Distribution Services, Attributes and Performance Requirements
Draft July 6, 2016

DISTRIBUTION GRID NEEDS

The electric utilities' distribution planning process ~~considers~~ evaluates and specifies project to ensure the availability of sufficient capacity and operating flexibility for the distribution grid to maintain a reliable and safe electric system. Electric utility distribution planning engineers ~~consider~~utilize: (1) ~~forecasting~~ forecasts of load and peak demand; (2) ~~using~~ power-flow modeling tools to simulate electric grid performance under projected conditions to forecast distribution capacity requirements; and (3) engineering expertise to identify~~ing~~ and develop~~ing~~ distribution capacity additions that meet forecasted conditions that address identified distribution capacity requirements, including safety and reliability deficiencies.

The electric distribution system must be planned for transmission, substation and circuit capability that ensures:

A. Substation and distribution facilities are not loaded beyond safe operating limits;
B. Voltage supplied to the customer is within limits as required by CPUC Rule 2 and industry electric system reliability standards;
~~B.~~C. Frequency is maintained within appropriate limits; and
~~C.~~D. Customer r~~The r~~eliability is ~~of continuous customer service is maintained~~ improved over time.

As a result of this planning process, electric utilities identify and implement "least cost-best fit" solutions for the distribution system to provide safe and reliable electric service for all the end-users. These distribution solutions may take the form of implementing a traditional utility "wires" or a "non-wires" solution, such as a DER portfolio that can defer a traditional utility "wires" solution for a number of years.

For DERs to successfully provide distribution services, they must meet the same technical and operating standards as the rest of the distribution system such that when DERs are interconnected, they do not impact the safety and reliability of the distribution grid. In addition, DERs providing distribution services must also operate in a manner that aligns with

Comment [DSG1]: SCE: This isn't done for the 10-year plan. Is done for short term upgrades where granular impact is needed. May be best to characterize as peak analysis modeling tools.

the local distribution area's electrical loading attributes to ensure safe and reliable distribution service.

PRINCIPLES FOR DEFINING DISTRIBUTION SERVICES AND ASSOCIATED ATTRIBUTES

In developing the definition for distribution services and the associated attributes describing the characteristics of those services, a common set of principles was developed and agreed upon by the CSFWG. Specifically, the following 3 principles w~~h~~ere shared with the CSFWG that formed the foundation and importance of defining the details around distribution services. These 3 principles were:

1. Location of where distribution service is provided by DERs
2. Timing of when distribution service is provided
3. ~~Amount of~~ DER Performance Guarantee~~response~~

Comment [DSG2]: SCE Comment: We've been thinking about these in terms of availability – the DERs need to be there when needed, reliability – that the DERs reliably perform, and durability – that they are sustained over time.

Location of Where Distribution Service

The distribution system may require very locational specific distribution services to address a constraint on its system. For example, a distribution capacity deficiency on a substation transformer may be met with DERs interconnected off that particular substation transformer's low side connection or off one or multiple distribution feeders interconnected onto that substation transformer. However, a deficiency on a certain section of a distribution feeder ~~may~~ will require that particular DER portfolio to be interconnected only on the overloaded section to ensure that overload issue is ~~to be~~ addressed.

Comment [DSG3]: SCE Comment: We also need to describe that the DERs, or consideration of how grid mod would work, to enable the system to preserve flexibility, i.e., reconfiguration.

Timing of When Distribution Service

The distribution system has varying needs that can occur at various times within a day, month, or season. For example the electric demand loading profile of a distribution feeder may reveal that high loading~~s~~ may occur for a few hours in the evening during the summer months, while another distribution feeder may exhibit high loading~~s~~ for a few hours in~~during~~ the early afternoon during~~hours of~~ the summer months.

DER Performance Guarantee~~*Amount of DER Response*~~

The amount of DER response matters when ensuring the distribution system can continue to operate safely and reliably to serve end-users. Not achieving the full response required from DERs providing distribution capacity services can result in a short fall of capacity on the distribution system. This shortfall can result in equipment overloads and/or inadequate voltage levels that affects electric service for end users and their devices. Conversely, DER responses that result in higher than required DER output can lead to thermal overloads and/or voltage levels above acceptable service levels which can lead to equipment damage on the customer side of the meter.

