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Value of Customer Data Access: Market Trends, Challenges, and Opportunities

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VALUE OF CUSTOMER DATA ACCESS –
MARKET TRENDS, CHALLENGES, AND OPPORTUNITIES

prepared for
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Executive Summary

Over the last decade, many utilities and customers have gained access to daily and hourly customer usage information because of advanced metering infrastructure (AMI). These data provide greater granularity on consumption and load curves, helping utilities to manage their operations better. Customers are empowered with unprecedented data connectivity. Customers can now better understand their energy consumption and review their usage patterns. The proliferation of electricity usage information has opened new options for energy efficiency and demand response programs and enabled residential customer services that were available only to large commercial or industrial customers previously. Access to data allows customers to evaluate available options and make informed decisions, which in turn empowers them to embrace a new role as active and engaged market participants.

Utilities benefit from information availability and evolving technologies. With access to customer data, many utilities have achieved significant cost reduction and operational benefits. These benefits stem from understanding customer consumption patterns, improving the accuracy of load curves to help meet capacity requirements efficiently, and continuing to leverage customer data to capitalize on operational improvements. Some examples of these benefits include reduced labor cost on meter operations, reduced costs due to theft of electricity, improvements in call center operations when handling high-bill inquiries or transferring services, improved programs to handle load capacity events, and reduced costs in managing energy conservation programs.

While there are many operational benefits associated to data access for utilities, Navigant has documented a list of benefit categories related specifically to customers. These are some of the key expected benefits:

- **New market activities -** Introduction of new services and products
- **Improved customer satisfaction -** More customized and streamlined services
- **Improved demand-side management (DSM) program performance -** Increased program participation
- **Reduced utility operations costs -** Cost reductions associated with the following processes:
    - Reduced meter reading costs
    - Reduced meter connects and disconnects
    - Improved customer service efficiency and effectiveness
    - Improved revenue protection and recovery
    - Reduced cost of DSM program measurements and verifications

Utilities and customers are not the only parties that benefit from access to customer data. The energy industry as a whole is undergoing dramatic transformations, which are driven by renewable energy sources, electric vehicles, energy storage, and micro-grids, among other innovations. The wave of smart grid deployments over the last decade overlay communications systems to the electric grid, while sensor-based data platforms provide vendors with necessary data to innovate applications and services

of benefit to the customers and utilities. Coupled with an accelerating pace of improvements in supporting technologies, such as sensors and mobile computing, there are thousands[1] of new entrants to this market sector. These entrants offer innovative services and products that are changing the paradigm of end-use energy management and customer interaction with data and data-driven services, and they are competing to offer innovative services to address current and future customer needs.

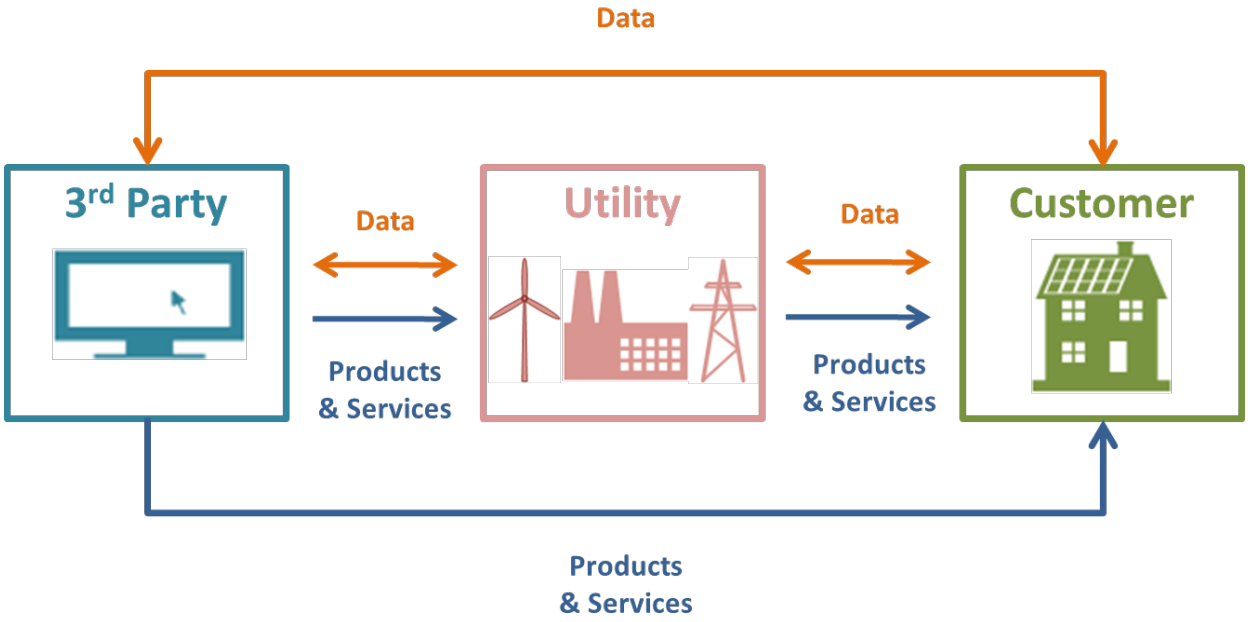
Over time, and as the market continues to evolve, so will the roles of those involved. Many, if not all, utilities will need to adapt to the changes. Third-party service providers and emerging energy sources will challenge the traditional role of the sole utility service provider in a service territory. Traditional electric utilities may also expand their responsibilities beyond electricity production and delivery to facilitation of data sharing, and other services, that will provide customers more options to manage their systems better.

The role of the regulator will also continue to change, in an ever-evolving environment that will pose complex issues. Regulators must determine which of these changes are most beneficial and important for the ratepayers served within their specific jurisdictions. In order to understand the impacts to ratepayers and establish equitable regulations that improve the overall efficiency of the electricity market over which they preside, regulators will, more than ever, need to understand how new technology and data access could impact their jurisdiction. Utility regulators face new challenges to protect interests of the ratepayers while managing many diverse and evolving aspects of this data-driven market. These challenges include data privacy and security, utility access to other data streams, and vendor availability of existing utility data.

This rapidly evolving energy market and business model presents both challenges and opportunities to utilities and regulators. Meanwhile, new third-party market entrants will continuously change expectations and capabilities. As Figure 1 illustrates, their involvement in the energy market will likely diversify the flow of customer data further.

[1] While there are no citable references on the number of entities providing data-driven services in the U.S. energy sector today, the industry experts and stakeholders that Navigant engaged believed that there are a significant number of players—in order of thousands. While some are well-established in the energy sector, many are not well-known but either participating in or entering this market.

Figure 1. Schematic of Diversified Customer Data Flow



Source: Navigant Consulting

With third-party vendors poised to gain direct access to customer data, regulators may need to adapt to maintain oversight of the flow of data among utilities, vendors, and customers. Maintaining the existing utilities' obligation to serve customers will require flexible and future-looking regulations. We will discuss the evolution of customer technologies (ranging from communications and sensors to distributed generation) and market participant roles throughout this paper, concluding with various possible future definitions of these relationships.

A more customer-focused business model is quickly evolving in the electricity market, where the customers' needs and wants drive the future evolution of products and services. Some utilities are already learning and adapting to this model, anticipating customers' needs and developing programs to address them. Utilities located in partially and fully deregulated environments appear to be the frontrunners of this trend, a result of their efforts to establish strong customer relationships. The full value of customer data and its impact is not yet fully known, but it is profound and will change the utility business model. The data enables utilities to proactively identify and resolve service issues for their customers, as well as personalize customer-facing programs and service offerings. This type of change does not occur in a linear fashion; it usually takes some time to gain traction, but takes off once it builds momentum.

Regulators are in a position to influence or drive how the evolving customer-focused model will continue to be shaped in their territories. Regulatory environments with more open data access markets will allow for faster innovation in products and services, providing more choices and value for customers. Regulatory environments with more limiting or conservative data access policies will potentially delay the availability of customer choices. As a result, third-party vendors will find their own data streams from other sources, including their own collection of data using sensor technologies or

additional meters. Progress is inevitable; therefore, how the customer-focused business model is shaped will partially depend on the regulatory environment of each territory, as well as the innovation, choices, and customer value stemming from a more open market.

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1. Introduction

This whitepaper, commissioned by the National Association of Regulatory Utility Commissioners (NARUC), presents findings from Navigant Consulting, Inc.'s (Navigant's) investigation on the value of access to customer data in the energy sector. The study focused on market trends, use-case examples, and implications to utilities and regulators. The objectives of this whitepaper are to help NARUC and state regulators understand the following:

- Broad market trends that drive proliferation of data-driven services to utility ratepayers
- Current examples of how access to, and use of, customer data is creating value today
- Key issues and implications for regulated utilities and regulatory agencies

The electric utility industry is entering a new phase in which innovations associated with many advanced technologies are converging to create new opportunities and challenges—for incumbent and new market players alike. Implementation of advanced metering infrastructure (AMI) and smart grid enables utilities and third-party vendors to access, collect, and analyze detailed customer usage data that were largely unavailable just ten years ago. With advancements in sensor and mobile computing technologies further fueling the evolution of data-driven services and products, both utilities and third-parties have significant opportunities to capture these new markets and aid the customers in effectively utilizing their data. However, the implications and full value of customer data access are not yet fully understood.

