sufficient information to assess potential impacts DER bids and dispatches have on the distribution system, or how current conditions on the distribution system may render an ISO dispatch infeasible. This information and coordination gap, if not addressed, could create operational challenges that affect the reliability of the distribution and transmission systems.

For the near-term, the following recommended real-time coordination procedures have been identified to close the information and coordination gaps:

1. DOs should pilot processes that communicate advisory information on current system conditions to DER providers, so that the providers can modify their ISO market bids accordingly and if necessary submit outage or derate notifications to the ISO;
2. The ISO should initiate processes that provide day-ahead DER schedules to the DO, for the DO to perform a feasibility assessment to identify schedules that may not be feasible based on current distribution conditions. In the longer term, if this procedure seems viable and useful, the ISO could also make available real-time dispatch instructions to the DO for feasibility assessment in conjunction with new DO technical capabilities including but not limited to DER Management Systems;
3. The distributed energy resource provider should communicate constraints on its resources' performance to the ISO. This could be in the form of updated market bids for market intervals where bid submission is still open, or outage notifications for intervals where dispatch instructions have already been issued and there is no subsequent bidding opportunity.

In the near term, with small numbers of DER participating in the wholesale market, the parties will likely implement these procedures on a manual and/or pilot basis and only for locations where participating DER are connected, rather than more permanent implementations for each DO's entire system. In the longer-term, learning from the near-term experiences will likely lead to improvements in the design of coordination procedures, and higher levels of DER penetration may warrant automation of the most effective coordination procedures.

Use Case B

Like use case A in all respects, except this use case anticipates an aggregation of DER providing wholesale service (only). The DO will typically have an interconnection agreement with an individual DER on its system, which is generally comes at the end of an interconnection process through which the DO performs studies to assess the impacts of the DER on its system. But when a DER provider aggregates multiple DERs into a DERA or virtual resource for ISO market participation, today there is no comparable interconnection study process or agreement between the DO and the DER provider.

The ISO's process for integrating a new DER/DERA into its market systems requires that the DER provider coordinate with the DO and obtain the DO's clearance for the DER/DERA to operate on the DO's system. To reflect this aspect of needed coordination this additional coordination procedure has been identified:

4. The DOs should pursue a pro forma "aggregation agreement" with the DER provider with regard to DER aggregations. The agreement could specify, for example, responsibilities of the parties to support reliability of the system and enable the DER provider to realize the full value of the DER aggregation through provision of the various services its performance characteristics allow.

Use Case B involves one further task, which is to examine how the introduction of aggregation over multiple DER at different points of interconnection on the distribution system (though still at a single T-D interface) may require enhancements to the coordination procedures identified thus far, or even require additional procedures. For this purpose we will consider two sub-cases: (1) all DER in the DERA are on the same distribution circuit, and (2) the DER within the DERA are located on multiple circuits.

Use Case C

Use case C is comprised of three sub-cases, all of which involve a DER asset installed at a single location, either behind or in front of the end-use customer meter, providing both wholesale services to the ISO and distribution grid services to the DO.

This DER asset at a single location may be a combination of devices such as solar generation + storage + energy efficiency, but the simplification of this use case is the limitation to a single point of interconnection on the distribution system. The DER asset may provide services to the DO to: 1) support reliable real-time operation of the grid; 2) lower and flatten local 24-hour load shapes by shifting load from periods of peak load to periods of low load; or 3) defer a distribution infrastructure upgrade.

As diagramed below in Figure 1, **Use Case C-1** is characterized by two essential features: the ISO and the DO both communicate directly with the DER asset, and the DER asset has bifurcated its capacity into separate shares to provide services to the DO and ISO respectively. The hypothesis, to be explored in this use case, is that limiting bifurcation of the capacity can avoid conflicts between DO and ISO instructions to the DER asset.

- The DER asset communicates directly with and receives instructions from the DO and ISO to provide separate services to each.
- The DO provides dispatch signals to DER asset to flatten and lower the load shape on the distribution circuit where the DER is located, thus reducing both peaks and the total energy imported within the substation area.
- The DO provides all voltage regulation signals to the DER asset. The DO is provided an allocation of the asset (kW/kWh) and may make best determined use of the asset (as determeind by DO). This includes adjusting load-leveling goals to address voltage issues.
- The ISO provides all frequency regulation or dispatch signals to the DER asset, via the usual ISO mechanisms (automatic generation control (AGC) or ADS system).

