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Demand Response Service Providers

Characterizing Offerings and Customer Types

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Technical Update, September 2015

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ABSTRACT

The study examines Demand Response (DR) Service providers to clarify who they are, what they offer, who are their customers, and why customers engage in their offerings. DR Service providers are described from a functional perspective to differentiate them from incumbent stakeholders in the electric power industry. A framework is presented for characterizing DR Service providers, and the types of customers they serve. While consumers are motivated to adopt provider offerings to meet lifestyle needs, businesses are focused on advancing business objectives towards ultimately improving a company's bottom line.

The study describes a generalized DR value chain to illustrate how different actors along the chain perceive and derive value from DR. It also illustrates how money or value flows between actors along the value chain. Reference technical diagrams are provided to illustrate supporting data flows between actors and/or their technology interfaces. Illustrative diagrams are provided under different models of DR engagement, including DR deployment under a vertically integrated utility, as well as deployment under a Bring-Your-Own-Device (BYOD) model of customer engagement.

The reader may apply findings from this report to quickly differentiate among the different types of DR Service providers and DR offerings available in the industry. By employing the frameworks presented in this report, the reader may rapidly characterize vendors in the DR marketplace, as well as their customers, to identify similarities and differences in offerings and value propositions of appeal to customers. Moreover, the reference technical diagrams in the report may be employed to identify key connectivity and data exchange requirements between technology systems that enable the coordination and automation of DR.

Keywords

Demand response service provider
Demand response aggregator
Demand response value chain
Customer characterization
Demand response management system
Information exchange diagram

ACRONYMS

The list of acronyms below appear in the report. The list is arranged in alphabetical order.

BYOD	Bring-Your-Own-Device
C&I	Commercial and Industrial Customers
DMS	Distribution Management System
DR	Demand Response
DRMS	Demand Response Management System
ERCOT	Electricity Reliability Council of Texas
ERS	Emergency Resource Service
ESP	Energy Service Provider
FERC	Federal Energy Regulatory Commission
G&T	Generation and Transmission Company
IPP	Independent Power Producer
ISO	Independent System Operator
IT	Information Technology
LSE	Load Serving Entity
M&V	Measurement and Verification
NERC	North American Electric Reliability Corporation
NOC	Network Operations Center
PJM	Pennsylvania, New Jersy, Maryland Interconnection
RTO	Regional Transmission Organization
T&D	Transmission and Distribution
UDC	Utility Distribution Company
U.S.	United States

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1
INTRODUCTION

Study Overview and Purpose

The electric power industry is undergoing restructuring, enabling competition and the introduction of new players including demand response (DR) service providers and DR aggregators. New offerings are being introduced into the market by DR Service providers. The report summarizes findings from an independent study of identifying and assessing the revenue-earning models of such players.

The study focuses on: who are the DR Service providers/aggregators, what are their revenue-earning models, who are their customers, and why customers engage in their offerings? Also, a key objective is to describe the DR value chain involving different actors (i.e. aggregator, end-user, etc.) in mature markets.

This report presents a framework for organizing and characterizing DR Service providers, and the types of customers of these service providers. Beyond long-standing and well-recognized DR aggregators like Enernoc and Comverge, distinct groups of vendors have been identified within the demand management industry that have or are considering strategies of extending their business models beyond technology (e.g., software and online services) to DR aggregation. Examples of business models are provided through case study of over six DR Service providers, falling in different groups including: 1) residential DR Service providers, large commercial and industrial DR Service providers, and aggregation technology providers.

Chapter 1 of this report provides background information useful for understanding findings summarized in subsequent chapters of this report on DR Service providers (Chapter 2) and customers of DR Service providers (Chapter 3). Chapter 4 describes how money flows between actors in the DR Value chain and supporting data flows between actors. The report ends with concluding remarks in Chapter 5.

Demand Response Terminology

Demand response (DR) is a *dynamic change* in electricity consumption coordinated with system or market needs, as defined in [1]. In this sense, the term DR is distinct from program and other enablers of the change. DR enablers include:

- **Programs, retail tariffs, and other activities** designed to coordinate electricity usage with power system or market conditions
- **Distributed or demand-side resources:**
  - located along the distribution system or customer-side of the meter
  - dispatchable load, distributed generation, storage

DR Market Size Indication

The demand response marketplace is significant, with North America leading in volume of DR participation. Table 1-1 provides an indicative snapshot of capacity by region resulting from commercial and industrial customer DR participation. This example is based on Navigant Research report [2] estimates for DR capacity from C&I customers in 2014.

Table 1-1
Commercial & Industrial DR Capacity by Region (Source: Navigant)

Region	Capacity (MW)
North America	21,041.8
Europe	3,336.6
Asia Pacific	1,951.9
Latin America	-
Middle East & Africa	500.1
Total	26,830.4

The U.S. Federal Energy Regulatory Commission (FERC) has assessed demand response potential as well, releasing updated findings in December 2014 in a publicly available report [3]. Table 1-2 below from the report indicates an excess of 28GW of peak reduction potential in 2013 is from DR programs operated by U.S. Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs). This figure is up from FERC's total estimate of 26GW from ISO/RTO DR programs in 2012.

Table 1-2
Potential Peak Reduction from U.S. ISO and RTO DR Programs (Source: FERC)

RTO/ISO	2012		2013	
	Potential Peak Reduction (MW)	Percent of Peak Demand[8]	Potential Peak Reduction (MW)	Percent of Peak Demand[8]
California ISO (CAISO)	2,430 [1]	5.2%	2,180 [9]	4.8%
Electric Reliability Council of Texas (ERCOT)	1,800 [2]	2.7%	1,950 [10]	2.9%
ISO New England, Inc. (ISO-NE)	2,769 [3]	10.7%	2,100 [11]	7.7%
Midcontinent Independent System Operator (MISO)	7,197 [4]	7.3%	9,797 [12]	10.2%
New York Independent System Operator (NYISO)	1,925 [5]	5.9%	1,307 [13]	3.8%
PJM Interconnection, LLC (PJM)	8,781 [6]	5.7%	9,901 [14]	6.3%
Southwest Power Pool, Inc. (SPP)	1,444 [7]	3.1%	1,563 [15]	3.5%
Total ISO/RTO	**26,346**	**5.6%**	**28,798**	**6.1%**

Table 1-3 below from the FERC report summarizes peak reduction capacity from retail DR programs. The table provides capacity estimates in MW by NERC region, with regions defined by the North American Electric Reliability Corporation (NERC). An excess of 28GW of total peak reduction capacity was estimated in 2012 across all retail DR programs in North America.

Table 1-3
Potential Peak Reduction (MW) from Retail DR Programs by Region and Customer Class in 2012 (Source: FERC)

	Customer Class				
NERC Region	Residential	Commercial	Industrial	Transportation	All Classes
AK	5	13	9	0	27
FRCC	1,762	1,097	447	0	3,306
HI	17	25	0	0	42
MRO	1,869	1,141	2,557	0	5,567
NPCC	84	421	88	14	606
RFC	1,520	815	3,502	0	5,836
SERC	1,399	1,170	3,475	2	6,046
SPP	172	391	760	0	1,323
TRE	88	333	59	0	480
WECC	1,684	1,056	2,365	165	5,269
All Regions	**8,600**	**6,462**	**13,261**	**180**	**28,503**

DR Value Chain

Energy efficiency and demand response are mechanisms for achieving utility or system objectives. In this sense, DR can be regarded as a means towards an end. That is, DR is a means for supporting targeted system objective(s). Figure 1-1 lists a range of system objectives for using DR, by category.

Category	Use Objective
Improve System Economics	Shift Load to Lower Cost Period
	Defer Capital Expansion
Maintain and/or Enhance System Reliability	Reduce Facility Loading
	Support System Restoration or Protection
	Provide Ancillary Service Operating Reserve
	Provide Ramping
	Provide Balancing Energy
	Provide Regulation
Environmental Compliance	Meet Energy Efficiency Resource Standards
	Reduce GHG Emissions
Enhance Customer Choice	Meet Customer Need
	Enhance Service Innovation

Figure 1-1
System Objectives for using DR

The majority of DR today is employed for improving system economics, by shifting load to lower cost period and/or deferring generation capacity expansion through peak load reduction. However, DR is also used in select cases for transmission and distribution system support in order to maintain and/or enhance grid reliability. Moreover, DR is being increasingly trialed to support system balancing needs by providing balancing energy, frequency regulation, and ramping energy. These balancing services require response in both directions, so that DR as a balancing resource or DR 2.0 requires capabilities beyond load reduction (DR 1.0). With the growing penetration of intermittent renewable generation at the bulk and distribution system levels, the industry will likely see increasing applications of DR 2.0 in the future. Programs for DR can also be driven by environmental compliance needs (e.g., meeting regional peak demand reduction targets) and/or needs to enhance customer choice through innovative retail service offerings and subscription plans. These various reasons for employing DR are grouped into progressive stages and further described in a published report [4].

Regardless of which application DR is employed for, value for DR originates from meeting power and/or market system objectives. Figure 1-2 depicts such a hierarchy, wherein DR is employed by a DR aggregator to meet a utility or other system operator's objectives. Lower in the hierarchy, a technology platform is provided by a technology provider to automate responses and provide technical capabilities desired to support the particular targeted system objective(s). Beyond connected device and technical system capabilities, customer preferences and behavior drive DR impact in a given program. Consequently, DR programs often leverage technology capabilities to engage customers and to automate responses according to customer preferences.

