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An Assessment of Interval Data and Their Potential Application to Residential Electricity End-Use Modeling

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Background

On September 30, 2014, the U.S. Energy Information Administration (EIA), with support from the Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), concluded a landmark research project focusing on EIA's energy consumption end-use models.

EIA uses these models to estimate how much of the total energy consumed in commercial buildings and residential units in the United States are used for space heating, air conditioning, refrigeration, lighting, and other end uses. The models use data from the Commercial Buildings Energy Consumption Survey (CBECS) and the Residential Energy Consumption Survey (RECS).

The following are major activities included in the year-long research project:

- Updated the 2003 CBECS engineering end-use models for use in the 2012 CBECS
- Developed new engineering models for RECS
- Standardized the CBECS and RECS methods of calibrating the sum of engineering end-use estimates to the reported (actual) total consumption
- Conducted an assessment of current availability of interval data from advanced metering infrastructure systems (AMI data) and from submeter systems (submeter data) managed by utilities in key jurisdictions in the U.S., and evaluated their usefulness in the end-use modeling of residential electricity consumption

Highlights from the Residential AMI and Submeter Data Assessment

- Over 40 million AMI meters that record kilowatt-hour (kWh) consumption in intervals as fine as 15 minutes are installed across the U.S., in every state and by every major type of utility. The numbers of installed AMI meters are expected to rise appreciably in the future, and the data they produce are expected to converge to a common standard of reporting.
- As residential customers are generally granted ownership of these kWh interval data, third parties wishing to access these data are required to ask permission from customers. Even with customer consent, however, ease of third-party access to AMI data depends on whether the utilities already have in place web-based systems for downloading the data.
- Mostly due to costs associated with installation and maintenance of submeter systems, and the relatively uncommon regulatory initiatives to spur growth, submeter data are significantly less prevalent and are more variable in reporting characteristics than AMI data. This state of affairs is not expected to change in the future.
- While submeter data are more directly useable for end-use modeling than AMI data, the situation just described makes AMI data the more favorable type of interval data to explore for applicability in the modeling and estimation of electricity end uses.

Volume I: Findings, Insights and Recommendations

Assessment of Residential Submeter Data for RECS
Volume 1: Findings, Insights and Recommendations

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Executive Summary

The Energy Information Administration (EIA) is investigating the potential benefits of incorporating interval electricity data into its residential energy end use models. This includes interval smart meter and submeter data from utility assets and systems. It is expected that these data will play a significant role in informing residential energy efficiency policies in the future. Therefore, a long-term strategy for improving the RECS end-use models will not be complete without an investigation of the current state of affairs of submeter data, including their potential for use in the context of residential building energy modeling. This report addresses the following tasks:

1. Characterize how prevalent smart meter and submeter data are within the electricity industry, and how electric utilities are using them for advancing residential energy efficiency policies or other purposes.
2. Recommend standards that unify the most widely available forms of smart meter and submeter electricity data in terms of format and sampling frequency.
3. Present a long-term outlook of the availability of smart meter and submeter electricity data and their potential use in the practical modeling of residential electricity end uses.

Below are summary insights for each of the tasks. Following the summary, the remainder of this report elaborates on the insights below. ***Volume II*** includes all Appendices, and provides the survey data and results from the interviews and research conducted during the project. Finally, the accompanying Excel workbook - ***Utility AMI Data_EIA-861_RY2012_052814.xlsx*** - provides the raw data used for analysis in the report.

Task #1: Prevalence of Submeter Data

In this task, the intended interpretation of submeter data is in the broadest possible sense. They could include submetered data for individual units and common areas in a multi-unit residential building, or data from devices (submeters) strategically positioned within the building to monitor consumption of individual equipment, or even data from smart meters. After discussions with EIA, Leidos attempted to further clarify this definition and dichotomized 'submeter' data into data from advanced metering infrastructure (AMI) systems ("AMI data") and data from submeter systems ("submeter data") because there are significant differences in systems and availability of submeter data versus data from AMI systems. Insights regarding AMI and Submeter data are provided below.

AMI Data Collection Insights

- Over 40 million AMI meters have been installed across the United States, in every state and by every major type of utility. Furthermore, utilities are forecasted to continue to roll-out residential AMI meters in their service territories and expand customer choices for access to their data.
- In nearly all cases, customer interval data cannot be given to third parties without customer consent and authorization. There are limited opportunities for third parties to directly request and receive data from the utilities, even with customer consent.
- In many instances, the utilities have set up systems or portals to allow customers to access their own data, thereby requiring third parties to go directly to the customer to receive the data.

- Data collection intervals vary by utility, from 15 minute intervals to daily reads. Also, in general, 12 to 24 months of historical data is available for download depending on the utility. KWh is the most common data element collected via the AMI systems.
- Collecting AMI data from thousands of customers will require a strategy for collecting, validating and analyzing this data, along with consolidating this information with other datasets.
- ***Since meters and associated systems have a technology life of 10 years or more, there will be an abundance of AMI meters and data well into the future.***

Submeter Data Collection Insights

- There are very few submeter projects under way at utilities today.
- Unlike regulatory involvement with utility AMI programs, there have been no regulatory initiatives or mandates to collect information at this level or interval. For most utilities, technology cost recovery is dependent on regulatory approval.
- Technology exists today to install and collect data on residential end uses. Several companies have developed the hardware and software applications to collect submeter data, and have projects underway outside the utility industry.
- Technology is expensive both to install and support relative to AMI meters.
- Technology exists with the capability to measure circuits or plugs at very short intervals (1 minute or less)
- Collected data is typically either stored on a cloud-hosted server or on internal hardware memory that may be accessed remotely via an embedded web server.
- Submeter systems and data outputs are much less standardized than AMI systems and data.
- Even with submeters, it is extremely difficult or impossible to disaggregate end uses that share circuits in a residential electrical system such as lighting and plug loads.
- Submeter technology companies have set up systems or portals to allow customers to access their own data, thereby requiring third parties to go directly to the customer to receive the data. Some companies currently offer data access to administrators of submeter programs using their technologies.
- The company with the most activity in this space is also a previous DOE grant recipient - Pecan Street Energy. They are monitoring over 700 homes, and have collected an extensive amount of information. Furthermore, they have developed a "Wiki Energy" site to allow universities and clients access to this information for review and analysis.
- The limited submeter projects identified all rely on the customer's broadband internet service to transport the data back to the organization doing the data collection and analysis. This solution requires ongoing support during the project to troubleshoot issues with the customer equipment and internet service.
- ***Because the technology is expensive to purchase, install and maintain, and because there is no foreseeable regulatory or legislative mandate to install these, there is little evidence to support that submeter data will be prevalent in the near term.***

AMI Systems and Energy Efficiency Programs

Heavily incentivized by the Smart Grid Investment Grant (SGIG) program[1], many utilities are using AMI data to advance residential energy efficiency policies and programs. The abundance of interval data has

[1] Authorized by Title XIII of the Energy Independence and Security Act of 2007 and funded by the American Recovery and Reinvestment Act, the Smart Grid Investment Grant (SGIG) program "accelerates the modernization

spurred utilities and states to strengthen customer data privacy laws, and has improved load forecasting, generation capacity planning, and outage management and reliability to support future needs for demand response programs. As more data and lessons learned become available from AMI and submeter projects, utilities, states and the federal government will be able to make increasingly informed decisions about how to implement and regulate a smarter electric grid.

Utilities are using AMI data to inform internal rate programs, improve operational efficiencies, and reduce costs to both utilities and customers. Utilities funded by the SGIG, including several interviewed for this report, are applying AMI systems for time-based rate programs, customer billing, power outage detection and response, tamper and theft detection, remote service connection and disconnection, load forecasting, and generation capacity planning. [2] Utilities also plan to utilize the AMI data to target customers for energy efficiency and demand response programs. Several pilot studies are underway, and many utilities have developed portals and applications to allow customers to receive information on how they are using energy. The expectation is that these programs will grow once the AMI systems are fully operational.

Although these AMI applications directly and indirectly save time and money, it is important to note that utilities will not implement residential AMI systems unless there is a viable business case for them. For example, in their interview, one utility stated that it implements AMI for commercial customers, but does not foresee implementing a residential AMI program unless a business case is made for it. As more information is collected on the costs and benefits of AMI systems, utilities will become better informed on how to structure internal programs and advance residential energy efficiency policies.

The following sections provide information, data and results from research into and interviews of companies and utilities implementing AMI and submeter systems

Task #2: Standards Recommendation

The EIA should investigate the use of the Green Button Initiative to collect residential AMI data. Over 43 million households and businesses currently use Green Button to access their energy usage data and dozens of utilities serving millions of additional households have committed to using the standard. Currently customers with Green Button capability can download their usage data and send it to any third party they choose. However, in the future it may be possible for third parties to link directly to customer usage data (with permission) through the Green Button platform. This functionality, called Green Button Connect My Data, is currently being tested in California. The Green Button data standard is extensible and can include any interval of data; however, most utilities currently provide hourly usage data to customers. This coincides with Leidos' recommendation that EIA use hourly interval data for model development. In addition, a new test and certification program for Green Button was announced in June 2014 through a public-private partnership (of which DOE is a partner) that will help to ensure interoperability among the wide range of Green Button adopters. The broad reach of this

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of the nation's electric transmission and distribution systems and promote investments in smart grid technologies, tools, and techniques that increase flexibility, functionality, interoperability, cybersecurity, situational awareness, and operational efficiency." More information is available online at: https://www.smartgrid.gov/recovery_act/overview/smart_grid_investment_grant_program

[2] Detailed AMI project descriptions of actions taken by each utility funded by the SGIG can be found at: https://www.smartgrid.gov/recovery_act/project_information?f[0]=im_field_project_type%3A5164

initiative along with DOE's involvement in helping to develop the standard make this a very promising tool for collecting residential energy usage data in the future.

Leidos recommends an AMI data sampling frequency standard of one hour based on: 1) a review of typical utility sampling intervals, 2) what is likely to be available from utilities (with utility customer consent) , and 3) the possible uses of the data by EIA to support RECS and other reports/products for its internal and external audiences . Note that in our research, 13 of the 17 utilities interviewed currently provide customers with access to AMI data with a sampling frequency of one hour or less. In addition, a natural alignment exists with commonly available hourly weather data and many industry-accepted engineering models and calculation methods that rely on hourly load profile data. Lastly, hourly AMI data provides ample granularity without overwhelming file size.

Leidos also suggests collecting AMI data on an annual or four year cycle depending on EIA's specific modeling or reporting needs. Most utilities with AMI make 12 to 24 months of historical data available to customers including a number of utilities that offer 12 to 13 months of rolling data. As a result, EIA would have to collect data annually to develop a continuous dataset spanning longer than one year. If EIA were to generate end-use energy estimates between RECS reporting cycles (e.g., annual or biennial updates), the results would need to be caveated since some housing characteristics could well have changed between the time of the RECS survey (typically 4 years) and the year of the report. This is because the energy end-use models are based in varying degrees on the building characteristics from RECS.

With respect to submeter data, there have been no standards developed yet for data collection since there has been little activity in this area. The limited pilots underway are collecting submeter data in one-minute intervals; however, the companies are now just beginning to analyze the data. Therefore, it is premature to speculate the future interval for submeter data.

Task #3: Long Term Outlook of AMI and Submeter Data

The long term availability of AMI and Submeter data is discussed in Task 1 above, with additional documentation in the respective sections below. With respect to using data for RECS modeling, Leidos believes that the data could benefit the modeling efforts, subject to the frequency interval and data collection plans discussed above in Task #2.

Advanced Metering Infrastructure (AMI) Review

Summary of Utilities with AMI in the U.S.

Methodology

Data from the Energy Information Administration (EIA) Form EIA-861, Annual Electric Power Industry Report, was used to identify utilities with AMI meters installed for residential customers. The Form EIA-861 is used to collect utility level information on peak load, generation, electric purchases, sales, revenues, customer counts, demand-side management programs, green pricing and net metering programs, distributed generation capacity, and number of AMI and Automated Meter Reading (AMR) meters installed for each customer sector (residential, commercial, industrial, and transportation) from all electric utilities, energy service providers, and distribution companies in the United States on an annual basis.[3] The EIA-861 asks respondent to select "Yes" or "No" on the survey to indicate whether they operated an AMI system during the reporting year. If "Yes," then the respondent reports by state and sector the number of AMI meters and the energy served via AMI.

The EIA-861 distinguishes between AMI meters and AMR meters. An AMI meter is defined as meter that has built in two-way communication capability and records and transmits instantaneous data (measured and recorded usage data at minimum hourly intervals) that is provided to both consumers and energy companies at least once daily.[4] AMR meters are defined as meters that collect data for billing purposes only and transmit this data one way, usually from the customer to the distribution utility.[5] This research used data for AMI meters only.

Data from the 2012 EIA-861 collection year was the latest available data. In 2012, 535 U.S. electric utilities reported installing 40,134,064 AMI meters for residential customers. All fifty states and the District of Columbia had at least one utility with residential smart meters installed. About 77 percent were installed by Investor Owned utilities, 15 percent by cooperative utilities, and the remaining 8 percent were installed by municipal and other utilities. Table 1 below shows the distribution of residential AMI meters by utility ownership type.

[3] Energy Information Administration. Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files. Online at: http://www.eia.gov/electricity/data/eia861/

[4] EIA Form-826 and EIA Form-861 Frequently Asked Questions (FAQs). Online at: http://www.eia.gov/survey/faqs/electricity.html

[5] EIA Form-826 and EIA Form-861 Frequently Asked Questions (FAQs). Online at: http://www.eia.gov/survey/faqs/electricity.html

Table 1. Number of Residential AMI Meters by Utility Ownership Type for 2012[6]

Utility Ownership	Number of Utilities with Residential AMI Meters	Number of Residential AMI Meters by Ownership Type	Percent Share
Investor Owned	72	30,900,724	77%
Cooperative	342	5,968,832	15%
Political Subdivision	18	1,521,395	4%
Municipal	98	1,708,451	4%
State	4	34,455	0%
Transmission	1	207	0%
Total	**535**	**40,134,064**	**100%**

Three states, California, Texas, and Florida, accounted for 50 percent of the residential AMI meters in the United States. California had the most meters with 9.5 million. Texas was second at 6.0 million and Florida was third at 4.5 million. Among North American Electric Reliability Corporation (NERC) regions, the Western Electricity Coordinating Council (WECC), which includes California, accounted for 35 percent of residential AMI meters in 2012 with 13.9 million. The Southeastern Electric Reliability Council (SERC) had 7 million and the Texas Reliability Entity (TRE) had 6.3 million. Table 2 below shows the distribution of residential AMI meters among the NERC regions. A consolidated version of the data used to identify utilities with AMI meters can be found in Appendix E.

Table 2. Residential AMI meters by NERC Region[7]

NERC Region	Number of Utilities with Residential AMI Meters	Number of Residential AMI Meters by NERC Region	Percent Share
WECC	102	13,851,879	35%
SERC	135	7,012,457	17%
TRE	30	6,336,501	16%
RFC	91	4,973,366	12%
FRCC	12	4,422,250	11%
SPP	54	1,310,999	3%
NPCC	28	1,277,930	3%
MRO	80	945,259	2%
AK	3	3,423	0%
Total	**535**	**40,134,064**	**100%**

The EIA-861 data show that there is a very large base of residential customers with AMI meters and this number is likely increasing. The Edison Foundation claims that as of July 2013 about 46 million AMI meters have been installed. That represents nearly 40 percent of households.[8] With each of those meters collecting data at hourly intervals, that would mean more than 1 billion data points are being

[6] EIA-861 data files, 2012. Online at: http://www.eia.gov/electricity/data/eia861/
[7] EIA-861 data files, 2012. Online at: http://www.eia.gov/electricity/data/eia861/
[8] The Edison Foundation. Utility Scale Smart Meter Deployments. August 2013. Online at: http://www.edisonfoundation.net/iee/Documents/IEE_SmartMeterUpdate_0813.pdf

collected per day. The primary use for this data at the utility is to measure interval usage for customer billing. However, methods to apply this wealth of data for other purposes, such as providing interval data directly to customers so they can manage their energy consumption, is only just beginning to materialize.

Green Button Initiative

Green Button is an industry-led effort that provides a common format for energy usage data so electricity customers can access their data in an easily readable and secure format via a "Green Button" on their electric utilities' website. Green Button is based on a common technical standard developed in collaboration with a public-private partnership supported by the National Institute of Standards and Technology (NIST). [9]

The Green Button initiative launched in January 2012 with two of California's three largest utilities, Pacific Gas & Electric and San Diego Gas & Electric, going live with the functionality on their websites. Southern California Edison, Glendale Power & Light, Oncor, Pepco Holdings Inc., and several other utilities launched later in 2012. As of summer 2014, 35 major utilities and electricity suppliers have committed to providing the Green Button on their websites and have either gone live or are in development.

Green Button data are provided as an Extensible Markup Language (XML) text file that is standard across multiple utilities. Green Button is consistent with the best practices of utility privacy and security, since customers have to first authenticate themselves on a utility portal with a login and password before they can view or download their data. Once customers access their data, they can share it as they choose, by independent choice and action, with those they trust. Voluntary adoption of a consensus standard by utilities across the Nation allows software developers to leverage a large enough market to support the creation of applications that can help consumers understand their energy usage information.

Source:
http://www.greenbuttondata.org/

Figure 1. Green Button Logo

In some cases Green Button data can be linked directly with third party software data analysis platforms using the Green Button "Connect My Data" functionality.[10] Several web and mobile applications have been developed to analyze customer usage using Green Button data. These applications use a set of tools known Application Programming Interfaces (APIs) which are used to access Green Button data. The Green Button data structure represents energy usage as defined in the Energy Services Provider Interface (ESPI) standard developed by the North American Energy Standards Board (NAESB). This standardized process was developed to create an interface for the exchange of a retail customer's energy usage information between the data custodian (i.e. the utility) and the retail customer or an authorized third party application. Figure 2 shows the relationship between the different parties involved in the data access interface.[11] The simplest relationship is the one that exists between the Data

[9] Greenbuttondata.org http://www.greenbuttondata.org/
[10] Greenbuttondata.org. http://greenbuttondata.org/greenhowto.html
[11] Green Button Developer Resources. http://energyos.github.io/OpenESPI-GreenButton-API-Documentation/

Custodian (i.e. the Utility) and the retail customer. This relationship allows the customer to view or download a file that contains their usage information. This simple relationship is the basis for the Green Button Download My Data operation. However, additional relationships are possible with Third Parties through the Green Button Connect My Data functionality.

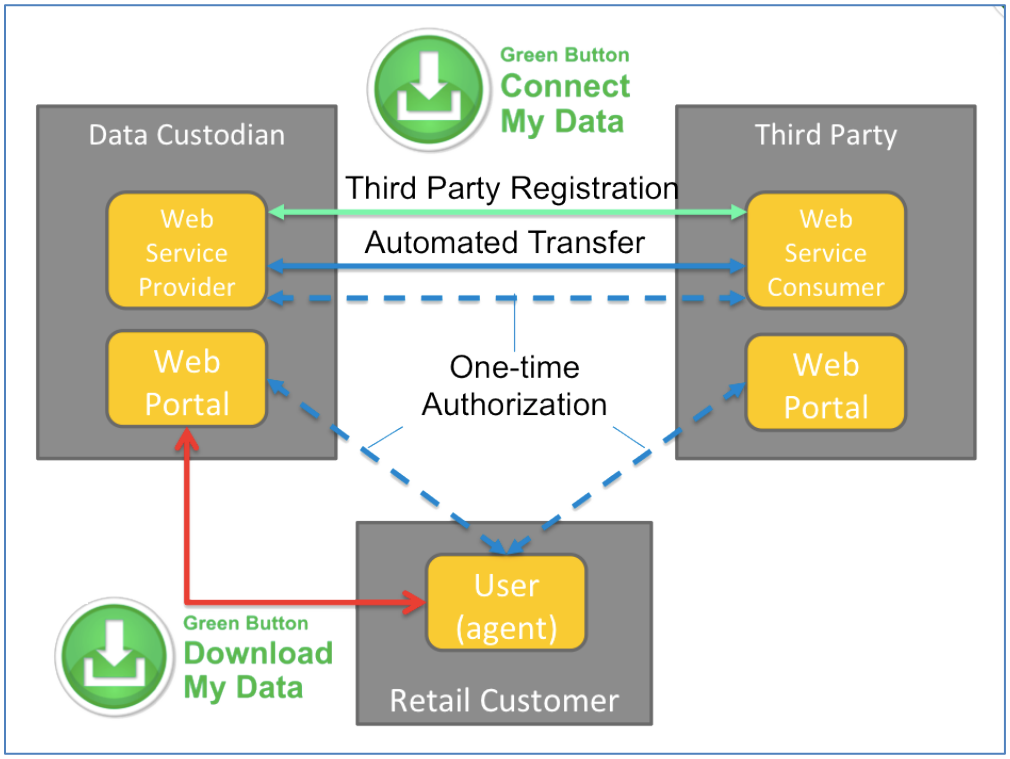

Figure 2. Relationship between parties involved in usage data access

The Green Button standard continues to build momentum. Today over 43 million households and businesses can use Green Button to access their energy usage data from their electric utility. In June 2014 the Green Button Test and Certification program was announced through a public-private partnership of UCA International Users Group (UCAIug), Underwriters Laboratories (UL), The American National Standards Institute (ANSI), the National Institute of Standards and Technology (NIST), and the Department of Energy (DOE).[12] This program will help to ensure the interoperability among the wide range of Green Button adopters across the nation.

Summary of AMI Privacy Law Regulation

Methodology

The Energy Independence and Security Act (EISA 2007) spurred the rapid development of the Smart Grid that continues today. This legislation acknowledged that smart meters would create new energy data

[12] American Consumer News. June 23, 2014. "Green Button Certification Initiated." Available online at: http://www.americanconsumernews.com/2014/06/green-button-certification-initiated.html

and the need for policies to protect consumer data privacy (Title XIII).[13] Since then, Public Utility Commissions in various states have begun developing privacy guidelines that define what investor-owned utilities (IOUs) and other electricity utilities must do with customer usage data gathered from smart meters. Leidos reviewed the legislative and regulatory actions involving smart meter data privacy for a sample of twelve states. A full review of all fifty states was considered to be outside the scope of this task. States were chosen based on knowledge of existing legislative or regulatory actions as well as location, with an aim to select a geographically diverse sample of states. A review of privacy laws at the state level was the focus of the review; however, in some cases utility specific rules or regulations were highlighted if they represented an important action within that state. The focus of the research was to determine the laws surrounding customer and third-party access to smart meter data. The analysis provides a brief summary of the legislative and/or regulatory actions related to AMI data privacy for each state, as well as a list of state laws and public utility commission decisions that impact privacy. The analysis attempted to answer the following questions:

- Are utilities required to provide data to customers?
- Are utilities able to provide data to third parties?
- Have utilities developed a process to provide customers access to their data?
- Does the State Have a Smart Meter Opt-Out Policy?

All of the states reviewed had at least some form of privacy law or regulation in place that governed how utilities handle customer usage data. However, the analysis showed that development of legislation and regulation regarding smart meter data is only just getting started. The California Public Utility Commission (CPUC) is leading the way on customer usage data and AMI privacy regulation. In 2011, the CPUC voted unanimously to adopt the first comprehensive set of rules and regulations to ensure that consumers can access their energy usage data collected by their smart meter while also protecting the privacy and security of their data.[14] The decision applies to the three large investor owned utilities in the state which serve over 80 percent of customers and contains a set of concrete rules that the utilities must follow regarding customer access to data and privacy of data. Texas is the only other state with similarly robust privacy laws in terms of scope and clarity. Table 3 below provides a brief summary of the results of the analysis for each state reviewed. The full State Level Legislative and Regulatory Review report is contained in Appendix A.

Table 3. Summary of State-Level Legislative and Regulatory Review

State	Customer Can Access Interval Usage Data?	Third Parties Can Access Customer Usage Data?
California	**Yes** – GreenButton (PG&E, SCE, SDG&E)	**Yes** – With "customer consent". CPUC is developing a process for third parties to obtain customer-authorized usage data directly from the utility through GreenButton.