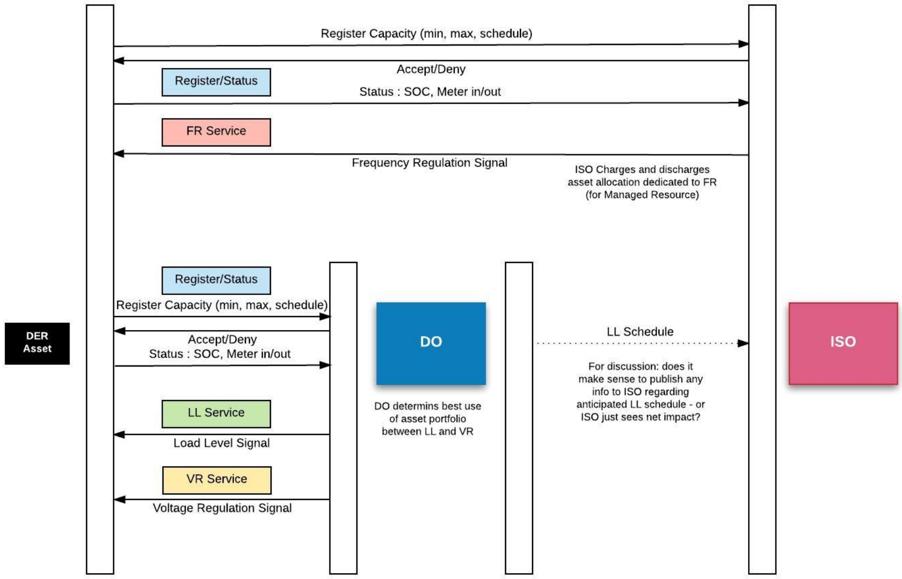

Figure 1: Scenario C-1

As diagrammed below in Figure 2, **Use Case C-2** builds on C-1 by removing the bifurcation of capacity and viewing the entire resource as offering services to both DO and ISO. This will increase the potential for conflicts between ISO and DO instructions to the DER asset and require ways to resolve the conflicts through coordination procedures, established priorities, or other means. It may also demonstrate that certain DO and ISO services cannot be provided by the same capacity.

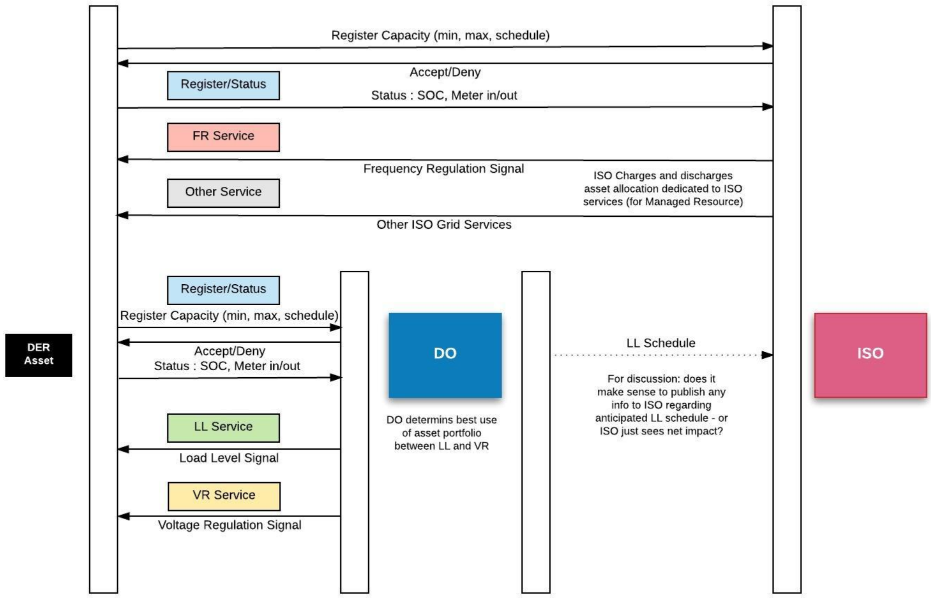

Figure 2: Scenario C-2

Use Case D

Use Case D replicates Use Cases C-1 and C-2 in all respects, except this use case aggregates multiple DER assets across multiple locations into a DERA or virtual resource providing both wholesale and distribution grid services.

Use Case E

Use **Case E** is characterized by one essential difference to C-2: the ISO communicates directly only with the DO, not the DER asset. This introduces new functions for the DO, and allows us to begin exploring what would be required for the DO to perform those functions. Thus C-3 begins to explore how T-D interface coordination needs and solutions will vary with different DO/DSO models.

- The DER asset communicates directly with and receives instructions from only the DO to provide services. Thus, the DO provides all capacity/energy, frequency regulation, and voltage regulation signals to the DER asset.
    - Scenario A. Initial solution may be implemented as the ISO dispatching FR signals (and other ISO grid service) through the DO broker– where the DO maintains control of asset and prioritizes signals over the DO's portfolio of assets. **DO Broker Scenario**
    - Scenario B. A second solution path would be for the DO to actively manage FR - where the ISO was then only responsible for dispatching 'gap' FR signals. That is,

only a much smaller set of grid service signals are required from the broader ISO system perspective - signals that address issues that have not already been addressed by the DO. **DO Balancing Scenario**

- The ISO communicates directly with the DO to implement all ISO service needs at the relevant T-D interface. The ISO communication thus stops at the T-D Interface. The DO communicates with the ISO to acknowledge the ISO's instruction and provide the ISO with needed response.
- In Use Case C-3 the DO will have to resolve any conflicts between its own needs and the instructions of the ISO. This case thus offers a vehicle to develop principles that should guide the DO's performance of this function. the DO will become more proactive in balancing the local system needs which will reduce signaling traffic between the DO and ISO.