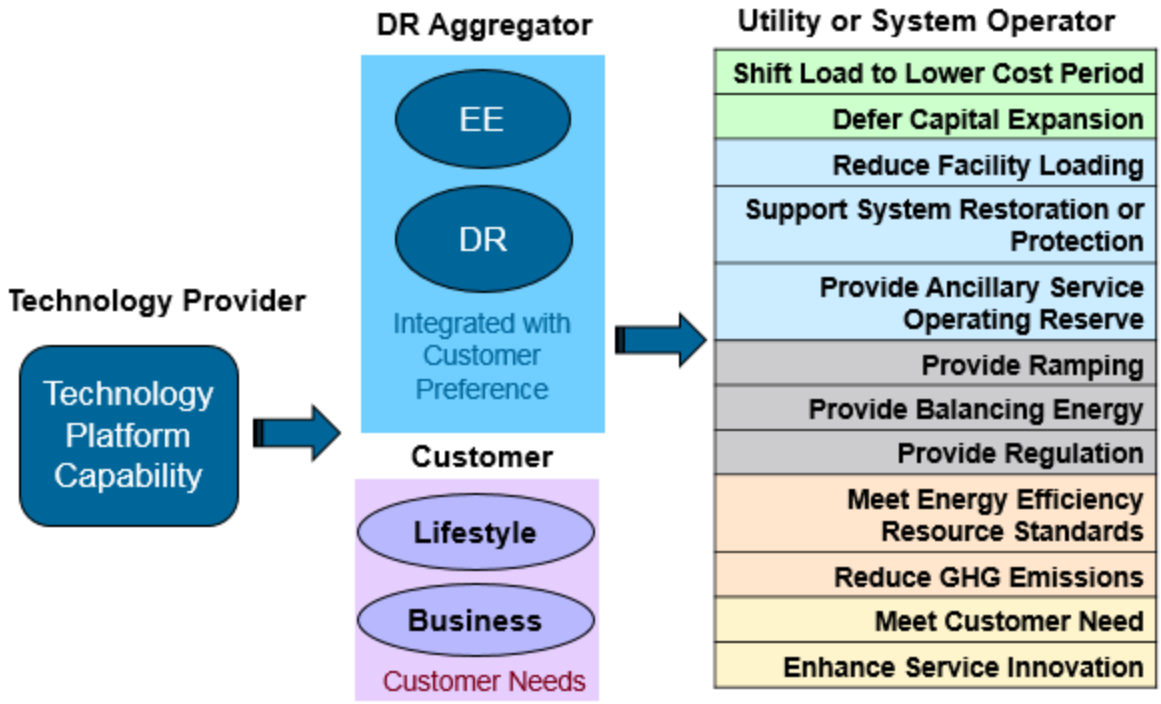

Figure 1-2
Illustration of DR Value Chain

Functional Perspective of Electric Power Industry

Status of electric power industry restructuring around the world varies by region, along with terminology in use for referring to the different types of stakeholders or actors in the industry. Common types of stakeholders generally emerge depending on industry structure and regulatory framework particular to a region. Common functions performed by stakeholders range from physical asset operations to financial operations. That is, different types of stakeholders in the power industry perform a different set of functions ranging from generation, transmission, and distribution asset operations to financial market, power marketing, and customer services. As depicted in Figure 1-3, under traditional industry structure, a vertically integrated utility performs all key functions in power system operations. In contrast, a restructured industry may disaggregate traditional functions and introduce new functions such as market operation and power marketing.

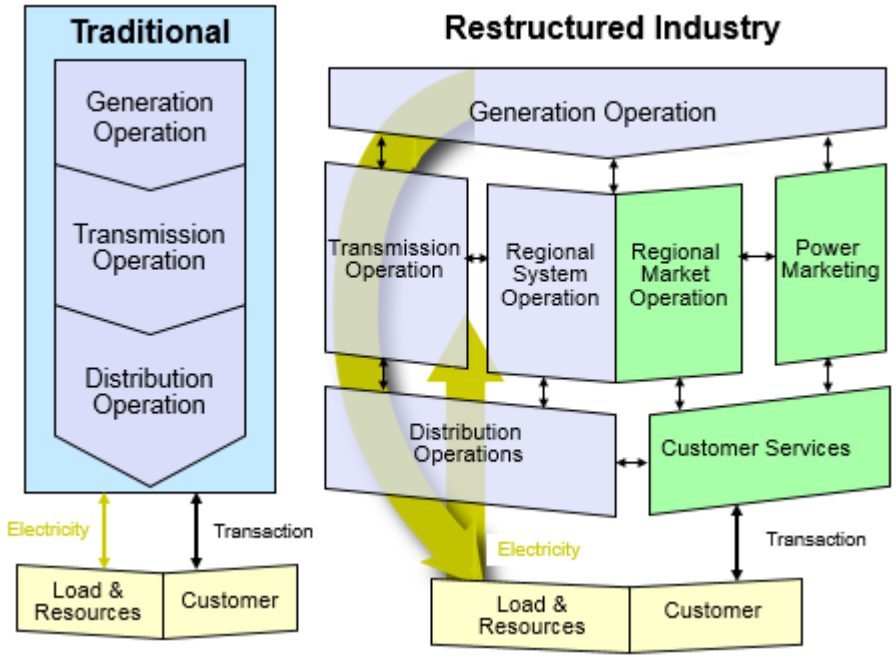

Figure 1-3
Traditional versus Restructured Industry

Figure 1-4 identifies typical stakeholders in the U.S. electric power industry by the functions typically performed. Further details are available in a published report [5]. By approaching the study of DR Service providers from a functional perspective, different actors can be understood more clearly by the function(s) they perform, regardless of differences in regional terminology or naming convention in use. The next chapters leverage the introductory chapter as background for explaining study findings.

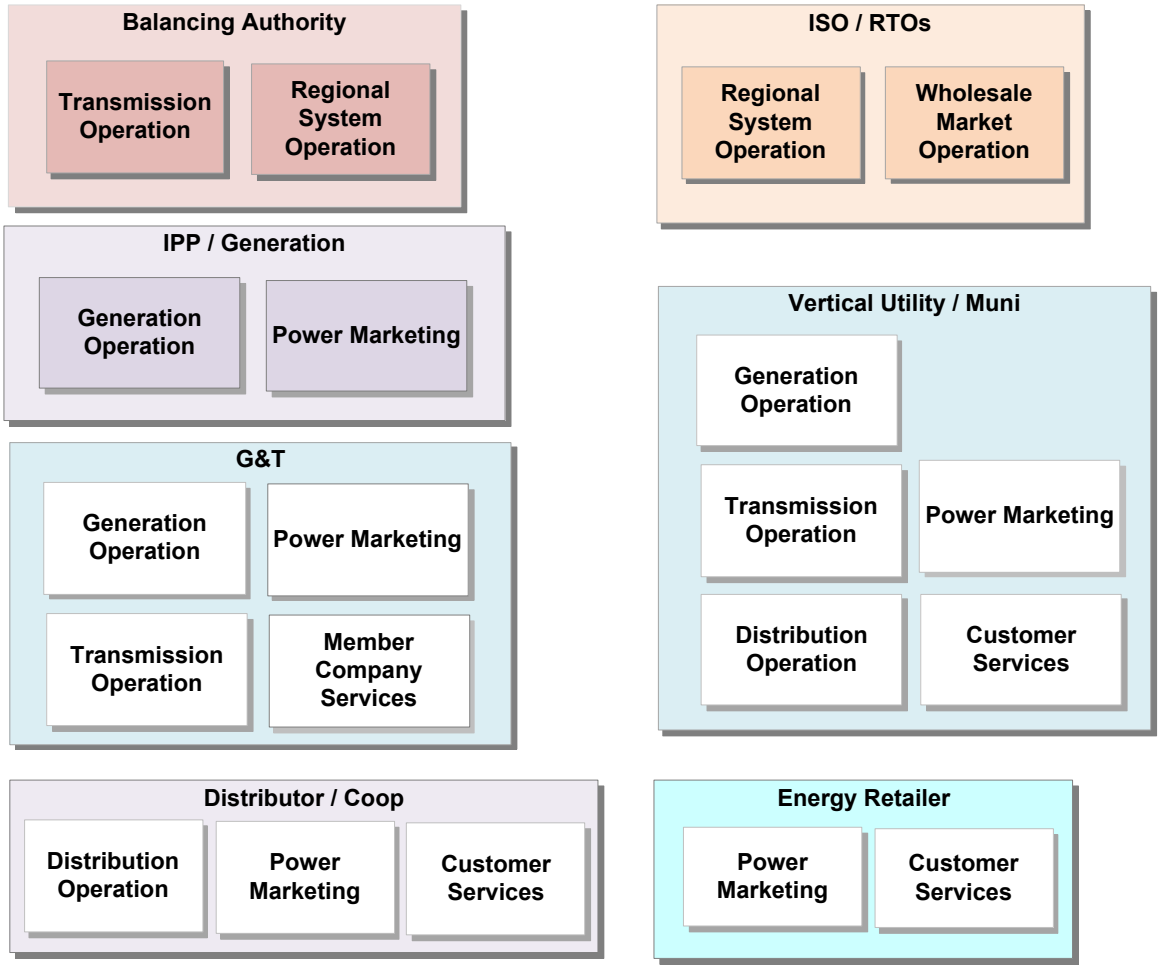

Figure 1-4
Common Stakeholder Types in North America by Function

2
CHARACTERIZATION OF DR SERVICE PROVIDERS

This chapter presents a framework for characterizing DR Service providers, their offerings, and the types of customers they serve. The findings presented in this chapter were informed through publicly available sources, prior publications, as well as discussion with technology and service providers on offerings and sales model details reviewed for feedback into the study.

A Functional Perspective of DR Service Providers

DR Service providers (or aggregators of DR) distinctly differ from other types of stakeholders that serve end-use customers. Figure 2-1 differentiates DR Service providers that aggregate DR from T&D Companies, Utility Distributors, and Energy Service Providers, by functions each performs.

As depicted in blue shading in Figure 2-1, a T&D company is a wires-only company operating and maintaining the transmission and distribution network in a geographic area. In Texas, T&D companies also serve as DR administrators given their regulated and assigned role to help meet state goals for peak demand reduction and energy efficiency. As depicted in orange shading in the figure, a Utility Distributor operates a distribution system and serves customer load, performing customer services function while maintaining a direct billing relationship with end-use customers. In contrast, an Energy Service Provider (ESP) is a competitive energy provider introduced by the onset of industry restructuring enabling direct access through retail competition. As indicated by the green shading in the figure, an ESP generally does not perform a wires operation function, but performs a customer service function and may also perform power marketing to procure wholesale supplies of electricity that it then resales and bills to its end-use customers.