[13] The Energy Independence and Security Act of 2007 can be found online at: http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf

[14] California Public Utilities Commission. "Decision adopting rules to protect the privacy and security of the electricity usage data of the customers of Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas and Electric Company." Decision on July 28, 2011. Available online at:http://docs.cpuc.ca.gov/published/FINAL_DECISION/140369.htm

State	Customer Can Access Interval Usage Data?	Third Parties Can Access Customer Usage Data?
Texas	**Yes** - Smart Meter Texas	**Yes** – With "written consent or other verifiable authorization". Residential customers may designate up to five "friends" to view their usage information via the Smart Meter Texas web portal.
District of Columbia	**Yes** – GreenButton (Pepco)	**Yes** – With written consent
Florida	**Yes** – Utility Website (FPL)	**Yes** – With "explicit and verifiable" authorization from customer
Vermont	**Yes** - GMP Smart Power (GMP)	**Yes** – With "express consent" of customer
Ohio	**Yes** – Upon request from customer	**Unknown**
Maryland	**No** – Customers will soon be able to access hourly data through Smart Energy Manager (BGE) (Coming "later this year")	**Yes** – With customer consent
Illinois	**Yes** – My Energy Tools portal (ComEd)	**Yes** – With customer consent
Wisconsin	**Unknown**	**Partially** – Rules are in place governing the release of customer data to the energy efficiency program administrator, Focus on Energy
Oklahoma	**Yes** – myOGEpower (OGE)	**Yes** – With "written consent"
Michigan	**Yes** – Utility website (DTE)	**Yes** – With "informed customer consent"
Massachusetts	**Yes –** WMECO has implemented GreenButton	**Yes –** with customer authorization

Utility AMI Interviews

A subset of approximately twenty utilities was selected from the list of all utilities with AMI to conduct detailed phone interviews. The primary objective of the phone interviews was to:

- Develop an understanding of utility protocols and data transfer pathways used for third parties to collect AMI data from residential customers.
- Identify challenges and barriers to collecting residential customer AMI data as a third party entity.
- Develop an understanding of specific types of data and format of data available to third parties.

An interview template was developed to structure the collection of information obtained from each

phone interview in a consistent manner. The interview contained questions on whether the utility has a process for allowing customers to access their data and if so how that process works. The interview also asked whether third parties can access customer data, and if so, how that process works. Additional questions included information about the type of data collected, the format of the data, what intervals are provided, and questions about the timestamp of the interval. The completed Utility AMI Data Collection and Documentation Process Template for each interview can be found in Appendix B.

Overview of process and criteria used to identify AMI utilities for interview

The list of utilities with residential AMI meters described previously in this report was used as the starting point for selecting utilities to interview. Utilities were chosen that represented a good mix of number of AMI meters, utility ownership type, and geographic region.

Table 4 shows a list of the utilities selected for interview. Of the 21 utilities selected, 15 resulted in completed interviews. An interview was not completed for 5 utilities because a contact could not be reached. One utility, City of Tacoma, WA, was determined to have only a very small smart meter pilot project and the contact at the utility did not have sufficient information about the project.

Table 4. Utilities selected for AMI interviews.

Utility	State	Ownership	NERC Region	Interviewed?
Austin Energy	TX	Municipal	TRE	Yes
Braintree Electric	MA	Municipal	NPCC	Yes
City of Kansas City - (KS)	KS	Municipal	SPP	No
City of Lakeland - (FL)	FL	Municipal	FRCC	Yes
City of Tacoma - (WA)	WA	Municipal	WECC	No
Cleco Power LLC	LA	Investor Owned	SPP	Yes
Consolidated Electric Coop Inc.	OH	Cooperative	RFC	No
Consumers Energy	IA	Cooperative	MRO	Yes
Dominion Electric	VA	Investor Owned	SERC	Yes
DTE Energy	MI	Investor Owned	RFC	No
Duke Energy	OH	Investor Owned	RFC	Yes
Florida Power and Light	FL	Investor Owned	FRCC	Yes
Jacksonville Electric Authority	FL	Investor Owned	FRCC	No
City of Kings Mountain	NC	Municipal	SERC	Yes
Madison Gas and Electric	WI	Investor Owned	RFC	Yes
Oncor	TX	Investor Owned	TRE	Yes
PEPCO	DC	Investor Owned	RFC	Yes
Rappahannock Electric Coop	VA	Cooperative	SERC	No
San Diego Gas and Electric	CA	Investor Owned	WECC	Yes
United Power	CO	Cooperative	WECC	Yes
Wisconsin Power and Light Co (Alliant Energy)	WI	Investor Owned	MRO	Yes

When a specific smart meter contact at a utility was not known, the first attempt at contacting the utility was typically through the main utility switchboard phone number. When contacting a main switchboard, it was often difficult to locate a contact that was knowledgeable about the utilities smart meters or smart meter program. In many cases a utility contact was knowledgeable of the general aspects of smart meters, for example, whether a customer was able to access usage data, but could not provide information on the more detailed questions, such as third party access, what type of data was provided, what intervals where provided, and the timestamp of the interval. In general, the investor owned utilities with larger, more established smart meter programs were more likely to have a knowledgeable contact available for interview than the smaller municipal and cooperative utilities. Table 5 provides contact information received through the utility AMI interviews.

Table 5. List of Utilities for AMI interviews

Utility
Austin Energy
Braintree Electric
City of Kansas City - (KS)
City of Lakeland - (FL)
City of Tacoma - (WA)
Cleco Power LLC
Consolidated Electric Coop Inc.
Consumers Energy
Dominion Electric
DTE Energy[15]
Duke Energy
Florida Power and Light
Jacksonville Electric Authority
City of Kings Mountain
Madison Gas and Electric
Oncor
PEPCO
Rappahannock Electric Coop
San Diego Gas and Electric
United Power
Wisconsin Power and Light Co (Alliant Energy)

Conclusions/Insights

Interview results showed that most utilities offer an online platform from which residential customers can download their AMI data. Customers can receive datasets in the following common file formats: hardcopy, portable document format (PDF), comma separated values (CSV) files, extensible markup language (XML), and Microsoft Excel spreadsheets (XLS/XLSX). Twelve of the fifteen interviewed utilities offered direct data access through their website, one utility (Cleco Power LLC) offered data upon request, and one utility (Wisconsin Power and Light) does not currently have a method for customers to access data online (Figure 3).[16] Both Cleco Power LLC and Wisconsin Power and Light mentioned that, in the next couple years, they are looking to implement an online platform from which residential customers can access their AMI data.

[15] DTE Energy was not interviewed, but the contact information given here is correct for their AMI program. Multiple efforts were made to schedule an interview time with the contact, but the contact did not respond.

[16] It is important to note that Madison Gas and Electric (MG&E) was interviewed but not included in the results here because they have only deployed AMI for high load commercial customers. MG&E does not foresee implementing a residential AMI program unless a business case is made for it.

Although most of the interviewed utilities offered data access to customers, there has been little progress made in allowing third parties to request and receive customer AMI data. Austin Energy, City of Lakeland, Cleco Power LLC, Dominion Electric, Duke Energy, and San Diego Gas and Electric (SDG&E) offered customer data to third parties under specific conditions. Austin Energy, Dominion Electric, Cleco Power LLC, and SDG&E will release customer data to a third party if the customer gives written consent. Duke Energy only provides data to third party competitive retail electric suppliers. The City of Lakeland has an interesting process in which a third party or non-customer can obtain data through an in-person request since all data is public for Florida Municipal utilities. The rest of the utilities generally stated that the customers themselves would have to provide data to a third party.[17]

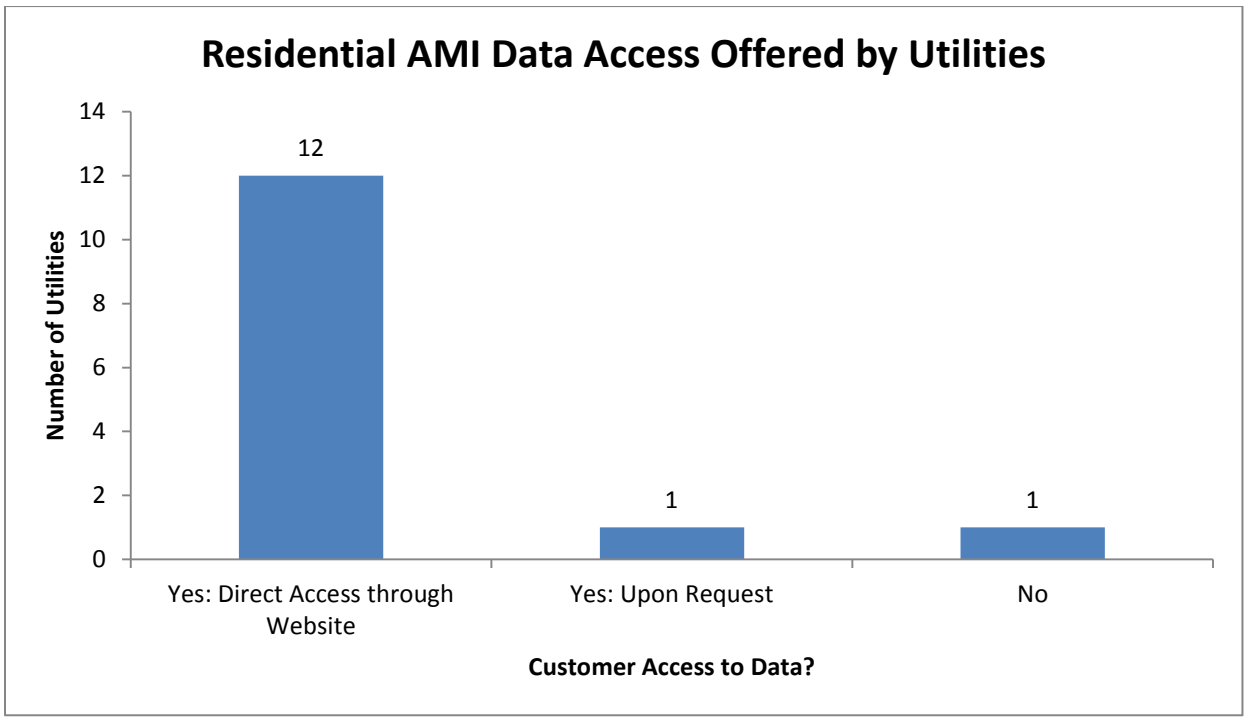

Figure 3. Interview results showing the number of utilities that provide customer's access to their residential AMI data. Only 14 of the 15 interviewed utilities are present in these results because Madison Gas and Electric has only deployed AMI for commercial customers.

Prevalent residential AMI data types provided to customers included kilowatt hours (kWh) and dollars per interval (Figure 4). Austin Energy and Wisconsin Power and Light were the only utilities at the time of the interviews that did not provide kWh data to customers. Utilities such as Braintree and Florida Power and Light mentioned that they collect other data types such as voltage, but do not provide customers with data in these units because they do not believe customers will find these units useful or helpful for understanding their energy usage. Providing AMI data to the customer in kWh has allowed utilities to stay consistent with data units on paper bills distributed before AMI customer data access programs were implemented.

[17] Utilities often mentioned that the customer would have to download and send the data to a third party or the customer would have to give a third party their username and password to access the data (this method was usually not recommended for customer privacy reasons).

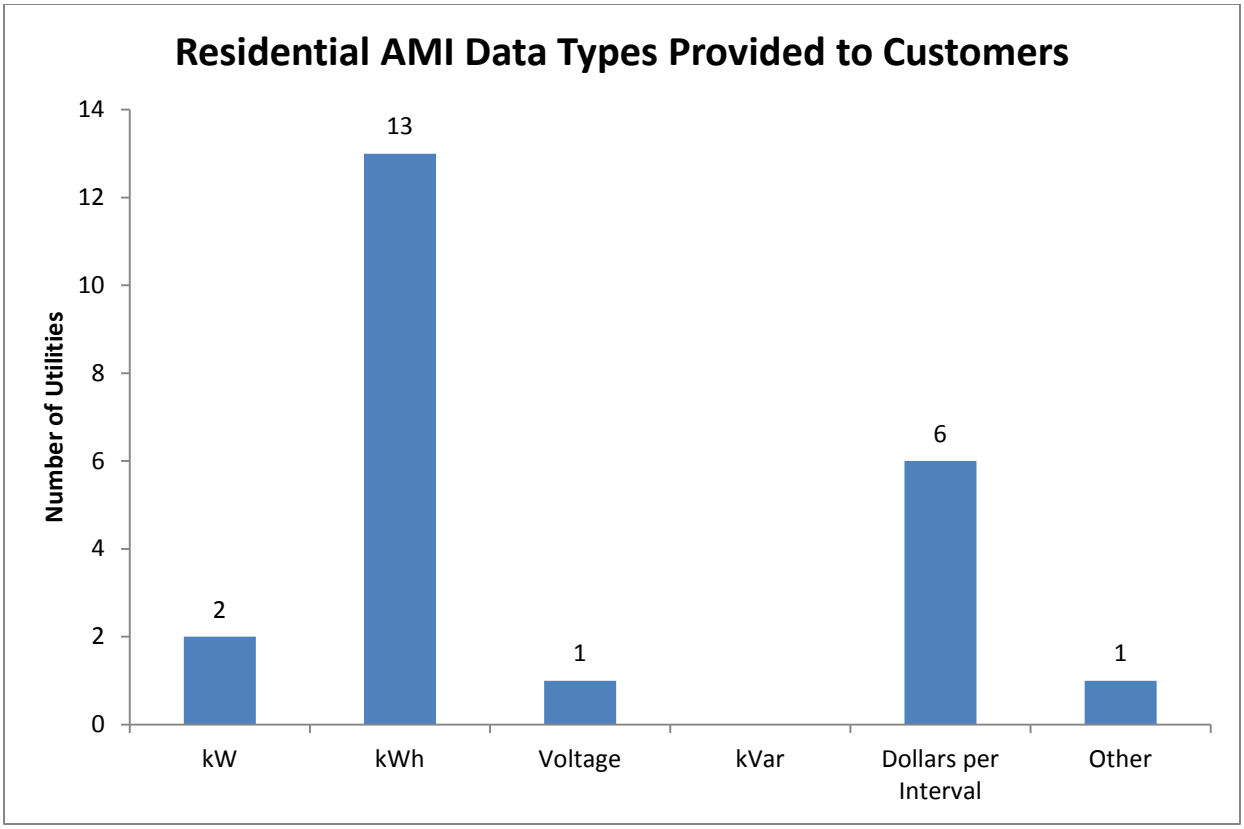

Figure 4. Interview results displaying the AMI data types that utilities provided to residential customers.

Utilities offered 15 minute, 30 minute, 1 hour, and daily interval data to customers (Figure 5).[18] Hourly and 15 minute data were the most commonly offered intervals, but some utilities allowed customers to view their AMI data in multiple intervals. For example, Cleco Power LLC offers hourly, daily and monthly intervals to customers while customers of the City of Kings Mountain see both 15 minute and 30 minute data[19] (Table 6). As with AMI data types, utilities collect other interval data that are not provided to the customers. For example, Braintree Electric collects 15 minute data but only provides customers with hourly data. Furthermore, utilities such as Pepco and Consumer's Energy stated that they are currently making an effort to collect and provide data as granular as 15 minutes, but there is no concrete timeframe for implementation yet.

[18] If a utility employed a timestamp for intervals, timestamps were at each quarter hour for 15 minute data (e.g., 6:00, 6:15, 6:30, 6:45, 7:00), at each half hour for 30 minute data (e.g., 12:30, 1:00, 1:30), and at each hour for 1 hour data (e.g., 1:00, 2:00, 3:00). Of the thirteen utilities that responded to how timestamps (and date stamps) are synchronized within the utility, seven use AMI solution provider headends, four use utility system time, and two use GPS.

[19] Kings Mountain offers both 15 minute and 30 minute intervals. Kings Mountain has a wholesale purchase power agreement with Duke Energy. This agreement is priced based on 30 minute intervals. Therefore, Kings Mountain wanted customer interval data to match the purchase power data so that they would have the ability (along with their customers) to directly compare energy costs during the same periods. In essence, business needs drove the decision to use the 30 minute interval.

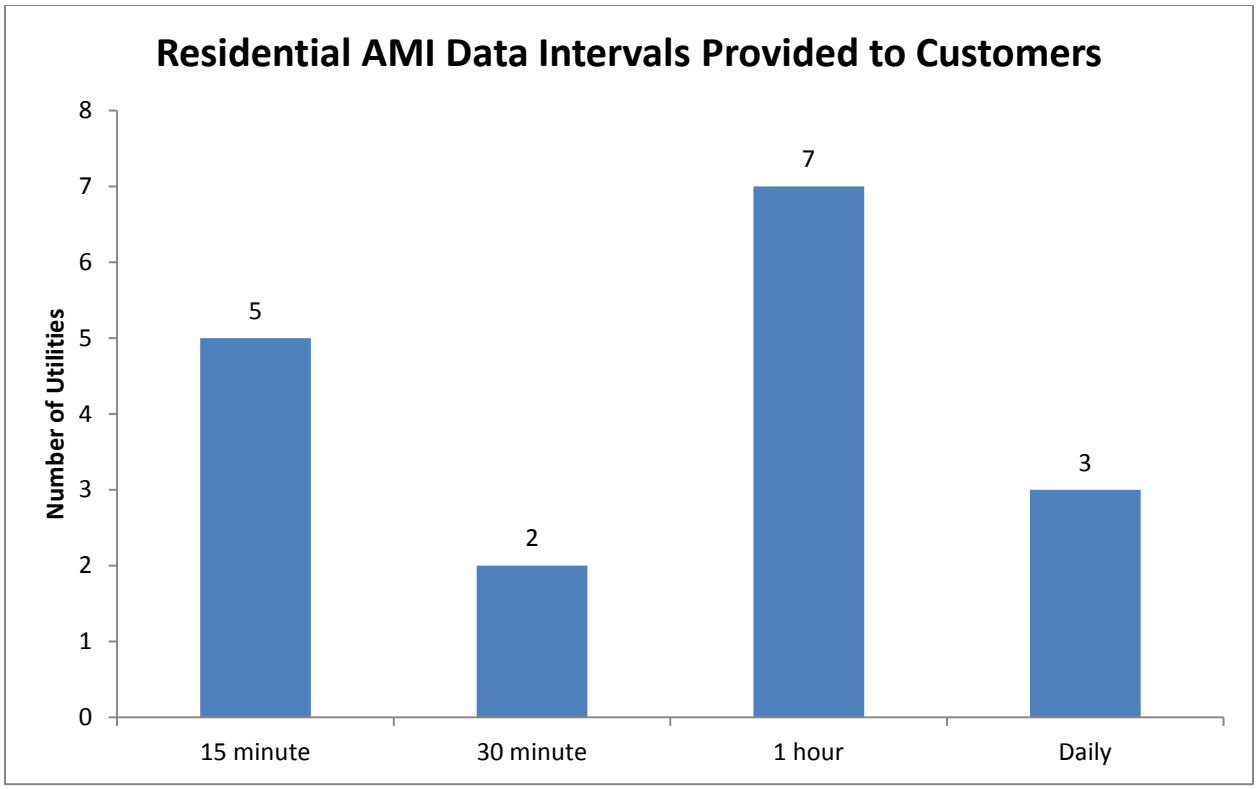

Figure 5. Interview results showing the intervals of AMI data that utilities offered to residential customers.

These interview results suggest that customer access to AMI data is becoming more prevalent through Green Button and other online platforms. Third party access to this data, however, is still limited, mainly due to concerns regarding customer privacy. Data provided to customers is generally in kWh at 15 minute or hourly intervals. Depending on the utility and the date of AMI implementation, approximately 12 to 24 months of historical data are available from most of the interviewed utilities; however, most interviewees mentioned that the utilities currently only allow the customer to view 12 to 13 months of rolling data.[20] A prevalent theme drawn from these interviews is that utilities often collect more data types, intervals, and history than they provide to the customer. Interviewees stated that they prioritized providing data that customers would find relevant, useful and easy to understand.

Since data collection intervals vary by utility, EIA may want to develop some test models with different intervals before ultimately deciding on which interval to use. The interval requirements may end up driving the RECS selection process in the future. For example, it may be more challenging to find customers with 15 minute intervals, but if the value is significantly more than hourly intervals, then the EIA will need to account for this requirement when selecting customers for its RECS sample. Assuming that customer consent is given, EIA may find that working directly with utilities could lead to access to larger datasets with finer granularity than those data provided to customers.

[20] In this context, rolling data means that the data roles over every day based on when the customer's billing cycle ends. For example, if the customer's billing cycle day is the 29th of the month, then the customer would have data for 13 months + 29 days into the 14th month.

Table 6 provides a brief summary of the results for each utility interviewed. For reporting purposes, it contains all utilities that were researched, and documents the ones that we were unable to interview during this project.

Table 6. Summary results from AMI utility interviews

Utility	Can Customers Currently Access Their AMI Interval Usage Data?	Can Third Parties Access AMI Usage Data on Customers Behalf?	What Type of Data is Provided to the Customer? (Collected?)*	What Interval Level is Provided to Customer? (Collected?)*	Was a Data Sample Obtained?	Does the Utility Use GreenButton?[21]
Austin Energy	Yes	Yes - Online	Dollars per Interval, (kWh)	Daily	Yes	Yes
Braintree Electric	Yes	No - Only through customer	kWh, Dollars per Interval, (Voltage)	1-hour, (15-minute)	No	No
City of Kansas City - (KS)	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	No
City of Lakeland - (FL)	Yes	Yes - In-person request	kWh, Dollars per Interval	1-hour	No	Yes
City of Tacoma - (WA)	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	No
Cleco Power LLC	No	Yes - Written request by government agency	kW, kWh, Dollars per Interval, Voltage, Meter Read Dates	1-hour, Daily, Monthly	No	No
Consolidated Electric Coop Inc.	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	No
Consumers Energy	Yes	No - Only through customer	kWh	1-hour	No	No
Dominion Electric	Yes	Yes - Written consent by customer	kWh	30-minute	No	Yes
DTE Energy	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	No
Duke Energy	Yes	Yes - Only those registered as a Competitive Retail Electric Supplier	kWh	Daily, (15-minute)	No	No
Florida Power and Light	Yes	No - Only through customer	kW, kWh, (Voltage)	1-hour	No	No
Jacksonville Electric Authority	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Yes
City of Kings Mountain	Yes	No - Only through customer	kWh, Dollars per Interval	15-minute, 30-minute	No	No
Madison Gas and Electric	N/A - Commercial only	N/A - Commercial only	kWh, (kW)	15-minute	No	No

[21] Utilities who have already adopted or committed to adopt Green Button can be found online here: http://www.greenbuttondata.org/greenadopt.html

Utility	Can Customers Currently Access Their AMI Interval Usage Data?	Can Third Parties Access AMI Usage Data on Customers Behalf?	What Type of Data is Provided to the Customer? (Collected?)*	What Interval Level is Provided to Customer? (Collected?)*	Was a Data Sample Obtained?	Does the Utility Use GreenButton?[21]
Oncor	Yes	No - Only through customer	kWh	15-minute	Yes	Yes
PEPCO	Yes	No - Only through customer	kWh	1-hour	Yes	Yes
Rappahannock Electric Coop	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	Not Interviewed	No
San Diego Gas and Electric	Yes	Yes - Written consent by customer	kWh	15-minute, 1-hour	Yes	Yes
United Power	Yes	No - Only through customer	kWh, Dollars per Interval	15-minute	No	No
Wisconsin Power and Light Co (Alliant Energy)	No	No Data	No Data	No Data	No	No

Sample AMI Data Collection

Along with understanding the processes associated with procuring AMI data, another objective of the Subtask 4 was to collect samples of data from each utility. This would give EIA a tangible appreciation of what would be collected in the future, and it would provide specific examples of the utilizing specific processes for requesting and collecting data. Given the time and scope of this Subtask, there was not time to formally identify and select random participants and recruit them for the project. Therefore, Leidos identified employees and friends that lived in specific utility territories that agreed to participate in the project. While we were not able to find participants for all utilities surveyed, there were enough to provide qualitative examples of the type of data collected, and to experience different processes set up by the utilities to allow customers access to their data.