DISTRIBUTION SERVICES DEFINITIONS

Considering these principles, the CSFWG was able to reach consensus on three key distribution services that DERs can provide, which may result in deferral of distribution capital costs. Specifically, these three distribution services are: 1) Distribution Capacity, 2) Voltage Support and 3) Reliability and Resiliency.

Distribution Capacity

Distribution Capacity services are defined as a load modifying or supply service that DERs provide via the dispatch of power output (MW) for generators and reduction in load for flexible loads that is capable of reliably and consistently reducing net loading on desired distribution infrastructure. These Distribution Capacity services can be provided by a single DER resource and/or an aggregated set of DER resources that ~~are able to demonstratively~~ reduce the net loading on a specific distribution infrastructure location coincident with the identified operational need in response to a control signal from the utility.

Comment [DSG4]: SCE Comment: Where needed.

Examples of traditional "Wires" equipment that currently support providing this type of service include, but are not limited to, transformers, overhead and underground line conductors, circuit breakers, and line and substation switches.

Voltage Support

Voltage support services are defined as a substation and/or feeder level dynamic voltage management services provided by an individual resource and/or aggregated resources capable of dynamically and demonstrably ~~responding to~~ correcting excursions outside voltage limits as ~~requested by utility~~ as well as supporting conservation voltage strategies in coordination with utility voltage/reactive power control systems. DERs providing these services will be delivering or absorbing real or reactive power (MVAr) or a combination thereof to ensure the voltage is within Rule 2 limits. ~~requested by the utility are met.~~

Examples of traditional "Wires" equipment that currently support providing this type of service include, but not limited to, fixed or switchable capacitors, fixed or switchable variable voltage regulators, overhead and underground line conductors, substation load tap changers, and reactors.

Reliability/Resiliency

Reliability/Resiliency services are defined as load modifying or supply service capable of improving local distribution reliability and/or resiliency. Specifically, this service provides a fast reconnection and availability of excess reserves to reduce demand when restoring customers during abnormal configurations. In addition, this service will also provide power to islanded end use customers when central power is not supplied~~,~~ and reduce~~d~~ duration of outages ~~and ability to withstand and recover from external threats~~. These Reliability/Resiliency services can be provided by a single DER resource and/or an aggregated set of DER resources that are able to demonstratively reduce the net loading on specific distribution infrastructure coincident with the identified operational need in response to a control signal from the utility. In a microgrid application it is necessary for a system to match generation to load while maintaining voltage, frequency, power factor and power quality within appropriate limits. This requires an isosynchronous generation resource.

DISTRIBUTION SERVICE ATTRIBUTES

Attributes of the needed distribution services further describes the specificity of the required response from a DER. These distribution service attributes include: 1) locational specificity as to where on the distribution system that the desired DER response is needed, 2) amount of the

Comment [DSG5]: SCE Comment: Not sure I understand this. Anti-islanding would prevent this.

Comment [DSG6]: SCE Comment: I don't agree with this as outage durations are dependent upon restoring the circuit. Maybe we can say – in concert with self-healing distribution circuits supported by advanced automation. The only other way I can think of this is via microgrids.

DER response that is required, 3) timing and duration of when the DER response is desired. For ease of discussion, the ~~following~~ distribution services and associated attributes are illustrated in the following example.

Comment [DSG7]: SCE Comment: I would refine this as well to include availability, reliability, and durability.

Example A: Distribution Capacity Services & Associated Attributes

Background:

Electric Distribution Planning analysis has identified that a distribution substation transformer is projected to overload in~~under projected~~ year 2019 during summer peak demand conditions. Specifically, this distribution substation transformer is projected to serve a peak demand of 13.2 MW, which exceeds this transformer's thermal capacity rating of 11.88 MW by 11%. Hence, this transformer is projected to overload by 11% under these peak demand conditions. Furthermore, additional Distribution Planning analysis has projected that this overload may reach up to 22% by year 2020 for summer peak demand conditions. The following schematic illustrates this example.