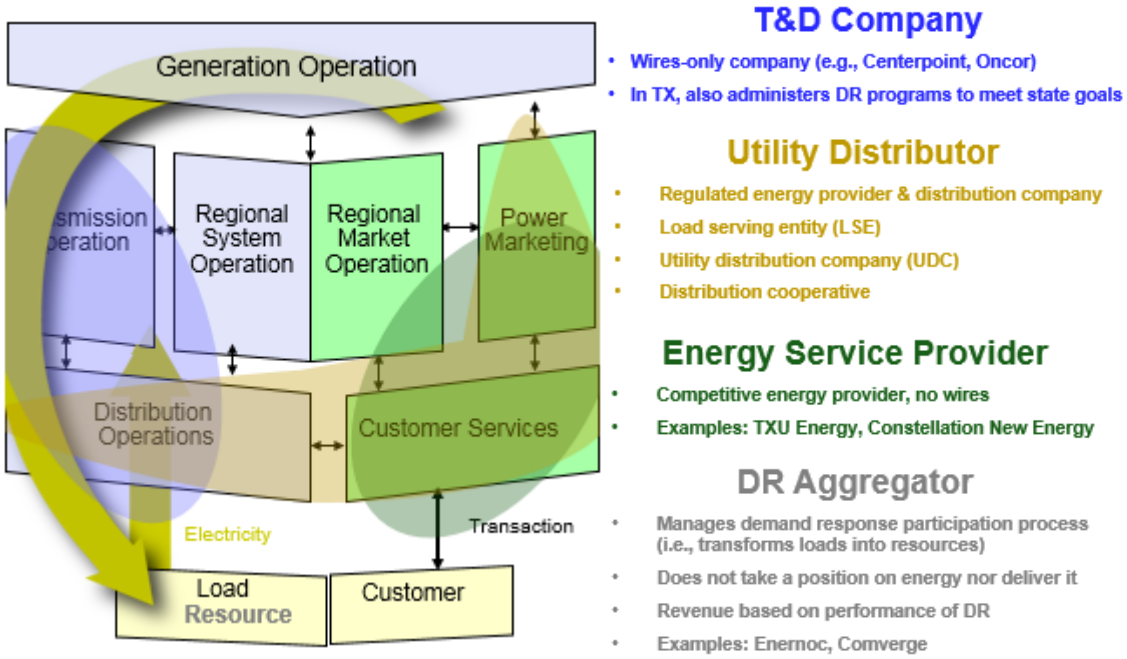

Figure 2-1
Types of DR Stakeholders – Utility, Energy Service Provider, DR Aggregator

Unlike ESPs and utility distributors (e.g., load serving entities), pure DR Aggregators do not take a position on energy, nor do they perform wires functions to physically deliver electricity like T&D companies. Rather, they manage demand response participation through a process to transform loads into demand response resources. Moreover, they earn revenue based on DR performance. Consequently, DR Aggregators do not perform any of the previously identified functions typically performed in the electric power industry, as described in Chapter 1 and Figure 1-4. Although they may have direct relationship with end-use customers, any form of customer service of a pure DR Aggregator is for the purpose of settling demand response performance, rather than for electric service provision.

Groupings of DR Service Providers

Beyond long-standing and well-recognized DR aggregators like Enernoc and Comverge, DR Service providers include technology, software, and online service providers that have extended their business models to include DR aggregation (or dabbled in this possibility). Distinct groups of vendors can be identified within the demand management industry that have such expanded business models. Considering this broader expanse of actors in the demand management industry, DR Service providers can be characterized and grouped by user type that their offerings target, as follows:

1. Offerings tailor to large C&I customers
2. Offerings tailor to mass market customers (residential and small commercial)
3. Offerings for utility users or other DR program administrators

As depicted in Figure 2-2, groupings include residential DR technology providers (e.g., EnergyHub, Weatherbug Home), large commercial and industrial DR technology providers (e.g., CPower), and demand response management service providers (e.g., Schneider Electric). That is, beyond providing DR aggregation services, DR Service providers differ by target user group for the provider's core offerings.

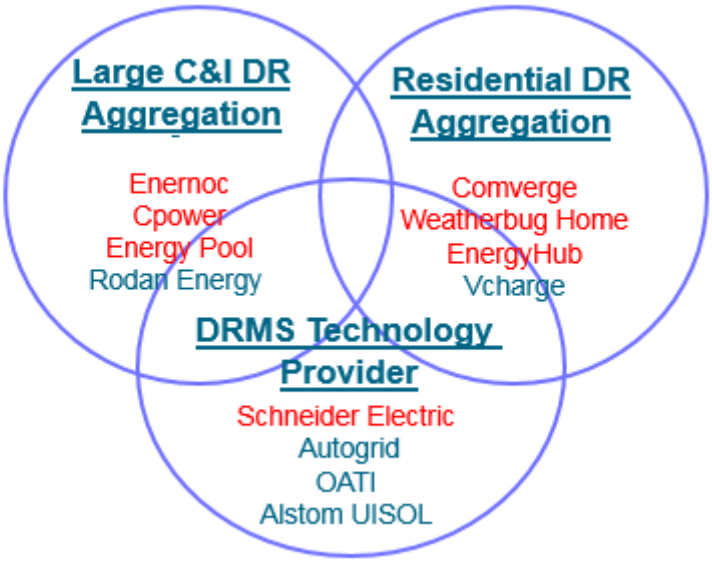

Figure 2-2
Groupings of DR Service Provider Examples by User Type for Core Offering

Characterizing providers by class of aggregated load for which their offerings are tailored to, is distinct from characterizing providers by who their paying customers are. Paying customers are characterized in the next chapter. Moreover, the vendors denoted in red text in the figure were the focus for review and business examples provided in the remainder of this chapter.

Core Offerings

DR Service providers also may be characterized by their core offerings. A DR aggregator's offerings are often supplemented by technology and/or technical services, as depicted in Figure 2-3. That is, DR Service Provider offerings can be grouped as follows:

- Customer-facing offerings that add-value to direct customers and/or end-use customers
- Demand Response Management System (DRMS) platform for managing the entire DR process
- DR aggregation service for aggregating DR up into markets
- Analytics for capturing operational efficiencies

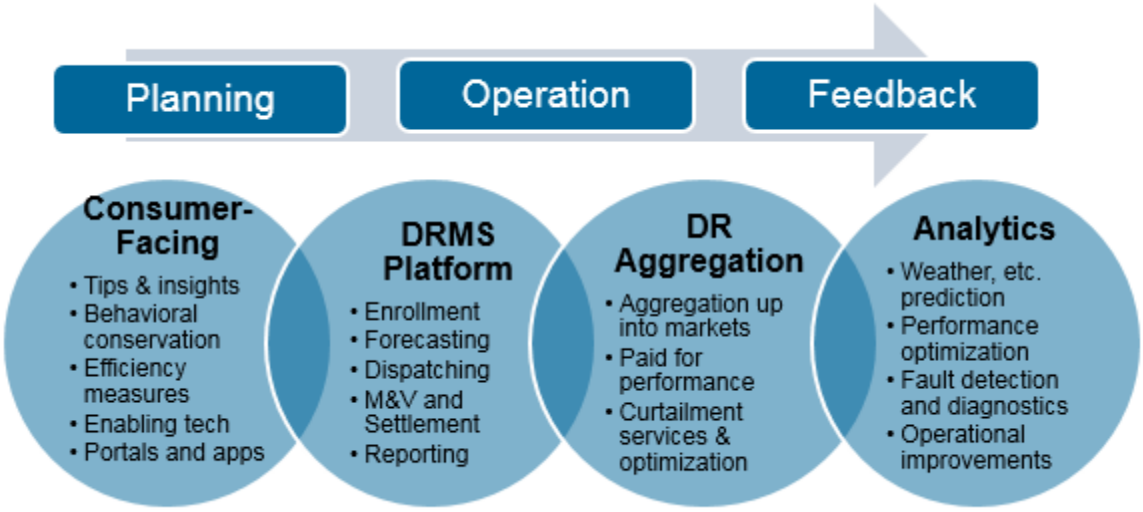

Figure 2-3
Groupings of Core Offerings

Customer-Facing Offerings

Customer-facing offerings may be provided to end-use consumers, who may not be the targeted paying customer, but rather the customer of the service provider's customer. Value-added offerings for consumers may include:

- Web portals with dashboards, for convenient access and control, or via apps
- Customer newsletters with personalized energy insights and tips for cost savings
- Information on what similar facilities are doing in energy, towards behavior conservation
- Enabling technology for DR
- Efficient equipment adoption measures

DRMS Platform

A DRMS platform supports the management of the entire DR process, from customer enrollment to settlement and reporting. The platform, which may be offered as a licensed software or an online service, enables DR administrators to manage the entire program management lifecycle, including customer enrollment, DR forecasting, dispatching, measurement and verification (M&V), settlements, analyses and reporting. The DRMS platform provider may license the software and/or provide the DRMS functionalities as a service over the cloud. Typically the platform is licensed to a utility, DR aggregator, or other DR administrator performing a DR aggregation function.

DR Aggregation Service

DR aggregation can be regarded as a service provided through organized efforts to aggregate DR at the retail level to support wholesale needs or system objectives. Typically a "paid for performance" revenue model is adopted by the company providing a DR aggregation service. Paid for performance revenue models have been reportedly adopted by Comverge, Weatherbug Home, EnergyHub, and other DR aggregators, in contrast to pure technology providers like Nest

who try to avoid paid for performance models of earning revenue. However, in select instances, the technology provider may accept a paid for performance payment scheme.

Analytics

Analytical services and/or software may be part of a provider's core offering. Examples are identified below of DR Service providers who are differentiating themselves from competitors by claiming advanced analytic capabilities.

- Predictive analytics have been touted as Autogrid's differentiator.
- Accurate DR prediction capability through weather-station and building modeling analytics are Weatherbug Home's key differentiator. This analytic capability is regarded as so valuable to its business that the company won't license the capability to other vendors for the particular use of optimizing DR.
- Analytics software for large C&I customers to capture efficiency savings is a growing area for Enernoc. Whereas the company's origins had initially focused on DR aggregation, its focus has since shifted to expanding customer-facing offerings leveraging analytics software capabilities developed in-house.

Sample Business Characteristics and Size

This section provides examples of businesses and their characteristics. Business size indicators are also provided, primarily informed through publicly available sources and discussion with technology and service providers during the year of report publication. Estimates and figures reported are noted as size indicators, and are not necessarily validated nor current at the time of publication review.

Enernoc is reportedly the top C&I DR aggregator in the U.S. and has an international business in DR aggregation. In 2013, the company (which is publicly traded) earned $383M in revenue, for which reportedly 90% was from its DR aggregation business (focused on C&I customer DR). In 2015, reportedly 20% of revenue was attributed to its growing overseas business (outside the U.S.). An estimated 24-27 GW of DR are under its management, mostly serving as capacity resources. Although Enernoc was originally founded as a DR aggregation business, its focus has been shifting to software-based tools for demand-side management. To do so Enernoc has developed and acquired customer-facing offerings to inform C&I customers on how to improve on operational efficiencies. Although Enernoc does not sell nor license its DRMS platform to other companies to aggregate DR, it advances in-house DRMS capabilities to power its Network Operations Center (NOC), to support its DR aggregation business.