Nearly all utilities with residential AMI meters have a process for allowing customers to obtain their AMI interval usage data. The most widely used method requires the customer to log in to their utility account online to access their data. Two of the utilities interviewed, Cleco Power (LA) and Alliant Energy (WI), do not currently have a process available for customers to access their data online; however, this functionality is expected to be available sometime in 2014 for Cleco and in 2015 for Alliant. Cleco customers can contact the utility via telephone or visit a customer service center and request their usage data. The online platform used to provide usage data to customers varies by utility. For example, the three large IOUs in California were the first to implement the Green Button on their website in 2011 and continue to utilize this platform today. Several other utilities interviewed also use the Green Button format. Utilities in Texas use a centralized website called Smart Meter Texas to provide customers online access to their usage data. The remaining utilities interviewed use a variety of online "portals" that are accessed directly through the respective utility website to provide data to customers.

Leidos obtained sample AMI data from Austin Energy, Oncor, Pepco, and SDG&E. Austin Energy provides customers with data in multiple formats (PDF, CSV, XML, XLS/XLSX), but only allows customers to view dollars per day data (Figure 6). Sample CSV datasets from Oncor, Pepco and SDG&E contained energy usage dates, timestamps for each interval, and consumption in kWh for each interval (Figure 7 and Figure 8). Pepco's sample data has the exact same format as SDG&E's sample data and is not included in this section of the report. Appendix F, however, provides screenshots of all sample data received from both AMI and submeter interviews.

Differences in sample data related more to data type and interval provided rather than the format of the data. Austin Energy was the only outlier from this small sample of utilities that had a completely different data format due to the type of data provided. Oncor, Pepco, and SDG&E generally had the same data elements that could be pulled for modeling.

	A	B
1	**Date**	**Daily Energy usage ($)**
2	19-Mar	$1.28
3	20-Mar	$1.49
4	21-Mar	$1.36
5	22-Mar	$1.51
6	23-Mar	$1.60

Figure 6. Austin Energy sample daily AMI cost data in Excel format.

	A	B	C	D	E	F	G
1	ESIID	USAGE_DATE	USAGE_START_TIME	USAGE_END_TIME	USAGE_KWH	ESTIMATED_ACTUAL	CONSUMPTION_GENERATION
2	1.04437E+16	1/1/2014	00:00	00:15	0.091	A	Consumption
3	1.04437E+16	1/1/2014	00:15	00:30	0.094	A	Consumption
4	1.04437E+16	1/1/2014	00:30	00:45	0.09	A	Consumption
5	1.04437E+16	1/1/2014	00:45	01:00	0.346	A	Consumption
6	1.04437E+16	1/1/2014	01:00	01:15	0.626	A	Consumption
7	1.04437E+16	1/1/2014	01:15	01:30	0.629	A	Consumption
8	1.04437E+16	1/1/2014	01:30	01:45	0.757	A	Consumption
9	1.04437E+16	1/1/2014	01:45	02:00	1.048	A	Consumption
10	1.04437E+16	1/1/2014	02:00	02:15	1.096	A	Consumption
11	1.04437E+16	1/1/2014	02:15	02:30	1.079	A	Consumption
12	1.04437E+16	1/1/2014	02:30	02:45	1.072	A	Consumption
13	1.04437E+16	1/1/2014	02:45	03:00	1.076	A	Consumption
14	1.04437E+16	1/1/2014	03:00	03:15	1.072	A	Consumption
15	1.04437E+16	1/1/2014	03:15	03:30	1.073	A	Consumption
16	1.04437E+16	1/1/2014	03:30	03:45	1.07	A	Consumption
17	1.04437E+16	1/1/2014	03:45	04:00	1.072	A	Consumption
18	1.04437E+16	1/1/2014	04:00	04:15	1.075	A	Consumption
19	1.04437E+16	1/1/2014	04:15	04:30	1.069	A	Consumption
20	1.04437E+16	1/1/2014	04:30	04:45	1.076	A	Consumption
21	1.04437E+16	1/1/2014	04:45	05:00	1.068	A	Consumption
22	1.04437E+16	1/1/2014	05:00	05:15	1.148	A	Consumption
23	1.04437E+16	1/1/2014	05:15	05:30	1.093	A	Consumption
24	1.04437E+16	1/1/2014	05:30	05:45	1.098	A	Consumption
25	1.04437E+16	1/1/2014	05:45	06:00	1.066	A	Consumption
26	1.04437E+16	1/1/2014	06:00	06:15	1.064	A	Consumption
27	1.04437E+16	1/1/2014	06:15	06:30	0.836	A	Consumption
28	1.04437E+16	1/1/2014	06:30	06:45	0.636	A	Consumption
29	1.04437E+16	1/1/2014	06:45	07:00	0.433	A	Consumption

Figure 7. Oncor sample 15-minute AMI data in CSV format.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Name													
2	Address													
3	Account Number													
4	Disclaimer	The information contained in this file is intended for the personal and confidential use of the recipient(s) named above. Any unauthorized use is prohibited.												
5	Title	CSV Export Electric Meter(s)												
6	Resource	Electric												
7	Meter Number													
8	Interval UOM	Minute(s)												
9	Readings Start	8/1/2013 0:00												
10	Readings End	3/31/2014 23:00												
11	Total Duration	349920 Minute(s)												
12	Total Usage	3492.25												
13	UOM	kWh												
14	Multiplier	1												
15	Meter Number	Date	Start Time	Duration	Value	Edit Code	Flow Direction							
16	[redacted]	8/1/2013	12:00 AM	60	0.37	Direct								
17		8/1/2013	1:00 AM	60	0.27	Direct								
18		8/1/2013	2:00 AM	60	0.27	Direct								
19		8/1/2013	3:00 AM	60	0.295	Direct								
20		8/1/2013	4:00 AM	60	0.275	Direct								
21		8/1/2013	5:00 AM	60	0.275	Direct								
22		8/1/2013	6:00 AM	60	0.415	Direct								
23		8/1/2013	7:00 AM	60	0.545	Direct								
24		8/1/2013	8:00 AM	60	0.41	Direct								
25		8/1/2013	9:00 AM	60	0.42	Direct								
26		8/1/2013	10:00 AM	60	0.395	Direct								
27		8/1/2013	11:00 AM	60	0.655	Direct								
28		8/1/2013	12:00 PM	60	0.535	Direct								

Figure 8. SDG&E sample hourly AMI data in CSV format.

Overall Insights – AMI

Based on the analysis above, we conclude that there are enough AMI meters installed today for the EIA to consider utilizing the data in future studies. However, while AMI meters (and therefore the data) exist, there are multiple issues to address with respect to the process that will be utilized to systematically collect, store and utilize the information. Below are insights learned from investigating AMI systems deployed in the U.S.:

- Over 40 million AMI meters have been installed across the United States, in every state and by every major type of utility. Furthermore, utilities are forecasted to continue to roll-out residential AMI meters in their service territories and expand customer choices for access to their data.
- In nearly all cases, customer interval data cannot be given to third parties without customer consent and authorization. There are limited opportunities for third parties to directly request and receive data from the utilities, even with customer consent.
- In many instances, the utilities have set up systems or portals to allow customers to access their own data, thereby requiring third parties to go directly to the customer to receive the data.
- An industry standard has been developed through the Green Button Initiative as a method to provide data to customers using website access. The Green Button Standard has been adopted by 63 utilities to date, with another 34 making future commitments to implement it.
- Data collection intervals vary by utility, from 15 minute intervals to daily reads. Also, in general, 12 to 24 months of historical data are available for download depending on the utility. EIA will need to determine how much historical data it will need to collect for its modeling process.
- KWh is the most common data element collected via the AMI systems.
- Utilities often collect more data types and intervals than they provide to the customer. Since data collection intervals vary by utility, EIA may want to develop some test models with different intervals before ultimately deciding on which interval to use. The interval requirements may end up driving the survey selection process in the future. For example, it may be more challenging to find customers with 15 minute intervals, but if the value for EIA modeling is significantly more than hourly intervals, then the EIA will need to account for this when it selects customers for its survey sample. EIA may find that working directly with utilities may lead to access to larger datasets with finer granularity than those data provided to customers – assuming they also get customer consent.
- Collecting AMI data from thousands of customers will require a strategy for collecting, validating and analyzing this data, along with consolidating this information with other datasets.

Submeter Review

The current worldwide market for submetering technology and services totals $771 million, and is expected to grow to $1.58 billion in 2020 based on a compound annual growth rate of 9.4 percent[22]. Research conducted for this study shows there to be over 50 different companies, ranging from hardware manufacturers to solutions providers to applications companies that claim to have products in the submeter market. Likely pathways to mass residential implementation include providing submeters as an ancillary offering with home security and/or home automation systems, providing submeters in a home builder offering, or implementing utility incentive, rebate or demand response programs. Unlike advanced metering infrastructure (AMI) programs that span over 500 utilities with over 33 million smart meters, there is significantly less activity in utility residential submeter projects. Project examples, each of which showcase whole house submetering by circuit, include Duke Energy's 60 home pilot project, San Diego Gas and Electric's (SDG&E) 30 home pilot project, Community Power Partnership's 50 home pilot project in Boulder, Colorado, and Pecan Street Energy's 700 home monitoring project in Austin, Texas.

The purpose of this review is to provide findings from research on the current availability of residential submeter data in order to characterize how prevalent the data are within the electrical industry and outline how electric utilities are using submeters to advance residential energy efficiency practices and policies. This review focuses on submeter technology companies and utilities implementing submeter programs so as to provide insights from both perspectives in the submeter market.

Submeter Technology Company Assessment

Submeter Technology Landscape

The landscape analysis focused on identifying and documenting those companies that have the hardware and applications to collect and store submeter data. Research showed there to be three common submeter technology types among companies in the current market:

1. **Plug-load Outlet Monitor:** Appliances plug into monitor and monitor plugs into wall outlet. Data is measured and recorded as electricity passes through the monitoring device as it measures the plug-load of the appliance.

2. **Circuit-level Monitor:** Monitor is mounted near or within a breaker panel, and uses current transformers and measured or assumed voltage to determine power and energy consumption for multiple electrical circuits.

3. **Whole-house Monitor with Load Disaggregation Algorithms:** Monitor is mounted near or within a breaker panel, and uses current transformers and measured line voltage to determine power and energy consumption at the electrical mains. A cloud service then uses electrical

[22] Pike Research. 2012. Electricity Submeters Basic and Advanced Submeter Hardware, Submeter Energy Management Software, and Submetering Services: Market Analysis and Forecasts. Available online at: http://www.navigantresearch.com/newsroom/electricity-submetering-market-will-double-in-size-to-1-6-billion-by-2020-according-to-pike-research

pattern detection algorithms to identify electrical signatures of specific appliances and other loads.

The submeter technology landscape analysis consisted of informed research to provide a diverse sample of companies based on parameters including, but not limited to, technology type, data measurements, and data storage methods. The following detailed criteria were used to identify the companies included in the submeter landscape analysis:

1. Companies must offer submeters for residential homes (i.e., single phase, 120/240v).

2. The company's products need to measure and collect any or all of the following energy information: kWh, kW, volts, and amps. This analysis focused on products capable of collecting or converting data to kWh.[23]

3. The product must collect data on least one device in the home. Whole-house electricity monitors with no end-use disaggregation capabilities are not included in this analysis.

4. There must be a clear method for retrieving data that has been collected from the submeter system. The preferred data collection method is through a communication-based remote collection system; however, this analysis also considered devices that have a memory card that can be manually extracted to collect the data stored on it.[24]

Submeter Technology Landscape Analysis Results and Conclusions

Table presents fifteen submeter technologies from companies that were ideal interview candidates given the criteria stated previously. It is important to note that this table is not an exhaustive list of submeter technology companies targeting the residential market, but rather a focused examination of products relevant to the scope of this project. Submeter product parameters featured in the table below include:

- Product Name
- Company Name
- Monitor Type
- Monitored Circuits
- Hardware Costs
- Data Services Costs
- Measurement Frequency
- Accuracy
- Communication Protocol(s)
- Data Storage Location
- Data Storage Capacity
- Data Download or Export Formats
- Third Party Data Availability

Of the three submeter technology types, circuit-level monitors are the most prevalent in this landscape analysis with twelve companies offering circuit-level technologies, three companies offering plug-load monitors, and one company selling whole-house monitors with load disaggregation capabilities. Hardware costs varied among companies and products, but data services costs were generally free or

[23] It is important to note that some submeters collect specific data elements that are then converted to kWh. For example, kWh can be calculated from volts and amps measured over time. Companies that employ this type of conversion system were also included in the landscape analysis.

[24] Data storage capacity is an important factor in these data collection systems. When possible, we noted how much data the system holds before it starts overwriting the card (or memory) with new information.

minimal with the caveat that these costs would be subject to change. Furthermore, although results consistently indicated that common data storage locations included local, cloud, and embedded web servers, data storage capacity varied from unlimited to storage capacities dependent on the interval of data collected (e.g., minute data as opposed to hourly data). In terms of distributing this data, a majority of the companies from this analysis have implemented web interfaces from which customers can analyze, download, and export data in common formats such as comma separated values (CSV) files or extensible markup language (XML). Third party data availability information was collected through phone interviews and will be discussed in greater depth in the next section.

Research suggests that there is a diverse landscape of submeter technologies targeting the residential sector. While the circuit-level monitor is the most common technology type, there appears to be a market for all three technology types given the variety of specifications offered for each type of monitor. The next section presents results and conclusions from telephone interviews with submeter technology companies that yielded in-depth information on monitor types, market strategy, and third party data availability.

Table 7. Submeter technology landscape analysis information. Note that certain companies offer multiple products.

Product	Company	Monitor Type	Monitored Circuits	Hardware Cost	Data Services Cost	Measurement Frequency	Accuracy	Communication Protocol(s)	Data Storage Location	Data Storage Capacity	Download or Export Formats	3rd Party Data Availability
SiteSage (formerly eMonitor)	Power House Dynamics, Inc.	Circuit-level	>200 circuits (via linked modules)	$490 - $900[25]	$7.99 - $14.99 per month[26]	1 min	N/A	Wi-Fi, Zigbee Module	Cloud Server*	Unlimited with monitoring service	CSV, XML	Yes
FIDO	Ecodog, Inc.	Circuit-level	8 Main or 16 Aux. per Module (64 Modules, 1024 Circuits Max.)	By Quote Only	N/A	Unknown	**Current:** less than ± 2.5% **Voltage:** less than ± 0.1%	Power Line, USB	N/A - Not IP based	**Adapter:** 45-100 days **Local PC:** Unlimited		Unknown
ECM-1240	BrulTech Research, Inc.	Circuit-level	2 Main, 10 Aux. per Module (6 Modules, 84 Circuits Max.)	$177 - $236	N/A	1 sec	± 3%	Wired Ethernet, USB, Wi-Fi	Local or Cloud Server*	Unlimited		Unknown
GreenEye Monitor	BrulTech Research, Inc.	Circuit-level	2 Main, 10 Aux. per Module (6 Modules, 84 Circuits Max.)	$500 - $571	N/A	1 sec	± 3%	Wired Ethernet, USB, Wi-Fi	Local or Cloud Server*	Unlimited		Unknown
PQube Meter	Power Standards Lab	Circuit-level	5 current channels	By Quote Only	Free	0.2 sec	± 0.1%	Wired Ethernet	Embedded web server**	Depends on memory card[27]	TXT, XML, and HTML, CSV, GIF, PQDIF	Unknown

[25] Price depends on the number of circuits. Pricing is as follows: $490 for 14 circuits, $655 for24 circuits, and $900 for 44 circuits.
[26] Price depends on the number of circuits. Pricing is as follows: $7.99 per month for 14 circuits, $10.99 per month for24 circuits, and $14.99 per month for 44 circuits. Two-year prepay prices include $173 for 14 circuits, $240 for 24 circuits, and $324 for 44 circuits.
[27] There are two options of memory card storage. A 4 GB secure digital card (SD-card) comes standard with the submeter, but there is also an optional 16 GB SD-card.

Product	Company	Monitor Type	Monitored Circuits	Hardware Cost	Data Services Cost	Measurement Frequency	Accuracy	Communication Protocol(s)	Data Storage Location	Data Storage Capacity	Download or Export Formats	3rd Party Data Availability
TED Pro Home	Energy, Inc.	Circuit-level	2 Main, 32 Aux	$300 - $1,050	Free	1 sec	Better than ± 2%	Wired Ethernet, PLC, WiFi, ZigBee Module, USB, or Xbee Module	Embedded web server**	Up to 90 days of hourly data[28]	CSV	Yes
TED 5000	Energy, Inc.	Circuit-level	4 Main	$200 - $456	Free	1 sec	± 2%	Power Line, Zigbee Module, Wired Ethernet	Embedded web server**	Up to 90 days of hourly data[29]	CSV	Yes
eGauge	eGauge	Circuit-level	1 Main, 10 Aux (expandable)	$500 - $550	Free	1 sec	CT dependent	Wired Ethernet, Power Line	Embedded web server**	Up to 30 years of 15-minute data[30]	XML	Yes
EnviR	Current Cost	Circuit-level, Plug-load	10 Main	$129	Free	6 sec	Less than 3%	SRD Band, Wired Ethernet, USB	Embedded web server**	Up to 31 days of hourly data[31]	XML	Unknown
WeMo Insight	Belkin	Plug-load	up to 16 outlets	$60 per outlet	Free			Wi-Fi	Cloud Server*	40 days	CSV sent by email	Unknown
Neurio	Energy Aware Technology	Algorithm	1 Main	$250	Free[32]	1 sec	1%	Wi-Fi	Cloud Server*	**Sensor:** 1 year **Cloud:** Unlimited	CSV	Unknown
Check-It Solutions	Check-It Solutions	Circuit-level	3 Channels (expandable)			0.5 sec	0.2%	Wired Ethernet, Zigbee Module, Wi-Fi	Cloud Server*	3 years		Unknown

[28] Storage capacity depends on interval of the data. Storage capacities for different intervals are as follows: 2 hours of second-data, 48 hours of minute-data, 90 days of hourly data, 2 years of daily data, and 24 years of monthly data.
[29] Storage capacity depends on interval of the data. Storage capacities for different intervals are as follows: 1 hour of second-data, 48 hours of minute-data, 90 days of hourly data, 2 years of daily data, and 10 years of monthly data.
[30] Storage capacity depends on interval of the data. Storage capacities for different intervals are as follows: 10 minutes of second-data, 1 year or minute-data, and 30 years of 15-minute data.
[31] Storage capacity depends on interval of the data. Storage capacities for different intervals are as follows: 7 days of minute-data, 31 days of hourly data, 90 days of daily data, and 7 years of monthly data.
[32] Data services costs are initially free, but costs are subject to change in the future.

Product	Company	Monitor Type	Monitored Circuits	Hardware Cost	Data Services Cost	Measurement Frequency	Accuracy	Communication Protocol(s)	Data Storage Location	Data Storage Capacity	Download or Export Formats	3rd Party Data Availability
g-Meter	Enalasys/greenNet	Circuit-level		$350 - $600	Free	3 to 5 sec	± 1%	ZigBee Module, Wired Ethernet	Cloud Server*			Unknown
Watts Up? .Net	ThinkTank Energy Products	Plug-load	Multiple using wireless bridge (maximum not specified)	$236 per outlet	Free to $50 per month[33]	1 sec	± 1.5%	USB, Wired Ethernet, Wi-Fi	Embedded web server**	Depends on number of parameters stored[34]	CSV	Yes
Watts Up? Smart Circuit 20	ThinkTank Energy Products	Circuit-level	Multiple using wireless bridge (maximum not specified)	$225 per circuit	Free to $50 per month[35]	1 sec	± 1.5%	USB, Wired Ethernet, Wi-Fi	Embedded web server**	Depends on number of parameters stored[36]	CSV	Yes

* A cloud server refers to a data storage location where data is transferred from the device over the internet to a remote server where the data is stored.
** An embedded web server refers to a data storage location where submeter hardware acts as a server. Data is stored on the device and the device connects to the internet and has an IP address. As a result, data stored on the device can be accessed from anywhere over the internet.

[33] Prices are dependent on number of meters, type of interval data and length of data history. Pricing is as follows: Free for 2 meters, 15-minute data, and a 30 day history; $5 per month for 5 meters, 5 minute data, and a 3 month history; $25 per month for 10 meters, 1 minute data, and a 6 month history; $50 per month for 25 meters, 1 minute data, and a 1 year history.
[34] Memory storage depends on how many parameters are stored, and in what mode the memory is in. 120,000 records is possible in stop/overwrite mode, and when only logging watts. In automatic mode with all parameters recorded the storage is approximately 4000 records
[35] Prices are dependent on number of meters, type of interval data and length of data history. Pricing is as follows: Free for 2 meters, 15 minute data, and a 30 day history; $5 per month for 5 meters, 5 minute data, and a 3 month history; $25 per month for 10 meters, 1 minute data, and a 6 month history; $50 per month for 25 meters, 1 minute data, and a 1 year history.
[36] Memory storage depends on how many parameters are stored, and in what mode the memory is in. 120,000 records is possible in stop/overwrite mode, and when only logging watts. In automatic mode with all parameters recorded, the storage is approximately 4000 records

Submeter Technology Company Interviews

Telephone interviews with selected submeter technology companies served to provide additional product information and insights into, target customer groups, data collection, storage and distribution practices, and pilot project involvement. Interviews also focused on developing an understanding of the opportunities for and challenges or barriers to collecting residential submeter data as a third party entity. Each interview consisted of contacting a manager within each technology company to discuss a relevant set of market research questions that had been pre-approved by EIA. Appendix C contains interview response sheets for the five technology companies interviewed. The next subsections discuss the methods and criteria for identifying company candidates for interview, sample data received from those companies, and conclusions drawn from each interview.

Criteria to Identify and Interview Submeter Technology Companies

The submeter technology landscape analysis provided a resource from which to choose companies for in-depth interviews and evaluation. Criteria for interviews included market penetration, pilot project experience, and monitor type. Submeter technology companies who were key players in the residential market were chosen based on a detailed literature review. These companies were often involved in pilot projects. For example, projects highlighted later in this report such as Pecan Street Energy and a pilot by Duke Energy use submeter technologies from eGauge and Powerhouse Dynamics, respectively. An effort was made to interview companies that employed at least one of the three common submeter technology types outlined earlier in this report.[37] Circuit-level monitors were the most prevalent in the landscape analysis, so we conducted multiple interviews with companies that offered this technology.

Table 8 provides a list of submeter technology companies interviewed and also includes contact information to allow for future dialogue and correspondence with these companies.

Table 8. List of submeter technology companies interviewed.

Company Name
Brultech Research, Inc.
eGauge Systems, LLC
Energy, Inc. (The Energy Detective)
Powerhouse Dynamics
Think Tank Energy Products

Submeter Technology Sample data: Trends and Differences

All interviewed companies except for Brultech Research, Inc., were able and willing to provide sample data from their monitors. The most common data measurements collected were date, time, volts, amps, and kWh, but different monitors collected varying data elements (Table 9). A common theme that interviews yielded was that if kWh was not collected directly by the submeter, software models on

[37] Neurio, the only company in this analysis that uses a whole-house monitor with load disaggregation capabilities, was contacted for an interview, but declined.

the back end calculated kWh once the data were received from the monitors. Interviewees mentioned that kWh data are generally presented to customers in their online data-viewing platforms, providing a consistent unit of measure for comparison with other electricity data.

Table 9. Data measurements collected for submeter products from each interviewed company

Company Name	Product Name	Monitor Type	Data Measurements Collected
Brultech Research, Inc.	ECM-1240 and GreenEye	Circuit-level	Volts, Amps, Temperature (GreenEye only) (kW calculated)
eGauge Systems, LLC	eGauge	Circuit-level	Date, Time, Volts, Amps, Watts, Wh, Frequency (Hz), VA, VAR, THD, Temperature
Energy, Inc. (The Energy Detective)	TED Pro Home and TED 5000	Circuit-level	Date, Time, Volts, Amps, kW, kWh, kVA, PF, Cost
Powerhouse Dynamics	SiteSage	Circuit-level	Date, Time, Volts, Amps (kW, kWh, and Cost calculated)
Think Tank Energy Products	Watts Up? .Net and Watts Up? Smart Circuit 20	**.Net:** Plug-load **Smart Circuit 20:** Circuit-level	Date, Time, Current Watts, Min. Watts, Max. Watts, PF, VA, Cumulative Wh, Average Monthly kWh, Elapsed Time, Duty Cycle, Frequency (Hz), Cumulative Cost, Average Monthly Cost, Line Voltage, Min. Volts, Max. Volts, Current Amps, Min. Amps, Max. Amps

Sample data provided by interviewees ranged from raw, unprocessed data to pre-processed data that would be available for customer viewing. Figure provides an example of raw data from Energy, Inc.'s, TED Pro Home monitor, while Figure provides a screenshot of raw data from Powerhouse Dynamics' energy management platform for the SiteSage monitor. Appendix F provides screenshots of all sample data received from both AMI and submeter interviews.

