How DR Can and Cannot Help Manage the Distribution System

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Overview

- Background
- Intersection of Distribution System Operations and Demand Response Opportunities
- Issues/Concerns at this Intersection

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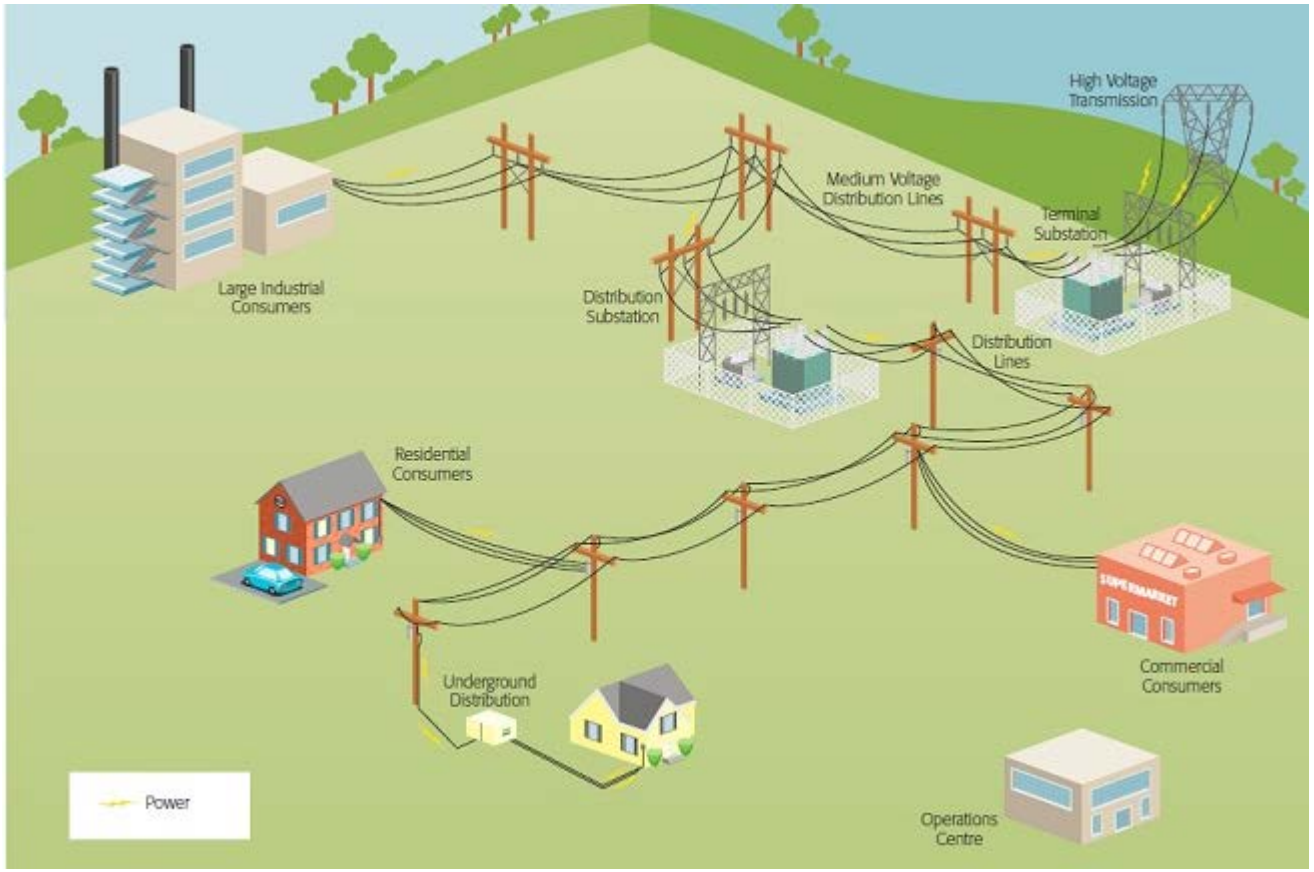
Historical Look at Distribution Systems