Comverge is reportedly the top residential DR aggregator in the U.S. In 2015, the company reportedly earned an estimated $70M in revenue, for which less than half was from DR aggregation of mass market customers. An estimated 6GW are under its management, including about 100MW in PJM's capacity market (and almost none in energy markets). So DR aggregation comprises lesser than half of its business. Rather, Comverge's core business is providing software and services for DR, for utilities to manage the entire DR process. Besides its DRMS platform offerings to utilities, Comverge provides customer-facing tools to facilitate

customer DR participation. However, its revenue is typically earned from utilities rather than end-use customers.

Cpower is reportedly the second largest C&I DR aggregator in the U.S. The company was formed out of a split from Comverge that occurred towards end of 2014 in order to form a separate company focused solely on C&I customers. An estimated 3GW C&I DR are under its management, mainly serving as capacity resources.

Weatherbug Home is a residential DR aggregator in that state of Texas. It is the DR aggregation division of its parent company Weatherbug, a weather station information service with about 160 employees. Weatherbug Home was started approximately three years ago as the DR aggregation division. An estimated 20MW of DR are under its management, participating in ERCOT's Emergency Resource Service (ERS). Payments from ERCOT can range from $22/kW for DR participation across a four-month summer season in 2014, to about $16/kW paid in 2015 across the summer season. The company manages about 20,000 thermostats in Texas, reportedly achieving on average 1.5 kW of reduction per thermostat. Weatherbug Home's customers include smart thermostat platform providers, who are pure technology providers and not DR aggregators. The company's value-add to smart thermostat providers is to enable their smart thermostat customers to participate in DR programs. Weatherbug home leverages its weather forecasting and building model analytics to predict DR availability and optimize DR participation in markets. It has developed DRMS, analytics, and customer-facing tools, and leverages these to support its DR aggregation business. The company also licenses such technical capabilities to utilities directly (e.g., through a DRMS offering).

EnergyHub is a DRMS and smart thermostat platform provider to utilities and ESPs. In 2015, the company merged with Alarm.com, a $160M revenue business. An estimated 25% of Energy Hub's revenue is from DR aggregation, under a pay for performance revenue model, in which the company is paid by MWs reduced. EnergyHub's offerings span across customer-facing tools, DRMS, DR aggregation services, and analytics. It has developed these capabilties and leverages them to support its DR aggregation business. The company also licenses such technical capabilities to utilities through its DRMS offering.

Energy Pool is a C&I DR aggregator in Europe. An estimated 2 GWs of DR are under its management in France. Most of the DR (1.5 GW) is committed to day-ahead energy market participation and intra-day hourly energy market participation, with the rest in frequency regulation and reserve markets. (Currently, France doesn't have a capacity market). Deployments of its DR aggregation platform are reportedly also underway in Turkey, Korea, Japan, and Cameroon. Energy Pool utilizes its DRMS platform and C&I customer-facing offerings to support its DR aggregation business. The company is a private subsidiary of Schneider Electric.

Schneider Electric is a DRMS provider in the U.S. It is also advancing its distribution management system (DMS) offering in the U.S. to include DR, with the goal of empowering utility grid operations personnel with respect to DR. The company's core business is as a technology provider of products and services. Though it is not a DR aggregator, the company reportedly is considering strategies of possibly entering the DR aggregation business in the U.S., leveraging its strong market position in low voltage electrical distribution and/or DRMS and DMS platform offerings. In the first quarter of 2015, the company reportedly earned total revenue of 6B Euro, across its buildings, industry, infrastructure, and IT businesses.

3
CHARACTERIZATION OF TARGET CUSTOMERS OF DR SERVICE PROVIDERS

Customer Types

DR Service providers may also be characterized by who their paying customers are, or the type(s) of customers that comprise the source of their revenue streams. Figure 3-1 groups DR Service providers by primary customer type they target. The customer groups include:

- Large C&I customers
- Mass market customers (e.g., residential and/or small commercial)
- Utility or other system operator
- Technology provider

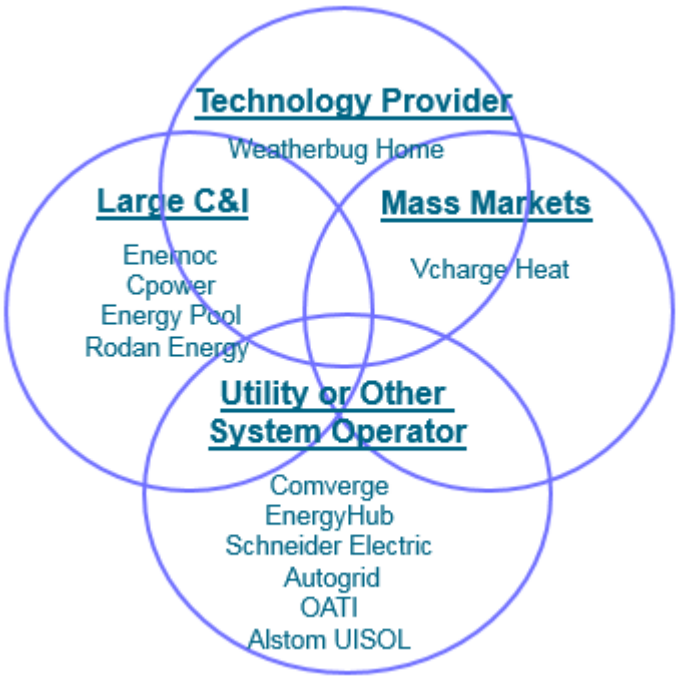

Figure 3-1
Groupings of DR Service Provider Examples by Primary Customer Type

Although DR Service providers may have offerings tailored to end-use customers as users (to facilitate and/or enhance program participation), few providers that aggregate DR actually target residential customers as their paying customer. Most DR Service providers serve utilities or other system operators (e.g., ISO/RTO) as their primary source of revenue. For example, utilities are the primary target customer of Comverge, EnergyHub, Schneider Electric, Autogrid, and other DRMS providers, as illustrated in Figure 3-1. Some service providers like Enernoc and Energy Pool aggregate large C&I load up into energy markets and are paid through direct revenue arrangements with the C&I customer.

In select cases, target customers are pure technology providers themselves, such as smart thermostat technology providers. For example, smart thermostat platform providers are the primary target customer of Weatherbug Home. Weatherbug Home offers to aggregate smart thermostat-controlled load using its DRMS platform, as an opportunity to earn a new revenue stream and provides a cut of the revenue to the smart thermostat provider.

As another example, EnergyHub has a software platform offering targeted to smart thermostat device manufacturers that want cloud-based data aggregation capabilities. The company sells its back-end software platform for data aggregation to device manufacturers, the paying customers for the particular offering. EnergyHub also retains the right to engage end-use customers whose smart thermostats are controlled on its platform, for future DR participation opportunities. However, EnergyHub's primary target customer are utilities or other system operators who want DRMS capabilities provided through the cloud, or a hierarchical DRMS that interfaces with multiple smart thermostat platforms. Consequently, EnergyHub is grouped in Figure 3-1 under providers whose primary target customers are utilities or other system operators.

Rationale for Customer Engagement

Rationale for customer engagement and adoption of a DR Service Provider's offering varies by customer class. Generally, residential customers are driven by desire to meet lifestyle needs, while commercial and industrial (C&I) customers are driven by business considerations to meet the bottom line.

Sample Value Propositions of Appeal to Residential Customers

Residential customers are mass market consumers. They are focused on meeting their individual lifestyle needs. How residential customers prioritize their needs varies from customer to customer. Figure 3-2 provides an example prioritization of lifestyle needs for a hypothetical customer making a technology purchase decision. The particular lifestyle needs being prioritized are influenced by the technology type being considered (e.g., a solar photovoltaic system can directly address needs for energy independence whereas a smart thermostat can more directly address lifestyle needs for comfort and convenience). In the figure, the particular sample ranking of lifestyle needs reflects a customer whose top need is for technology to provide control and meet comfort and convenience needs, followed by providing cost savings and being good for the environment.

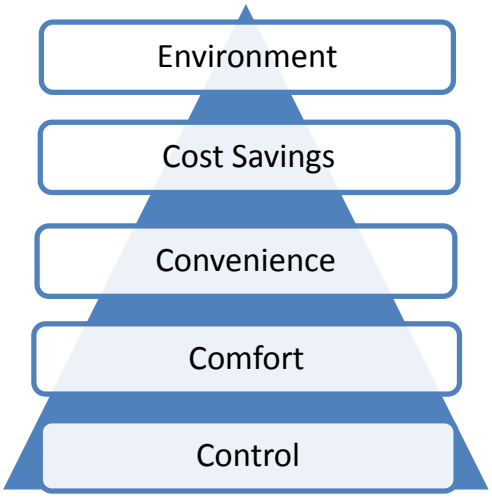

Figure 3-2
Example Ranking of Consumer Lifestyle Needs

For mass market consumers, home security systems and home automation systems generally lead in sale of connected devices before adoption of energy management systems. This reflects a general higher prioritization among consumers for meeting personal security needs over meeting home control and convenience needs, followed by optimizing energy cost savings through energy management. That is, security and home automation tend to be leading plays before energy.

Because consumer purchase decision are driven by their lifestyle needs, rationale for consumer engagement in a DR Service provider's offerings is best expressed in terms of consumer perception of how the offering can meet the consumer's prioritized lifestyle needs. Successful engagement depends highly on establishing connections in the consumer's mind between the features of the offering and the offering's ability to meet the consumer's top lifestyle needs.

For example, a DR Service provider that provides smart thermostat devices and apps along with DR aggregation services, may message to consumers on the merits of adoption of its smart thermostat offering based on its ability to optimize consumer comfort while providing remote control and automation for consumer convenience. While consumers may decide to adopt the particular offering based on these merits, the DR Service provider may also leverage the adopted smart thermostat platform to automate settings and demand response participation with willing customers. Though customers initially engage for other reasons like comfort, convenience, and control capabilities received through adoption of the offering, engagement in DR is also technically enabled by the adopted platform. Formal agreement for customer DR participation could be in exchange for a reduced cost for the adopted technology and/or for addressing additional needs (that may be lower priority) like capturing energy cost savings.