	B	C	D	E	F	G	H	I	J
1	Time	Power	Cost	Voltage	PF	Apparent Power	Reactive Power	Amps Average	
2	7/2/2013 15:23	14.229	1.43	122.4	95.8	14.853	3.388	41.3	
3	7/2/2013 15:22	14.196	1.42	122.4	95.8	14.818	3.380	41.2	
4	7/2/2013 15:21	14.291	1.43	122.4	95.8	14.918	3.403	41.4	
5	7/2/2013 15:20	14.738	1.48	122.4	95.7	15.400	3.427	42.8	
6	7/2/2013 15:19	15.76	1.58	122.3	95.6	16.485	3.582	45.8	
7	7/2/2013 15:18	15.745	1.58	122.4	95.5	16.487	3.499	45.8	

Figure 9. Raw data collected from Energy, Inc.'s, TED Pro Home monitor.

	A	B	C	D	E	F
1			Minute Level SiteSage Data			
2						
3	Column name is Energy Monitor Serial Number/Energy Monitor Channel Number-Circuit Name					
4	Channel Columns contain average power usage(production) in watts for minute					
5	Voltage is average voltage for minute					
6						
7	Date/Time	12044/CH1-Inactive	12044/CH2-Main Power	12044/CH3-Main Power	12044/CH4-Kitchen GFI Right Side	12044/CH5-Refrigerator
8	active	12044/CH37-Inactive	12044/CH38-Inactive	12044/CH39-Inactive	12044/CH40-Inactive	12044/CH41-Inactive
9	12056/CH38-Inactive	12056/CH39-Inactive	12056/CH40-Inactive	12056/CH41-Inactive	12056/CH42-Inactive	12056/CH43-Inactive
10	3/20/2014 0:00	41	174	309	0	77
11	3/20/2014 0:01	41	172	309	0	77
12	3/20/2014 0:02	41	175	310	0	77
13	3/20/2014 0:03	41	174	311	0	78
14	3/20/2014 0:04	41	175	311	0	78
15	3/20/2014 0:05	41	175	311	0	78
16	3/20/2014 0:06	41	175	311	0	78
17	3/20/2014 0:07	41	175	311	0	78
18	3/20/2014 0:08	41	175	311	0	78
19	3/20/2014 0:09	41	175	311	0	78
20	3/20/2014 0:10	41	175	311	0	78
21	3/20/2014 0:11	41	175	311	0	78
22	3/20/2014 0:12	41	174	311	0	77
23	3/20/2014 0:13	41	176	310	0	76
24	3/20/2014 0:14	41	175	309	0	75
25	3/20/2014 0:15	41	175	308	0	74
26	3/20/2014 0:16	41	175	308	0	74
27	3/20/2014 0:17	39	176	295	0	61
28	3/20/2014 0:18	32	178	239	0	6
29	3/20/2014 0:19	31	177	236	0	3
30	3/20/2014 0:20	31	177	236	0	3
31	3/20/2014 0:21	31	177	236	0	3
32	3/20/2014 0:22	31	177	236	0	3

Figure 10. Sample raw 1-minute submeter data from Powerhouse Dynamics' SiteSage circuit-level monitor.

Also, along with raw data, several vendors also supposed "processed" or summary data. These data are typically available for customer review via a portal or website. Figure 11 below provides an example of processed data from Powerhouse Dynamics.

	A	B	C	D	E	F	G	H
1	Electricity Usage by Load							
2								
3			from	3/1/2014	to:	3/26/2014	total days	26
4								
5	report generated 2014-03-27 10:43:00							
6								
7	Name		kWh	Cost	kWh/Day	Cost/Day		
8	Kids Room		113	15.91	4.3	0.61		
9	Family Room and Hall		46	6.48	1.8	0.25		
10	Stove		32	4.45	1.2	0.17		
11	Kitchen GFI Right Side		30	4.28	1.2	0.16		
12	Refrigerator		28	3.98	1.1	0.15		
13	Routers/Network		22	3.15	0.9	0.12		
14	Dryer		22	3.13	0.9	0.12		
15	Garage Sub-Panel Outside Lights		21	2.95	0.8	0.11		
16	Utility Room		21	2.94	0.8	0.11		
17	Kitchen GFI Left Side		21	2.91	0.8	0.11		
18	Master Bedroom and Hall		14	2.04	0.6	0.08		

Figure 11. Processed submeter data from Powerhouse Dynamics' energy management platform for the SiteSage monitor.

Submeter Technology Phone Interview Results and Conclusions

All five interviewed companies are small (i.e., less than-20 employees), and have targeted both residential and commercial customers in their marketing strategies. Typical product distribution channels included universities and research organizations, utilities, residential energy efficiency organizations, solar installers, service contractors, and direct sales through the company's website.

Four companies[38] offered data to third party entities only through customers, meaning that customers could download submeter data and provide the data to the third party through email or U.S. mail. Customers can access data mostly through web platforms and download the data in common formats such as CSV and XML. Alternatively, eGauge, Energy Inc. and Think Tank Energy Products each provide an Application Programming Interface (API) that can be used by customers and third parties to communicate submeter data. Powerhouse Dynamics Systems and Think Tank Energy Products also currently offer data access to administrators of submeter programs using their technologies. For example, a utility running a submeter program would have access to all participant data through the online data portal provided by the technology company.

Results from these interviews suggest that submeter technology companies are targeting the residential market mainly through organizations conducting research or administering energy efficiency programs and through solar power system installers. Although companies have implemented platforms from which customers can access their submeter data, third parties can only receive direct access to the data if they administer the submeter program or work with a submeter user to setup automated data transfer via API. Sponsoring a submeter program may be a practical way for EIA to collect large datasets from multiple customers for RECS modeling purposes. More research is required to assess the feasibility of developing a database that uses available APIs to collect submeter data from a large number of residential customers.

Utility Submeter Programs Assessment

Utility Submeter Interviews

There are very few submeter projects under way at utilities today. Unlike regulatory involvement with utility AMI programs, there have been no regulatory initiatives or mandates to collect information at this level or interval. For most utilities, technology cost recovery is dependent on regulatory approval. Because the technology is expensive to purchase, install and maintain, and because there is no foreseeable regulatory or legislative mandate to install these, there has been little utility activity to date. However, as utility distribution systems become more constrained with new customer load and distributed generation loads, utilities are becoming more interesting in learning how they can better operate and optimize their systems. This requires a more granular understanding of how their customers use energy. As a result, there have been some pilots undertaken. Duke Energy and Pecan Energy were the two most visible ones (Table 10).

[38] Four of the five companies provided information on third party data availability. The fifth company, Brultech Research, Inc., was not able to provide that information.

Table 10. Utility Submeter Program Interview Results.

Survey Question	Duke Energy	Pecan Street Energy
Goals of Submeter Project	To collect information for grid optimization and operations research	To provide installation, operations, technical support and data for research and analysis by its members and academic institutions.
# Customers Involved	61	700+
Location of Customers	North Carolina	Texas, Colorado, California
End Uses Monitored	Individual circuits in the home	Individual circuits in the home
Monitoring Technology	Clamp on CTs	Clamp on CTs
Data Collected	kW, voltage	kW, KWh, voltage, energy costs
Interval Level	1 minute	1 minute
Communications Used	Wireless, customer broadband	LonWorks PLC, customer broadband
Data stored in MDMS?	No – separate big data platform	No – developed their own big data platform

Case Study: Pecan Street Energy

Pecan Street Inc. carries out the nation's deepest research on customer electricity use. Pecan Street is a 501(c)3 organization headquartered at the University of Texas at Austin. It operates the world's largest research database on disaggregated customer electricity use from over 1,200 participants nationally. The Institute's data operations include unique circuit-level energy readings and analysis into residential solar performance and home electric vehicle charging.

Pecan Street's research trials measure disaggregated residential electricity use and voltage from eight to 24 circuits per home at one-minute intervals, as well as gas, water, and vehicle data. The Institute also performs annual sociodemographic surveys of participants and detailed home energy audits. These combined data sources enable the research team to measure and verify statistical relationships, multivariable causation and behavioral responses that cannot be identified through information from smart meters. This level of information makes it possible to better model customer preferences and electric system impacts.

Pecan Street owns and operates WikiEnergy, a searchable online database of time-stamped research data related to energy and water use includes the world's largest research database of original data on customer electricity use, appliance and HVAC use, electric vehicle charging, rooftop solar panel generation and behavioral response. WikiEnergy is a massive searchable online research site that includes these resources:

- Time-stamped, disaggregated electricity use from a diversity of regions and building types (houses, apartments, small commercial and school buildings available at 1-minute and 15-minute intervals)
- Appliance and device level use data
- "Ground truth" circuit measurement data for AMI meter disaggregation algorithm verification
- Electric vehicle charging patterns

- Data measuring behavioral response to interventions related to utility use
- High resolution water and gas use from a diversity of building types and regions
- Generation profiles from utility scale and distributed renewables
- Local weather data
- Wholesale and retail energy pricing data
- Home energy audit and participant survey data

Data availability depends on participant location, status of installation, date of energy data router installation and status of reporting device.

Submeter Conclusions and Insights

Based on the analysis above, we conclude that there are not enough submeter systems installed today for the EIA to consider utilizing the data in future studies. This technology is not yet widely adopted by utilities. Below are additional insights learned from investigating submeter systems deployed in the U.S.:

- There are very few submeter projects under way at utilities today.
- Unlike regulatory involvement with utility AMI programs, there have been no regulatory initiatives or mandates to collect information at this level or interval. For most utilities, technology cost recovery is dependent on regulatory approval.
- Technology exists today to install and collect data on residential end uses. Several companies have developed the hardware and software applications to collect submeter data, and have projects underway outside the utility industry.
- Technology is expensive, and it is expensive to install and support relative to AMI meters.
- Technology has capability to measure circuits or plugs at very short intervals (1 minute or less)
- Collected data is typically either stored on a cloud-hosted server or on internal hardware memory that may be accessed remotely via an embedded web server.
- Submeter systems and data outputs are much less standardized than AMI systems and data.
- Even with submeters, it is extremely difficult or impossible to disaggregate end uses that share circuits in a residential electrical system such as lighting and plug loads.
- Submeter technology companies have set up systems or portals to allow customers to access their own data, thereby requiring third parties to go directly to the customer to receive the data. Some companies currently offer data access to administrators of submeter programs using their technologies.
- The company with the most activity in this space is also a previous DOE grant recipient - Pecan Street Energy. They are monitoring over 700 homes, and have collected an extensive amount of information. Furthermore, they have developed a “Wiki Energy” site to allow universities and clients access to this information for review and analysis.
- The limited submeter projects identified all rely on the customer’s broadband internet service to transport the data back to the organization doing the data collection and analysis. This solution requires ongoing support during the project to troubleshoot issues with the customer equipment and internet service.

Volume 2: Appendices

Assessment of Residential Submeter Data for RECS
Volume 2: Appendices

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Introduction

The Energy Independence and Security Act (EISA 2007) spurred the rapid development of the Smart Grid that continues today. This legislation acknowledged that smart meters would create new energy data and the need for policies to protect consumer data privacy (Title XIII)[1]. Since then, Public Utility Commissions in various states have begun developing privacy guidelines that define what investor-owned utilities (IOUs) and other electricity utilities must do with customer usage data gathered from smart meters. For example, in the state of California, smart meter data is owned by the individual consumer and the California Public Utilities Commission (CPUC) has stated it will ensure equal regulatory treatment for third parties who acquire usage data from the utility. This treatment is applicable whether that smart meter data remains with the utility or if the consumer authorizes it to be shared with a third party.

[1] http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf

State Public Utility Commissions

Alabama Public Service Commission	Montana Public Service Commission
Alaska Public Utilities Commission	Nebraska Public Service Commission
Arizona Corporation Commission	Nevada Public Utilities Commission
Arkansas Public Service Commission	New Hampshire Public Utilities Commission
California Public Utilities Commission	New Jersey Board of Public Utilities
Colorado Public Utilities Commission	New Mexico State Corporation Commission
Connecticut Department of Public Utility Control	New York Public Service Commission
Delaware Public Utilities Commission	North Carolina Utilities Commission
District of Columbia Public Service Commission	North Dakota Public Service Commission
Florida Public Service Commission	Ohio Public Utility Commission
Georgia Public Service Commission	Oklahoma Corporation Commission
Hawaii Public Utilities Commission	Oregon Public Utility Commission Gopher Site
Idaho Public Utilities Commission	Pennsylvania Public Utility Commission
Illinois Commerce Commission	Rhode Island Public Utilities Commission
Indiana Utility Regulatory Commission	South Carolina Public Service Commission
Iowa State Utilities Board	South Dakota Public Utility Commission
Kansas Corporation Commission	Tennessee Regulatory Authority
Kentucky Public Service Commission	Texas Public Utility Commission
Louisiana Public Service Commission	Utah Public Service Commission
Maine Public Utilities Commission	Vermont Public Service Board
Maryland Public Service Commission	Virginia State Corporation Commission
Massachusetts Department of Public Utilities	Washington Utilities and Transportation Commission
Michigan Public Service Commission	West Virginia Public Service Commission
Minnesota Public Utilities Commission	Wisconsin Public Service Commission
Mississippi Public Service Commission	Wyoming Public Service Commission
Missouri Public Service Commission	

Summary of State Level Review

State	Customer Can Access Interval Usage Data?	Third Parties Can Access Customer Usage Data?	Interval Data Provided	Length of Data Provided
California	**Yes** – GreenButton (PG&E, SCE, SDG&E)	**Yes** – With "customer consent". CPUC is developing a process for third parties to obtain customer-authorized usage data directly from the utility through GreenButton.	1 hour	Unknown
Texas	**Yes** - Smart Meter Texas	**Yes** – With "written consent or other verifiable authorization". Residential customers may designate up to five "friends" to view their usage information via the Smart Meter Texas web portal.	15 minute	Unknown
District of Columbia	**Yes** – GreenButton (Pepco)	**Yes** – With written consent	1 hour	Up to 600 days (Pepco)
Florida	**Yes** – Utility Website (FPL)	**Yes** – With "explicit and verifiable" authorization from customer	1 hour	At least two years (FPL)
Vermont	**Yes** - GMP Smart Power (GMP)	**Yes** – With "express consent" of customer	Unknown	1 hour (GMP)
Ohio	**Yes** – Upon request from customer	**Unknown**	Unknown	24 months
Maryland	**No** – Customers will soon be able to access hourly data through Smart Energy Manager (BGE) (Coming "later this year")	**Yes** – With customer consent	1 hour (when Smart Energy Manager becomes available)	Unknown
Illinois	**Yes** – My Energy Tools portal (ComEd)	**Yes** – With customer consent	1 hour	At least two years (ComEd)
Wisconsin	**Unknown**	**Partially** – Rules are in place governing the release of customer data to the energy efficiency program administrator, Focus on Energy	Unknown	Unknown
Oklahoma	**Yes** – myOGEpower (OGE)	**Yes** – With "written consent"	Unknown	Unknown
Michigan	**Yes** – Utility website (DTE)	**Yes** – With "informed customer consent"	1 hour	Unknown
Massachusetts	**Yes –** WMECO has implemented GreenButton	**Yes –** with customer authorization	Unknown	Unknown

California

California Public Utilities Commission

Legislative or Regulatory action on AMI data privacy:

On September 29, 2010, SB 1476 was signed into law.[2] SB 1476 added sections 8380 and 8381 to the Public Utility Code. These new sections address issues of privacy, including disclosure and protection issues, arising from the use of smart meters. The law states that utilities that collect meter data may not share the customer data with any third party without the customer's consent. The only exception is if this data is part of an energy efficiency or demand response program in which the customer participates. In that case, the third party must sign a contract agreeing to implement data protection measures. The law also states that utilities that release data to a third party with customer consent "shall not be responsible for the security of that data, or its use or misuse" unless the utility has a business relationship with the third party.

On July 29, 2011, the California Public Utilities Commission (CPUC) adopted rules to protect the security and privacy of data generated by smart meters being deployed by the three largest California investor-owned electric utilities (PG&E, SDG&E, and SCE).[3] The decision includes policies to govern access to customer usage data by consumers and authorized third parties. The decision identifies the type of data that must be made available and instructs the utilities to adopt a common data format. The utilities must file tariff revisions that will provide customer-authorized third parties access to usage data via the utilities backhaul and utilities should propose a process, such as registration, by which the CPUC can exercise oversight of third parties that receive such information. The order implements a recently adopted California statute designed to protect consumer energy data[4] and includes Fair Information Practice (FIP) Principles utilized by the U.S. Department of Homeland Security, which are adopted as California policy. The CPUC does not regulate, nor take a position regarding its jurisdiction to regulate, third parties that receive data directly from the consumer. The CPUC defined the data to be covered as "any usage information obtained through the use of the capabilities of Advanced Metering Infrastructure" when associated with information that can reasonably be used to identify individual customers or households.[5]

The CPUC released decision 12-08-045 on August 23, 2012.[6] This privacy rules in this decision are similar to those established in Decision 11-07-056 for electric corporations and electric customer data, but contain minor modifications that pertain to gas operations.

State Laws:

- California Assembly Bill 1274[7] – Privacy: customer electrical or natural gas usage data (October 2013).
- California Senate Bill 1476[8] - Privacy Protections for Energy Consumption Data (September 29, 2010)

[2] http://www.leginfo.ca.gov/pub/09-10/bill/sen/sb_1451-1500/sb_1476_bill_20100929_chaptered.html
[3] http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/140369.pdf
[4] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1476
[5] http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/140369.pdf
[6] http://www.lawofficesofcarolynelefant.com/fercfights/wp-content/uploads/2012/12/californiaprivacy.pdf
[7] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1274
[8] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1476

- California Public Utilities Code 8380(c)[9] - Privacy Protections for Energy Consumption Data

CPUC decisions:

- D.11-07-056[10] - Decision Adopting Rules to Protect The Privacy and Security of the Electricity Usage Data of The Customers of Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company (July 29, 2011)
- 12-08-045[11] - Decision Extending Privacy Protections to Customers Of Gas Corporations and Community Choice Aggregators, and to Residential and Small Commercial Customers of Electric Service Providers (August 23, 2012)

Are utilities required to provide data to customers?

- Each utility must provide pricing, usage and cost data to customers in a customer-friendly manner, online and updated at least on a daily basis.[12]
- Utilities should propose a common data format to the extent possible and be consistent with ongoing national standards efforts
- The three large IOUs adopted the GreenButton format and began providing data to customers in this format in 2012.[13]

Are utilities able to provide data to third parties?

- AB 1274 prohibits a business from sharing, disclosing, or otherwise making accessible to any third party a customer's electrical or natural gas usage data without obtaining the express consent of the customer and conspicuously disclosing to whom the disclosure will be made and how the data will be used.[14]
- Utilities can provide customer data to a third party upon consent from the customer (SB 1476, Sec 2, Chap. 5, 8380)[15]
- Utilities can use customer data for analysis, reporting, or program management if all information has been removed regarding the individual identity of a customer.[16]
- Utilities can disclose a customer's data to a third party for system, grid, or operational needs, or the implementation of demand response, energy management, or energy efficiency programs, "provided that, for contracts entered into after January 1, 2011, the utility has required by contract that the third party implement and maintain reasonable security procedures and practices appropriate to

[9] http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=08001-09000&file=8380-8381
[10] http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/140369.pdf
[11] http://www.lawofficesofcarolynelefant.com/fercfights/wp-content/uploads/2012/12/californiaprivacy.pdf
[12] http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/140369.pdf
[13] http://www.greenbuttondata.org/greenadopt.html
[14] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1274
[15] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1476
[16] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1476

the nature of the information, to protect the personal information from unauthorized access, destruction, use, modification, or disclosure, and prohibits the use of the data for a secondary commercial purpose not related to the primary purpose of the contract without the customer's consent." (SB 1476, Sec 2, Chap. 5, 8380, (e)(2))[17]

Have utilities developed a process for customer access to their data?

Customer process

- CPUC Decision 11-07-056 states that utilities must make price, usage and cost information available to its customers online and updated at least on a daily basis. Each day's usage data, along with applicable price and cost details, and with hourly or 15-minute granularity (matching the time granularity programmed into the customer's smart meter), must be available by the next day.[18]
- Customers of the three utilities can access their usage data using GreenButton the format provided on each utilities website.

Third party process

- As of July 2012:[19]
  - SCE will provide 13 months of customer/service account data usage history (if available) within a matter of days from receipt of written customer authorization and expects to be able to provide data for all customers by 2013 on a 24-hour lagged, interval basis. The data will not be validated, estimated, and edited (VEE'd).
  - PG&E will provide 24 months of historical history within 5 days of receipt of a correct customer authorization form. For smart meters and some MV-90s, data will be transmitted within 24 hours and will be VEE'd. Other MV-90s will not be VEE'd until the end of the billing cycle. For those that are VEE'd, the data will also be available in Green Button format.
  - SDG&E will provide 13-months of historical data within 24 hours, as well as access to interval data on a 24-hour lagged basis.
- The CPUC has authority over any third party who obtains access to a customer's energy usage data.[20]

Does the State Have a Smart Meter Opt-Out Policy?

- Each of the three large IOUs in CA have opt out policies
- PG&E, SDG&E, and SCE customers can choose an analog meter but must pay a $75 setup charge and $10 monthly charge.[21,22,23]

[17] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB1476
[18] http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/140369.pdf
[19] http://www3.sce.com/sscc/law/dis/dbattach4e.nsf/0/85F737E43A32978088257A4C00002628/$FILE/A.12-03-002+et+al.+PGE+Open+ADE_Joint+IOU+Report.pdf
[20] http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/140369.pdf
[21] https://www.sce.com/wps/portal/home/customer-service/my-account/smart-meters/opt-out/

Texas

Public Utility Commission of Texas

Legislative or Regulatory action on AMI data privacy:

Section 39.107 of the Public Utility Regulatory Act within the Texas Utilities Code states that all meter data shall belong to the customer and the customer may authorize its data to be provided to one or more retail electric providers under rules and charges established by the commission. Additionally, the commission is generally directed to ensure that retail customer protections are established that entitle a customer to privacy of customer consumption and credit information per Section 39.101(a)(2). Neither of these sections applies to municipal electric utilities or electric cooperatives per Section 39.002[24]. Section 39.107 does not prohibit an REP from releasing information to agents, vendors, partners or affiliates engaged to perform services on behalf of the REP, including marketing the REP's services, as long as the recipient agrees to be held to the same confidentiality standards as the REP. Before sharing such customer proprietary information to a third party, the REP must provide the customer a chance to opt out.[25]

An amendment to 39.107(b), SB 1219, was proposed on March 6, 2013, and would require that an entity other than a retail electric provider or electric utility may only have access to meter data with written consent from a customer. SB 1219 is currently pending in committee. SB 241 was proposed January 23, 2013 and would amend 39.107 to allow a consumer to "opt-out" of having a smart meter installed in their home, at no extra cost to that consumer. Under SB 241, an electric utility that deploys smart meters would be required to send notice to their customers informing them of their ability to "opt-out" of installation. Similarly, an electric utility that has already deployed smart meters is required to send notice to their customers informing them that they may choose to have their smart meter removed.[26]

Section 25.130(j) of the PUC Substantive Rules concerns access to meter data. Section 25.130(j)(1) states that an electric utility shall provide a customer, the customer's retail electric provider (REP), and other entities authorized by the customer read-only access to the customer's advanced meter data, including meter data used to calculate charges for service, historical load data, and any other proprietary customer information (note that the definition of "electric utility" does not include municipal electric utilities or electric cooperatives per Section 25.5(41)). The access shall be convenient and secure, and the data shall be made available no later than the day after it was created. Furthermore, section 25.130(j)(5) empowers customers to authorize their data to be made available to an entity other than its REP.[27] On August 9, 2013, Section 25.133 was adopted for the purpose of allowing a customer whose standard meter is an advanced meter to choose to receive electric

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[22] http://www.sdge.com/residential/smart-meter-opt-out/smart-meter-opt-out-program
[23] http://www.pge.com/en/myhome/customerservice/smartmeter/optout/index.page
[24] http://www.puc.texas.gov/agency/rulesnlaws/statutes/Pura13.pdf
[25] http://www.lexology.com/library/detail.aspx?g=10943bfa-8f9b-4cb8-8451-ebc73ddd5e66
[26] http://www.legis.state.tx.us/tlodocs/83R/analysis/pdf/SB01219I.pdf#navpanes=0
[27] http://www.legis.state.tx.us/tlodocs/83R/analysis/pdf/SB00241S.pdf#navpanes=0

service through a non-standard meter and authorizes a transmission and distribution utility (TDU) to assess fees to recover the costs associated with this section from a customer who elects such a meter.[28]

State Laws:

- Public Utility Regulatory Act (PURA), Texas Utilities Code §39.107 - Metering and Billing Services[29]
  - SB 241 - proposed amendment to §39.107 relating to the regulation of advanced meters and the interconnection of ERCOT with another grid; requiring a study on the health effects of advanced meters; authorizing an administrative penalty[30]
  - SB 1219 - proposed amendment to §39.107(b) relating to a customer's right to privacy of smart meter collected data[31]

PUCT Rules:

- P.U.C. Substantive Rule 25.130 - Advanced Meters[32]
- P.U.C. Substantive Rule 25.133 - Non-Standard Metering Service[33]

Are utilities required to provide data to customers?