- Simple radial “hub-and-spoke” design of the distribution system has worked efficiently and effectively for over 125 years

Major Changes on the Horizon

- Large increases in the penetration of distributed energy resources (DER)
  - National forecasts for next 5 years suggest CAGR of 25% for solar PV and 28% for thermal storage
  - Introduces variable, intermittent and two-way power flows
  - Distribution systems may not be adequately designed to manage DER at high penetration levels
- Substantial investment will be required in an aging grid
  - 35-48% of T&D assets either current need or will soon be replaced
  - Investments should anticipate future operations of the distribution grid

Use DR to Mitigate Investment & DER Impacts

- When properly designed, DR has been identified as a potential resource well suited to help manage distribution system operations
- Simulation studies have shown how DR can support very specific aspects of distribution system operations
- Outside of New York, few if any utilities are using DR in this way; viewed as just a bulk-power system resource
- Broad AMI investment is expanding the potential resource pool

Scoping Study

- Identify the needs of a distribution system with high penetration levels of distributed energy resources;
- Define a suite of services based on those changing operational needs that could be provided by collocated resources;
- Identify existing and future DR opportunities' ability to provide these distribution system services; and
- Provide a qualitative assessment of coordination issues that bulk-power and distribution system providers of DR opportunities will need to address.

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Characteristics of Services to Manage Distribution System

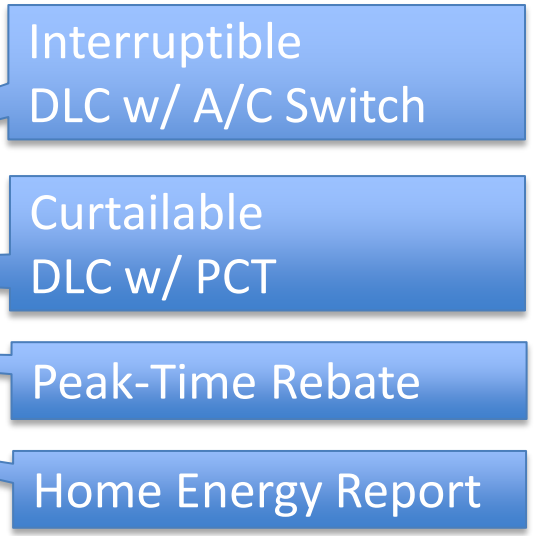
	Procurement or Schedule	Advanced Notice	Response Time	Duration of Response	Frequency	Geographic Specificity
Max. Capacity Relief	Years (planning) or Day-ahead (operation)	Day-ahead	10-30 mins	<4 hrs	Seasonal but potentially multiple times per day	One level below overloaded equipment
Emergency Load Transfer	Years (planning)	<1 min	Secs to mins	<4 hrs	Infrequent	Substation to transformer
Steady State Voltage Mgmnt	Years (planning)	<1 min	Secs to mins	Continuous	Continuous	Close proximity to affected area
Power Quality	Years (planning)	<1 min	<1 sec	Continuous	Continuous	Substation to transformer
Phase Balancing	Years (planning) or Day-ahead (operation)	Day-ahead	Secs to mins	Continuous	Continuous	Substation to secondary feeder
Outage Recovery	Years (planning)	<1 min	Secs to mins	<1 hour	Infrequent	Substation to transformer

Characteristics of DR Opportunities

- ***Signal Variability***: Ability for price/incentive/control signal to change
  - None ➔ Static ➔ Dynamic
- ***Temporal Variability***: Timing of price/incentive/control signal variability
  - None ➔ Pre-set period ➔ Any time
- ***Availability***: Dispatchability of price/incentive/control signal change
  - Limited ➔ Unlimited
- ***Advanced Notice***: Lead-time of price/incentive/control signal change
  - Multi-Day-Ahead ➔ Day-ahead ➔ In-day ➔ Unlimited
- ***Targeted Geographic Specificity***: Granularity of change
  - Bulk power system ➔ Secondary feeder ➔ Primary feeder
- ***Automation***: Ability to override automated control signal
  - None ➔ Customer override ➔ No override