Sample Value Propositions of Appeal to Business Customers

Commercial and industrial customers are businesses. Their primary focus is on the success of their businesses, wherein energy efficiency and DR are generally secondary considerations. However, energy-intensive businesses may more readily perceive EE and DR as mechanisms for efficiency gains and cost-cutting in order to stay competitive.

Figure 3-3 illustrates a sample ranking of business objectives. Such objectives drive business engagement decisions when considering whether to adopt a DR Service provider's offering(s). For the particular ranking in the example, staying competitive is a primary consideration, followed by an offering's support for efficiency gains and cost cutting. Any ability to provide an additional revenue stream to the company or to improve rapport with upper management may also be considered. Though not a primary consideration nor necessarily sufficient for a decision to adopt, the ability of an offering to enhance rapport to convince management may be a necessary enabler for adoption (e.g., initial analyses producing key insights in financial terms readily understood by management for necessary justification to adopt).

Figure 3-3
Example Ranking of Business Objectives

For example, a DR Service provider may provide customer-facing tools displaying customer energy usage and tips for efficiency improvements, while also providing DR aggregation services to large C&I customers. The provider may message to business customers on the merits of adoption of its online tools based on their ability to help the customer stay globally competitive by revealing actionable ways to optimize processes and/or schedules of operations to achieve operational efficiencies and cut costs. Whiles businesses may decide to adopt the particular offering based on these merits, the service provider may also leverage the adopted online tools to provide tips and incentives for demand response participation to willing customers. Though customers initially engage for these business reasons, engagement in DR is also technically enabled by the adopted online platform. Formal agreement for customer DR participation could be in exchange for reduced cost of the initial offering that addressed primary needs and/or through addressing lower priority needs like earning an additional revenue stream through DR participation.

4
REFERENCE TECHNICAL DIAGRAMS

Overview

This section identifies how "money" or value flows along the DR value chain. Examples of money flows are provided under contrasting models of DR provider engagement. Types of data exchanged are also identified under each model.

The information presented is based on internal assessment under consultation with technology experts to discern and classify commonality and differences based on known cases of vendors and models they operate under. Illustrative flow diagrams are provided to simplify presentation of findings on information flows and money flows under different examples.

Money Flows

As depicted in Figure 1-3, different types of actors derive different forms of value along the DR value chain. Value of DR originates at the wholesale market or system level by meeting the objectives of a utility or other system operator in the performance of their power or market system function(s). The value chain extends down to DR providers (i.e., DR aggregators and end-use customers) who are incented to provide the desired response in coordination with system or market conditions. The chain reaches DR technology providers, who receive compensation with each technology or service sale. How money flows along the DR value chain mirrors this chain of value derivation, wherein value originates in meeting system objectives of the utility of other system operator.

A simplified illustration of the general direction of money flow is given in Figure 4-1. The figure depicts money flowing in the direction of the DR value chain. That is, money flows from the utility or system operator and extends to DR providers, like DR Aggregators and DR participating customers who respond in a coordinated fashion with system or market needs by adjusting demand. Money ultimately flows down to technology providers for provision of technology capabilities to automate power consumption responses when triggered. The technology platforms implemented often consider and maintain customer preferences given consumer lifestyle needs or business limitations.

The specifics of how money flows and between which different actors depend on the particular business model of the DR Service provider. Figure 4-1 identifies the DR Aggregator separately from the Technology Provider. However, DR Service Providers may perform either or both of these roles. The remainder of this subsection provides examples of how money flows under sample cases.

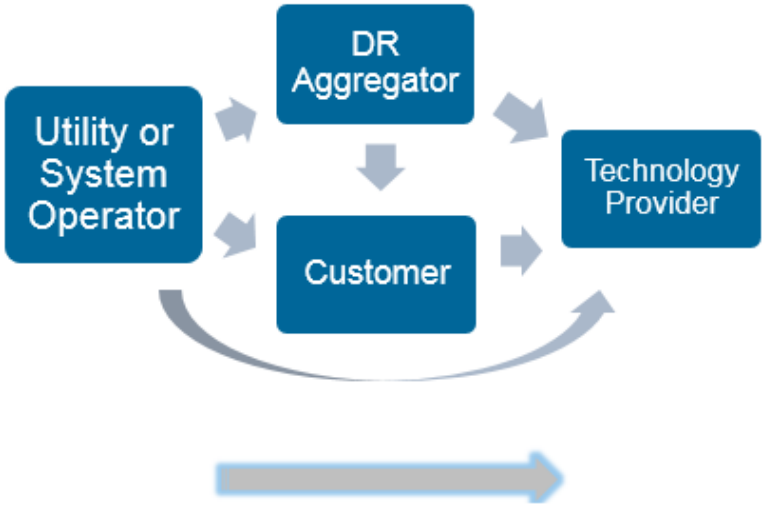

Figure 4-1
General Direction of Money Flow – From Utility to DR providers and Technology Providers

Traditional Model

In the first case, depicted in Figure 4-2, a traditional vertically integrated utility engages DR Service Provider(s) as technology providers of software and/or services. The traditional utility has no need for a third-party DR aggregator. Rather, the utility aggregates DR and contracts for technologies, including DRMS technology (e.g., DRMS software or online service) and customer-facing technologies (e.g., online portals, apps, and end-use controls devices). Consequently, DR Service Provider(s) under this traditional case are pure technology providers. Since there is no third-party "DR Aggregator", this actor is dropped from the general case shown in Figure 4-1, resulting in the money flow diagram in Figure 4-2 below. The resulting figure illustrates that money flows directly from the utility to providers of DR (the end-use customer in this case) and to DR Service Providers who are technology providers.

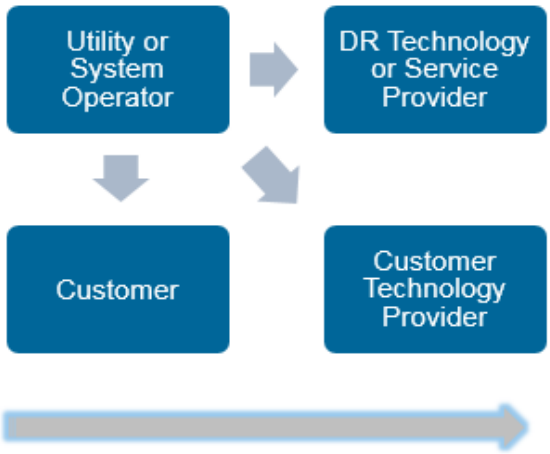

Figure 4-2
Money Flow Model 1: Traditional – Utility to Providers of DR and Technology

Bring-Your-Own-Device Model (Customer Paid Device)

Under a Bring-Your-Own-Device-Model (BYOD), end-use customers make the purchase decision and procure customer DR-enabling technology. Under this model, the utility or other system operator can engage a DR Service Provider that is a DR Aggregator. This case is depicted in Figure 4-3. Since DR Aggregators typically own and operate their own system for aggregating and managing DR, there is typically no separate Technology Provider for such technology. Since there is no third-party "DR Technology Provider", this actor is dropped from the general case shown in Figure 4-1, resulting in the money flow diagram in Figure 4-3 below. However, a Customer Technology Provider is generally included under a BYOD model, and so shown as a separate entity in Figure 4-3.

The resulting figure illustrates that money flows directly from the utility to the provider of DR (i.e., the DR Aggregator). There is no direct money transfer from the utility to end-use customers nor to Customer Technology Provider(s) in this case. Rather, the utility is more distant under the assumed BYOD model, wherein the customer pays for its own DR-enabling device (e.g., smart thermostat, connected refrigerator, etc.), and the DR Aggregator owns the customer DR relationship.

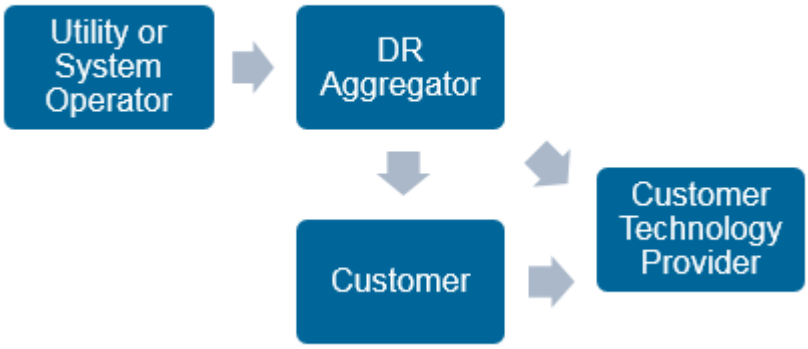

Figure 4-3
Money Flow Model 2: Bring-Your-Own-Device (Paid by Customer) – Utility to DR Aggregator to Customer

Figure 4-3 depicts the possibility of money flow from the DR Aggregator to the Customer Technology Provider as well, for providing necessary data aggregation software and/or services across customer devices. The wealth transfer from the DR Aggregator to Customer is to incentivize DR participation, which may include an incentive for program participation and/or DR enabling-device adoption. That is, the DR Aggregator may incent adoption of DR enabling technology by the customer, who directly procures the device from the Customer Technology Provider.

Bring-Your-Own-Device Model (Utility Paid Device)

Under a BYOD model, the utility may alternatively provide direct incentives to customers for DR-enabling device adoption. This case mirrors the previous Bring-Your-Own-Device-Model (BYOD), except the utility ultimately provides an incentive to the customer for adopting a

qualified device. Like in the previous BYOD case, the utility or other system operator engages a DR Service Provider that is a DR Aggregator with its own DRMS technology, so there is no third-party DR Technology Provider.

The resulting money flow diagram in Figure 4-3 illustrates wealth transfer directly from the utility to the provider of DR (i.e., the DR Aggregator), as well as from the utility to end-use customers, who in this case make the device purchase decision and directly pay the Customer Technology Provider(s). Although the DR Aggregator still owns the customer DR participation relationship, the utility is less distant in that it may influence the customer's decision for procuring a DR-enabling device, by incentivizing the customer to adopt a utility-qualified DR-enabling device. That is, the money flow from the utility to customer is to incentive DR enabling-device adoption by the customer, who directly procures the device from the Customer Technology Provider.