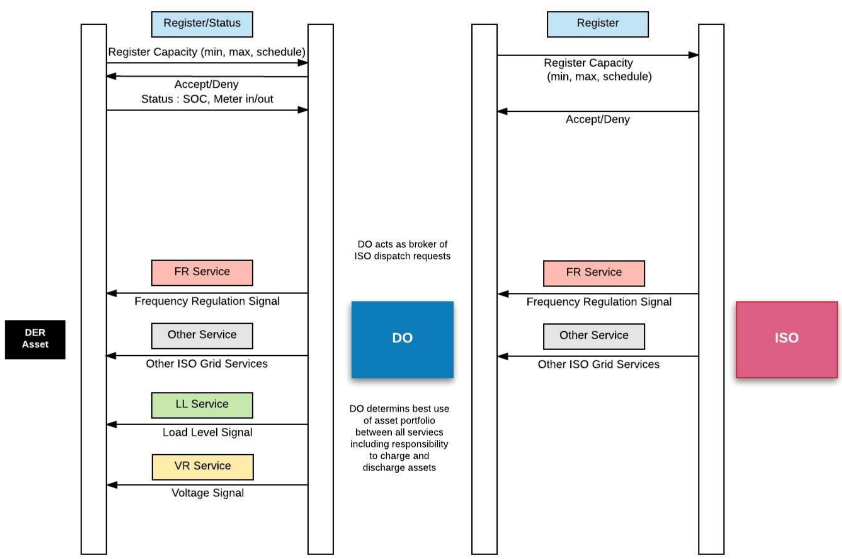

Figure 3: Scenario E

Use Case F

Use Case F replicates Use Cases E in all respects, except this use case aggregates multiple DER assets across multiple locations into a DERA or virtual resource providing both wholesale and distribution grid services.

Use Cases E and F are intended to begin consideration of an additional goal of the Working Group, to investigate how coordination needs and methods could change with alternative future Distributio System Operator models. These cases do not represent actual models being considered or proposed by the IOUs at this time.

Potential Pilots:

The following pilots have been proposed. If approved, each may provide an opportunity to test identified T-D Coordination steps.

- PG&E's DERMS project will be integrating resources at the ISO while providing distribution services
- CEC Solar+ Grant: the "Valencia Gardens Energy Storage" project. This project provides a state-sponsored deployment pilot that directly supports Use Cases C-1 and C-2, with an investigation into C-3 as well. This also has the potential to support Use Case D.
- Others?

Action Item 5: Identify principles for a DO approach to DER curtailment resulting from distribution level constraints.

The Working Group anticipates that changing conditions and configurations on the distribution system can lead to distribution level constraints impacting the ability of a particular DER or DERA to provide wholesale and distribution grid services, for example, to comply with a previously issued ISO schedule or dispatch instruction. With higher levels of DER on the system it is likely that in some instances the same distribution constraint may affect the DERs operated by different entities, in which case the DO will need to allocate the reduced capacity among the different DERs. This action item is intended to begin to develop approaches for managing such situations in a manner that is fair and transparent to all affected DERs.

The following scenarios constitute the most likely situations in which such a constraint exists, including the cause of the constraint and the potential effect on one or more DER.

Define Scenarios X, Y, and Z

Matthew Tisdale 4/28/2017 10:24 AM
Comment [1]: Requesting IOUs and POUs provide input during discussion on May 17.

From these scenarios, the Working Group suggests the following principles as a starting point for discussion:

A. Safe and reliable electric service is paramount
B. Distribution systems access should be analog to FERC's "Open Access" policy[2]

Matthew Tisdale 5/9/2017 11:13 PM
Comment [2]: Do responsibilities for safety and reliability evolve with DER grid integration or remain the same? If so, how?

[2] FERC's Open Access Policy requires all public utilities that own, control or operate facilities used for transmitting electric energy in interstate commerce: To have on file open access non-discriminatory transmission tariffs that contain minimum terms and conditions of non-discriminatory service, and permits public utilities and transmitting utilities to seek recovery of legitimate, prudent and verifiable stranded costs associated with providing open access and Federal Power Act section 211 transmission services. The Commission's goal is to remove impediments to competition in the wholesale bulk power marketplace and to bring more efficient, lower cost power to the Nation's electricity consumers. (https://www.ferc.gov/legal/maj-ord-reg/land-docs/order888.asp)

C. Distribution Operators need flexibility to adapt to innumerable variations in system conditions
D. DER providers should be provided economic signals and allowed to respond
E. Triggers for curtailment should be known up front and determined transparently
F. Stacking of services DERs can provide should not be unnecessarily inhibited

Matthew Tisdale 4/28/2017 10:41 AM
Comment [3]: How can we consider these variations?

Matthew Tisdale 4/28/2017 10:42 AM
Comment [4]: What are the alternatives to this principle? What advantages do price signals have relative to alternatives?

Esguerra, P Mark 5/9/2017 11:13 PM
Comment [5]: Could there be situations where triggers for curtailment are market related?....Would we not want that information kept confidential and not transparently shared.

Matthew Tisdale 4/28/2017 10:43 AM
Comment [6]: Is there tension between D and others? If so, how to address tension?