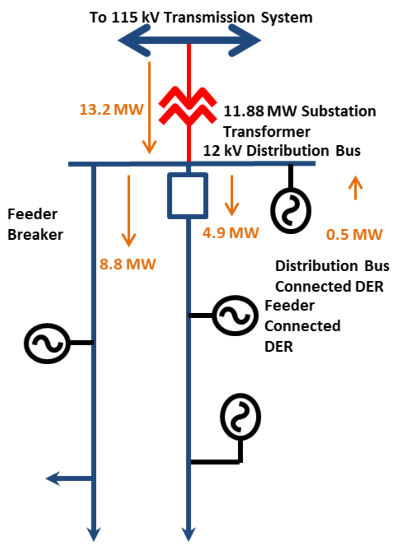

Figure 1: Example of Projected Substation Transformer Overload

Distribution Capacity Service Requirements and Associated Attributes

To ensure safe and reliable electric service, additional distribution capacity is required for this transformer. This additional capacity can be achieved through a traditional "wires" alternative~~.~~, which in this case would be the addition of a new substation transformer, or via a DER alternative that effectively reduces this transformer's net demand loading to be within its thermal rating. The associated attributes for DERs to provide distribution capacity services for this location can be described using the three Distribution Services principles described earlier, which were

1. Location of where distribution service is provided by DERs
2. Timing of when distribution service is provided
3. DER Performance GuaranteeAmount of DER response

Location of Where Distribution Service is Provided by DERs

For this example, to address the projected overload of this transformer, DERs would need to be located and interconnected off the electrical system "downstream" of the overloaded transformer. This is depicted as the area in the blue shade in Figure 2. Essentially, for a DER portfolio to be effective in reducing loading on this transformer, they would have to be interconnected within this location.

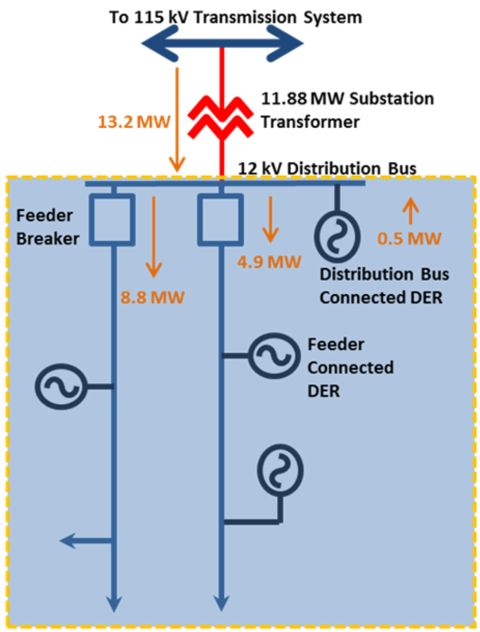

Figure 2: Example A - Location Shaded in Blue Depicts where DERs are to be located

Timing of when Distribution Service is Provided

Through additional Distribution Planning analysis, the projected overload condition in 2019 is forecast to occur during the summer months of August through September. Furthermore, additional analysis around the timing of this overload reveals that it is projected during the hours of 15:00 to 20:00 for weekdays and weekends during those months.

The following chart illustrates the projected demand loading of this transformer for the summer months of August to September.