As a part of this investigation, Navigant engaged multiple market players and stakeholders, including investor-owned utilities, third-party vendors and service providers, state regulators, and other industry experts. In addition, Navigant has conducted reviews of publicly available literature and proceedings from industry conferences, including DistribuTECH 2015 and the Consumer Energy Alliance conference, as a part of this investigation.

2. Benefits and Value of Customer Data Access

This section provides a summary of the categories of benefits associated with data-driven services and products, plus a review of some documented examples of how access to customer data is creating benefits for customer and utilities today.

2.1 Categories of Expected Benefits

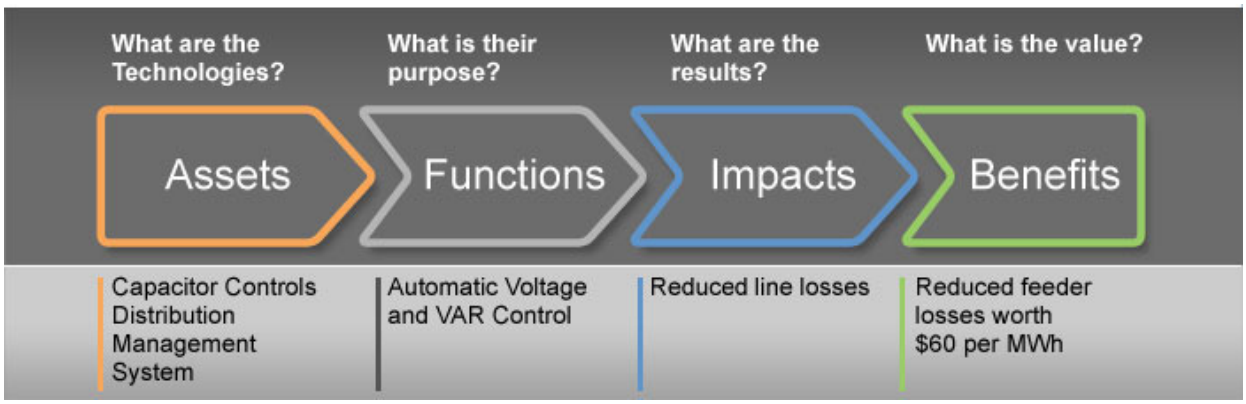
Access to customer data benefits not only customers, but also utilities. Measuring, quantifying, and attributing the benefits associated with customer data access is a challenging task, especially given that access to customer data is still evolving. As discussed below, the traditional cost-effectiveness tests that regulators use (e.g., the total resource cost test) may not be sufficient to assess the full costs and benefits associated with data-driven services. Although a thorough attribution of costs and benefits associated with data-driven services and products will be challenging, several key considerations and categories of expected benefits emerged through this investigation.

2.1.1 Limitations of Existing Tools and Approaches to Assessing Benefits

Typical regulatory cost-effectiveness tests for demand-side management (DSM) programs focus on reduced supply cost and program implementation costs as benefit and cost outcomes, respectively. However, costs and benefits of data-driven services and products encompass broader sets of considerations. For instance, data-driven services could, and often do, rely on utility smart meter data, which is available today because of utilities' significant infrastructure investments. Traditional cost-effectiveness tests typically do not consider such capital investments.

One possible alternative to traditional cost-effectiveness tests is to leverage the cost-benefit evaluation framework used for smart grid projects. Figure 2 presents an analytical framework developed by Navigant and adopted by the U.S. Department of Energy (DOE) as the process to estimate impacts and benefits of smart grid projects.

Figure 2. Outline of DOE's Smart Grid Cost-Benefit Analytical Framework



Source: U.S. Department of Energy[2]

State regulators in many jurisdictions have applied this framework to provide insight to specific technological or regional smart grid deployments. For example, the Massachusetts Department of Public Utilities' grid modernization initiatives recommends the 2010 Electric Power Research Institute (EPRI) summary report[3], which incorporates the Navigant framework, as a starting point for Massachusetts utilities to design their own cost-benefit analyses[4]. However, that framework is designed primarily to quantify benefits of infrastructure investments and is not meant to attribute the benefit to access to customer data.

2.1.2 Expected Benefits of Customer Data Access

Access to customer data enhances the effectiveness and efficiency of existing market activities (e.g., utility programs) and supports the creation of new markets and customer expectations. While there are many operational benefits associated to data access for utilities, Navigant has documented a list of benefit categories related specifically to customers. Some examples of expected benefits include the following:

- **New market activities:** Access to customer data for utilities and third-party vendors is enabling the introduction of new services and products (e.g., automated demand response, smart appliances, and time-based rates) that were previously not feasible. This leads to demands for new types of jobs (e.g., communications engineers, software developers, and customer service professionals) and helps companies capture new ways to generate revenue. Customer data has also been beneficial for suppliers in a competitive (deregulated) market where historical granular data allows for more competitive, lower cost/more targeted offers

[2] U.S. Department of Energy. "Analytical Framework." Available at: https://www.smartgrid.gov/recovery_act/program_impacts/analytical_framework.
[3] Wakefield, M. January 2010. "Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects." Electric Power Research Institute (EPRI).
[4] Massachusetts Department of Public Utilities. "Grid Modernization." Available: http://www.mass.gov/eea/energy-utilities-clean-tech/electric-power/grid-mod/grid-modernization.html.

- **Improved customer satisfaction:** Customers benefit from data-driven services beyond reduction in their electricity bills. Access to new or improved services that are real-time and more customized and streamlined, compared to conventional utility services, could significantly improve customer satisfaction.
- **Improved DSM program performance:** Detailed customer data improves traditional DSM programs. Some utility experts indicated that personalized reports and outreach mechanisms have dramatically increased program participation. Targeted program implementation also increases customer awareness and attractiveness of the program to customers. The type of data available to design and execute a program will influence the magnitude of this benefit (see Section 2.1.3).
- **Reduced utility operations costs:** Utilities are already taking advantage of significantly reduced operations and maintenance costs (see Section 2.2.1 for more detail). The availability of data decreases costs of the following processes:
    - **Reduced manual meter reading:** Remote access to customer energy consumption data will significantly reduce or eliminate the need for physical visits to customer premises for meter reading (i.e., billing) purposes. It also reduces estimated bills, errors associated with meter readings, and customer complaints because of high-bill investigations or errors.
    - **Reduced manual on-demand meter connects and disconnects:** Remote access to customer energy consumption data significantly reduces the time required for various customer services transactions, for example: transfer a service, connect a new account, or disconnect for the final bill or for collection purposes. The transaction can take place immediately as the customer is requesting the transfer or new connect without requiring a visit to the customer premise to record the meter reading prior to the transfer or disconnect. It also improves customer satisfaction and the accuracy of transactions, reducing complaints and repeat calls to customer service centers.
    - **Improved customer service efficiency and effectiveness:** A better understanding of customer profiles and preferences makes utility processes more cost-effective and enables higher customer satisfaction by focusing on specific customer segments. Some examples include budget billing, consumption alerts to help customers manage their consumption, payment options enabled by mobile apps, notifications of outages, and periodic updates of service restoration status.
    - **Improved revenue protection and recovery:** Access to customer usage data enables utilities to implement accurate and sophisticated approaches to improve their revenue collection. Detection of electricity theft is a significant part of such efforts and it relies on advanced analytics of consumption data. Many solutions are available to assist utilities with identification of meter tampering. Other operational improvement programs in revenue recovery include pre-pay rate programs and remote service connects and disconnects.
    - **Reduced cost of DSM program measurements and verifications:** Where allowed by their regulatory environment, utilities are starting to rely on non-meter customer data (e.g., third-party home devices) to track the result of their DSM program results. This

non-meter customer data also allows utilities to manage load-capacity events in a more proactive manner and track results immediately.

2.1.3 Other Considerations

2.1.3.1 Types of Data Collected

The performance of utility DSM programs and enabling services and products by third-party vendors may vary, based on what types of data the utilities and third-party vendors collect and analyze. Some of the possible data types considered in different programs include the following:

- Interval kilowatt-hour (kWh) usage
- Interval kilowatt (kW) demand
- Household size/number of occupants
- Building characteristics
- Load characteristics
- Distributed generation (DG) and/or distributed energy resource (DER) performance
- Customer preference for communications
- Customer preference for DSM program participation

2.1.3.2 Customer Engagement Approach

Benefits of access to customer data that enables data-driven services and products will vary, depending on how those services utilize the data and how customers interact with the information presented. Some examples of the ways customer data turn into valuable, actionable information include the following:

- **Enhanced customer-facing operations:** Service providers leverage customer profiles and usage data to improve the effectiveness and efficiency of customer-facing activities, such as call center operations and marketing efforts. The available detailed energy consumption provides personalized data and information to support conclusions or recommendations.
- **Customized data presentment:** Presenting customers with their interval usage data may help them change their usage patterns, based on their preferences. In a more sophisticated application, utilities segment their customers based on needs and interests and develop personalized messages targeting specific needs. For example, budget-conscious customers interested in maintaining a low consumption level will receive timely alerts notifying them when their monthly energy consumption approaches a specified threshold or even their weekly energy consumption.
- **Unilateral utility/aggregator control:** A conventional direct load control and curtailment program may enjoy increased customer participation if the utility targets recruitment based on customer data.
- **Pre-programmed customer participation:** Enabling home devices such as programmable communicating thermostats will help customers respond to time-based incentives and pricing programs, while contributing to the utility's peak load management needs.