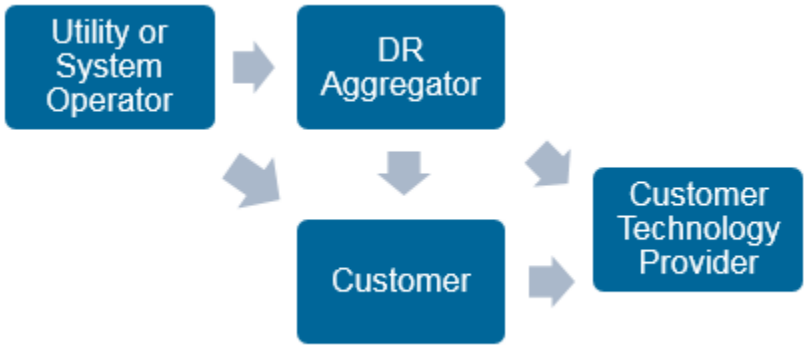

Figure 4-4
Money Flow Model 3: Bring-Your-Own-Device (Paid by Utility) – Utility to DR Aggregator and Customer

Figure 4-4 depicts the possibility of money flow from the DR Aggregator to the Customer Technology Provider as well, for providing necessary data aggregation services and/or software across customer devices. The money flow from the DR Aggregator to Customer is to incentivize ongoing DR participation upon program adoption.

Data Flows

Figure 4-5 categorizes the types of data exchanged between different types of actors along the DR value chain (or the electronic systems they utilize) through the process of DR planning, operation, and settlement. Data exchanged basically support determination of DR capability and availability, and provide DR visibility and verification as needed.

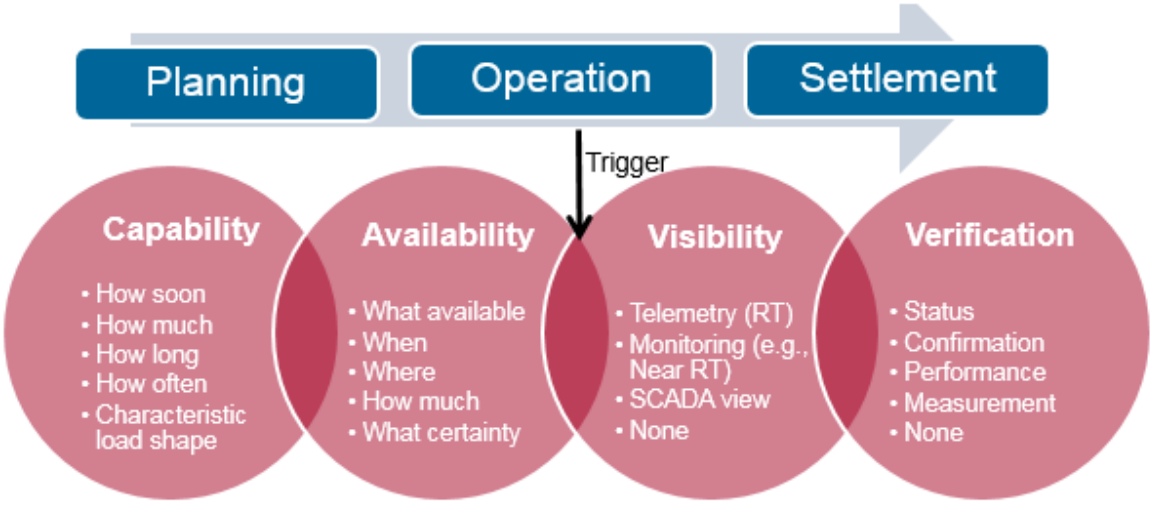

Figure 4-5
Groupings of Information Exchanged in the Demand Response Process

DR capability addresses how soon, how much, how long, and how often a DR resource is physically capable of responding. These technical capability questions can be answered by understanding the operational characteristics of a resource, and/or by examining the end-use resource's characteristic load shape reflecting typical electricity usage patterns.

Beyond capability, DR availability addresses what and how much of a resource is actually available to respond, when, where, and with what certainty, when needed at the time of trigger. While capability can be established well in advance in planning timeframes, availability is generally determined closer to operational timeframes (e.g., day-ahead or day-of), when resource availability can be forecasted to support operations and updated closer to real-time.

After a DR resource is called or triggered, DR visibility and verification become critical. DR visibility addresses situations or use cases requiring monitoring of resource status. Generally, DR visibility can be provided in real-time through telemetry (e.g., providing frequent updates on resource status like power consumption every few seconds); collectively through distribution system feeder monitoring utilizing utility SCADA systems; or in near real-time through other electronic monitoring systems.

When required, DR visibility is generally desired before and during a DR event, to provide immediate feedback on resource response to a utility or other system operator-issued trigger. After the conclusion of a DR event, verification of response normally occurs to determine DR performance or to verify response, as input into the DR settlement process.

Figure 4-5 indicates what types of information are desired at which points of the overall process of DR planning, operations, and settlement. The remainder of this chapter organizes the identified information types into data flows between different actors or their technology interfaces, in order to describe how data typically flows before, during, and after a DR event is triggered. Illustrative examples are provided for the same three cases used to describe money flows.

Traditional Model

Figure 4-6 presents an overview of types of data exchanges typically needed to support the DR process when a traditional vertically integrated utility directly engages technology providers and customers providing DR. The arrows represent the general direction and types of data exchanged between actors or their technology interfaces. The one-way arrows may actually require two-way communications, since ancillary data and/or message exchange overhead (e.g., queries and acknowledgements) may be involved.

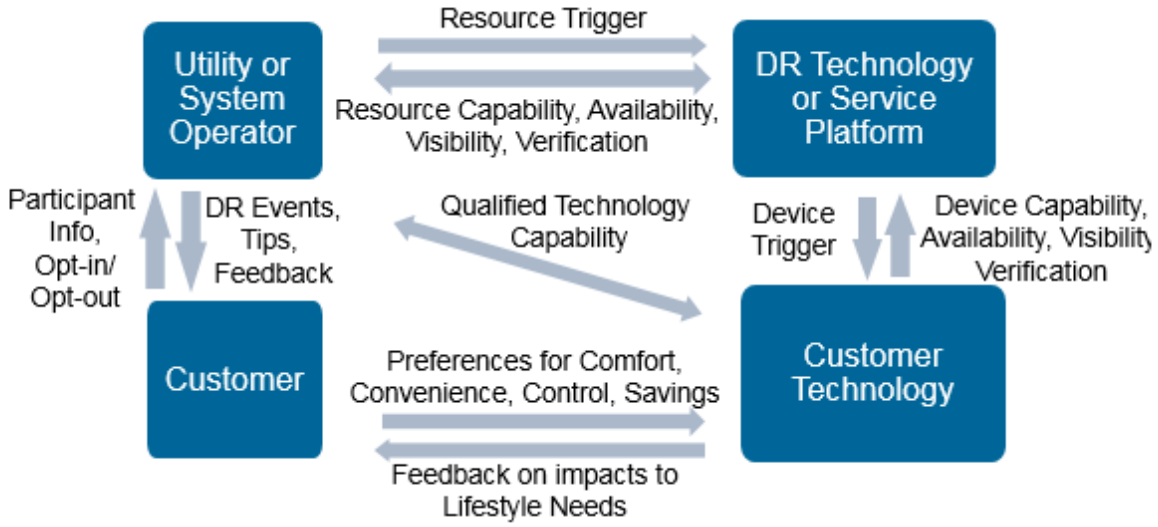

Figure 4-6
Representative Data Flow under Traditional Model

The types of data exchanged under the traditional model can also be described through a three-step illustration of data exchanges that occur before, during, and after a DR event, respectively. In particular, Figure 4-7 depicts key data flows before a DR event, while Figure 4-8 depicts flows during a DR event, and Figure 4-9 illustrates flows that typically occur after the conclusion of a DR event.

Before Event

In preparation for triggering DR, a utility or other system operator collects resource capability and latest DR availability information, which is sometimes based on monitoring systems providing DR visibility. As illustrated in Figure 4-7, resource-level capability, availability, and visibility may be informed by aggregation of device-level capability, availability, and visibility, through a third-party technology platform. During this stage in the DR process, customer preferences are established through user settings to configure customer-sited technologies. The customer technologies may also provide feedback on anticipated impacts of the user-set preferences. Moreover, utility systems through customer-facing tools often provide information on any forecasted DR events, demand savings tips, or other feedback to the customer to better prepare for a DR event and improve participation outcomes.

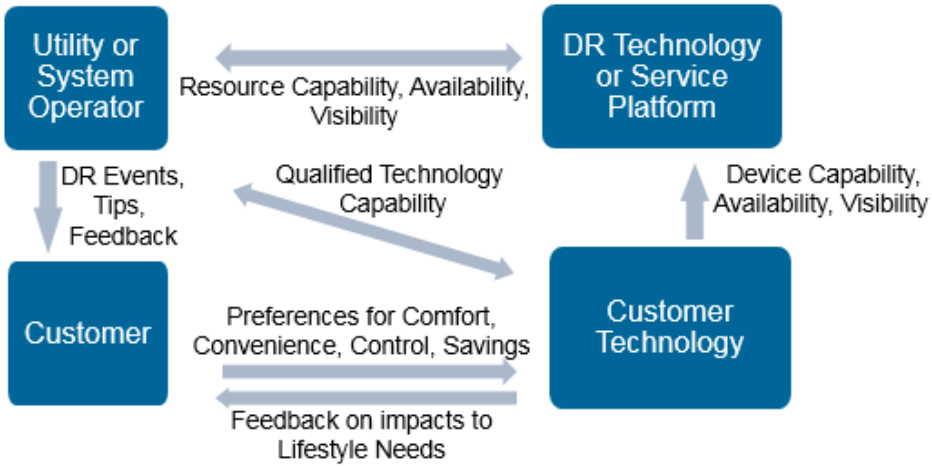

Figure 4-7
Data Flow under Traditional Model – *Before a Demand Response Event*

During Event

When a DR event is issued by the utility or system operator, DR resources are called or dispatched via an established DR signal that is sent from the utility to trigger response from individual DR resources. Assuming many devices comprise a single resource in aggregate, a third-party technology platform may be used to translate the resource-level trigger to device-level triggers.

What specific actions are taken upon trigger signal receipt, depends on participant by participant opt-in (or override status) during the issued DR event. As Figure 4-8 indicates, participation opt-out choice can be transmitted directly from the customer to the utility and/or registered through preference settings configured by the user on his/her customer-sited technology interface.