- Electric utilities must provide the customer, the customer's retail electric provider (REP), and other entities authorized by the customer read-only access to the customer's advanced meter data [PURA, Sec. 39.107(b)]
- "Advanced meter data" includes any meter data used to calculate charges for service, historical load data, and any other proprietary customer information [PUC Subst. R. 25.130(j)(1)]
- The access shall be convenient and secure, and the data shall be made available no later than the day after it was created [PUC Subst. R. 25.130(j)(1)]
- Commission rules require the development of a data exchange web portal as part of utility AMS deployment the capability to provide direct, real-time access to customer usage data to the customer and the customer's REP [PUC Subst. R. 25.130(d)(4)]

Are utilities able to provide data to third parties?

- Retail Electric Providers may provide customer data and information to agents, vendors, partners or affiliates engaged to perform services on behalf of the REP, including marketing the REP's services, as long as the recipient agrees to be held to the same

[28] http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/ch25complete.pdf
[29] http://www.puc.texas.gov/agency/rulesnlaws/statutes/Pura13.pdf
[30] http://www.legis.state.tx.us/tlodocs/83R/billtext/pdf/SB00241S.pdf#navpanes=0
[31] http://www.legis.state.tx.us/tlodocs/83R/billtext/pdf/SB01219I.pdf#navpanes=0
[32] http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/ch25complete.pdf
[33] Ibid

confidentiality standards as the REP. Before sharing such customer proprietary information to a third party, the REP must provide the customer a chance to opt out.[34]

- Unless a utility obtains prior affirmative written consent or other verifiable authorization from the customer, it shall not release any proprietary customer information to a competitive affiliate or any other entity, other than the customer, an "essential" independent organization, or a provider of corporate support services for the sole purpose of providing corporate support services (other exceptions are also provided) [PUC Subst. R. 25.272(g)(1)].[35]
- A utility (including IOUs, municipally owned utilities, and electric cooperatives) may release proprietary customer information without customer authorization to a federal, state, or local governmental entity or in connection with a court or administrative proceeding involving the customer or the utility; provided, however, that the utility shall take all reasonable actions to protect the confidentiality of such information, including, but not limited to, providing such information under a confidentiality agreement or protective order, and shall also promptly notify the affected customer in writing that such information has been requested [PUC Subst. R. 25.272(g)(1)(B) and 25.275(l)(1)(B)].[36]
- "Essential" organizations are independent system operators or other persons sufficiently independent of any producer or seller of electricity that are certified by the commission as critical to T&D system accessibility, grid reliability and adequacy, customer's choice information sharing, and accuracy of electricity production and delivery accounting [PURA, Sec. 39.151(a) and (b)].[37]
- Third parties receiving proprietary customer information are subject to the same confidentiality and data-handling rules and protocols as the utility with respect to releasing the information to other persons [PUC Subst. R. 25.272(g)(1) and 25.275(l)(1)].[38]
- A utility may aggregate and disseminate non-proprietary customer information, including, but not limited to, information about a utility's energy purchases, sales, or operations or about a utility's energy-related goods or services [[PUC Subst. R. 25.272(g)(1)(B) and 25.275(l)(1)(B)].[39]

Have utilities developed a process for customer access to their data?

Customer process

- The Smart Meter Texas web portal is sponsored by a group of electric utility companies doing business in the state of Texas and allows registrants to track and review their electric usage in monthly, daily and fifteen minute intervals and access meter and premise information.[40]
- The Smart Meter Texas web portal has adopted Green Button Initiative data formatting and exports datasets in CSV file format.[41]

[34] http://www.lexology.com/library/detail.aspx?g=10943bfa-8f9b-4cb8-8451-ebc73ddd5e66
[35] http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/ch25complete.pdf
[36] Ibid
[37] http://www.puc.texas.gov/agency/rulesnlaws/statutes/Pura13.pdf
[38] http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/ch25complete.pdf
[39] Ibid
[40] https://www.smartmetertexas.com/CAP/public/home/home_faq.html

- The Smart Meter Texas web portal is utilized by several large Texas REPs that have deployed AMS (Austin Energy and TXU Energy use separate web portals accessed through their company websites).

Third party process

- Third parties may be provided assess to customer meter data and information if affirmative written consent or other verifiable authorization is acquired from the customer, if they are designated by the commission as an "essential" organization per PURA §39.151, or by commission rule exception (federal government entities are listed in the rules as an exception) [PUC Subst. R. 25.272(g)(1) and 25.275(l)(1)].[42]
- Alternatively, residential customers may designate up to five "friends" to view their usage information via the Smart Meter Texas web portal.[43]

[41] Ibid
[42] http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/ch25complete.pdf
[43] https://www.smartmetertexas.com/CAP/public/home/home_faq.html

District of Columbia

Public Service Commission of the District of Columbia (DCPSC)

Legislative or Regulatory action on AMI data privacy:

As of December 2013, Pepco had installed 277,222 smart meters.[44] In September 2012 the DCPSC started an investigation into AMI issues, including data privacy, health & safety, and the feasibility of opt-outs.[45] Pepco and its parent company, Pepco Holdings Inc., have a comprehensive Data Privacy Protection Policy[46] that covers the energy use and operational data collected by smart meters as well as other metering devices. The policy states that Pepco will use customer data for legitimate utility-related business purposes only, such as billing and load forecasting and that Pepco will not sell customer usage data to other parties under any circumstances. Specific policies regarding access to customer information by third parties were not immediately identified.

State Laws:

- None identified.

Regulatory decisions:

- DCPSC Formal Case No. 1056[47] - Investigation into AMI issues including data privacy, health and safety, and opt-out.

Are utilities required to provide data to customers?

- Pepco provides electricity usage data to customers in up to one hour intervals through the GreenButton format.[48]

Are utilities able to provide data to third parties?

- Pepco's policy states that a customer's energy usage data cannot be shared with a third-party without the written consent of the account holder.[49]
- Pepco's Data Privacy Policy protects the confidentiality of Personally Identifiable Information. Individual customer information, including energy usage data, is included within the scope of this policy.[50] The Policy states that "Procedures must be in place to ensure

[44] http://www.dcpsc.org/edocket/docketsheets_pdf_FS.asp?caseno=FC1056&docketno=593&flag=D&show_result=Y
[45] http://www.dcpsc.org/pdf_files/commorders/orderpdf/orderno_16892_FC1056.pdf
[46] http://www.pepcoholdings.com/services/governance/policies/protection/
[47] http://www.dcpsc.org/pdf_files/commorders/orderpdf/orderno_16892_FC1056.pdf
[48] http://www.pepcoholdings.com/about/news/archives/2012/article.aspx?cid=2152
[49] http://www.pepco.com/energy/blueprint/smetersmd/faq.aspx
[50] http://www.pepcoholdings.com/services/governance/policies/protection/

that those who do have access, including entities outside the Company, are informed of the requirements for safeguarding Personally Identifiable Information."

Have utilities developed a process for customer access to their data?

Customer process

- Pepco provides electricity usage data to customers in up to one hour intervals through the GreenButton format.[51]

Third party process

- A specific process for third parties to obtain customer usage data was not identified at the PSC level.

Does the State Have a Smart Meter Opt-Out Policy?

- DC does not currently have an opt-out policy.
- On December 7, 2011, the Office of Peoples Counsel petitioned the District of Columbia Public Service Commission to initiate a formal investigation to determine whether it is reasonable for Pepco to offer an opt-out provision to its AMI program.[52]

[51] http://www.pepcoholdings.com/about/news/archives/2012/article.aspx?cid=2152
[52] http://www.smartgridlegalnews.com/orderno_16708_FC1056.pdf

Florida

The Public Service Commission of the State of Florida (FPSC)

Legislative or Regulatory action on AMI data privacy:

According to the 2012 EIA-861 survey, 15 utilities have installed almost 4.5 million residential AMI meters in Florida as of 2012. The vast majority, almost 4 million, have been installed by Florida Power & Light (FPL). Regarding data privacy issues, the FPSC website only states that "Florida's IOUs treat individual customer data as confidential, except for release for regulated business purposes and to comply with court orders."[53]

State Laws:

- Florida Statute §817.5681 covers "Breach of security concerning confidential personal information in third-party possession".[54]
- Florida Statute §119.01(1) (2008): "It is the policy of this state that all state, county, and municipal records are open for personal inspection by any person."[55]

FPSC Decisions:

- None identified

Are utilities required to provide data to customers?

- FPL provides smart meter usage data to customers through the utilities website in up to hourly intervals.[56]
- No specific rules or policies were identified at the state or regulatory level regarding a utilities requirement to provide data to customers, however, in Florida, records kept in connection with the operation of a city-operated utility are considered public records. See Florida Statute §119.01(1) above.

Are utilities able to provide data to third parties?

- FPL can provide data to a third party with explicit and verifiable authorization from the customer.[57]

Have utilities developed a process for customer access to their data?

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[53] http://www.psc.state.fl.us/utilities/electricgas/smartmeter/
[54] http://www.flsenate.gov/Laws/Statutes/2011/817.5681
[55] Public Records—Records of Municipally Operated Utility, Op. Att'y Gen. Fla. 74-35 (1974), http://www.myfloridalegal.com/ago.nsf/Opinions/B4AED736C2272860852566B30067371A
[56] http://www.fpl.com/ami/index.shtml
[57] http://www.fpl.com/energysmart/pdf/facts_about_smart_meters_and_privacy.pdf

- Florida's IOUs treat individual customer data as confidential, except for release for regulated business purposes and to comply with court orders.[58]
- Information on specific processes for access to customer data was not readily available.

Does the State Have a Smart Meter Opt-Out Policy?

- The Florida Public Service Commission staff has posted its recommendation to the Commission regarding Florida Power & Light's (FP&L) request to charge for an opt out. The Commission met on this docket on January 7, 2014. [Docket 130223][59]

[58] http://www.floridapsc.com/utilities/electricgas/smartmeter/
[59] http://www.floridapsc.com/dockets/cms/docketFilings3.aspx?docket=130223

Vermont

Vermont Public Service Board

Legislative or Regulatory action on AMI data privacy:

State Laws:

- HB 402[60] - An act relating to the use of smart meters
  - o

Public Service Board Decisions:

- Docket No. 7307[61] - Investigation into Vermont Electric Utilities' Use of Smart Metering and Time-Based Rates
  - o Privacy Statement Number 9 states that "Customer personal information and data shall not be sold, given or in any fashion conveyed to third persons for any commercial purpose whatsoever without the written, express consent of the customer".

Are utilities required to provide data to customers?

- Green Mountain Power provides up to hourly interval data to customers through their GMP Smart Power program.[62]

Are utilities able to provide data to third parties?

- State Law HB 402 provides rules for third party access to customer usage data:
  - o HB 402 §2811 SMART METERS; PRIVACY , Section (2)(j): “Customer data shall not be sold, given, or in any fashion conveyed to third persons for any commercial purpose without the express written consent of the customer, except to the extent, if any, that such disclosure may be required by law.”
  - o HB 402 §2811 SMART METERS; PRIVACY , Section (2)(k): “ Nothing in this section or in any privacy policy adopted by an electric company shall restrict a customer from choosing to provide information or access to customer data directly to a third-party company, through software applications, devices, or otherwise.”

Have utilities developed a process for customer access to their data?

[60] http://openstates.org/vt/bills/2013-2014/H402/documents/VTD00006157/
[61] http://psb.vermont.gov/sites/psb/files/orders/2011/2011-2/7307%20Procedural%20Sched%20Order.pdf
[62] http://www.greenmountainpower.com/smart/

Customer Process:

- Green Mountain Power provides usage data to customers in up to one hour intervals through their GMP Smart Power program.[63]

Third Party Process:

- HB 402 §2811 SMART METERS; PRIVACY, Section (2)(b): "A person or entity seeking customer data may request such information directly from the customer under any applicable legal procedure or authority, such as a subpoena. An electric company, in response to a subpoena, may disclose a customer's name, address, and contact information."

Does the State Have a Smart Meter Opt-Out Policy?

- Vermont state law allows customers to opt-out of smart meters (State Law S. 214 §2811)[64]. Unlike several other states, Vermont does not charge a fee for opting out of a smart meter.
    - §2811. SMART METERS; CUSTOMER RIGHTS; REPORTS Section (b)(2): "allows a customer to choose not to have a wireless smart meter installed, at no additional monthly or other charge."
    - §2811. SMART METERS; CUSTOMER RIGHTS; REPORTS Section (b)(3): "allows a customer to require removal of a previously installed wireless smart meter for any reason and at an agreed-upon time, without incurring any charge for such removal."

[63] http://www.greenmountainpower.com/smart/
[64] http://www.leg.state.vt.us/docs/2012/Acts/ACT170.pdf

Ohio

Public Utilities Commission of Ohio (PUCO)

Legislative or Regulatory action on AMI data privacy:

Section 4901:1-10-24 of the Ohio Administrative Code provides general safeguards and information for utility customers but is not specific to AMI data and information. In fact, Section 4901:1-10-24(E)(1) protects only a customer's account number from discloser by a utility without the customer's written consent, or electronic authorization, or a court or commission directive ordering disclosure. Similarly, Section 4901:1-10-24(E)(2) protects only a customer's social security number from discloser by a utility without the customer's written consent or without a court order. Both sections provide a few exceptions including credit evaluation and reporting activities, participation in utility energy programs, and in cooperation with governmental aggregation programs. It is not clear if federal government aggregation programs would qualify under these exceptions.[65]

Upon request, electric utilities shall provide twenty-four months of a customer's usage history, payment history, detailed consumption data, if available, and time differentiated price data, if applicable, to the customer without charge. For third-parties, electric utilities are required to provide generic customer load pattern information to other electric service providers and are required to provide customer-specific information to competitive retail electric service (CRES) providers, unless the customer objects to the disclosure of such information. In other words, customers may opt-out from having customer-specific information sent to CRES providers. [66]

To date, the Public Utilities Commission of Ohio has not developed specific rules regarding AMI data privacy, however, they have compiled a list of consumer privacy and customer data access issues related to smart grid and advanced metering deployments that might need to be considered by the Commission in the future. The PUCO requested public comments on this list in 2011 under Case No. 11-277-GE-UNC, a review of the consumer privacy protection, customer data access, and cyber security issues associated with distribution utility advanced metering and smart grid programs. The Commission is not requesting substantive comments on these issues and is not actively developing rules to address these issues at this time.[67]

State Laws:

- General Protection Statute: Ohio Admin. Code 4901:1-10-24 Customer safeguards and information[68]

PUCO Rules:

- Docket: Review of the Consumer Privacy Protection Customer Data Access and Cyber Security Issues. Case No. 11-277-GE-UNC, Public Utilities Commission of Ohio[69]

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[65] http://codes.ohio.gov/oac/4901:1-10-24
[66] Ibid
[67] http://www.puco.ohio.gov/puco/index.cfm/industry-information/industry-topics/smart-grid-consumer-privacy-and-customer-data-access-issues/
[68] http://codes.ohio.gov/oac/4901:1-10-24

Are utilities required to provide data to customers?

- Upon request, electric utilities shall provide twenty-four months of a customer's usage history, payment history, detailed consumption data, if available, and time differentiated price data, if applicable, to the customer without charge (this is not specific to AMI data).[70]

Are utilities able to provide data to third parties?

- Electric utilities are required to provide generic customer load pattern information to other electric service providers.[71]
- Electric utilities are required to provide customer-specific information to competitive retail electric service (CRES) providers, unless the customer objects to the disclosure of such information (opt-out). [72]

Have utilities developed a process for customer access to their data?

Customer process

- No formal process observed. It appears customers may request their data using traditional methods such as by phone, email, or through their utility's website.

Third party process

- No process observed.

[69] http://dis.puc.state.oh.us/CaseRecord.aspx?CaseNo=11-0277
[70] http://codes.ohio.gov/oac/4901:1-10-24
[71] Ibid
[72] Ibid

Maryland

Maryland Public Service Commission

Legislative or Regulatory action on AMI data privacy:

On August 13, 2010 the Maryland Public Service Commission issued Order No. 83531 approving Baltimore Gas and Electric Company's (BGE) advanced metering initiative. Pursuant to this Order, BGE submitted a smart meter data privacy policy in April 2013.[73] The policy covers Smart Meter interval energy use data. Smart Meter interval energy use data that is not specific to the customer, such as combined data, is not covered under the policy. The policy states the BGE will "protect the confidentiality of Smart Meter interval energy usage data that is under the custody of the Company, whether residing within the Company or under control of the Company through a third party."[74] Pepco has a smart meter data privacy policy through their holding company PHI, Inc. (see Washington, D.C. Public Service Commission), which included Delmarva Power.
The MD PSC issued Order No. 86798 in June 2013[75] authorizing Southern Maryland Electric Cooperative (SMECO) to proceed with deployment of its AMI proposal. SMECO possesses a comprehensive data privacy protection policy that covers the energy use and operational data collected by AMI meters as well as other metering devices.

State Laws:

- None identified

MD PSC Rules:

- MD PSC Order No. 83531[76] - In The Matter of the Application of Baltimore Gas and Electric Company for Authorization to Deploy a Smart Grid Initiative and to Establish a Surcharge for the Recovery of Cost.
- MD PSC Order No. 86798[77] - Authorization for SMECO to deploy AMI
- MD PSC Order No. 85294[78] - Investigation into an additional option related to the installation of smart meters in homes. The order essentially begins an investigation into whether or not Maryland utilities should allow an opt-out and how it should be funded.

Are utilities required to provide data to customers?

- BGE provides interval usage data to customers through BGE's Smart Energy Manager suite of online tools.[79]

[73] http://webapp.psc.state.md.us/Intranet/Casenum/NewIndex3_VOpenFile.cfm?ServerFilePath=C:%5CCasenum%5C9200-9299%5C9208%5C%5C209.pdf
[74] Ibid.
[75] http://webapp.psc.state.md.us/Intranet/Casenum/NewIndex3_VOpenFile.cfm?ServerFilePath=C:%5CCaseNum%5C9200-9299%5C9294%5C43.pdf
[76] http://webapp.psc.state.md.us/Intranet/sitesearch/CN9208.pdf
[77] http://webapp.psc.state.md.us/Intranet/Casenum/NewIndex3_VOpenFile.cfm?ServerFilePath=C:%5CCaseNum%5C9200-9299%5C9294%5C43.pdf
[78] http://webapp.psc.state.md.us/Intranet/Casenum/NewIndex3_VOpenFile.cfm?filepath=C:%5CCasenum%5C9200-9299%5C9208%5CItem_187%5C%5C9208OptOutSecondOrder.pdf
[79] http://www.bge.com/smartenergy/smartenergymanager/pages/default.aspx

- SMECO is currently negotiating contracts for the installation of the new meters and a web portal for customers to actively view their energy usage.[80]

Are utilities able to provide data to third parties?

- BGE may provide energy usage data with customer consent to a third party primarily providing energy-related products and/or services, taking into account the nature and frequency of the request.[81]
- No specific information about SMECO's policy for providing data to third parties was identified.

Have utilities developed a process for customer access to their data?

- None identified.

Does the State Have a Smart Meter Opt-Out Policy?

- In January, the MD PSC issued an order [Order No. 85294][82] that Maryland utilities should provide customers with an additional option related to the installation of smart meters in their homes. The PSC is still conducting proceedings to determine whether customers can retain their current meter or if utilities will have to provide customers with smart meters that operate in an "RF-free" or near RF-free manner. The PSC will require that customers who select the ultimately approved option pay the appropriate costs.

[80] http://www.smeco.coop/yourEnergy/smartMeters.aspx
[81] http://webapp.psc.state.md.us/Intranet/Casenum/NewIndex3_VOpenFile.cfm?ServerFilePath=C:%5CCasenum%5C9200-9299%5C9208%5C%5C209.pdf
[82] http://webapp.psc.state.md.us/Intranet/Casenum/NewIndex3_VOpenFile.cfm?filepath=C:%5CCasenum%5C9200-9299%5C9208%5CItem_187%5C%5C9208OptOutSecondOrder.pdf

Illinois

Illinois Commerce Commission (ICC)

Legislative or Regulatory action on AMI data privacy:

Illinois has seen a long struggle to develop a smart grid and deploy smart meters. Governor Pat Quinn vetoed the first version of smart grid legislation, but he was overridden by the legislature. Then there was a disagreement between the regional utilities and the Illinois public utility commission regarding the smart grid, which resulted in corrective legislation which Quinn again vetoed. The Illinois General Assembly overrode the veto to enact Senate Bill 9[83], getting the state's Smart Grid program back on track. Ameren is currently determining which customers will receive an advanced meter. Installation is slated to begin in mid-June 2014. By the end of the 10-year Modernization Action Plan, in 2021, about 62% of Ameren customers will have smart meters.[84]

State Laws:

- Senate Bill 1652[85] - Contains language on securing the privacy of customer data

ICC Decisions:

- No decisions specific to data privacy were identified.

Are utilities required to provide data to customers?

- No specific state or PSC rules requiring utilities to provide usage data to customers were identified.
- Commonwealth Edison (ComEd) has begun smart meter installation and will provide hourly usage data to customers through the "My Energy Tools" portal on the ComEd website.[86]

Are utilities able to provide data to third parties?

- SB 1652 states that "The AMI Plan shall secure the privacy of personal information and establish the right of consumers to consent to the disclosure of personal energy information to third parties through electronic, web-based, and other means in accordance with State and federal law and regulations regarding consumer privacy and protection of consumer data." "Personal information" for this purpose

[83] http://www.ilga.gov/legislation/BillStatus.asp?DocNum=9&GAID=12&DocTypeID=SB&SessionID=85&GA=98
[84] http://www.ameren.com/sites/aiu/MAP/Pages/NewMeters.aspx
[85] http://www.ilga.gov/legislation/fulltext.asp?DocName=09700SB1652ham001&GA=97&SessionId=84&DocTypeId=SB&LegID=57620&DocNum=1652&GAID=11&Session=
[86] https://www.comed.com/home-savings/web-tools/Pages/my-energy-tools.aspx

consists of the customer's name, address, telephone number, and other personally identifying information, as well as information about the customer's electric usage.

- The City of Naperville has prepared a "Smart Grid Bill of Rights,"[87] in which the right to privacy is a key element. One of the tenets is that "Personal information will not be connected to usage data released to any third parties". The policy also states that "Customers can choose how they will receive information from the utility." The Naperville initiative is a city-based policy only and has not received the endorsement of the State of Illinois.

Have utilities developed a process for customer access to their data?