- **Automated customer load and resource optimization:** Advanced analytics of customer data could help customers balance multiple considerations such as energy costs, comfort, and prioritization of critical loads.

2.1.3.3 Benefits across Customer Segments

Evaluation of the costs and benefits of data-driven programs and services differs across customer segments. Certain DSM programs or third-party products target specific customer types (e.g., residential versus commercial/industrial), customer preferences (e.g., green-conscious versus budget-conscious), and customer locations (rural versus urban/suburban), in order to address specific customer needs and therefore create customer satisfaction or value.

2.2 Documented Examples of Customer Data Access Benefits

Although many market players, particularly third-party service providers, are developing new ways to access and extract value from customer data, the implications of many of these use cases are not well documented. Non-surprisingly, we found that several vendors treat such information with a high level of confidentiality. Vendors discussed generally how they are developing programs for customers to reduce energy consumption or to provide alerts to proactively monitor and manage their energy consumption. Significantly, many of the vendors are aiming to make the programs actionable based on real-time data to produce tangible results. Utilities are also working to develop these value-creating services, but vendors are able to provide more real-time data instead of the near real-time data or interval data which utilities receive from their AMI systems (see Section 3.3 for a more detailed discussion).

Much of the publicly available literature that discusses benefits of customer data focus on two conventional avenues through which access to customer data provides value to stakeholders, particularly for utilities today:

- *Informing or guiding utility operations*, which helps the utility to achieve benefits such as reduced cost, improved asset utilization, improved customer experience, and more
- *Presenting customers with their usage data* in a useful, actionable form, which primarily results in reduced electricity bills, reduced peak load, or both

One example of how utilities are using customer data to improve the customer experience was provided by one of the third party vendors. This vendor had just announced a new solution line to assist utilities with tools that would enable them to provide better customer care. These tools use AMI data in conjunction with communications guidance to create a robust solution focused on providing more personalized information to customers calling in with an inquiry, and thus reducing the number of call backs for the utility.

2.2.1 Impact on Utility Operations

Near real-time customer energy usage data is a valuable resource to the utilities that collect it. It gives utilities a far more complete picture of the workings of their system and enables them to provide services that redefine the utility–customer relationship. Compared to the monthly data obtained by traditional

metering, real-time data provides the utility with tools to help diagnose outages, communicate with the customer about billing and outages, and increase billing accuracy.

2.2.1.1 Data Leveraged

To help customers maximize benefits from their data, utilities try to anticipate customers' needs, in addition to measuring their electricity demand and usage. Customers' ability to take advantage of data, feedback, and new data-driven products and services will vary. Whereas in the past utilities planned according to their total system demand, they now need to define more-detailed profiles of their customers.

Conventional customer identification tracks three customer categories: industrial, commercial, and residential. However, every customer has unique needs, and each category includes groups with similar behaviors, expectations, or both. For example, industrial customers include electronic manufacturers and laboratories, which have different operational and energy needs. A laboratory might find few options to reduce or change its electricity usage habits, while an electronic manufacturer can flexibly schedule work shifts or optimize its equipment to conserve electricity. Similarly, commercial customers such as restaurants may find it challenging to reduce electricity usage because they want to maintain ambiance, while a big-box store can cycle its heating, ventilation, and air conditioning (HVAC) system. Residential customers include households of renters who do not have incentives to install efficiency measures, such as weatherization or high-efficiency appliances, and families caring for someone on a medical device that cannot be turned off.

Understanding all of these customer needs is the starting point for utilities to offer new services to customers. For example, customers who cannot shift or reduce their electricity usage are still able to reap the benefits of data availability through other products and services, such as pre-pay rates, high bill alerts, and outage restoration time estimates. Utilities will engage customers when the value of new services and products exceed the required effort to evaluate and participate in these new offerings.

2.2.1.2 Utility Operational Practices

Comprehensive and real-time energy-usage data creates a variety of benefits to utilities. Utilities with AMI are able to streamline operations in a number of ways by leveraging its remote communications capabilities. Most obvious among these operational benefits is automated meter reading. This reduces the costs associated with the manual reading of each customer's meter, such as labor, truck rolls, and site re-visits, and it provides both precise on-cycle data for billing and off-cycle data.

The interval data produced by AMI also creates the possibility for many new utility offerings, such as expedited outage response, increased billing accuracy, and theft detection. Expedited outage response is a multi-faceted service that can include outage messages sent directly to the smart meter, improved outage restoration time due to insights from the AMI data, and increased detail in customer service communications. Theft detection and increased billing accuracy are achieved by analyzing interval usage data. Accuracy is improved because there is no longer a need to estimate usage, and usage may be cut off at the exact moment of disconnect. Similarly, theft can be detected by comparing customer data to distribution data.

AMI provides other operational improvements for utilities beyond those created by the meter data. The wireless communications imbedded in AMI equipment give utilities the ability to remotely connect and disconnect customers from the grid. This capability eliminates the need for a physical trip and is especially valuable in short-term rental situations where frequent connection and disconnection is desired. While these improvements in utility operations are substantial, further benefits of AMI data may still be attainable in areas such as planning, maintenance, and upgrades.

2.2.1.3 Examples of Outcomes

Utilities across the country are already realizing operational benefits from AMI systems. The reduction in meter reading operations costs is especially striking. As part of the Smart Grid Investment Grant (SGIG) Program, the Town of Danvers, MA installed an AMI system and reduced meter reading costs by 40%[5]. Tri-State Electric Membership Corporation similarly reduced their meter operations costs by 65%[6], and Central Maine Power achieved $6.7 million in total savings[7]. These cost savings are due to reduced truck rolls, labor, and eliminated manual connects/disconnects.

Another area of proven operational benefits is billing accuracy. Central Maine Power and the Town of Danvers, MA had equally positive results in this domain, posting respectively a 90% reduction in the number of estimated bills and $240,000 in labor savings from improved bill accuracy[5, 7]. Duke Energy demonstrated how AMI-related billing improvements could improve customer service. By using their AMI system for billing, Duke reduced billing disputes by 1.4 million in 2013.[8]

AMI system data has also been demonstrated to have a positive effect on outage response. PECO has shown that, even at lower AMI penetrations (approximately 10%), they were able to reduce electric restoration time by an estimated three days. This improvement was augmented by their new ability to remotely confirm power restoration, as demonstrated over 5,000 times following Superstorm Sandy in 2012.[9] These service enhancements were a direct result of the data and communication abilities of the AMI system.

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[5] "Municipal utilities' Investment in Smart Grid Technologies Improves Services and Lowers Costs", U.S. Department of Energy, Published October 2014, Available: https://www.smartgrid.gov/sites/default/files/doc/files/B4-revised-10-03-2014-100614.pdf.

[6] "Smart Meter Investments Benefit Rural Customers in Three Southern States." U.S. Department of Energy, Published March 2014, Available: https://www.smartgrid.gov/news/smart_meter_investments_benefit_rural_customers_three_southern_states.

[7] "Smart Meter Investments Yield Positive Results in Maine", U.S. Department of Energy, Published January 2014, Available: https://www.smartgrid.gov/sites/default/files/doc/files/Central%20Maine%20Power%20Case%20Study_0.pdf.

[8] "Integrated Smart Grid Provides Wide Range of Benefits in Ohio and the Carolinas", U.S. Department of Energy, Published September 2014, Available: https://www.smartgrid.gov/sites/default/files/doc/files/C7-Duke-Energy-Case-Study-FINAL-092914.pdf.

[9] "Smart Grid Investments Improve Grid Reliability, Resilience, and Storm Responses", U.S. Department of Energy, Published November 2014, Available: https://www.smartgrid.gov/sites/default/files/doc/files/B2-Master-File-with-edits_120114.pdf.

2.2.2 Impact on Demand-Side Management Programs

Real-time electricity information empowers customers to manage their electricity costs because they gain insight into the amount and cost of electricity they are consuming at a given moment. Customers can use this information to make short-term and long-term decisions about their electricity usage. For example, in the short term, a residential customer might decide whether to postpone doing laundry, based on usage and rate information. In the long term, that customer might decide whether to purchase a higher-efficiency dryer based on his or her own usage data. Commercial and industrial customers can use this real-time information to identify operational inefficiencies.

2.2.2.1 Customer Use of Data

Customer interval data creates new opportunities for all customer classes to participate in demand reduction programs. Without AMI systems, time-based rates and demand response would be impossible for all but the largest industrial customers. Additionally, detailed interval data is more effective than a simple bill at creating changes in consumer behavior. This data thus provides a better channel to influence consumer behavior because it can be presented in a way that is more individualized and customized.

Information empowers customers to manage their electricity costs because they gain insight into the amount of electricity they use, and the cost of electricity at a given moment. Customers can use this information to make short-term and long-term decisions about their electricity usage. In the short term, a customer might decide whether she will postpone chores based on usage and rate information. In the long term, a customer might decide whether to take steps to improve efficiency. For example, a residential customer might consider his energy consumption when selecting a new appliance or deciding whether to purchase an EV, while a commercial or industrial customer might consider revising its operations. As discussed above, information can be presented in a variety of ways, from showing interval usage and rate data on a web portal to providing peer comparisons or customized alerts.