Data flows that update the utility on latest status of resource capability, availability, and visibility continue to be critical during a DR event, as well as data flows that provide ongoing feedback to customers on their DR participation progress and any impacts foreseen from their participation levels.

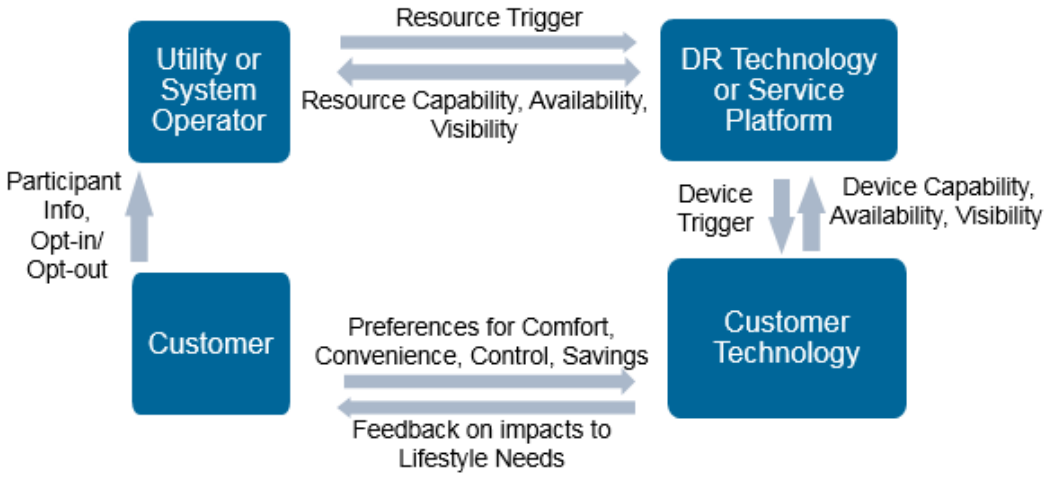

Figure 4-8
Data Flow under Traditional Model – *During a Demand Response Event*

After Event

Figure 4-9 illustrates key flows that typically occur after the conclusion of a DR event. Verification of response normally occurs to determine DR performance, as input into the DR settlement process. Resource-level verification or measured DR performance may be based on device-level. Customers receive concluding feedback on participation results, which may be presented in terms of individual opt-in and other preferences that influence actual participation.

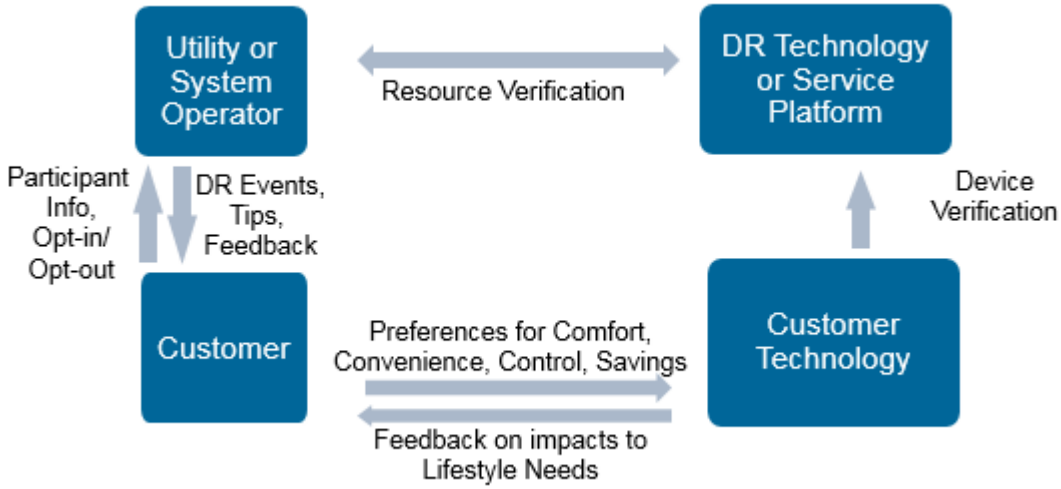

Figure 4-9
Data Flow under Traditional Model – *After a Demand Response Event*

Although additional data flows exist and specifics of the information exchanged between systems vary by program and technology platform, the types of data described are generally required or desired through the DR process in support of system operations.

Bring-Your-Own Customer-Paid Device

Figure 4-10 illustrates data flows under a BYOD model of customer DR engagement through a third-party DR Aggregator, who qualifies technology capabilities of devices customers can adopt and leverage for DR participation. Types of data exchanged resemble that in the traditional model, except data exchanges may occur between different actors or technology interfaces.

As in the traditional model, the utility or system operator still originates DR events. However, the DR aggregator manages data gathering to estimate DR capability and availability in aggregate and triggers response at the resource-level, in step with DR events issued by the utility or system operator. Moreover, the utility or system operator provides incentives to the DR Aggregator based on DR performance achieved.

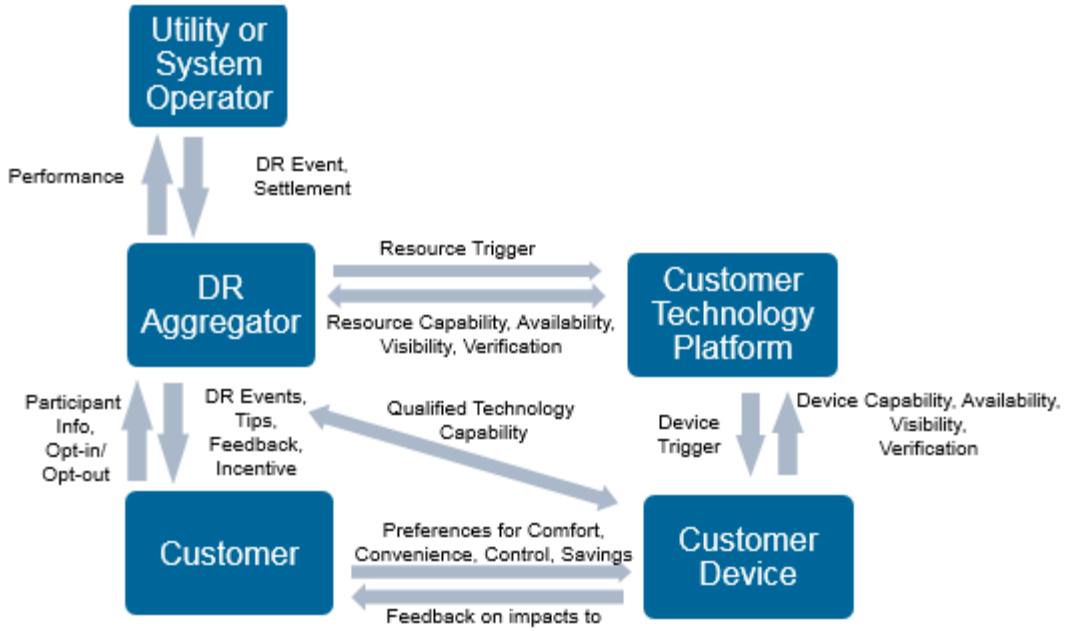

Figure 4-10
Representative Data Flow under Bring-Your-Own-Device Model (Paid for by Customer)

Figure 4-11 through Figure 4-13 illustrate data flows under the BYOD model, according to flows that typically occur before, during, and after a DR event, respectively. The pattern of data exchanges are similar to the traditional model, except some exchanges occur with the DR Aggregator which manages and aggregates DR. Before any event is called, the utility or system operator still maintains control over determining when to originate a DR event. Upon triggering an event, the utility relies on the DR Aggregator to coordinate response from participating customers. The Aggregator typically tracks latest information on resource capability, availability, and/or visibility. At the conclusion of a DR event, Aggregator-achieved DR performance is reported to the utility or system operator to inform financial settlement between the utility and Aggregator. In a sense, data flows under BYOD ultimately determine Aggregator DR performance for settlement purposes, as well as Aggregator incentives to be awarded to participating customers.