- None identified. Smart meter rollout is just beginning in Illinois.

Does the State Have a Smart Meter Opt-Out Policy?

- No formal opt-out policy was identified.
- ComEd has asked state regulators for permission to charge a $25 fee for those customers who want to opt out of the smart meter program.[88]

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[87] http://www.naperville.il.us/emplibrary/Smart_Grid/NSGI-CBoR-web.pdf
[88] http://articles.chicagotribune.com/2013-10-04/business/chi-comed-smart-meter-tariff-20131004_1_comed-smart-meters-tariff

Wisconsin

Wisconsin Public Service Commission (PSC)

Legislative or Regulatory action on AMI data privacy:

Although utilities in Wisconsin have begun implementing AMI systems, particularly Wisconsin Power & Light, there does not appear to be much movement on data privacy issues at the State level as of the date of this document. Two PSC decisions touch on rules controlling the release of customer usage data (see below). Under the PSC's Service Rules for Electric Utilities, the only mention of customer usage data is in regards to low income customers. Docket 9501-GF-101 is specific to the release of data to the state's independent energy efficiency administrator, Focus on Energy.

State Laws:

- No State laws specific to smart meter data privacy were identified.

WPSC decisions:

- **Docket 9501-GF-101**[89] **-** Provision of Energy Utility Customer Information to Focus on Energy (2009).
  - Orders Wisconsin electric utilities to release customer-specific information to Focus on Energy for the purposes of improving the delivery of energy efficiency and renewable resource programs.
  - This order is apparently limits the release of customer information to the independent energy efficiency administrator, Focus on Energy. No specific regulations were identified at the PSC level regarding release of information to other third parties.
- **PSC 113.0505(2)**[90] **–** Service Rules for Electric Utilities.
  - Controls the release of information which serves to identify low-income customers by usage or status. This information "shall not be released by a utility to any source other than a utility low–income assistance program or the customer, without the customer's consent".
  - It is not clear if this applies to all customers or just low-income customers.

Are utilities required to provide data to customers?

- No specific rules or regulations regarding customer access to data were identified.
- Alliant Energy (IPL and WPL) provides 18 months of energy use and payment history to customers. Alliant has begun implementing AMI, however, it is not clear whether interval data is provided to customers.[91]

[89] http://psc.wi.gov/apps35/ERF_search/content/SearchResult.aspx
[90] http://docs.legis.wisconsin.gov/code/admin_code/psc/113.pdf

Are utilities able to provide data to third parties?

- Wisconsin PSC Docket 9501-GF-101 provides rules for releasing data specifically to Focus on Energy and sets guidelines for how the data can be used.[92]

Have utilities developed a process for customer access to their data?

Customer process

- Customers can request energy use and payment history from utilities, however, it is not clear whether detailed interval usage is available to customers.

Third party process

- The Wisconsin PSC has specific rules for access to customer data by Focus on Energy, the State's independent energy efficiency program. The energy efficiency administrator enters into an agreement with the utilities that specifies how the administrator will handle the data, including a) that it will protect the confidentiality of customer information, b) specifies how long the administrator will retain the information, c) specifies when the administrator will destroy the information, and d) states that it will pay a monetary penalty for any unauthorized release of data. [Docket No. 9501- GF – 101][93]

Does the State Have a Smart Meter Opt-Out Policy?

- Wisconsin utilities are not currently required to offer an opt-out policy.
- A bill was introduced in August 2013 (Wisconsin Assembly Bill 345)[94] that would require utilities to provide an opt-out policy. The bill is currently in committee.

[91] http://www.alliantenergy.com/CustomerService/AccountManagement/
[92] http://psc.wi.gov/apps35/ERF_search/content/SearchResult.aspx
[93] http://psc.wi.gov/apps35/ERF_search/content/SearchResult.aspx
[94] https://docs.legis.wisconsin.gov/2013/related/proposals/ab345

Oklahoma

Oklahoma Corporation Commission

Legislative or Regulatory action on AMI data privacy:

The Electric Usage Data Protection Act (codified at 17 O.S. § 710[95]) went into effect November 1, 2011. The Act requires that an electric utility provide certain access to and maintain the confidentiality of customer information. The Act also allows electric utilities to utilize customer-identifiable usage data for certain internal business purposes without customer consent. Electric utilities must provide standard usage data to a customer as a component of basic service and must provide nonstandard usage data to a customer under certain circumstances. However, the electric utilities may charge a reasonable fee for providing this nonstandard usage data. Additionally, the Act authorizes the disclosure of customer information to affiliates and third parties under certain circumstances, including when the customer provides written consent to the disclosure. Lastly, the Act provides for the use of aggregate usage data without customer consent under certain circumstances. [96]

The Company Commission of Oklahoma has not promulgated any rules additional to the Electric Usage Data Protection Act standards.[97]

State Laws:

- Electric Usage Data Protection Act codified at 17 O.S. § 710[98]

Commission Rules:

- Title 165, Chapter 35, Subchapter 19, Part 1.1. Consumer electric usage data[99]

Are utilities required to provide data to customers?

- Yes. Electric utilities must provide standard usage data to a customer as a component of basic service and must provide nonstandard usage data to a customer under certain circumstances.
- Electric utilities may charge a reasonable fee for providing nonstandard usage data.

Are utilities able to provide data to third parties?

- Yes. When the customer provides written consent to the disclosure.

[95] http://webserver1.lsb.state.ok.us/OK_Statutes/CompleteTitles/os17.rtf [§17-710, pg. 249-252]
[96] http://webserver1.lsb.state.ok.us/cf_pdf/2011-12%20SUPPORT%20DOCUMENTS/BILLSUM/House/HB1079%20CCR%20BILLSUM.PDF
[97] http://www.occeweb.com/pu/NOI201300012/201300012%20Proposed%20Rules.pdf [165:35-19-1.1., pg. 13]
[98] http://webserver1.lsb.state.ok.us/OK_Statutes/CompleteTitles/os17.rtf [§17-710, pg. 249-252]
[99] http://www.occeweb.com/pu/NOI201300012/201300012%20Proposed%20Rules.pdf [165:35-19-1.1., pg. 13]

Have utilities developed a process for customer access to their data?

Customer process

- At no extra charge, OG&E's Smart Grid community customers can enroll and log on to the myOGEpower energy information website where they can access detailed information about their energy use, including the electricity they've used so far that day, week, or month. And it's available.[100]

Third party process

- No specific process defined.
- OG&E will share any individual or aggregated electricity use and cost information related to the myOGEpower energy information website and Service only (a) within OG&E (b) with third party contractors who maintain or improve the website or Service, (c) upon written request directly to you, and (d) if the disclosure is required by law.[101]

[100] http://www.oge.com/RESIDENTIAL-CUSTOMERS/PRODUCTS-AND-SERVICES/POSITIVE-ENERGY-SMART-GRID/Pages/myOGEpower.aspx
[101] https://myogepower.com/welcome/privacy-policy/

Michigan

Michigan Public Service Commission

Legislative or Regulatory action on AMI data privacy:

There are currently no state laws focused on AMI data privacy and/or security issues, however, two related House Bills (HB) currently pending in committee. HB 4728 would deem a residential customer's energy use data as confidential and prohibit disclosure by a utility except with the express consent of the customer. The bill also requires utilities to implement a number of safeguards and security measures related to wireless data communication. Separately, HB 4315 also deems AMI and other customer data confidential and prohibits disclosure without customer consent and also requires utilities to implement a number of data communication security measures including data encryption. HB 4315 goes further and also includes AMI opt-out regulations.

Two commission orders adopting investor-owned utility (IOU) opt-out and data privacy policies are currently in place. In September of 2012, the MSPC ordered IOUs to "make available an opt-out option, based on cost-of-service principles, for their customers if or when the provider elects to implement AMI. In October of 2013, the MPSC ordered DTE Gas Company, DTE Electric Company, and Consumers Energy Company to file customer protections related to data privacy. Commission-approved data privacy policies for DTE Energy and Consumers Energy (the two primary IOUs) are virtually identical. Both policies allow customers to request that his or her account and usage information be released to a third party of their choice and require informed customer consent from the Customer.

State Laws:

- Proposed House Bill 4728 – Advanced meter data regulations (this is not the formal bill title)
- Proposed House Bill 4315 – Advanced meter deployment ,installation, and data security regulations (this is not the formal bill title)

MSPC Orders:

- Case No. U-17102, Document No. 0026 – Order to file customer data privacy tariffs[102]
- Case No. U-17053, Document No. 0330 – Order approving DTE Energy application for authority to implement an advanced metering infrastructure non-transmitting meter provision (i.e. AMI opt-out program)[103]
- Case No. U-17000, Document No. – Review of issues bearing on the deployment of smart meters by regulated electric utilities in Michigan[104]

[102] http://efile.mpsc.state.mi.us/efile/docs/17102/0026.pdf
[103] http://efile.mpsc.state.mi.us/efile/docs/17053/0320.pdf
[104] http://efile.mpsc.state.mi.us/efile/docs/17000/0461.pdf

Are utilities required to provide data to customers?

- Yes. When data requested is Standard Usage Information[105], the request will be fulfilled without charge.
- Some requests for information extend beyond Standard Usage Information and the costs of fulfilling any special requests shall be borne solely by the Customer, or third party if deemed appropriate, and be based on the specifics of the data request and the associated costs of developing, processing, and transmitting the requested data.
- The Customer has a right to know what Customer Account Information the IOU maintains about the Customer, however, the IOU shall not provide data to a customer which the IOU considers proprietary or used for internal business.
- The IOU will make a reasonable effort to respond to requests for information within 30 business days of being contacted by the Customer.
-

Are utilities able to provide data to third parties?

- Yes. Informed customer consent is required.

Have utilities developed a process for customer access to their data?

Customer process

- Customers with advanced meters will have the choice of enrolling in an optional program that allows them to view their individual usage data on line.[106]

Third party process

- None noted.

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[105] "Standard Usage Information" means the usage data that is made available by the electric or gas utility to all similarly situated customers on a regular basis, delivered by the electric or gas utility in a standard format.

[106] DTE Energy Website AMI FAQs

Massachusetts

Massachusetts Department of Public Utilities

Legislative or Regulatory action on AMI data privacy:

Massachusetts has about 3.4 million electricity customers, all but about 400,000 of which are served by an investor-owned utility.[107] However, according the EIA as of 2012, only about 50 thousands AMI meters have been installed. On October 2, 2012, the Department of Public Utilities ("Department") issued a Notice of Investigation (NOI) into the modernization of the electric grid.[108] In December 2013, the Massachusetts Department of Public Utilities released an order that will require the state's big utilities to submit a ten-year grid modernization plan (GMP). Advanced metering will be required as part of that plan.[109] No specific state level action or investigation into AMI privacy concerns was identified.

State Laws:

- 201 CMR 17.00: Standards for the Protection of Personal Information of Residents of the Commonwealth (2010).[110]
- 220 C.M.R. § 11.05(4)(a): Release of Customer Usage Information (2001).[111]
- 220 C.M.R. § 11.04(12)(2): Disclosure of Customer Usage Information (2001). [112]

DPU decisions:

- DPU 12-76: Massachusetts Electric Grid Modernization Stakeholder Working Group Process: Report to the Department of Public Utilities from the Steering Committee (July 2013).[113]
- DPU 12-76-A: Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid (December 2013).[114]

Are utilities required to provide data to customers?

- A DPU investigation into grid modernization that began in December 2013 noted that future collection of interval data from all customers through advanced metering functionality raises additional potential privacy concerns. The report stated that "while

[107] http://www.greentechmedia.com/articles/read/massachusetts-makes-smart-grid-mandatory
[108] http://www.mass.gov/eea/docs/dpu/electric/12-76-a-order.pdf
[109] http://www.mass.gov/eea/docs/dpu/electric/grid-mod/d-p-u-12-76-a-12-23-2013.pdf
[110] http://www.mass.gov/ocabr/docs/idtheft/201cmr1700reg.pdf
[111] http://www.mass.gov/eea/docs/dpu/cmr/220cmr1100.pdf
[112] Ibid.
[113] http://magrid.raabassociates.org/Articles/MA%20Grid%20Mod%20Working%20Group%20Report%2007-02-2013.pdf
[114] http://www.mass.gov/eea/docs/dpu/electric/12-76-a-order.pdf

protecting customer data must be a high priority for electric distribution companies, electricity usage and consumption data must be available to customers, as well as to competitive suppliers and other service providers if authorized by customers, in order to fully realize the benefits of a modern grid."[115]

- Western Mass Electric (WMECO) provides usage data to customers using the GreenButton format.[116]

Are utilities able to provide data to third parties?

- Massachusetts currently has regulations governing the release of customer usage data to distribution utilities under competitive market initiatives. Currently, in order to gain access to a customer's historic usage data, a supplier must obtain authorization from the customer pursuant to 220 C.M.R. § 11.05(4)(a), and then request release of the data from the distribution company pursuant to 220 C.M.R. § 11.04(12)(2).[117] A customer must provide separate authorization to each supplier that seeks access to the customer's usage data.[118]
- A report by the grid modernization working group to the Department of Public Utilities in July 2013 (DPU 12-76) recommended that customer privacy policies and regulations be reassessed and further developed before any grid modernization filings or proposals are put forward and that "such policies should reflect and affirm that affirmative customer authorization is required prior to allowing utilities to enable access to such data to any third party".[119]

Have utilities developed a process for customer access to their data?

- No process for accessing customer data was identified. Smart meters are only just beginning to be rolled out in the State.

Does the State Have a Smart Meter Opt-Out Policy?

- During an investigation into a smart grid pilot program in 2012, all parties agree that customers should be given a clear opportunity to opt out of the installation of AMI meters.[120]

During the implementation of National Grid's smart meter pilot program, the company stated that it will allow any customer to opt out of the installation of an AMI meter, at any time before or during the pilot program. National Grid will provide customers with a an opt-out form as well as a toll-free telephone number to call in order to opt-out of the installation or have the AMI meter removed.[121]

[115] http://www.mass.gov/eea/docs/dpu/electric/12-76-a-order.pdf
[116] http://www.wmeco.com/residential/saveenergy/greenbutton.aspx
[117] http://www.mass.gov/eea/docs/dpu/cmr/220cmr1100.pdf
[118] http://www.energymarketers.com/Documents/Order_on_Phase_I_Competitive_Markets.PDF
[119] http://magrid.raabassociates.org/Articles/MA%20Grid%20Mod%20Working%20Group%20Report%2007-02-2013.pdf
[120] http://www.env.state.ma.us/dpu/docs/electric/11-129/8312dpuord.pdf
[121] Ibid.

Select National Level Data Privacy Initiatives

North American Energy Standards Board (NAESB)

- As of late 2012, the NAESB was developing a new standardized form to obtain a Retail Customer's Authorization for the release of their information to a third party.[122]
- The NAESB discussion noted that "The Retail Customer Authorization Form is used to obtain the Retail Customer's Authorization for the release of their information to a third party. The form is designed to be printed double-sided on legal paper to minimize inconvenience to the Retail Customer. It is also envisioned that an online version of this form could be submitted by the Retail Customer. There may also be other electronic means where a Retail Customer could provide Authorization for the release of particular information described on this form."
- Additional third party data access issues discussed by NAESB - http://www.naesb.org/misc/data_privacy_bd120910.ppt

National Institute of Standards and Technology (NIST)

- The Smart Grid Interoperability Panel–Cyber Security Working Group (SGIP-CSWG) has worked since June 2009 to research privacy issues within the existing and planned Smart Grid environment.
- The SGIP-CSWG prepared a three-volume report, Guidelines for Smart Grid Cyber Security, which presents an analytical framework that organizations can use to develop effective cyber security strategies tailored to their particular combinations of Smart Grid-related characteristics, risks, and vulnerabilities.
- The privacy subgroup membership is derived from a wide range of organizations and industries, including utilities, state utility commissions, privacy advocacy groups, academia, Smart Grid appliance and applications vendors, information technology (IT) engineers, and information security (IS) practitioners.
- Guidelines for Smart Grid Cyber Security, August 2010:
    - Volume 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements.
        - http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol1.pdf
    - Volume 2, Privacy and the Smart Grid.
        - http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol2.pdf.
    - Volume 3, Supportive Analyses and References.
        - http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol3.pdf

[122] http://www.naesb.org/pdf4/retail_2012_api_10b_rec.doc

General Federal Privacy Legislation

- General federal privacy safeguards provided under the Federal Privacy Act of 1974 (FPA) protect smart meter data maintained by federal agencies, including data held by federally owned electric utilities. Section 5 of the Federal Trade Commission Act (FTC Act) allows the Federal Trade Commission (FTC) to bring enforcement proceedings against electric utilities that violate their privacy policies or fail to protect meter data from unauthorized access, provided that the FTC has statutory jurisdiction over the utilities.
- It is unclear how Fourth Amendment protection from unreasonable search and seizures would apply to smart meter data, due to the lack of cases on this issue. However, depending upon the manner in which smart meter services are presented to consumers, smart meter data may be protected from unauthorized disclosure or unauthorized access under the Stored Communications Act (SCA), the Computer Fraud and Abuse Act (CFAA), and the Electronic Communications Privacy Act (ECPA).
- Smart Meter Data: Privacy and Cybersecurity. Congressional Research Service. February 2012. http://www.fas.org/sgp/crs/misc/R42338.pdf.

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Appendix B: Utility AMI Interview Response Sheets

The Utility AMI interview response sheets began with an introduction to task purposes and objectives so as to provide the interviewee with some context to the project. The following descriptions reflect the background provided to the interviewee. Interview results for each utility follow this description.

Task Purposes/Objectives:

- Develop an understanding of utility protocols and data transfer pathways for collecting AMI data for specific residential customers as a third party entity.
- Identify challenges/barriers to collecting residential customer AMI data as a third party entity.
- Develop an understanding of specific types of data (e.g. kw, kwh, voltage, current, power factor) and format of data (e.g. hardcopy, read-only online, PDF, XML, CSV, XLS, XLSX) available to third parties.

Introduction:

Leidos Engineering is working on a project to better understand the specific actions required to obtain customer AMI interval data. We are working with customers to obtain their data for process and analysis activities. To help us understand your process, we would appreciate your answers to a short list of questions we have today:

Austin Energy

Utility Name: Austin Energy	
Date of Contact: March 26, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
Austin Energy recently set up a process for customers to sign up and view energy cost data**.** Approximately 3,000 customers have signed up to date. The application is www.austinenergyapp.com	
Austin Energy also has a process for customers to call in and request their information from the call center. The call center – nicknamed "311" allows the owner the data to release it for a period of time.	
Note: customers are only allowed to request data that they "own". Specifically, they can only have data for the residence they are living in during the time they lived in it. For example, if the customer has lived in a home for 11 months, that is the extent of time they can receive it.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online/e-mail: There is an online form that needs to be filled out and e-mailed in. Once this is done, the data is available, but only for a certain period of time.
	Phone call
	Other – Describe:
Notes:	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
X	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes: Can be sent directly to the utility if a consent form is filled out. Supposedly this can be found at the austinenergy.gov website.	
How is data delivered to third party?	
	U.S. Mail

X	Email – preferred method
	Viewable Read-Only Online
	Downloadable
Notes:	
What type of data is provided?	
	kW
	kWh
	Voltage
	kVar
X	$/interval - This is the only thing available today.
	Other data (please list)
Notes: kWh raw data is available to Austin Energy – they are just not providing this to their customers yet.	
What interval(s) of data are provided?	
	15 minute
	1 hour
X	Daily
	Monthly
	Other
Notes: Although Austin Energy can get data at a more granular level, they are only offering daily information to their customers at this time. There is no indication that this will change in the future.	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	
No time stamp; only a date stamp.	
Notes:	

Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
X	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes: This is a date stamp, not a time stamp.	
What format does the data set come in?	
	Hardcopy
X	PDF
X	CSV
X	XML
X	XLS/XLSX
X	Other
Notes: They use the Green Button application on their website to allow customers to retrieve the data.	
How much past data is available?	
	<= 12 months – describe:
X	>12 and <=24 months – describe: Rolling two years
	>24 months – describe:
Notes:	

Length of time data access is authorized?	
X	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: It is rolling two years for customers who download it from the website. For third parties wanting to access information, there is a time limit, although the Austin Energy team members did not know what this was.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Big Data and Analytics	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
X	Yes
	No
Explanation: In theory, if a third party has a stack of signed consent forms, they can submit a formal request to Austin Energy. However, Austin Energy considers these ad hoc "projects", and gets to these when time is available. The response time could be days to weeks…	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

Additional Notes:

Although we were not able to download specific customer information, Norman did let us look at his account and screen of information. Below are examples of information pulled from a bar chart:

Date	Daily Energy usage ($)
3/19	$1.28
3/20	$1.49
3/21	$1.36
3/22	$1.51
3/23	$1.60

Braintree Electric Light Department

Utility Name: Braintree Electric Light Department	
Date of Contact: 3/26/2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Yes, they have set up a portal that customers can log into to see their energy usage and cost information. This requires the customer to register with the utility and set up a username and password for access. To register, you need your account number and phone number. Registration and account set up takes a couple of minutes if the customer has the required information.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
X	Other – Describe:
Notes: Third parties are only allowed to receive information directly from the customer. Braintree will not respond to requests to send information directly to the third party. One of the key reasons Braintree developed the portal was to have the customers do the work associated with viewing and downloading their own information.	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
X	Self-serve web portal
Notes: Information is available immediately through an export/download process	

How is data delivered to third party?	
	U.S. Mail
X	Email
	Viewable Read-Only Online
	Downloadable
Notes: The data is available only through the customer. Specifically, if the customer is part of a future EIA research initiative and the data is required, then the customer would download it into a file. This file could then be e-mailed to EIA.	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
X	$/interval (hourly)
	Other data (please list)
Notes: Voltage information is also collected; however Braintree does not make this available on the portal. They don't believe the customers care about this (or would understand it).	
What interval(s) of data are provided?	
X	15 minute (the utility uses this information – not available to customers)
X	1 hour (This is what is available on the portal)
	Daily
	Monthly
	Other
Notes:	

For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
Hourly, at the top of the hour (1:00, 2:00, etc)	
Notes:	
Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
X	AMI solution provider headend
	Other
Notes:	
What format does the data set come in?	
	Hardcopy
X	PDF
X	CSV
X	XML
X	XLS/XLSX
	Other
Notes: The format is dependent on customer preference; the customer can choose the format when he/she downloads the data.	
How much past data is available?	

X	<= 12 months – describe:
	>12 and <=24 months – describe:
	>24 months – describe:
Notes: The customer can select up to one year of hourly data. The year is the latest twelve months.	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: The customer has access to the data whenever he/she signs in. It is just a rolling twelve months of data they are looking at. For example, on January 1, 2014, the would be able to look at a calendar years' worth of data. On January 2, it would be data from January 2, 2013 to January 1, 2014.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Customer Service Group	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation: Braintree set up the portal to minimize the work associated with customer requests for data. The customers now have access to all their information; third parties need to approach them directly.	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data: If the customer has a username and password, this can be done in real time.	
How many calls/emails were made: N/A	

How many different people were involved: Only one person is involved in obtaining the data: the customer

Cleco Power, LLC[123]

Contact Information	
Utility Name: Cleco Power LLC	
Name of Contact:	
Name of Office or Division: Customer Experience	
Phone Number:	
Email:	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? No Cleco does not have a process where customers can learn about requesting their data.	
If no, do customers currently have the ability to obtain their data upon request to the utility? Customers can contact our Call Center, Customer Billing, visit a Customer Service Office, or request online using Contact Us.	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe. In 2014 Cleco is working with one our 3rd party vendors to provide the interval data via our Customer Self-Service website. The project is in the planning stages so we have not determined how much interval data will be available.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes: Cleco will release requested information to the customer who can then provide the information to a third party of their choosing. Any request for information from a Law Enforcement or Government Agency should be in writing on stationary that properly identifies the requesting agency. If the agency request substantial billing records, is referred to a Lead or Supervisor. We limit disclosure to agencies who have established a valid public basis for the need to discover such information. We do not divulge customer information to private investigators, bill collectors or similar interest.	
Who can deliver data to third party?	

[123] The contact at Cleco Power, LLC, did not have time to talk over the phone, but did fill out the interview response sheet and emailed it back. The format of this interview response sheet is slightly different than those completed during phone interviews.