Customer opinion about the information's usefulness will vary. Some customers may see the information as valuable in managing their electricity costs, while other customers may not prioritize their electricity bill. Of the customers who are interested in managing their electricity costs, some customers might find it easy to understand, while others find it overwhelming. Depending on how they perceive the data, some customers will use this information directly to make decisions about electricity usage, while others might prefer to program an energy management system to interpret data and automate tasks.

2.2.2.2 Typical Program Design and Objectives

Utilities and service providers are continuously exploring how to make the provided information timely, actionable, and accessible. A generic website that displays unfiltered data is not compelling to customers, so its usage decreases quickly. To make the information more compelling, many successful services combine usage data with additional customer information from third-party resources, such as data collected from devices at the customer location, weather, and comparable household consumption habits. It is also critical to make the information easy to understand and, as applicable, manipulate. The value to the customer must be greater than the effort involved in either tracking or analyzing the data.

Customer value depends on the needs and wants of the specific customer or customer segment. To some degree, this is unchartered territory for utilities.

The customer can also provide some detailed information, such as energy conservation goals, desired bill savings, building information, household size, DER capacity, and preferences about how to access information (e.g., online, via a "weekly digest" email, paper bill insert, and text messages). To increase the number of times that a customer will access the data, the utility or service provider considers all these factors, which enable customers to access information across a range of devices and protocols in a holistic fashion. To date, information that customers have been interested in viewing include their usage statistics, an estimate of their potential expenses if they were to switch to another rate, identification of unexpected usage, and resolution of questions about their bills.

However customers choose to obtain their data, they can use it to fulfill their unique needs. For example, a residential customer can stay apprised of issues regarding the monthly bill through high bill alerts. Industrial customers who get information about their loads can better manage their electricity consumption to gauge their operations demand and prioritize capital spending for energy efficiency improvements. When an industrial customer receives detailed load information, they gain insight into the "black box" of electricity costs and can see how they are being billed for capacity, transmission, and local distribution. Many industrial customers do not have a line item to manage electricity, which is typically their third most expensive operating cost. When they have insight into how their electricity usage changes by time of day, season, and weather conditions, they can budget and plan for electricity consumption better. Customers might be less caught off-guard by electricity price shocks related to extreme weather, such as the 2013 Polar Vortex, if they gain insights from their electricity usage data in combination with weather data.

2.2.2.3 Examples of Outcomes

Detailed electricity usage data supports a variety of new utility services, such a web portal for customer information, insight into service restoration, faster bill resolution, and feedback on energy usage. Such feedback includes electricity usage interval data, appliance or equipment loads, and high-usage alerts. According to Neenan, et al., studies have shown that, on average, customers reduce their demand by 10%—and as much as 18%—when they receive feedback on their usage.[10]

Utilities can offer new rates, such as time-based rates that incentivize customers to use electricity during off-peak rather than on-peak periods, because they can now measure how much electricity is used during on-peak and off-peak hours and charge customers accordingly. Utilities are also designing incentive programs to encourage customers to change their behavior. Customer response to incentives increases when they have devices that help them manage or automate their response. For example, Oklahoma Gas & Electric (OG&E) offered customers a variable peaking price with critical peak event with the option of using a web portal, in-home display, or programmable controllable thermostat (PCT). The customers with a PCT reduced their peak demand by 30%, much more than the customers who relied on the web portal or in-home display for information. OG&E customers credit the PCT for

[10] Neenan, B., J. Robinson, and R. N. Boisvert. "Residential electricity use feedback: A research synthesis and economic framework." Published by Electric Power Research Institute (EPRI), 2009.

providing the greatest control over their electricity usage during peak and off-peak periods. The in-home display was as effective in aiding customer response to critical peak event as the web portal.[11] PCTs are one step toward helping customers manage their electricity.

The utility can also help customers manage their bills through a pre-pay program or high-bill alert program. A pre-pay program allows customers to pay for service ahead of time, similar to a pre-pay cell phone service. The customer can sign up for an alert via text, email, or phone when she gets close to spending her pre-paid amount. Similarly, high-bill alert programs issue an alert when the customer's net usage for the month hits a preset threshold. The alert informs the customer that he will have a higher bill than normal if he does not change his electricity usage. Customers have reduced their electricity usage by 14% with a pre-pay program and in-home display,[12] and by 3% with bill alerts.[13] Customers who are benchmarked against their peers reduce their consumption at a similar rate of 1.4%–3.3%[14]. Based on these customer response rates, customers appear to reduce their electricity usage by at least 2% with feedback about their usage or customized alerts. Utilities can likely improve this response rate with more customized information and alerts.

[11] "Demand Response Defers Investment in New Power Plants in Oklahoma" U.S. Department of Energy, Published April 2013, Available: https://smartgrid.gov/sites/default/files/doc/files/OGE%20CBS%20case%20study.pdf.
[12] Faruqui, Ahmad, Sanem Sergici, Ahmed Sharif. "The impact of informational feedback on energy consumption – A survey of the experimental evidence" Energy (2010) 1598-1608.
[13] George, Stephen, Michael Sullivan, Josh Schellenberg, and Taylor Smart. "Central Maine Power Bill Alert Pilot Evaluation" November 20, 2013.
[14] Hunt Allcott. "Social norms and energy conservation" Journal of Public Economics (2011) 1082-1095.

3. Key Trends and Outlook

Third-party vendors and utilities believe that access to customer data will dramatically transform the ways in which service providers of all varieties develop, design, and deliver their services to customers, particularly in the retail energy market. This chapter discusses, at a high level, various drivers that are behind this market evolution, as well as the types of services that are emerging because of these market drivers.

3.1 Empowered Customers

Customer preferences are becoming increasingly diverse. The "one size fits all" mentality no longer describes how businesses interact with customers. Even in the traditional energy sector, industry players have found that their customers wish to prioritize different objectives. While environmental consciousness drives some customers' decisions, others might focus on cost-effectiveness or convenience of using web-based and mobile applications to conduct business. Other customers are early adopters of new technologies and services.

Today's consumer markets enable and empower customers with more choices, and if their needs are not being met, customers have outlets and means to ensure their voice is heard. For example, AARP maintains a strong voice in the energy sector to ensure that the industry players are cognizant of different generational attitudes, focuses, and expectations. Some other groups with strong opinions in the energy sector include the following:

- Local energy consumer advocates
- Building management associations
- Consumer Energy Alliance (CEA)
- Environmental groups
- Commercial/industrial industry groups

Customers have higher expectations for quality of service and less tolerance for inefficiency on the part of their service providers. In a deregulated energy market, where there are other energy and service providers, customers may change service providers immediately if a different option would better meet their needs. Third-party providers know that customers are increasingly conscious of how they spend their time and money. Abundance of data and market information further fuels customers' interests and demands for services and products that help them achieve their desired outcomes. With access to data, customers can much more easily evaluate options and determine with whom and how they want to conduct business. Third-party vendors that capitalize on these unmet needs and gaps in customer experiences are in the best position to compete against and excel past the incumbent service providers.

3.2 Confluence of Interest in Customer Data

Three key trends that cut across industries are driving value from customer data access:

1. Advancement in data analytics solutions

2. Targeted marketing and consumer engagement
3. The "Internet of Things"

These trends, which are being honed in other markets, have significantly changed how services and products related to information are being developed and marketed to customers. Third-party vendors and some utilities collect and manage data to create value to customers by addressing customers' needs and wants. Some typical and proven examples in the energy space is to provide customers with insights into their electricity usage and help them manage tasks such as turning on the washing machine or changing the ambient temperature to what types of appliances to buy and use.

3.2.1 Advancement in Data Analytics Solutions

With the advent of Big Data[15], many businesses have created value by accessing data from different facets of our lives. Through data mining and advanced analytics, large and small businesses are able to glean insights from significant volume of data to pursue new business opportunities, by segmenting the customer population to understand and isolate specific unmet needs and subpar customer experiences. There are myriad examples of this trend, which can be organized into three categories:

- **Tracking of web-based transactions** (e.g., retention and analysis of e-commerce transactions to decipher behavioral trends)
- **Targeted marketing and consumer engagement** (e.g., determining best marketing protocols to focus and personalize advertisements and marketing messages)
- **Low-cost, ubiquitous connectivity** (e.g., mobile applications through smart phones and tablets have opened new forms of communications and transacting business)

3.2.2 Targeted Marketing and Consumer Engagement

In a data-driven effort to provide more value to customers, leaders in many industries are strategically bundling products and services that were once independent and standalone. Examples abound in telecommunications, information technology (IT), grocery stores, and beyond, where vendors improve customer satisfaction and win customer loyalty through increased convenience and cost-effectiveness. In addition, product bundling increases revenues while leveraging existing processes. Established vendors and newly forming businesses alike are seeing sizeable opportunities in applying these bundling of services to the energy area. Combining customer behaviors and attitudes at home and businesses with energy consumption patterns provides many opportunities to create valuable products and services. Our discussions with many third-party vendors identified this bundling trend as one ripe with opportunities in the energy sector. Some ideas mentioned during our stakeholder engagements include the following:

- Combining consumption with movement at home for elderly customers living alone to detect variation in behavior to alert emergency services in case of accident or injury
- Providing greater flexibility and monitoring with security systems

[15] According to Snijders, et al. (2012), Big Data is a "loosely defined term used to describe data sets so large and complex that they become awkward to work with using standard statistical software."