Types of DR Opportunities

Time-Based Retail Rates DR signal: Price Level	Incentive-Based Programs DR signal: System State
Time-of-Use (TOU)	Disconnectable
Critical Peak Pricing (CPP)	Configurable
Day-Ahead Real-Time Pricing (DA-RTP)	Incentivized Behavioral
Real-Time Real-Time Pricing (RT-RTP)	Non-Incentivized Behavioral
	Energy Bidding
	Capacity Bidding
	Ancillary Services Bidding



Lack of Geographic Specificity Restricts DR Opportunities Providing Any Distribution Services

	Max Capacity Relief	Emergency Load Transfer	Voltage Management	Outage Recovery	Power Quality	Phase Balancing
TOU	×	×	×	×	×	×
CPP	×	×	×	×	×	×
DA-RTP	×	×	×	×	×	×
RT-RTP	×	×	×	×	×	×
Disconnectable	×	×	×	×	×	×
Configurable	×	×	×	×	×	×
Incentivized Behavioral	×	×	×	×	×	×
Non-Incentivized Behavioral	×	×	×	×	×	×
Demand Bidding	×	×	×	×	×	×
Capacity Bidding	×	×	×	×	×	×
Ancillary Services Bidding	×	×	×	×	×	×

×	Unable to provide distribution system service
○	Minimally effective at providing distribution system service
◎	Reasonably effective at providing distribution system service
●	Highly effective at providing distribution system service

Geographic Specificity Enables DR Opportunities to Provide More Distribution Services

	Max Capacity Relief	Emergency Load Transfer	Voltage Management	Outage Recovery	Power Quality	Phase Balancing
TOU	×	×	×	×	×	×
CPP	○	×	×	×	×	×
DA-RTP	○	×	×	×	×	×
RT-RTP	○	×	×	×	×	×
Disconnectable	●	◎	◎	◎	×	×
Configurable	◎	×	×	×	×	×
Incentivized Behavioral	○	×	×	×	×	×
Non-Incentivized Behavioral	○	×	×	×	×	×
Demand Bidding	×	×	×	×	×	×
Capacity Bidding	×	×	×	×	×	×
Ancillary Services Bidding	×	×	×	×	×	×

×	Unable to provide distribution system service
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Advanced Sensing and Control Tech of Inverter Loads Enables More Services to be Provided

	Max Capacity Relief	Emergency Load Transfer	Voltage Management	Outage Recovery	Power Quality	Phase Balancing
TOU	×	×	×	×	×	×
CPP	○	×	×	×	×	×
DA-RTP	○	×	×	×	×	×
RT-RTP	○	×	×	×	×	×
Disconnectable	●	◎	◎	◎	○	◎
Configurable	◎	×	×	×	○	○
Incentivized Behavioral	○	×	×	×	×	×
Non-Incentivized Behavioral	○	×	×	×	×	×
Demand Bidding	×	×	×	×	×	×
Capacity Bidding	×	×	×	×	×	×
Ancillary Services Bidding	×	×	×	×	×	×

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Greater Coordination Will Be Required

- Joint use of DR for bulk power and distribution system operations may create new challenges
  - Load increases/decreases called for at one level of the system may create or exacerbate problems at other levels
  - Dispatch in opposing directions by bulk and distribution system program providers
  - Joint dispatch in same direction by bulk and distribution system program providers
- Bulk power and distribution system program providers will need to be better coordinated
  - Identification of minimum load change that warrants communication/coordination
  - Hierarchy of dispatch or performance
  - Central dispatch authority that coordinates efforts of all program providers

Conclusions

- Given current designs and use of DR Opportunities, the lack of distribution-level geographic specificity makes it unlikely can positively effect distribution system operations and planning activities
- Simple changes to design can enable DR Opportunities to provide a subset of distribution system services
- Greater coordination between bulk power and distribution system operators will be required for DR to reach its full potential

Questions/Comments

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