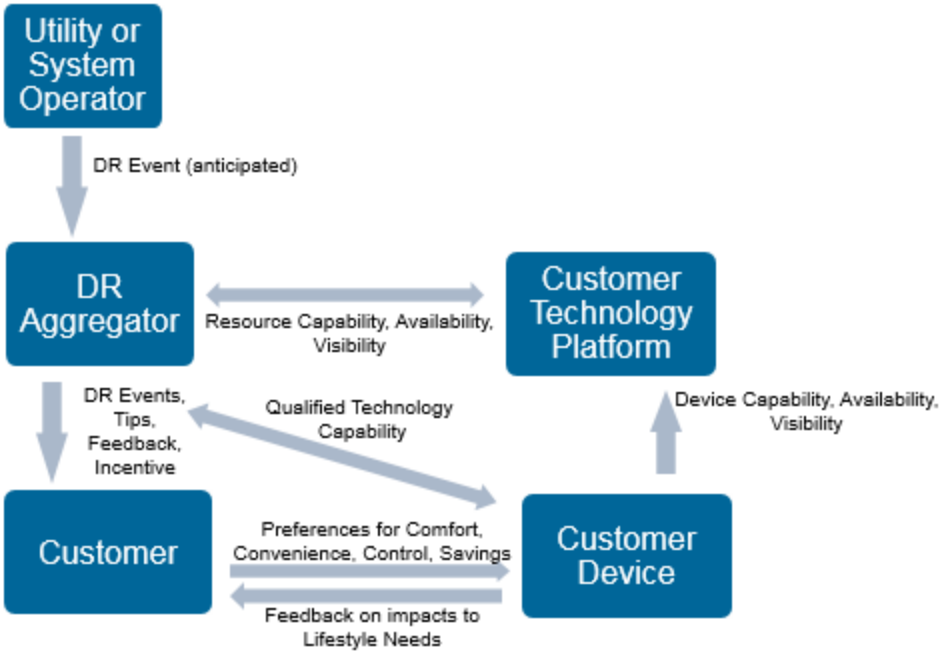

Figure 4-11
Data Flow under BYOD – *Before a Demand Response Event*

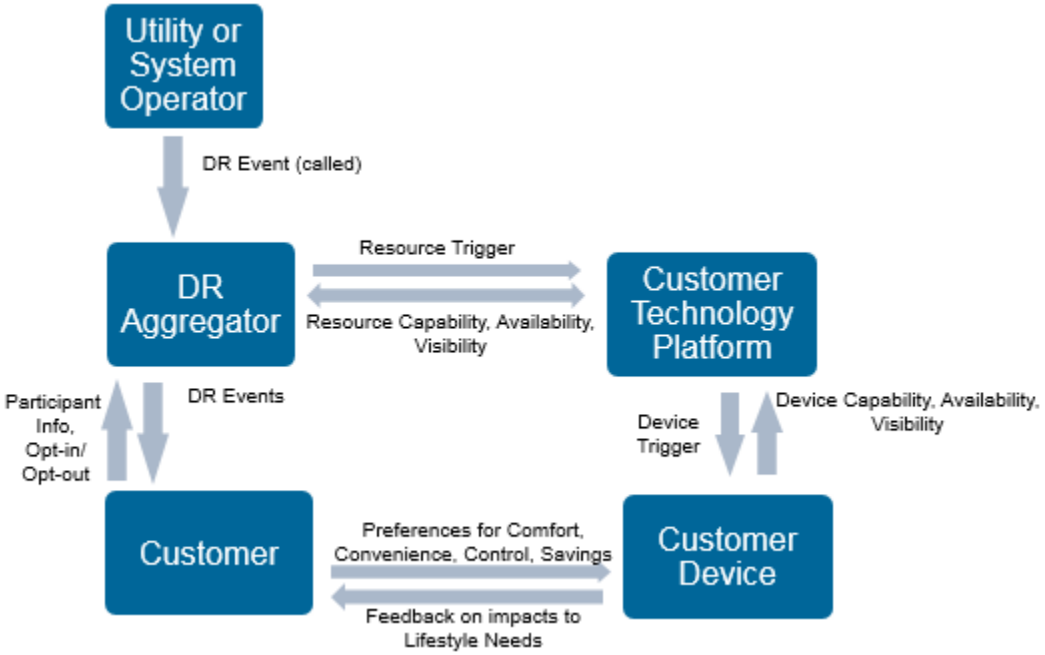

Figure 4-12
Data Flow under BYOD – *During a Demand Response Event*

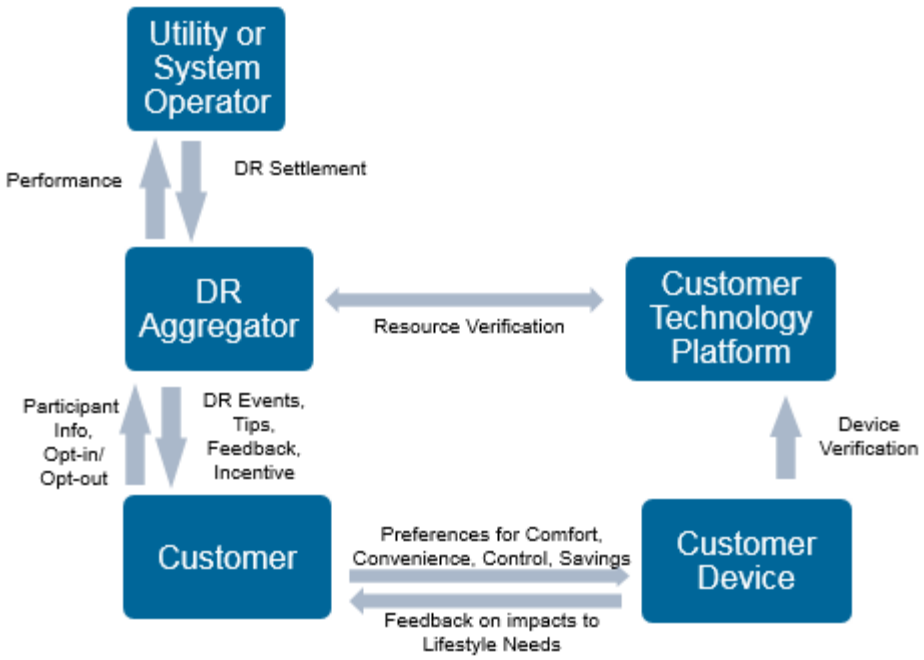

Figure 4-13
Data Flow under BYOD – *After a Demand Response Event*

Bring-Your-Own Utility-Paid Device

Figure 4-14 illustrates data flows under a BYOD model of customer DR engagement through a third-party DR Aggregator, assuming a utility qualifies technology capabilities of devices customers can adopt and leverage for DR participation. Types of data exchanged resemble that in the previous BYOD model depicted in Figure 4-10, except the qualifying entity is the utility (who pays, reimburses, or rebates for customer device adoption) instead of the DR Aggregator. Data flows ultimately determine Aggregator performance for settlement and incentive to participants who adopt utility-qualified customer technology.

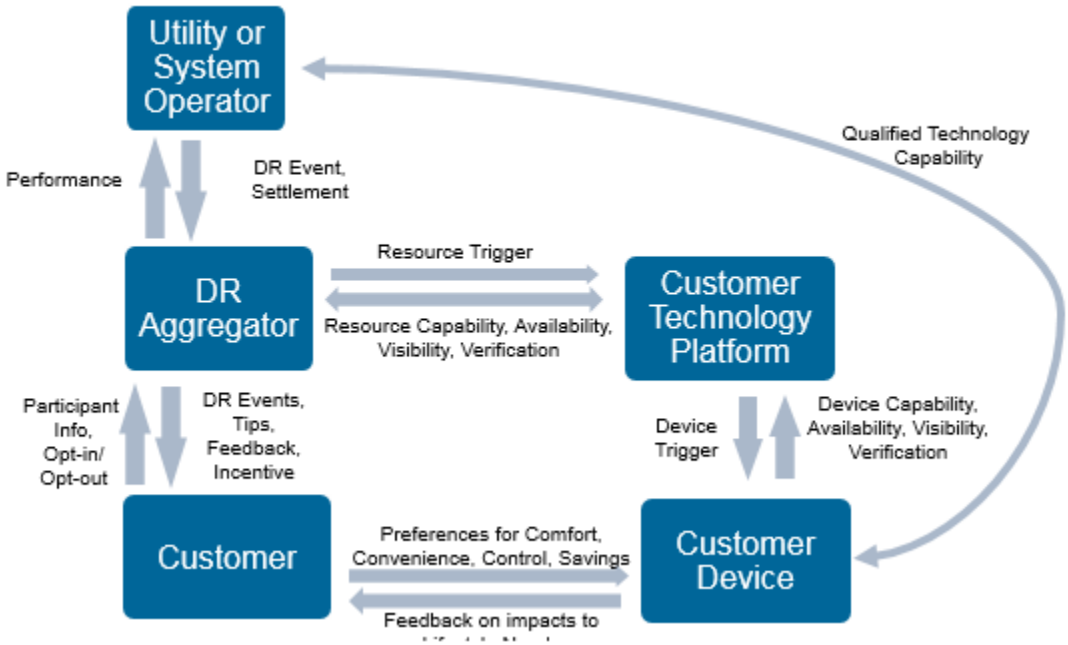

Figure 4-14
Representative Data Flow under Bring-Your-Own-Device (Paid for by Utility)

5
CONCLUSION AND FUTURE WORK

The DR value chain includes a variety of different actors. Incumbent electric power companies drive application of DR to support power system or market needs, ultimately triggering DR for specific system objectives. DR providers include DR Service providers as well as end-use customers participating in DR programs. Some DR Service providers are Aggregators of DR, while others are pure technology providers.

The study examined DR Service providers to clarify who the providers are, what are their revenue-earning models, who are their customers, and why customers engage in their offerings. By approaching the study from a functional perspective, different actors can be understood more clearly by the function(s) they perform, regardless of differences in regional terminology or naming convention in use.

A framework was presented for characterizing DR Service providers, and the types of customers they serve. Namely, DR Service providers can be characterized by business category (e.g., residential DR providers, large commercial and industrial DR providers, and aggregation technology providers); core offerings; and targeted customer types. On the other hand, customers of DR Service providers can be characterized by customer type (e.g., large C&I customer, mass market customer, utility or other system operator, and technology provider); and whether the customer is a consumer or business.

Generally, consumers are motivated to adopt provider offerings to meet lifestyle needs, while businesses are focused on advancing business objectives towards ultimately improving a company's bottom line. A consumer engages in new offerings to the extent the offerings are perceived to maintain and/or enhance individual lifestyle needs. Prioritization of needs vary by individual consumer as well as individual business.

The study described how money or value flows between actors in the DR value chain and how supporting data flows between actors. Generally, money flows in the direction of the DR value chain. That is, money or value flows from the utility or system operator to DR providers (e.g., DR Aggregators and DR participating customers), and ultimately to technology providers. Under a traditional model in which a vertically integrated utility directly engages DR and technology providers, money flows directly from the utility to end-use customers (who are the providers of DR) and also directly to DR Service Providers who are the technology providers. In contrast, under a BYOD model, money flows directly from the utility to DR Aggregator (who is the provider of DR). The Aggregator manages DR participation of end-use customers, owning the customer DR relationship, and can incentivize the customer response. Whether there is money flow from the utility to the customer depends on who pays for customer DR technology adoption. That is, there is no direct money transfer from the utility to end-use customers if the customer ultimately pays for the DR-enabling device (e.g., smart thermostat, connected refrigerator, etc.).

Data flows between actors or their technology interfaces in order to support the DR planning, operations, and settlement process with information on DR capability and availability, and to

provide DR visibility and verification as needed. Reference technical diagrams provided in Chapter 4 illustrate the general types of information exchanged before, during, and after a DR event, respectively. Future work may include expansion of reference technical diagrams to provide a more detailed perspective on the enablers of DR, including:

- the types of actuation and control methods used in DR program offerings of service providers
- how different types of actuation and control methods are capable of triggering, reducing or disconnecting loads at customer premises
- how customer-sited distributed resources like generators, batteries, or other backup technologies are integrated to respond to system or market signals
- how far down the electricity value chain have DR programs gone, and to what extent have they reach to the residential customer

To develop a more detailed and macroscopic perspective beyond the current U.S.-centric study, future work could include findings based on international investigations of:

- regulatory frameworks found in different regions of the U.S., Europe, Brazil, and abroad
- which countries are most active in demand-side management and why
- major players with presence in several countries or globally

Advancing a macroscopic and more international perspective can clarify where global DR Service providers are most active in which countries and why. This can point to aspects of regulatory frameworks contributing to the major drivers of DR today, and creating the most promising opportunities to be captured with DR. One way to advance these goals would be to have a workshop at Enel, which EPRI would be happy to facilitate.

A
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