- Alerting customers that energy consumption variation is occurring for a vacation or second home

As data sharing becomes more critical for the innovation of these services and products, some utilities become increasingly focused on the implications of customer data privacy. Data availability and data security are challenges to overcome, but not exclusive to the electric industry. The third-party vendors, utility personnel, and public utility commission staff we interviewed were confident that these are not "show-stoppers," as we will further discuss in Section 4.2.1.

3.2.3 The "Internet of Things"

The third trend is the "Internet of Things," a world in which everyday items, from home appliances to phones and printers, are integrated online and remotely controlled and monitored. The International Data Corporation (IDC) projects this trend to create a market that could reach $7.1 trillion by 2020.[16] This increasing market opportunity is expected to automate home and business transactions through mobile applications, creating convenience and customer dependencies for every day simple tasks. In the energy sector, commercially available products allow customers to control their air conditioner, and this connectivity could expand to starting the dishwasher, monitoring the home movement or lighting, switching to solar energy at a specific time, and beyond.

3.3 Diversified Inputs to Flow of Customer Data

As innovation continues to drive data-driven products and services, so do the technology and mechanisms to capture and track the data. Some utilities are continuing to improve their flow and management of data, but so are the third-party vendors that are motivated by market opportunities to overcome barriers to availability of data. In this section, we will discuss the utility's data flow and existing barriers for data availability to vendors. We will also begin a discussion on how third-party vendors are bypassing the utility to obtain the desired data.

Data security remains an area of significant focus and is central to ensuring that customers maintain control over their data. The utilities and third-party vendors that we spoke with emphasized this fact, as it is critical to ensuring the value of customer data collection and use. Customer data is routinely audited, following DOE data security guidelines and financial-firm-grade Service Organization Controls (SOC) 2[17] security audit standards. Multiple experts at state regulatory agencies noted that the energy sector may be able to leverage best practices and innovations from the finance sector to improve data security such as having external firms conduct annual reviews of their data, processes, and protocol. There is also a precedent in some of the regulatory environments in how to deal with these challenges and ensure privacy rights of customers are being considered.

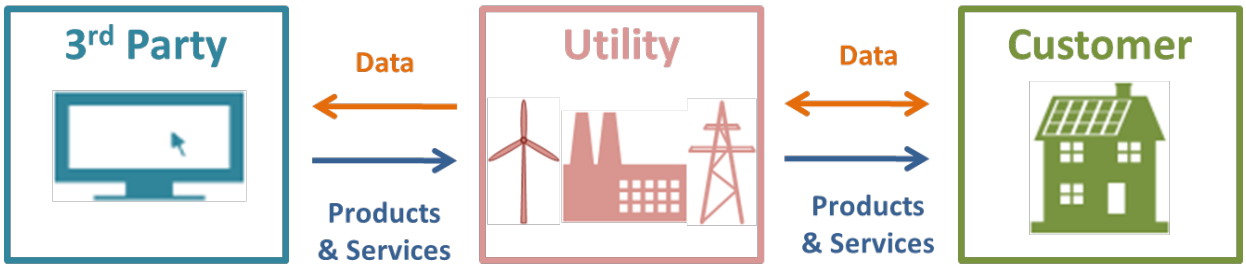
[16] Spencer, Leon. "Internet of Things market to hit $7.1 trillion by 2020: IDC." ZDNet, June 5, 2014. Available: http://www.zdnet.com/article/internet-of-things-market-to-hit-7-1-trillion-by-2020-idc/.
[17] SOC are accounting standards that measure the control of financial information for a service organization. SOC 2 was established in January 2014.

3.3.1 Utilities' Flow of Customer Data

For utilities, the implementation of AMI has been the most significant factor that enables customer data access. It has enabled important operational efficiencies for those utilities that have implemented and leveraged AMI. Before smart metering, utilities provided customers with information about their electricity usage primarily in their monthly bill, and frequently, the utility had to estimate customers' electricity usage when faced with logistical issues with obtaining the monthly meter readings. When customers questioned their monthly consumption, which typically resulted in a lengthy call, it was a painful experience for customers, who often had no real basis available to defend or contend the number. Sending a meter reader to the location was frequently the best manner to ensure the meter was not faulty or the meter reader had made an error.

Utilities with AMI assets currently own the data collection hardware, and they collect, process, and secure the customer data. As shown in Figure 3, this structure places utilities in a central role on consumer data and value creation. It provides utilities with a competitive advantage, as they connect with each customer and have important pieces of information that can be used to create consumer and stakeholders' value.

Figure 3. Schematic of Utility-Centric Flow of Customer Data



Source: Navigant Consulting

However, despite utilities' relationship with the customers and various pieces of consumer information available to them, utilities in the near future will likely face significant challenges in maximizing the value of information and its relationships. Simultaneously, vendors relying on utilities' data to drive products and services are also impacted by these barriers, and will search for new technology and processes to overcome them. Some of the significant barriers that will need to be addressed in the future include the following:

- **Low data collection frequency:** The prevalent practice among utilities today is to track and collect data from the customer meter in one-hour or 15-minute intervals. Advancements in data analytics offer great promise for service providers to enhance the convenience and effectiveness of their services by using data that are collected more frequently—in order of minutes or even seconds. However, the current utility practice diminishes the data value and the opportunity to be more proactive and actionable.
- **High data latency:** Smart meter data is typically sent to the utility only once or a few times per day, depending on the AMI system and configuration. The utility back-office system (e.g., meter data management system [MDMS]) then processes this information or consumption data to

"clean" it for anomalies or gaps, allowing it to be meaningful and usable for operational purposes (e.g., billing).[18] This process takes one to two days at a minimum, further reducing the value of data. It is also a significant barrier for utilities as changes or new technologies cannot be implemented without impacting significant Information Technology (IT) infrastructure.

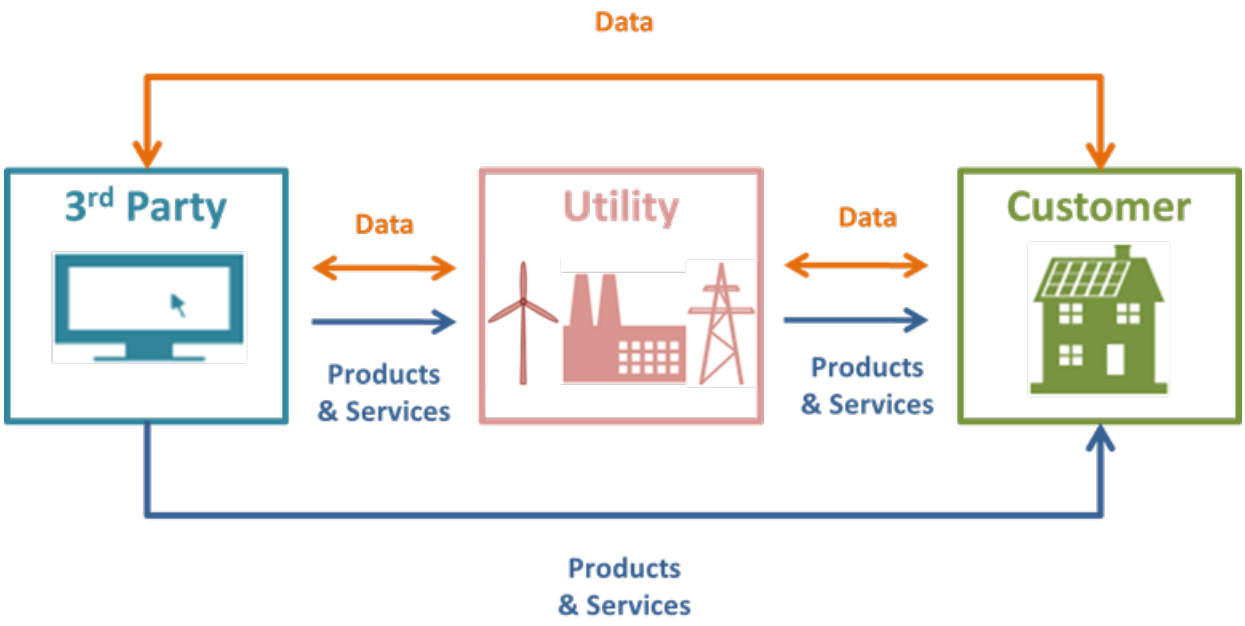
- **Gap in AMI coverage:** Not all utilities currently have AMI systems. Lacking interval or real-time consumption data will effectively preclude some utilities, and third-party service providers that depend on utility smart meter data, to enable their services from providing consumption services to customers of such utilities. Furthermore, even utilities that have an AMI system may not have deployed it to cover their entire service territories.
- **Limiting regulatory environment:** Unavailability of consumption data or limited access to third-party vendors due to the regulatory environment creates another layer of complexity for vendors dependent on utilities' data collection process. This results in limited opportunities or at worst, totally cripples opportunities for vendors. Even when utilities are able to provide certain data to vendors, some third-party vendors noted that the time required for file transfer may take up to four to six months, significantly reducing value of the data. This also puts utilities at a disadvantage, as this could preclude them from contracting vendors or third parties to augment their databases with additional information and provide valuable services to their customers.
- **Costs and time to update system infrastructure:** With rapid and continuous innovation in supporting technologies, the existing metering infrastructure may not be able to support functionalities or capabilities that new services and products might require. It is costly and time-consuming for utilities to update systems infrastructure and interoperability. Some cost drivers include the network investment, IT support, and process and organizational changes. The level of accuracy that utilities need for billing is not required for vendors developing services to manage energy consumption, providing vendors with a cost advantage when keeping up with the newest technology to provide services.