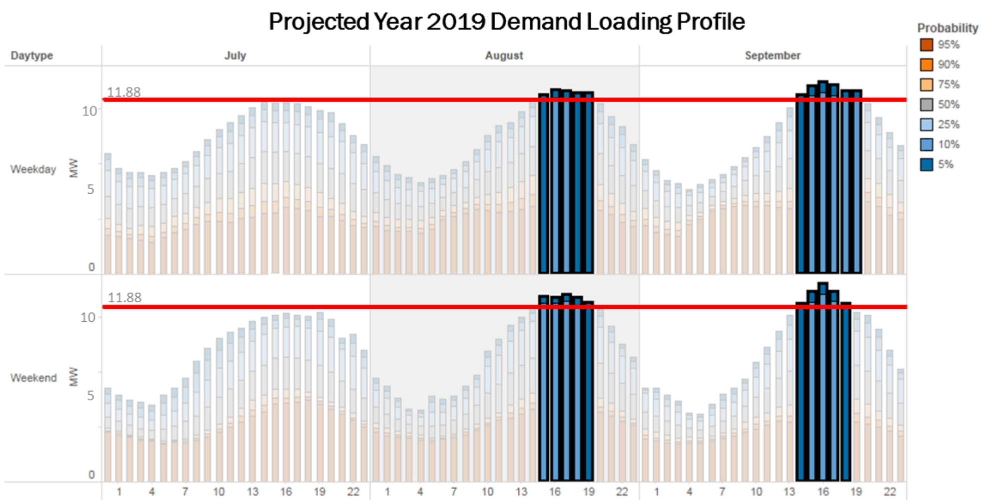

Figure 3: Example A: Projected Substation Transformer Loading during Summer Months of July - September

DER Performance Guarantee ~~*Amount of DER Response*~~

As discussed previously, the amount of DER response matters when ensuring the distribution system can continue to operate safely and reliably to serve end-users. Not achieving the full response required from DERs providing distribution capacity services can result in a short fall of capacity on the distribution system. This shortfall can result in equipment overloads and/or inadequate voltage levels that affect electric service for end users and their devices. For this example the amount of DER response that is required is 1.4 MW during the time frame specified. The following table summarizes the attributes sought from a DER portfolio to successfully provide distribution capacity services for this transformer. Specifically, this table includes the required amount of DER response (MW and MVArs) and associated timing and frequency.

Table 1: Distribution Capacity Service Attributes

DER Attributes to Procure	YEAR				
	2017	2018	2019	2020	2021
Distribution Capacity Need (MW)	-	-	1.4	2.6	3.6
Distribution Capacity Need (MVAR)	-	-	-	-	-
Months when needed	-	-	Aug-Sept	Aug-Sept	July-Sept
Days when needed	-	-	All	All	All
Time when needed	-	-	15:00-20:00	14:00-20:00	14:00-20:30
Duration (hours/day)	-	-	5	6	6.5
Frequency of Need (days/month)			1	3	5

For this example, the amount of DER response increases from 1.4 MW to 2.6 MW by year 2020. Furthermore, as demand continues to grow, by year 2021 the amount of DER response increases to 3.6 MW with the time frame and duration of DER response also expanding.

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Example B: Voltage Support Service and Associated Attributes

Background

Electric Distribution Planning utilizes modeling tools to perform power-flow studies of the distribution system simulating electric grid performance. The loading values inputted for each distribution circuit are based off of forecasted values. The 2016 results from the power flow identified a circuit with steady-state voltage below the CPUC Rule 2 limit at specific sections on a highly residential circuit and based on real-time data the circuit reported a power factor below industry electric system reliability standards. The area in question is also forecasted to incur future residential development in the next several years increasing the demand and reducing the voltage further. The following schematic identifies the distribution circuit forecasted to have voltage violations during peak conditions.

Figure 4: Example of a Distribution Circuit with Voltage limit Violations

Voltage Support Service and Associate Attributes

To ensure safe and reliable electric service as well as maintaining compliance with the mandated CPUC Rule 2 limits, additional reactive resources are required. A traditional “wires” solution to provide additional reactive resources is installing a switch capacitor on the circuit or installing a voltage regulator. Another alternative is interconnecting DERs to provide reactive resources effectively acting as a capacitor either when requested by the utility or provided with a required operating profile. The DER reactive resource could be from an individual resource and/or aggregated resources capable of dynamically and demonstrably providing the reactive resource amount. The associated attributes for DERs to provide reactive resources for the feeder can be described using the three Distribution Services principles described earlier, which were

1. Location of where distribution service is provided by DERs
2. Timing of when distribution service is provided
3. DER Performance Guarantee

Location of Where Distribution Service is Provided by DERs

For this example and similar to the Example A, to address the voltage violation DERs would be required to locate and interconnect to the electric system upstream of the voltage violation occurrence identified by the utility. The location for the voltage violation is depicted as the area in blue within Figure 5. For a DER portfolio to be effective in providing additional reactive resources, interconnection in the area in blue is required.