X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes: Cleco does not provide data to third parties	
What type of data is provided?	
X	kW
X	kWh
X	Voltage
	kVar
X	$/interval
X	Other data (please list) Read Dates
Notes: Cleco has the ability to provide all of the items listed.	
What interval(s) of data are provided?	
	15 minute
X	1 hour
X	Daily
X	Monthly

	Other
Notes:	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
The timestamp is :00	
Notes:	
Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
X	AMI solution provider headend
	Other
Notes:	
What format does the dataset come in?	
X	Hardcopy
X	PDF
X	CSV
	XML
X	XLS/XLSX
X	Other RTF
Notes:	

How much past data is available?	
	<= 12 months – describe:
X	>12 and <=24 months – describe:
	>24 months – describe:
Notes:	
Length of time data access is authorized?	
X	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: This is on a per request basis. Cleco follows the same procedure to verify who the customer is prior to releasing customer information.	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation:	

Consumers Energy

Utility Name: Consumers Energy	
Date of Contact: March 11, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Yes, customers can access data through eServices account (essentially online billing), click on their smart meter data and download it in an Excel spreadsheet format.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes: Consumers Energy has not reached the point of allowing consumer data to be accessed by a third party yet; however, this is something they are considering in the future once the program is further along and legal steps are taken to ensure privacy.	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	

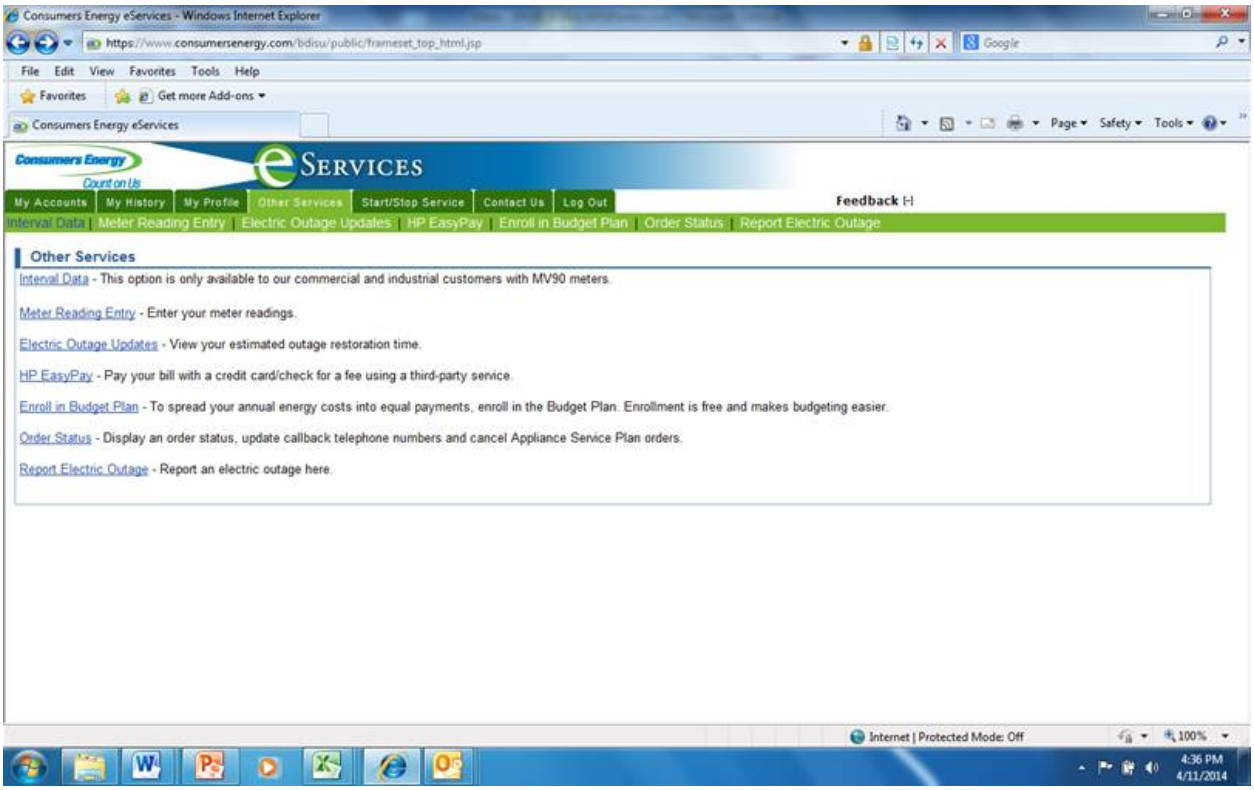
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes:	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
	15 minute
X	1 hour
	Daily
	Monthly
	Other
Notes: Currently data is at 1 hour intervals, but Jim mentioned that they are looking to get as low as 15 minute intervals and eventually real-time (real-time may be more into the future).	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
00:00, 01:00	

Notes: Timestamps are at the top of every hour for the hour ending for 60 minute intervals (e.g., 00:00, 01:00). When we go to 15 minute intervals it will be the same. Usage between 3:00 and 3:15 has a timestamp of 3:15.	
Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes: Timestamp is the same for all meters.	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
X	AMI solution provider headend
	Other
Notes: Meter time syncs with the HeanEnd server time, upon first communication. We also have a schedule on the meter to synch each night at midnight.	
What format does the data set come in?	
	Hardcopy
	PDF
	CSV
	XML
X	XLS/XLSX
	Other
Notes: Customers can access data through eServices account (essentially online billing), click on their smart meter data and download it in an Excel spreadsheet format.	
How much past data is available?	
X	**<= 12 months – describe:** Consumers Energy has about 1.8 million electric customers, and they are have currently installed about 200,000 smart meters on homes. According to the website, they hope to finish by 2019. They started collecting validated/accurate data in July 2013.

	>12 and <=24 months – describe:
	>24 months – describe:
Notes:	
Length of time data access is authorized?	
X	**Limited (describe exact amount of time, 1 year, 2 years, etc.):** Online description states that data will be retained for 7 years.
	Unlimited
Description:	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Smart Meter Program	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
	No
Explanation: Consumers Energy has not reached the point of allowing consumer data to be accessed by a third party yet; however, this is something they are considering in the future once the program is further along and legal steps are taken to ensure privacy.	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

Additional Notes:

At this time, only Commercial and Industrial customers are getting interval meter data from Consumers Energy. See screenshot below:



Dominion Power

Utility Name: Dominion Power Energy Conservation Department	
Date of Contact: March 11, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Yes, customers can view the data through their online billing platform.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
X	**Written Consent (U.S. Mail):** A third party can only receive access to customer data with customer permission. The customer must provide a signed, written letter of authorization for this to be considered.
	Online
	Phone call
	Other – Describe:
Notes:	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
X	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail

	Email
	Viewable Read-Only Online
	Downloadable
Notes: Delivery method not specified.	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
	15 minute
	1 hour
	Daily
	Monthly
X	**Other:** 30 minute intervals
Notes:	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	
Notes: Unknown	
Is this timestamp the same for all meters/customers?	

	Yes
	No
Notes: Unknown	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes: Specifics about timestamp are unknown; however, data communications go through a radio frequency mesh technology. This technology gathers data from the meter and then the network access point (router) collects this data and sends the data to the utility.	
What format does the data set come in?	
	Hardcopy
X	PDF
	CSV
	XML
	XLS/XLSX
	Other
Notes: No dataset type was specified. The customer service representative only mentioned that the customer can look at the data online and likely download the bill in a PDF format.	
How much past data is available?	
	<= 12 months – describe:
	>12 and <=24 months – describe:
X	**>24 months – describe:** The program has been going on since the early 2010s, so there is likely data for 24 months or more.
Notes:	

Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: Unknown.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Energy Management Team	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
	No
Explanation: There is no apparent restriction on this except for the fact that each customer would have to provide written consent.	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

Duke Energy

Utility Name: Duke Energy	
Date of Contact: April 15, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Duke Energy – Ohio is the only place where smart meters have been installed. They have been installed in approximately 1 million homes. Customers who have ***certified*** smart meters (i.e. they have been deemed operational for commercial use) have the ability to view daily information on the Duke Energy website. This information is available for as long as the meter has been certified, up to a year. Customers have to sign up and receive a username and password to access their information on site. Note: Duke Energy collects the information in 15 minute intervals, and may offer this to customers in the future. However, right now, it is only available daily.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
x	Other – Describe: Ohio offers retail electric competition. Therefore, those third parties who are registered as a Competitive Retail Electric Supplier (CRES) can request and receive 15 minute interval data from Duke Energy *without* getting the customer's consent. More research needs to be done to determine what other third parties may have access to this information.
Notes:	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
X	Sent from Utility directly to third party (via email)
	Self-serve web portal

Notes: CRES companies can receive information directly from the utility. Others will have to receive it from the customer for now.	
How is data delivered to third party?	
X	U.S. Mail/FedEx
	Email
	Viewable Read-Only Online
x	Downloadable
Notes: For CRES companies, depending on how many customers they are requesting and the size of the dataset, this may require mailing the information.	
What type of data is provided?	
	kW
x	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
x	15 minute – available to CRES companies
	1 hour
x	Daily – currently offered via portal to customers.
	Monthly
	Other

Notes:	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
Notes: For 15 minute intervals, the timestamp is :00, :15, :30, :45. For the daily reads, it is the calendar day	
Is this timestamp the same for all meters/customers?	
x	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
X	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes:	
What format does the data set come in?	
	Hardcopy
	PDF
X	CSV
	XML
	XLS/XLSX
	Other
Notes:	

How much past data is available?	
x	<= 12 months – describe: 12 months on a daily rolling system
	>12 and <=24 months – describe:
	>24 months – describe:
Notes:	
Length of time data access is authorized?	
X	Limited (describe exact amount of time, 1 year, 2 years, etc.): Limited by the days available via the rolling calendar.
	Unlimited
Description:	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Grid Modernization	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
X	Yes
	No
Explanation: See notes above about CRES companies	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

Florida Power and Light

Utility Name: Florida Power and Light	
Date of Contact: 4/21/2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? It is an Energy Dashboard, and it is available for residential and commercial customers.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes: FP&L does not have a program in place for third parties to access customer information directly.	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes: Customers can send their data to third parties after they get it through the Energy Dashboard.	
How is data delivered to third party?	
X	U.S. Mail
X	Email

	Viewable Read-Only Online
	Downloadable
Notes: At this time, customers cannot get electronic downloads of their data, just printouts of it. Therefore, this would either be sent via U.S. mail, or scanned and delivered via e-mail.	
What type of data is provided?	
X	kW
X	kWh
	Voltage – they can ping the meter for the customer to get instantaneous reads. However, these are not stored. (This is used also for outage management activities.)
	kVar
	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
	15 minute
X	1 hour
	Daily
	Monthly
	Other
Notes:	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	
Hourly at the :00 time	
Notes:	
Is this timestamp the same for all meters/customers?	

X	Yes
	No
Notes: Jeff believes that the entire industry has standardized the timestamps for AMI data to be at the quarter hour format. EIA should look into this in the future if they decide to utilize AMI data.	
How are interval timestamps synchronized within the utility?	
	GPS
X	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes:	
What format does the data set come in?	
X	Hardcopy
	PDF
	CSV
	XML
	XLS/XLSX
	Other
Notes: Residential customers cannot get electronic downloads of their data, just printouts of it. Commercial customers can get electronic downloads. Residential customers may be able to get this electronically via request; however it would be considered an "ad hoc" request, and the timing and expense of it would have to be determined. When asked if electronic access might be a future option, Jeff indicated it could be; however, there would need to be a business case to support it.	
How much past data is available?	
	<= 12 months – describe:
X	**>12 and <=24 months** – describe: 13 months rolling data based on when the customer's billing cycle ends. For example. If the customer's billing cycle day is the 29th of the month, then the customer would have 13 months + 29 days into the 14th month.

	>24 months – describe:
Notes:	
Length of time data access is authorized?	
X	Limited (describe exact amount of time, 1 year, 2 years, etc.): Rolls over every day.
	Unlimited
Description:	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division:	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation: There is no process in place for third parties to request data from FP&L	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	
Additional Notes: Jeff would like to receive a copy of the final report if it is publicly available. If not, he would like some sort of a summary document on the results.	

City of Kings Mountain Municipal Utility

Utility Name: City of Kings Mountain Municipal Utility	
Date of Contact: April 15, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Kings Mountain customers will have access to their interval usage information starting the Summer of 2014, when the customer energy portal comes online.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes: Third parties at this time will not have the opportunity to directly request the information. Customers will need to download their information and provide it directly to the third parties.	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail
X	Email

	Viewable Read-Only Online
X	Downloadable
Notes: Customers can download their information and e-mail it to the third party	
What type of data is provided?	
	kW
x	kWh
	Voltage
	kVar
x	$/interval: this can be developed via a separate report
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
x	15 minute
	1 hour
	Daily
	Monthly
X	Other: 30 minutes
Kings Mountain has a wholesale purchase power agreement with Duke Energy. This agreement is priced based on 30 minute intervals. Therefore, Kings Mountain wanted customer interval data to match the purchase power data so they would have the ability (along with their customers) to directly compare energy costs during the same periods. In essence, business needs drove the decision to use the 30 minute interval.	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	
Notes: The timestamp is :00, :30.	

Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
X	AMI solution provider headend
	Other
Notes: The AMI headhead is synchronized to a utility time server; the head end then synchs up with all the "gatekeepers" in the service territory to ensure the times are the same for all devices. The gatekeeper is the data collector that collects the AMI data from the 900 MHz mesh system and sends it back office via the wide area network (WAN).	
What format does the data set come in?	
	Hardcopy
	PDF
X	CSV
	XML
	XLS/XLSX
	Other
Notes:	
How much past data is available?	
	<= 12 months – describe:
X	>12 and <=24 months – describe: rolling 13 month view on the portal
	>24 months – describe:

Notes: Since the system is new, data will be available for the amount of time that the meter was installed. Also, Kings Mountain is investigating different archiving strategies where more than 13 months could be provided upon request. This has not been developed yet.	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: See note above about archiving.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: United Power/Leidos Engineering	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation:	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

Lakeland Electric

Utility Name: Lakeland Electric	
Date of Contact: April 8, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Customers can log into their account on the Lakeland Electric website to access the FlexNet portal and view and download their usage data in near real time. Hourly intervals are provided to the customer. The Green Button format is used provide electric usage data.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
X	Other – Describe:
Notes: Mr. Dotson stated that for Florida Municipal utilities all data is public. However, only customers can access their data online using a utility username and password. For a third party or non-customer to obtain data must be in person request and there may be a charge involved. Mr. Dotson was not aware of this ever happening so could not provide the amount of charge or amount of time the request would take.	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	

How is data delivered to third party?	
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes: Unknown at this time, however, request for data must be in person.	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
X	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
	15 minute
X	1 hour
	Daily
	Monthly
	Other
Notes: System can go down to 5 minute. But only hour interval is used right now.	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	

The timestamp is at the start of the hour, for example 1AM,2AM, etc.	
Notes:	
Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
X	GPS
	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes:	
What format does the data set come in?	
	Hardcopy
	PDF
	CSV
	XML
	XLS/XLSX
	Other
Notes: Currently customers can view their usage data but can't download it. This functionality is coming soon. Mr. Dotson was not able to provide a timeframe.	
How much past data is available?	
	<= 12 months – describe:
X	>12 and <=24 months – describe:

	>24 months – describe:
Notes: 13 months of past data are available to the customer	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
X	Unlimited
Description:	
Can you provide a sample of the data you provide to customers?	
	Yes
X	No
Notes: Not able to provide a sample at this time.	
Can you provide a sample of the data you provide to third parties (if different than that provided to customers)?	
	Yes
X	No
Notes: Not able to provide a sample at this time.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Smart Grid Operations	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes

	No
Explanation: Unknown at this time.	
Anecdotal description of process:	
How long does the process take from first contact to delivered data: Customers must log in to their account on the Lakeland Electric website to access their usage data. This takes only seconds if customer already has an account registered. Account registration also takes less than a minute to set up.	
How many calls/emails were made: 2 calls to date. Brief conversation with customer service representative. Longer, more detailed conversation with Smart Grid Operations Manager, Mr. Randall Dotson.	
How many different people were involved: 2	

Madison Gas and Electric

Utility Name: Madison Gas and Electric **NOTE:** It is important to note that MG&E has only deployed AMI for high load commercial customers. They do not foresee implementing a residential AMI program unless a business case is made for it. Thus, all information collected below is for AMI aimed at commercial customers.	
Date of Contact: March 25, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data?	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes:	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail
	Email

	Viewable Read-Only Online
	Downloadable
Notes:	
What type of data is provided?	
X	kW
X	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes: kWh for the customer billing, but KW for demand data.	
What interval(s) of data are provided?	
X	15 minute
	1 hour
	Daily
	Monthly
	Other
Notes: Only for commercial/high load customers.	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	
The timestamp is :00, :15, :30, :45 and starts at the top of the hour.	
Notes: Only for commercial/high load customers.	
Is this timestamp the same for all meters/customers?	
X	Yes

	No
Notes: Each meter starts at the top of the hour.	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
X	AMI solution provider headend
	Other
Notes: Data is synchronized through a cellular communication device.	
What format does the data set come in?	
	Hardcopy
	PDF
	CSV
	XML
	XLS/XLSX
	Other
Notes:	
How much past data is available?	
	<= 12 months – describe:
	>12 and <=24 months – describe:
	>24 months – describe:
Notes:	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):

	Unlimited
Description:	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: No specific name for the AMI program	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
	No
Explanation:	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

Oncor

Utility Name: Oncor (TX)	
Date of Contact: 3/3/2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Residential customers can learn about the data request process through the SmartMeterTexas.com (SMT) portal. Here customers can: • Manage your residential Smart Meter Texas account. • View your electricity usage. • Manage your Home Area Network devices. To register, customers need to enter their contact information as well as their service provider, meter number, and ESIID (All Oncor customers have a 17-digit Electric Service Identifier (ESI ID), which they can find on their electric bill along with their meter number.) Once registered customers can use the Green Button format to download energy usage information from SMT. Customers can then easily load the information into programs obtained from others or voluntarily share it with Third Party entities.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes: No, only customers can access their data.	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)

	Self-serve web portal
Notes: Only the customer can access data and deliver it to a third party.	
How is data delivered to third party?	
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes: Customer has final choice as they are the only party that can access data.	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
X	15 minute
	1 hour
	Daily
	Monthly
	Other

Notes:	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
15 minutes intervals at :00, :15, :30, :45	
Notes:	
Is this timestamp the same for all meters/customers?	
	Yes
	No
Notes: Unknown	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes: Unknown	
What format does the data set come in?	
	Hardcopy
	PDF
	CSV
X	XML
X	XLS/XLSX
	Other
Notes: Customers can download data in XLS spreadsheet format or in standard GreenButton XML format.	

How much past data is available?	
	<= 12 months – describe:
	>12 and <=24 months – describe:
	>24 months – describe:
Notes: Unknown	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: N/A, only customer can access data.	
Can you provide a sample of the data you provide to customers?	
X	Yes
	No
Notes: Sample data provided in XLS and XML format	
Can you provide a sample of the data you provide to third parties (if different than that provided to customers)?	
	Yes
	No
Notes: N/A, only customers have access to data	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division:	
Name of Contact Person:	
Phone Number:	

Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation: No, only customers can access data.	
Anecdotal description of process:	
How long does the process take from first contact to delivered data: Smart Meter Texas registration takes just a few minutes to complete. Once registered, data can be viewed and downloaded in just a few clicks.	
How many calls/emails were made: 1 call	
How many different people were involved: 1	

Pepco

Utility Name: Pepco	
Date of Contact: March 24, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Yes, customers can access this data through their online billing portal.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
X	Other – Describe:
Notes: Pepco does not distribute customer data to a third party. The only way a third party can get customer data is if the customer gives the third party their username and password.	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes: Pepco does not distribute customer data to a third party. The only way a third party can get customer data is if the customer gives the third party their username and password.	
How is data delivered to third party?	
	U.S. Mail

	Email
	Viewable Read-Only Online
	Downloadable
Notes:	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
	15 minute
X	1 hour
	Daily
	Monthly
	Other
Notes: Pepco is working towards 15 minute interval data, but there is no timeframe specified for completion of this initiative.	
For the above interval, what is the typical timestamp for the interval? **(For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)**	
Notes:	
Is this timestamp the same for all meters/customers?	

	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes:	
What format does the data set come in?	
	Hardcopy
	PDF
X	CSV
X	XML
	XLS/XLSX
	Other
Notes:	
How much past data is available?	
	<= 12 months – describe:
	>12 and <=24 months – describe:
	>24 months – describe:
Notes:	
Length of time data access is authorized?	
X	Limited (describe exact amount of time, 1 year, 2 years, etc.)

	Unlimited
Description: Pepco intends to retain energy usage data for 7 years.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: Energy Advisors (Department of Pepco)	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation: Pepco does not distribute customer data to a third party. The only way a third party can get customer data is if the customer gives the third party their username and password.	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	

San Diego Gas and Electric

Utility Name: San Diego Gas and Electric	
Date of Contact: March 31, 2014	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? Yes, customers can access and request data through SDG&E's online account site. Customers can download data through the Green Button program under this account site.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
X	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes:	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes: Contact was unsure of delivery method.	
How is data delivered to third party?	
	U.S. Mail

	Email
	Viewable Read-Only Online
	Downloadable
Notes:	
What type of data is provided?	
	kW
X	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes: Data are provided in kWh. The meter, however, does not record data in kWh, but instead records data in pulses. These pulses are sent to a data collection engine which then converts the pulses into watt hours based on an SDG&E constant of 1 pulse = 5 watt hours. This is then converted into kWh for the customer to see.	
What interval(s) of data are provided?	
X	15 minute
X	1 hour
	Daily
	Monthly
	Other
Notes: Electric energy use is recorded every hour for a majority of residential homes and every 15 minutes at commercial businesses. There are, however, some residential homes where 15 minute data are collected. Some of these homes have one-way communications while others have two-way communications.	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
12:00, 13:00, 14:00	

Notes: Data is reported based on the interval ending time.	
Is this timestamp the same for all meters/customers?	
	Yes
X	No
Notes: See answer to next question for explanation.	
How are interval timestamps synchronized within the utility?	
	GPS
X	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes: Data transmits to the collection engine from the smart meters. The data is then aggregated and sent to the cell relay, or the "take out" point. This process occurs once per day. Final timestamps are ultimately synced with the utility system time; however, to get to this end point, there are two timestamps to begin with: a network (utility system) timestamp and the smart meter timestamp. Every hour, the smart meter communicates with the network and sends a time stamp for the hourly data. If the smart meter timestamp is within 20 seconds of the network timestamp, the network does not adjust the smart meter timestamp. If the smart meter timestamp is not within 20 seconds of the network timestamp, the network with adjust the smart meter timestamp to be within a more accurate margin of error.	
What format does the data set come in?	
	Hardcopy
	PDF
	CSV
X	XML
	XLS/XLSX
	Other

Notes: Customers can download up to 13 months of data through the Green Button program and provide the data to third parties in an XML file.	
How much past data is available?	
	<= 12 months – describe:
X	>12 and <=24 months – describe:
	>24 months – describe:
Notes: Customers can access up to 13 months of smart meter energy usage data.	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: Contact was unsure of how long data access is authorized.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: AMI Division	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
	No
Explanation: Contact was unsure about this.	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	

How many different people were involved:

United Power

Utility Name: United Power	
Date of Contact: April 15, 2014	
Notes: United Power is an electric cooperative based in Brighton CO. United Power has contracted with Leidos Engineering, LLC to provide its Smart Grid as a Service (SgaS) solution, which includes AMI, smart meters, and a customer energy portal. Therefore, Leidos participated in this interview on behalf of the United Power, since they are responsible for the implementation and operation of the smart meters and systems.	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data? United Power customers will have access to their interval usage information starting the Summer of 2014, when the customer energy portal comes online.	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:

Notes: Third parties at this time will not have the opportunity to directly request the information. Customers will need to download their information and provide it directly to the third parties.	
Who can deliver data to third party?	
X	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail
X	Email
	Viewable Read-Only Online
X	Downloadable
Notes: Customers can download their information and e-mail it to the third party	
What type of data is provided?	
	kW
x	kWh
	Voltage
	kVar
x	$/interval: this can be developed via a separate report
	Other data (please list)
Notes:	
What interval(s) of data are provided?	
x	15 minute

	1 hour
	Daily
	Monthly
	Other
Notes: Customers will have the flexibility to aggregate the intervals into different time buckets. It could be hourly, daily, weekly, etc. They also have the ability customize how they see the data. (For example, they could ask to only see interval data from 4:00-6:00pm on weekdays during the summer)	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
Notes: The timestamp is :00, :15, :30, :45.	
Is this timestamp the same for all meters/customers?	
X	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
	GPS
	Utility system time (i.e. network operations center, etc.)
X	AMI solution provider headend
	Other
Notes: The AMI headhead is synchronized to a utility time server; the head end then synchs up with all the "gatekeepers" in the service territory to ensure the times are the same for all devices. The gatekeeper is the data collector that collects the AMI data from the 900 MHz mesh system and sends it back office via the wide area network (WAN).	
What format does the data set come in?	
	Hardcopy
	PDF

X	CSV
	XML
	XLS/XLSX
	Other
Notes:	
How much past data is available?	
	<= 12 months – describe:
X	>12 and <=24 months – describe: rolling 13 month view on the portal
	>24 months – describe:
Notes: Since the system is new, data will be available for the amount of time that the meter was installed. Also, United Power is investigating different archiving strategies where more than 13 months could be provided upon request. This has not been developed yet.	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: See note above about archiving.	
Name and contact information of the person or office with utility who ultimately provides the data (if available)	
Name of Office or Division: United Power/Leidos Engineering	
Name of Contact Person:	
Phone Number:	
Email:	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No

Explanation:
Anecdotal description of process (may be standardized if enough similarity):
How long does the process take from first contact to delivered data:
How many calls/emails were made:
How many different people were involved:

Wisconsin Power and Light[124]

Contact Information	
Utility Name: Alliant Energy	
Name of Contact:	
Name of Office or Division: WPL Billing	
Phone Number:	
Email:	
Have you set up a formal process for allowing customers to obtain their AMI interval data?	
If yes, where can customers learn about this process to request their data?	
If no, do customers currently have the ability to obtain their data upon request to the utility?	
If no, does the utility have plans to set a process for obtaining data in the future? Please describe. Yes, a new Billing System will be implemented in 2015 which will allow for more robust website data to be presented to the customers. The full extent of what will be available is yet to be fully defined.	
Do customers have ability to allow third parties to request data on their behalf? If so, How is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call

[124] Wisconsin Power and Light asked to fill out their form and email it back, so the format of this interview response sheet is slightly different than those completed during phone interviews.