3.3.2 Vendors' Flow of Customer Data

While most vendors or third-party providers traditionally depended on utilities for information in order to provide customer products and services, evolving technologies have created new types of energy monitoring and are following on the heels of AMI. Solar monitoring, smart grid sensor networks, affordable sensor monitoring (such as the ones used in smart buildings), and soon battery and electric vehicle (EV) monitoring are some examples of streams of information on customer energy usage that do not depend on the utility. These new streams of data provide vendors with the opportunity to develop software and create applications and programs that are offered directly to customers, thereby bypassing the utility. Additionally, the data constraints described in Section 3.3.1 are motivating factors for vendors to continue to find ways to access data directly to create customer value. Figure 4 shows how the traditional data flow is updated with vendors and data bypassing the utility, directly from the third party to customers, to create value and meet customer needs.

[18] See Figure 6 in Section 4.1.1.

Figure 4. Schematic of Diversified Customer Data Flow



Source: Navigant Consulting

With customer's needs at the center, driving new services and products, equipment manufacturers and third party vendors will continue to develop services and programs independently of the utilities. Advancement in this area already occurring includes the following:

- **Sensor networks** provided by equipment manufacturers and focusing on meeting utilities and market entrants to provide real-time data in a much more affordable manner. These networks have already proven useful in automating and optimizing distribution grids, often with applications developed by third parties for utilities.
- **Monitoring devices** associated with emerging energy sources such as solar photovoltaics (PV), microgrids, and EVs, where the information could be transmitted to third-party vendors directly.
- **Advancing sensor technologies** that leverage affordable smart sensors used to enable customer action for energy efficiency or demand response. In the energy industry, these technologies are being leveraged to communicate with each other and share information, as in smart buildings and home automation.

With thousands of vendors and market entrants focusing on this market[19], the opportunities to develop products and services are significant, as are the opportunities for utilities and regulators to navigate this evolving energy model in order to remain relevant and provide ratepayers with the best options.

3.4 New Service Offerings

There are significant opportunities in the energy market for innovating new services and products. Where customers' choices are increasing as their role as an electricity market participant evolves, vendors and market entrants continue to focus on meeting needs and wants driven by the availability of data and emerging technologies. One utility stated that they receive about 50 emails per day from third-party providers requesting information to serve small commercial customers better with various services in the areas of energy efficiency. While many of these services have been available to large commercial and industrial customers, the availability of data has enabled vendors to provide these services to accounts with smaller energy consumption.

The traditional data flow as presented in Figure 3[20] is built upon utility-owned AMI and associated communications infrastructure. As Section 3.3.2 discusses, this model of utility-centric collection, storage, and sharing of customer information is being challenged with emergence of more fluid and customized data flow, as presented in Figure 4.

Figure 5 shows an emerging model where data flows fluidly among stakeholders, and vendors and third-party service providers leverage this new data and technology to create customer value. We have identified five areas within the model where data is available and products and services will create value:

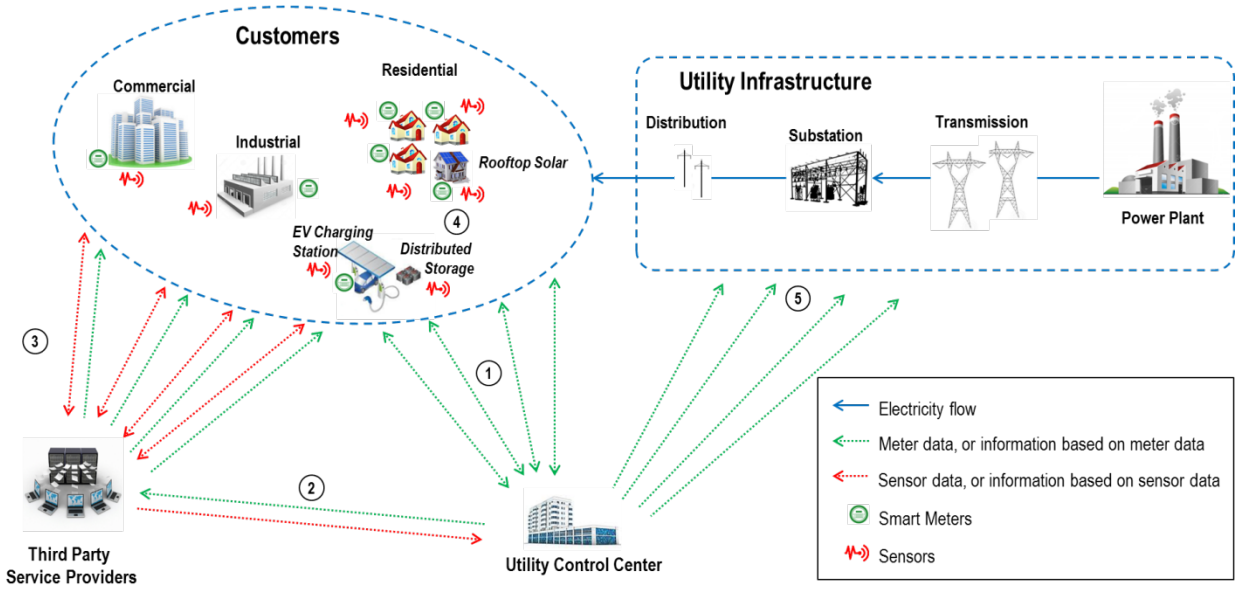
1. Bills, consumption patterns, and customer information driven by utilities (e.g., more innovative pricing structures such as fixed monthly rates for access to electricity with lower cost per kWh, fixed monthly rates for a specified kWh consumption with the ability to carry over, and weekend special rates)
2. Innovative uses to identify new services using data analytics by third-party vendors to provide value to utilities and customers (e.g., task automation and advanced customer segmentation based on behavioral patterns)
3. Data gathered by third-party vendors with their own sensors and equipment to provide new services and bypass AMI constraints (e.g., real-time electricity usage data)
4. Data gathered by monitoring systems imbedded in emerging technologies (e.g., distributed energy resources and electric vehicles) and used for data mining to help utilities and customers

[19] While there are no citable references on the number of entities providing data-driven services in the U.S. energy sector today, the industry experts and stakeholders Navigant engaged believed that there is a significant number of players—in order of thousands. While some are well-established in the energy sector, many are not well-known but either playing in or entering this market.

[20] See Figure 6 for an illustration of how meter data is recorded, transmitted, and processed by utilities and how products and services are developed.

5. Data gathered by utilities and sensor networks to improve their operations, energy demand projections, and projection of financial information

Figure 5. Illustrative Operational Model of Electric Utility with AMI



①	A key business case for many smart meter deployments is efficiency improvements around meter reading and billing. At a minimum, utilities present detailed usage data back to the customers, through the Internet, in-home devices, and/or monthly bills.
②	Third-party vendors provide data analytics service to turn the large volume of smart meter data into information and knowledge that is actionable for both utilities and their customers.
③	Some third-party vendors are starting equip utility customers with their own sensors to collect data that is currently not available through the utility's AMI system, to offer further value-added services to both utilities and customers.
④	Smart meters and sensors collect various customer data to be analyzed by utilities and vendors. Some examples of data collected include aggregated usage through smart meter, HVAC settings and loads through smart thermostats, and outputs from customer-owned DER.
⑤	Utility uses customer data (smart meter data and vendor-provided data) as one of the inputs to guide and control the operation of generation, transmission, and distribution assets.

Source: Navigant Consulting

4. Key Challenges and Opportunities for Utilities and Regulators

The following discussion focuses on the implications of the energy market evolution and access to customer data for utilities. We will also explore what the evolving customer options and utility business model mean for regulators. In our conversations with third-party vendors and utility personnel in the field, we learned that there is a need to standardize data collection and access. Utilities may need to expand their roles from being a sole source of electricity and distribution to enabling new services for their customers by securely storing and releasing data if their customers request that it be shared with other parties. Regulators will need to expand how they consider the costs, benefits, and rate recovery mechanisms of utility investments, especially now that many parties can gain the benefits. Regulators' roles may also become more focused on consumer protection, as has occurred in the telecommunications industry.