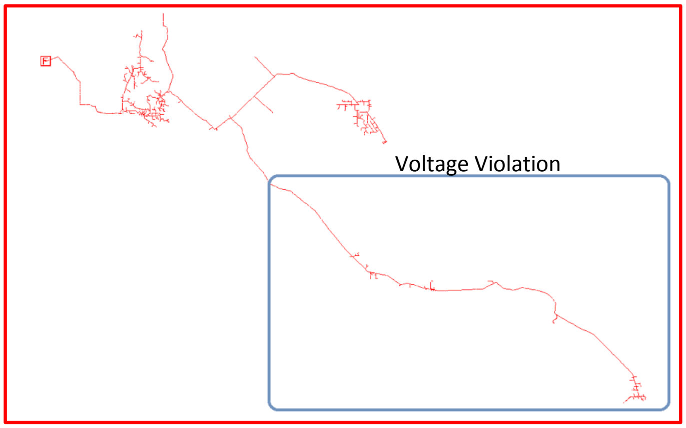

Figure 5: Example B - Location within Blue square Depicts where DERs are to be located

Timing of when Distribution Service is Provided

During the Distribution Planning analysis, results from the power-flow model inputting adverse forecast values projected a reactive resource deficiency during peak conditions. The peak conditions are expected to occur during the summer months of August through September. Additional analysis reveals an operation of DERs providing additional reactive resources are required to occur during the hours of 13:00 to 20:00 for weekdays and weekends during those months.

DER Performance Guarantee

Similar to Example A, the amount of DER response plays a significant role when ensuring the distribution system can continue to operate safely and reliably to serve end-users. Not achieving the desired reactive output required from the DER portfolio can result in violating voltage limits and reduce the power quality of the distribution system. The absence can lead to damaging end users equipment and affecting their usage of the electric system. For this example, the amount of DER response required during the specific time frame is 0.6 MVARs. The following table summarizes the attributes from a DER portfolio to successfully provide an additional reactive resource. Specifically this table includes the required amount of DER response and associated timing as well as frequency.

Table 2 Distribution Voltage Support Attributes

DER Attributes to Procure	YEAR			
	2017	2018	2019	2020
Distribution Capacity Need (MW)	-	-	-	-
Distribution Capacity Need (MVAR)	0.6	0.65	0.7	0.7
Months when needed	Aug - Sept	Aug - Sept	Aug - Sept	Aug - Sept
Days when needed	All	All	All	All
Time when needed	13:00-20:00	12:30-20:00	12:00-20:30	12:00-20:00
Duration (hour/day)	7	7.5	8	8
Frequency of Need (days/month)	2	4	6	6

As stated previously, the feeder is expecting to see growth in the next several years; as a result the MVAR deficiency and associated time are increased in the table from 0.6 MVARs to 0.70 MVARs.

~~**Example B: Voltage Support Service and Associated Attributes**~~

DISTRIBUTION SERVICES PERFORMANCE REQUIREMENTS

To ensure that DERs are able to provide ~~and are providing~~ distribution services in a safe and reliable manner, a DER will be required to meet certain performance standards that can be measured by the utility. Depending on the location and attributes of the local distribution area where DERs are providing these distribution services, these performance requirements may vary. However, these DER performance requirements will include at a minimum the following:

- system availability
- data availability
- response time following a utility command signal
- Quality of Response (e.g. measurement if DER provided required output for specified duration and frequency as defined by agreement)

System Availability

Data Availability

Response Time following a Utility Command Signal

Communication Bandwidth and Latency Requirements

Operational communications requirements are evolving based on a more highly distributed power system. The increasing need is for highly available, low latency[1] fiber networks to link substation and control center operations, as well as robust, secure wireless field area networks to support distribution automation, mobile field force automation, and DER integration leveraging electric utility's existing multi-tier smart metering communication system. The latency between utility command signal to actual operation of DERs will be measured.

Quality of Response

CONCLUSION

(NEED TO ADD CONCLUSION, KEY POINTS TO EMPHASIZE FROM THIS DISCUSSION)

[1] Latency refers to the time from the source sending a voice/video/data packet to the destination receiving it.