4.1 Implications for Utilities

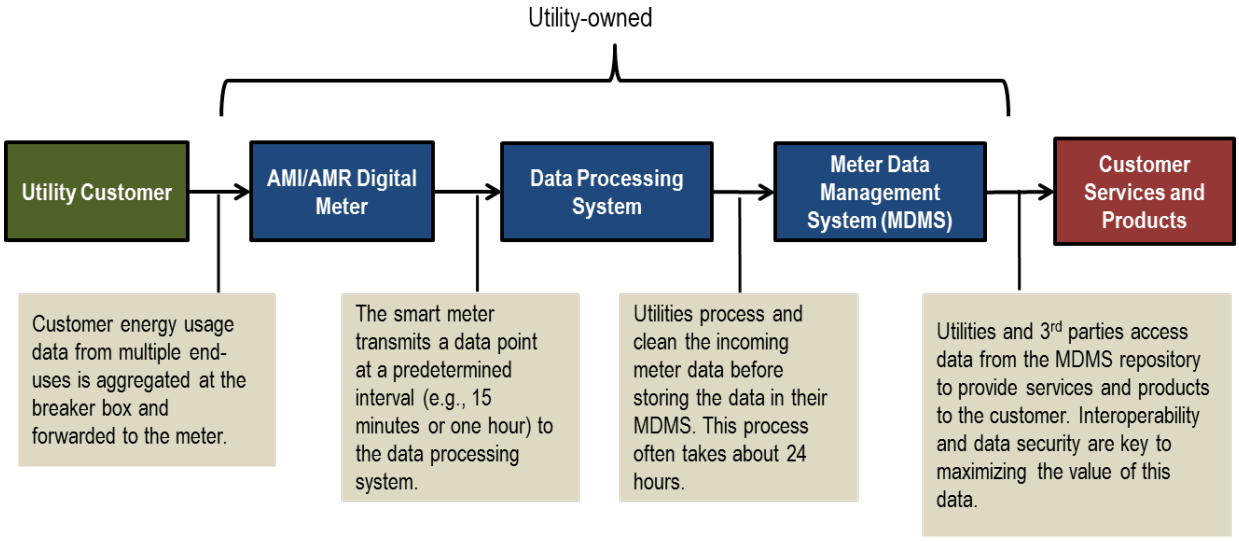
4.1.1 Challenges for Utilities

The traditional role of utilities as the only energy service provider is starting to change. With different energy sources becoming available with improved cost-competitiveness (and other technologies such as residential energy storage and EVs), many utilities may find themselves competing with third-party aggregators and vendors to serve the customer. Products and services that third-party service providers and vendors are developing may also challenge utilities. Competition may arrive in many forms. Based on our research and discussions with different organizations, there is a consensus among the groups that the next best idea (driving product and/or service derived from data access) is still being formulated. The new environment will challenge utilities, which will need to adapt strategically to manage costs, ensure customer satisfaction, and maintain their value propositions in the industry. Some of the challenges identified through our discussions with industry experts include the following:

- Large number of established businesses and start-ups (venture capital-funded or small businesses) focusing on this space with higher flexibility, faster decision-making processes, and the ability to focus on only one customer segment/process/opportunity while leveraging market and other industries' processes
- Increasing availability of customer data, including energy consumption data, to third parties, which in many instances bypass the utility and other existing barriers
- Data privacy considerations and guidelines that would be accepted by the regulatory environment, customers and applicable laws in area served
- Inflexible systems infrastructure and interoperability issues, creating significant time lags to implement new processes, technology, or ideas
- Need for forward thinking and planning in order to leverage past infrastructure investments (e.g., AMI) to stay cost-competitive and relevant in the information flow
- Regulatory approval process impeding quick decision-making and/or flexibility in some areas

- Utilities' responsibility toward all customers and to abide by regulations (i.e., cannot sacrifice some to maximize value for others)
- Established (and aging) workforce focusing on the traditional operational processes and efforts, without the skillset or pertinent experience to innovate and/or create new programs focusing on engaging customers
- Internal resource constraints, especially among municipalities and smaller utilities
- A narrowly focused view of data and opportunities to innovate (see Figure 6 below for a schematic of how most utilities view data today and the corresponding opportunities for customer services based on data flow)

Figure 6. Schematic of Customer Data Processing Flow for a Utility



Source: Navigant Consulting

4.1.2 Opportunities for Utilities

The availability of data access provides utilities with opportunities to continue to develop new customer services and options. However, as is often the case, there are time constraints to capitalize effectively on these opportunities. Utilities that are planning and strategizing now about how they can best serve their customers—and position themselves in this new environment—will have a significant competitive advantage over other utilities and vendors. On the other hand, once the technologies mature and data flow patterns become better established, influencing the outcome or utilities' position will be much more difficult.

As third-party vendors are starting to capture and track data directly from customers in order to overcome issues inherent in working through utilities, utilities have much to offer in collaborating with them to provide customers the best of both worlds. They have an opportunity to collaborate with vendors to leverage all available streams of data in such way that they could leverage their customer relationship and vendor innovation. For instance, there are industry leaders such as EPRI who envision the future of smart grid devices as open application platform. An open standard that supports

independently developed applications would enable many market players beyond utilities and established hardware and software vendors to develop "apps" for that could support utility operations as well as customer interest. If utility-owned system were to be leveraged as a platform, utilities, as the system owner/operator, would be in the best position to exercise control and judgment over evaluating, testing, and approving use of these apps.[21]

This presents utilities with an opportunity to collaborate with customers and vendors to influence the evolving energy model and guide customers navigate among all the available options.

Some of the competitive strengths or advantages for utilities identified include the following:

- Existing relationship with customers and the credibility that comes with it
- Access to customer information and, if an AMI system is installed, the customer's interval usage data
- More resources and structure than most start-ups, which could put such utilities at a relative advantage with large-scale technology implementation
- Knowledge of customers' energy needs based on customers' segments
- Understandings of certain customer behaviors and profiles (e.g., consumption patterns, how often customers move, and second or vacation homes owned) based on a longer relationship with their customers
- Institutional knowledge and experience with data security protocols, which, coupled with the customer trust that many utilities enjoy today, could be perceived as preferable over small or start-up businesses

4.2 Implications for Regulators

4.2.1 Challenges for Regulators

A key charter of utility regulators is to ensure that all ratepayers have equitable access to utility services and energy options. Regulators will be challenged to maintain their current obligations and to understand how the current trends and evolving technology will affect their jurisdictions. In order to develop the proper regulations in their areas and create a regulatory environment that supports economic growth and equity, regulators will need to determine how they will support or influence the changes occurring in this market sector. They will face different regulatory risks and impacts, depending on the following conditions, among others:

- The economic and regulatory environment of the areas they serve
- The makeup of the customers and industries present within their jurisdiction (and therefore the customers' needs and wants)
- The current situation with utilities load, capacity, and projected energy demand

[21] Seal, B.. "Transforming Smart Grid Devices into Open Application Platform." Technical Update published by Electric Power Research Institute (EPRI), July 2014.

- The rate of integration of renewable and/or disruptive energy sources (e.g., rooftop solar PV, energy storage, and microgrids)
- The position of critical stakeholders (e.g. government and influential consumer groups)
- The cost-effectiveness of generation and operations in their areas

The availability of third-party data-driven products and services that are offered to only certain customer segments, and the corresponding data security risks, will also challenge regulators. To this end, regulators may need to take an active role in emphasizing interoperability between utility, customer, and third-party vendor products and services.

The third-party vendors and utility personnel we spoke with highlighted data availability and data security as challenges that are best addressed by the regulatory environment, especially if the market is saturated with vendors providing data-driven customer services. However, the same third-party vendors and utility personnel discussing these challenges were confident that these are not "show-stoppers." Some of the observations include the following:

- Data management solutions can be transferred from other industries to minimize the risk and liability
- Customers need to control or voice which data they are comfortable sharing, and with whom
- Customers allow personal data-sharing whenever the benefit from the products/services is greater than the risk
- There are existing data privacy regulations and guidelines that can be used as examples for other states such as:
    - Texas Public Utility Commission has data access provision which states that the data belongs to the customer; in 2011, they implemented a database with customer interface allowing customers to share energy consumption data with third parties.
    - Colorado Public Utility Commission has customer data provisions being reviewed by an administrative law judge to establish how the two main utilities will govern customer data.

New data-driven services that help lower technical barriers to grid integration of DER systems, coupled with possible future increases in overhead costs for conventional power generation, may result in a significant increase in the penetration of customer-sited DER systems, especially for areas with a high number of large commercial/industrial customers. These may include residential energy storage, cost-effective renewable energy and disruptive energy sources (e.g., rooftop solar PV), and other disruptive energy sources. Equitable access to DER may emerge as a pertinent issue to many regulatory jurisdictions.

4.2.2 Opportunities for Regulators

The impact of these market changes and access to data will not only present challenges, but also great opportunities. Regulators will play a critical role in how the market will be shaped in their territories and as a whole. We have identified the three most likely scenarios given the need or appetite for regulatory

change. In each of these scenarios, the relationship among customers, data, utilities, and regulators takes different directions as the market develops over the course of the next decade:

- **Regulators drive** a new energy model with innovation of customer services and pushing implementation of renewable energy sources. They will be driving engaged, empowered customers who will play a significant role as market participants and decision-makers. This scenario is more likely in states with more aggressive and ambitious energy policies that target renewable energy, DER, and DSM programs. Usually these regulatory environments will follow existing electricity markets that have capacity risks, focus on environmental objectives, or have strong customer preferences for emerging technologies. The utility follows and focuses on building strong alliances with customers to help navigate diverse choices.
- **Regulators focus on consumer protection** as the competition and the market drives an evolving energy model. Data security and privacy are important agenda items, as is ensuring that certain groups are not discriminated against or disadvantaged. Vendors will bypass utilities for some customer services but will also maintain significant relationships with utilities. Utilities will consider how best to keep lower costs and will want to provide excellent customer services, often including third-party vendor products and services, while maintaining their traditional role.
- **Regulators maintain the status quo** and maintain their obligation to all stakeholders for as long as possible. This scenario will probably occur in geographic areas with high capacity, lower-income customers, and the need to provide cost-effective services to all ratepayers. Third-party vendors may bypass utilities to provide services and products to customers relying on other data sources. Energy efficiency and demand response programs will be the likely areas of focus for the vendors and utilities.

5. Conclusions

It is becoming increasingly clear among industry stakeholders that significant trends within the energy market are advancing technologies and require access to more customer data to enable higher customer value. Some of these key trends and evolving technologies include the following:

- **Evolving and more affordable energy sources** such as rooftop solar, utility-scale renewables, customer-owned energy storage, microgrids, and EVs, including charging equipment, will increase the need for accurate and real-time availability of data to maximize their usefulness and cost-effectiveness.
- **Empowered customers** with higher energy dependencies and higher expectations for desirable products and services demand choices that may include any combination of preferences, including but not limited to environmentally conscious products, convenience, and cost-effectiveness. Customers want ubiquitous control (e.g., remotely managing their homes and businesses), and they want home automation to simplify their lives.
- **Access to data from various streams** is driving new products and services in every industry. As the data needs and value continue to increase, so does the technology that makes it available. From data collection (e.g., low-cost sensors) to data transmission (e.g., communications infrastructure), new technologies enable various market players to combine and analyze data and open opportunities for innovative products and services.
- **Third-party vendors and market entrants** are offering energy-related products and services. The evolving energy market is attracting a significant number of established and new vendors are entering this area, from equipment manufacturers to software developers.

Given these trends, we have identified the three most likely scenarios driving the direction for how we anticipate the market to evolve. These scenarios define the relationship among customers, data, utilities, and regulators that may develop over the course of the next decade:

- **Regulators drive a new energy model** with innovation of customer services and pushing implementation of renewable energy sources and open data access.
- **Regulators focus on consumer protection** as the competition and the market drives an evolving energy model. Data security and privacy is an important agenda item, as is ensuring that certain groups are not discriminated against or disadvantaged.
- **Regulators maintain the status quo** and maintain their obligation to all stakeholders for as long as possible, delaying open data access and maintaining a more conservative role.

In conclusion, regulators have significant opportunities to drive a new energy market model that embraces innovation of customer services as well as aggressive and ambitious energy policies that target renewable energy, DER, and DSM programs. Third-party vendors are motivated to provide services and products to customers, and, if necessary, they are willing to bypass utilities to access the necessary data. Regulators and utilities are well positioned to play critical roles in ensuring consumer protection, improved customer service, reliable services and cost-effective services to ratepayers.

Appendix A. References

Bensch, Ingo, Ashleigh Keene, and Scott Pigg. "Minnesota Power's Advanced Metering Infrastructure Project: AMI Behavioral Research Project – Phase 1." Energy Center of Wisconsin, 2014.

Boughen, N., Z. C. Castro, and P. Ashworth. "Understanding the residential customer perspective to emerging electricity technologies: Informing the CSIRO Future Grid Forum." *Brisbane, Queensland: CSIRO* (2013).

Cooney, Kevin, Erik Gilbert, Brad Rogers, Robin Maslowski, Chris Wassmer, Cory Welch, Mark Bielecki. "Smart Grid Regional Business Case for the Pacific Northwest: Interim Results & Analysis." Navigant Consulting, 2013.

Darby, Sarah. "The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing, and direct displays (2006)." *Environmental Change Institute, University of Oxford: Oxford, UK* (2006).

Ehrhardt-Martinez, Karen, Kat A. Donnelly, and Skip Laitner. "Advanced metering initiatives and residential feedback programs: a meta-review for household electricity-saving opportunities." Washington, DC: American Council for an Energy-Efficient Economy, 2010.

Faruqui, Ahmad, Sanem Sergici, and Ahmed Sharif. "The impact of informational feedback on energy consumption—A survey of the experimental evidence." *Energy* 35, no. 4 (2010): 1598-1608.

George, Stephen, Michael Sullivan, Josh Schellenberg, and Taylor Smart. "Central Maine Power Bill Alert Pilot Evaluation." Freeman, Sullivan, and Co. 2013.

Houde, Sébastien, Annika Todd, Anant Sudarshan, June A. Flora, and K. Carrie Armel. "Real-time Feedback and Electricity Consumption." *Economics* 95, no. 9 (2013): 1082-1095.

Hunt Allcott. "Social norms and energy conservation." *Journal of Public Economics* (2011): 1082-1095.

Massachusetts Department of Public Utilities. "Grid Modernization." Available: http://www.mass.gov/eea/energy-utilities-clean-tech/electric-power/grid-mod/grid-modernization.html.

Navigant Research. "In-Home Displays, Networked HEM Systems, Standalone HEM Systems, Web Portals, and Paper Bill HEM Reports: Global Market Analysis and Forecasts." 2014. Available: http://www.navigantresearch.com/research/home-energy-management.

"Smart Electric Meters, Advanced Metering Infrastructure, and Meter Communications: Global Market Analysis and Forecasts." 2014. Available: http://www.navigantresearch.com/research/smart-meters.

Neenan, B., J. Robinson, and R. N. Boisvert. "Residential electricity use feedback: A research synthesis and economic framework." Published by Electric Power Research Institute (EPRI), 2009.

Nexus Energy Software, Opinion Dynamics Corporation, and Primen. "Information Display Pilot: California Statewide Pricing Pilot." 2010.
Available: http://sites.energetics.com/MADRI/toolbox/pdfs/pricing/nexus_2005_ca_info_display_pilot.pdf.

Petersen, John E., Vladislav Shunturov, Kathryn Janda, Gavin Platt, and Kate Weinberger. "Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives." *International Journal of Sustainability in Higher Education* 8, no. 1 (2007): 16-33.

Seal, B.. "Transforming Smart Grid Devices into Open Application Platform." Technical Update published by Electric Power Research Institute (EPRI), July 2014.

Snijders, Chris, Uwe Matzat, and Ulf-Dietrich Reips. "Big data: Big gaps of knowledge in the field of internet science." *International Journal of Internet Science* 7, no. 1 (2012): 1-5.

Spencer, Leon. "Internet of Things market to hit $7.1 trillion by 2020: IDC." *ZDNet*, June 5, 2014.
Available: http://www.zdnet.com/article/internet-of-things-market-to-hit-7-1-trillion-by-2020-idc/

U.S. Department of Energy. "Experiences from the Consumer Behavior Studies on Engaging Customers." 2014. Available: http://www.energy.gov/oe/downloads/experiences-consumer-behavior-studies-engaging-customers-september-2014.

"Municipal utilities' Investment in Smart Grid Technologies Improves Services and Lowers Costs", Published October 2014,
Available: https://www.smartgrid.gov/sites/default/files/doc/files/B4-revised-10-03-2014-100614.pdf

"Smart Meter Investments Benefit Rural Customers in Three Southern States", Published March 2014,
Available: https://www.smartgrid.gov/news/smart_meter_investments_benefit_rural_customers_three_southern_states.

"Smart Meter Investments Yield Positive Results in Maine", Published January 2014,
Available: https://www.smartgrid.gov/sites/default/files/doc/files/Central%20Maine%20Power%20Case%20Study_0.pdf

"Municipal utilities' Investment in Smart Grid Technologies Improves Services and Lowers Costs", Published October 2014,
Available: https://www.smartgrid.gov/sites/default/files/doc/files/B4-revised-10-03-2014-100614.pdf

"Integrated Smart Grid Provides Wide Range of Benefits in Ohio and the Carolinas", Published September 2014, Available: https://www.smartgrid.gov/sites/default/files/doc/files/C7-Duke-Energy-Case-Study-FINAL-092914.pdf

"Smart Grid Investments Improve Grid Reliability, Resilience, and Storm Responses", Published November 2014, Available: https://www.smartgrid.gov/sites/default/files/doc/files/B2-Master-File-with-edits_120114.pdf

"Demand Response Defers Investment in New Power Plants in Oklahoma", Published April 2013,
Available: https://smartgrid.gov/sites/default/files/doc/files/OGE%20CBS%20case%20study.pdf

"Analytical Framework."
Available: https://www.smartgrid.gov/recovery_act/program_impacts/analytical_framework.

Vermont Electric Cooperative. "Consumer Behavior Study Interim Process Evaluation Of Year 1." U.S. Department of Energy. 2013.

Wakefield, M. January 2010. "Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects." Electric Power Research Institute (EPRI).

Walton, Robert. "What Will Utility Regulators Decide to Do with Customer Data?" Utility Dive. September 24, 2014.

Webb, Thomas L., Yael Benn, and Betty PI Chang. "Antecedents and consequences of monitoring domestic electricity consumption." *Journal of Environmental Psychology* 40 (2014): 228-238.