	Other – Describe:
Notes: We do not currently provide AMI data, we would, however, provide monthly billing history.	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Utility directly to third party (via email)
	Self-serve web portal
Notes: N/A per above	
How is data delivered to third party?	
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes: N/A per previous questions	
What type of data is provided?	
	kW
	kWh
	Voltage
	kVar
	$/interval
	Other data (please list)
Notes: N/A per prior answers	
What interval(s) of data are provided?	
	15 minute

	1 hour
	Daily
	Monthly
	Other
Notes: No AMI interval data is provided.	
For the above interval, what is the typical timestamp for the interval? (For example: for 15 minute interval, the timestamp may be :00, :15, :30, :45)	
Notes:	
Is this timestamp the same for all meters/customers?	
	Yes
	No
Notes:	
How are interval timestamps synchronized within the utility?	
X	GPS
	Utility system time (i.e. network operations center, etc.)
	AMI solution provider headend
	Other
Notes:	
What format does the dataset come in?	
	Hardcopy
	PDF
	CSV
	XML

	XLS/XLSX
	Other
Notes: N/A – no dataset is provided.	
How much past data is available?	
	<= 12 months – describe:
	>12 and <=24 months – describe:
X	>24 months – describe:
Notes: All AMI data from AMI ready meters is available since converting to AMI in 2008.	
Length of time data access is authorized?	
	Limited (describe exact amount of time, 1 year, 2 years, etc.):
	Unlimited
Description: N/A	
Can the third parties request data from multiple customers at one time?	
	Yes
X	No
Explanation:	
Any other relevant information on AMI program implementation?	

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Appendix C: Submeter Company Interview Response Sheets

The submeter technology company interview response sheets began with an introduction to task purposes and objectives so as to provide the interviewee with some context to the project. The following descriptions reflect the background provided to the interviewee. Interview results for each company follow this description.

Submeter Technology Company Data Collection and Documentation Process Survey

Task Purposes/Objectives:

- Develop an understanding of leading submeter technology products and developers and data transfer pathways for collecting submeter data for specific customers as a third party entity.
- Identify challenges/barriers to collecting residential customer submeter data as a third party entity.
- Develop an understanding of specific types of data (e.g. kw, kwh, voltage, current, power factor) and format of data (e.g. hardcopy, read-only online, PDF, XML, CSV, XLS, XLSX) available to third parties.

Introduction:

Leidos Engineering is working on a project to better understand the current state of residential submeter technologies including the capabilities and features of a selection of submeter solutions, and the specific actions required to obtain customer submeter data. Your company was identified as a key residential market player with product(s) capable of multi-circuit or plug load monitoring. To help us understand your product(s), services, and policies, we would appreciate your answers to a short list of questions we have today:

Brultech Research, Inc.

Date: April 9, 2014
Company Info:
Name: Brultech Research Inc
Location: St. Catharines, ON, Canada
Size Indicator:
Founding:
Contact Info:
Name:
Title/Position/Role:
Email:
Phone:
Product Info:
Available Multi-Circuit/ Plug-in Monitor Product Name(s): GreenEye Monitor, ECM-1240
Product Launch Date: 2013, 2009
Annual Product Sales:
Lifetime Product Sales/Installed Base:
Who are your target customers?
Residential, Commercial
How heavily to focus on the residential sector?
We don't really focus on a specific sector.

What are your distribution channels?	
Direct sales	
Is professional installation required?	
Electrician	
How many circuit or sockets can be measured?	
32 circuits with the GreenEye Monitor, 7 with the ECM-1240. Loads can be combined onto a channel to provide more.	
Where is data stored?	
x	Data logger memory
x	Local PC
	Remote In-house Server
x	Remote 3rd Party Server
Notes:	
How do customers access their data?	
x	Local PC
	In-house data service/web interface
x	3rd Party data service/web interface
Notes:	
Can data be downloaded, exported, or otherwise saved by users?	
If yes, in what format(s)?	
If yes, what types of data/metrics are available and at what interval(s)?	
If yes, what historical range is available?	
If yes, do you have generic sample data file you could send us to look at?	
Notes:	
Do customers have ability to give third parties access to their data? If so, how is authorization for third party access granted?	

	Written Consent (U.S. Mail)
	Online
	Phone call
	Other – Describe:
Notes:	
Who can deliver data to third party?	
	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Company directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes:	
Can the third parties request data from multiple customers at one time?	
	Yes
	No
Explanation:	
Is your company involved with any pilot, demonstration, or other research projects sponsored by utilities or other entities?	
If yes, what is the purpose?	
If yes, who are the stakeholders?	
If yes, how many participants?	

If yes, what is the status and timing of the project?
If yes, do you have contact info for someone actively involved?
Use the space below to provide additional relevant information as appropriate

eGauge Systems, LLC

Date of Contact: 4/2/14
Company Info:
Name: eGauge Systems LLC
Location: Boulder, CO
Size Indicator: 15 employees
Founding: 2007
Contact Info:
Name:
Title/Position/Role:
Email:
Phone:
Product Info:
Available Multi-Circuit/ Plug-in Monitor Product Name(s): eGauge 3 Series
Product Launch Date: 2007
Annual Product Sales: 4,000-5,000 anticipated for 2014; sales have been ramping up in recent years
Lifetime Product Sales/Installed Base: about 11,000
Who are your target customers?
Residential and small commercial

How heavily to focus on the residential sector?	
No real focus on any one sector.	
What are your distribution channels?	
Majority of sales are made to solar installers, energy service providers, and electricians. Limited sales are made through web store.	
Is professional installation required?	
Yes	
How many circuit or sockets can be measured?	
12 circuits @ 120V OR Main @ 240V and 10 circuits @ 120V	
Where is data stored?	
x	Data logger memory
	Local PC
	Remote In-house Server
	Remote 3rd Party Server
Notes:	
How do customers access their data?	
	Local PC
x	In-house data service/web interface – web viewer
x	3rd Party data service/web interface – Data can be pushed or pulled using open API
Notes:	
Can data be downloaded, exported, or otherwise saved by users?	
If yes, in what format(s)? - CSV and XML	

If yes, what types of data/metrics are available and at what interval(s)?

- Reported metrics must be "turned on" by installer during installation
- Typically, only W and Wh are turned on for residential customers
- All available metrics are provided in the table below:

Name	Records	Unit	Res	Max @ 30 yr	Code
power [Watts]	(Real) power	W	$1W$	$19.4GW$	P
app. power [VA]	Apparent power	VA	$1\,VA$	$19.4GVA$	S
react. power [var]	Reactive power	var	$1\,var$	$19.4Gvar$	PQ
voltage [V]	Voltage	V	$1mV$	$19.4MV$	V
current [A]	Current	A	$1mA$	$19.4MA$	I
freq. [Hz]	Frequency	Hz	$1\,mHz$	$19.4M\,Hz$	F
irrad. [W/m^2]	(Solar) irradiance	W/m^2	$1W/m^2$	$19.4GW/m^2$	Ee
temp. [C]	Temperature	$°C$	$1m°C$	$19.4M°C$	T
humidity [%]	Relative humidity	$\%$	0.1%	$194M\%$	h
mass flow [kg/s]	Mass flow	kg/s	g/s	$19.4Gg/s$	Q
volumetric flowa [m^3/s]	Volumetric flow	m^3/s	$1mm^3/s$	$19.4m^3/s$	Qv
speed [m/s]	Speed (e.g., rain-fall rate)	m/s	$1mm/s$	$19.4Mm/s$	v
res. [Ohm]	Resistance	Ω	1Ω	$19.4G\Omega$	R
monetary	Money	*var.*	$1.86n$	36.2	$
angle [deg]	Angle (e.g., wind-direction)	°	$1m°$	360°	a
number	Unit-less quantity	*n/a*	1	$19.4G$	#
total harm. dist	Total Harmonic Distortion	$\%$	0.1%	$194M\%$	THD
pressure [Pa]	Pressure (e.g., atomospheric)	Pa	$1Pa$	$19.4GPa$	Pa

If yes, what historical range is available?

- Option 1: 10 minutes of second-data; 1 year or minute data; 30 years of 15-min data
- Option 2: 3 weeks of second data

If yes, do you have generic sample data file you could send us to look at?

- Yes. Available and sent by Charlie.

Notes:

Do customers have ability to give third parties access to their data? If so, how is authorization for third party access granted?

	Written Consent (U.S. Mail)
	Online
	Phone call
x	Other – Describe: Push or pull data using XML API

Notes:

Who can deliver data to third party?

x	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Company directly to third party (via email)
	Self-serve web portal
Notes:	
How is data delivered to third party?	
	U.S. Mail
x	Email – customer download and email or XML API
	Viewable Read-Only Online
	Downloadable
Notes:	
Can the third parties request data from multiple customers at one time?	
	Yes
x	No
Explanation:	
Is your company involved with any pilot, demonstration, or other research projects sponsored by utilities or other entities?	
If yes, what is the purpose? - Pecan Street (program interviewed separately in this study)	
If yes, who are the stakeholders?	
If yes, how many participants?	
If yes, what is the status and timing of the project?	
If yes, do you have contact info for someone actively involved?	
Notes:	
Use the space below to ask additional questions and document answers that fill data gaps in Submeter Landscape Summary table:	

n/a

PowerWise Systems

Date of Contact: 3/25/14
Company Info:
Name: PowerWise Systems (distributor for Powerhouse Dynamics)
Location: PowerWise Systems – Maine; Powerhouse Dynamics – Boston, MA)
Size Indicator: PowerWise Systems – 8 employees; Powerhouse Dynamics – 15-20 employees
Founding: PowerWise Systems was founded in 2000. They designed and programmed the original eMonitor (now called SiteSage and developed by Powerhouse Dynamics), and designed the original database for collecting energy use data. When the Powerhouse Dynamics went corporate and moved to Boston, we stayed in Maine, and created PowerWise Systems. Powerhouse Dynamics was founded in 2008.
Contact Info:
Name:
Title/Position/Role:
Email:
Phone:
Product Info:
Available Multi-Circuit/ Plug-in Monitor Product Name(s): SiteSage for Homes (formerly eMonitor)
Product Launch Date: Originally launched as “eMonitor” in about 2000
Annual Product Sales: Not provided
Lifetime Product Sales/Installed Base: about 6,000 nationwide
Who are your target customers?

Residential	
How heavily to focus on the residential sector?	
About 80% residential and 20% small commercial	
What are your distribution channels?	
Utilities (Green Mountain Power), state programs (Efficiency Maine, Massachusetts Energy and Environmental Affairs), energy service providers (Vermont Energy Investment Corp), regional energy efficiency organizations (NEEP), tradeshows, and website	
Is professional installation required?	
Highly recommended	
How many circuit or sockets can be measured?	
200+	
Where is data stored?	
x	Data logger memory – memory stores up to 3 weeks of data
	Local PC
	Remote In-house Server
x	Remote 3rd Party Server
Notes: - Data logger memory stores up to 3 weeks of data - Remote 3rd Party Server provided by Amazon	
How do customers access their data?	
	Local PC
x	In-house data service/web interface
	3rd Party data service/web interface
Notes: - Maintained by Powerhouse Dynamics, subscription required	
Can data be downloaded, exported, or otherwise saved by users?	

If yes, in what format(s)? - CSV and XML	
If yes, what types of data/metrics are available and at what interval(s)? - Historical data is aggregated progressively over time	
If yes, what historical range is available? - Unlimited	
If yes, do you have generic sample data file you could send us to look at? - Yes, available.	
Notes: - 2-3 second interval data is available onsite with additional equipment (this data is RARELY if ever used and is not stored on server)	
Do customers have ability to give third parties access to their data? If so, how is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
x	Other – Describe: In dashboard settings, users can make their data available anonymously and as read-only
Notes:	
Who can deliver data to third party?	
x	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Company directly to third party (via email)
x	Self-serve web portal
Notes: - Submetering program administrators can access all user data through an administrative web dashboard	
How is data delivered to third party?	
	U.S. Mail
	Email

x	Viewable Read-Only Online
x	Downloadable
Notes:	
Can the third parties request data from multiple customers at one time?	
x	Yes
	No
Explanation: - Only as a program administrator	
Is your company involved with any pilot, demonstration, or other research projects sponsored by utilities or other entities?	
If yes, what is the purpose? - Multiple projects (see notes below)	
If yes, who are the stakeholders? - Multiple projects (see notes below)	
If yes, how many participants? - Not provided	
If yes, what is the status and timing of the project? - Not provided	
If yes, do you have contact info for someone actively involved? - Not provided	
Notes: - VEIC: mini-split heat pump monitoring - NEEP/EEA: study of electricity and water use in homes - Efficiency Maine: study of customer response to availability of submeter data - Green Mountain Power: heat pump monitoring	
Use the space below to ask additional questions and document answers that fill data gaps in Submeter Landscape Summary table:	
n/a	

Energy, Inc. (The Energy Detective)

Date of Contact: 3/31/14		
Company Info:		
Name: Energy, Inc. (The Energy Detective)		
Location: Charleston, SC		
Size Indicator: 10 employees		
Founding: 2001		
Contact Info:		
Name:		
Title/Position/Role:		
Email:		
Phone:		
Product Info:		
Available Multi-Circuit/ Plug-in Monitor Product Name(s):	TED 5000	TED Pro
Product Launch Date:	2001	2014
Annual Product Sales:		
Lifetime Product Sales/Installed Base:	100,000+	Limited; New product
Who are your target customers?		
TED 5000 – residential	**TED Pro** – residential and small commercial	
How heavily to focus on the residential sector?		
TED 5000 – 100%	**TED Pro** – Not Provided	

What are your distribution channels?	
Utilities, solar installers, energy service providers, internal website, external websites	
Is professional installation required?	
TED 5000 – recommended but not required; potentially a DIY job	**TED Pro** – highly recommended
How many circuit or sockets can be measured?	
TED 5000 – up to 4	**TED Pro –** up to 32 with Spyder module add-ons

Where is data stored?	
x	Data logger memory
	Local PC
	Remote In-house Server
	Remote 3rd Party Server
Notes:	

How do customers access their data?	
	Local PC
x	In-house data service/web interface
x	3rd Party data service/web interface
Notes:	

Can data be downloaded, exported, or otherwise saved by users?
If yes, in what format(s)?
If yes, what types of data/metrics are available and at what interval(s)? - TED 5000: 1 hour of second-data; 48 hours of minute-data; 90 days of hourly data; 2 years of daily data; 10 years of monthly data - TED Pro Home: 2 hours of second-data; 48 hours of minute-data; 90 days of hourly data; 2 years of daily data; 24 years of monthly data

If yes, what historical range is available? - TED 5000: 1 hour of second-data; 48 hours of minute-data; 90 days of hourly data; 2 years of daily data; 10 years of monthly data - TED Pro Home: 2 hours of second-data; 48 hours of minute-data; 90 days of hourly data; 2 years of daily data; 24 years of monthly data	
If yes, do you have generic sample data file you could send us to look at? - Requested	
Notes:	
Do customers have ability to give third parties access to their data? If so, how is authorization for third party access granted?	
	Written Consent (U.S. Mail)
x	Online
	Phone call
	Other – Describe:
Notes: - 3rd party posting available via Footprints dashboard; 3rd party URL and activation code/password are required.	
Who can deliver data to third party?	
x	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Company directly to third party (via email)
	Self-serve web portal
Notes: - 3rd party posting available via Footprints dashboard; 3rd party URL and activation code/password are required.	
How is data delivered to third party?	
	U.S. Mail
	Email
	Viewable Read-Only Online
	Downloadable
Notes: - Via 3rd party API	

Can the third parties request data from multiple customers at one time?	
	Yes
x	No
Explanation:	
Is your company involved with any pilot, demonstration, or other research projects sponsored by utilities or other entities?	
If yes, what is the purpose? - Not able to disclose	
If yes, who are the stakeholders? - Not able to disclose	
If yes, how many participants? - Not able to disclose	
If yes, what is the status and timing of the project? - Not able to disclose	
If yes, do you have contact info for someone actively involved? - Not able to disclose	
Use the space below to ask additional questions and document answers that fill data gaps in Submeter Landscape Summary table:	

Think Tank Energy Products

Date of Contact: 4/7/14
Company Info:
Name: Think Tank Energy Products
Location: Milton, Vermont
Size Indicator: 2 employees (10-12 total including contractors)
Founding: Founded at Electronic Educational Devices in 1997, purchased by Think Tank Energy Products in 2012
Contact Info:
Name:
Title/Position/Role:
Email:
Phone:
Product Info:
Available Multi-Circuit/ Plug-in Monitor Product Name(s): Web connected products include WattsUp? .Net and Smart Circuit 20. Both products are built on the same platform and have virtually identical capabilities and functionality, however, the .NET product is a plug load monitor and Smart Circuit 20 is hard-wired into the circuit panel.
Product Launch Date: .NET = 2008 and Smart Circuit 20 = 2009
Annual Product Sales: roughly 3,000-5,000
Lifetime Product Sales/Installed Base: Unknown
Who are your target customers?
No real "target" customers but typical customers include universities, utilities, and energy efficiency research organizations. These customers typically use these products for relatively short term monitoring for research/laboratory/field study purposes, not for long term circuit-level monitoring of buildings and homes. Appliance installers and service contractors also use the product to verify equipment performance following installation or during maintenance.

How heavily to focus on the residential sector?	
Residential uses probably account for 30-40% of sales but it is difficult to estimate since sales to utilities are considered "commercial" but utilities may use the products in residential programs.	
What are your distribution channels?	
Universities, utilities, energy efficiency organizations, appliance installers and service contractors, and direct sales through website	
Is professional installation required?	
.NET = No and Smart Circuit 20 = Yes.	
How many circuit or sockets can be measured?	
• .NET = 1 outlet per monitor, number of monitors is unlimited since each monitor has its own MAC address • Smart Circuit 20 = unlimited • Monthly data hosting subscription charge increases with number of monitors/circuits	
Where is data stored?	
x	Data logger memory
x	Local PC – via USB
	Remote In-house Server
x	Remote 3rd Party Server – SQL server
Notes:	
How do customers access their data?	
x	Local PC
x	In-house data service/web interface
	3rd Party data service/web interface
Notes:	
Can data be downloaded, exported, or otherwise saved by users?	
If yes, in what format(s)? • CSV	

If yes, what types of data/metrics are available and at what interval(s)? • Optional down to 1 sec granularity	
If yes, what historical range is available? • Depends on interval selection and number of stored parameters • 120,000 records is possible in stop/overwrite mode, and when only logging watts. • In automatic mode with all parameters recorded the storage is approximately 4000 records	
If yes, do you have generic sample data file you could send us to look at? • Requested	
Notes:	
Do customers have ability to give third parties access to their data? If so, how is authorization for third party access granted?	
	Written Consent (U.S. Mail)
	Online
	Phone call
x	Other – Describe:
Notes:	
Who can deliver data to third party?	
x	Customer Only (i.e., utility provides to customer, customer provides to third-party)
	Sent from Company directly to third party (via email)
x	Self-serve web portal - program administrators only
Notes:	
How is data delivered to third party?	
	U.S. Mail
x	Email – direct from customer
x	Viewable Read-Only Online – for program administrators only
x	Downloadable – via FTP service for program administrators only
Notes:	

Can the third parties request data from multiple customers at one time?	
x	Yes – program administrators only
	No
Explanation:	

Is your company involved with any pilot, demonstration, or other research projects sponsored by utilities or other entities?
If yes, what is the purpose? • Many projects, no specifics available • Primarily university and utility research projects
If yes, who are the stakeholders? • No data available
If yes, how many participants? • No data available
If yes, what is the status and timing of the project? • No data available
If yes, do you have contact info for someone actively involved? • No data available
Use the space below to ask additional questions and document answers that fill data gaps in Submeter Landscape Summary table:
Additional notes: • Smart Circuit 20 is hard-wired to circuit panel (i.e. electricity runs directly through meters and CTs are not used) • Both products are capable of remote on/off control as well as limited logic based control (e.g. based on time-of-day) • Library programs have been successful - Utility providers supply Watts Up? Meters to libraries across their service area. Library patrons can “check-out” a meter to conduct their own audit of households appliance.

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Appendix D: Utility Submeter Interview Response Sheets

The submeter utility interview response sheets began with an introduction to task purposes and objectives so as to provide the interviewee with some context to the project. The following descriptions reflect the background provided to the interviewee. Interview results for each utility follow this description.

Utility Submeter Pilot/Program Information Collection Template

Task Purposes/Objectives:

- Develop an understanding of current and potential future utility submetering programs involving residential customers.
- Identify challenges/barriers to collecting residential customer submeter data as a third party entity.
- Develop an understanding of specific types of data (e.g. kw, kwh, voltage, current, power factor) and format of data (e.g. hardcopy, read-only online, PDF, XML, CSV, XLS, XLSX) available from submetering systems.

Introduction:

Leidos Engineering is working on a project to better understand the current landscape of submetering programs and pilots being implemented by utilities at the residential level. We are working with utilities and submeter companies to learn more about these programs such as the technology used and the types of data being collected. You were selected because of your company's participation in a program or pilot that utilizes submeter technology. To help us understand your program, we would appreciate your answers to a short list of questions we have today:

Boulder Community Power Partnership

Utility Name and Contact: Boulder Community Power Partnership (Pecan Street)

Date of Contact: No interview conducted. Information obtained online.

Name of submeter program or pilot and location

The Community Power Partnership is a pilot program in Boulder, Colorado to track energy use in 50 homes in two neighborhoods and 25 businesses, as well as at Boulder High School. The program is administered by the Pecan Street Research Institute.

What are the overall goals of this submeter program?

The purpose of this research pilot project is twofold: to understand how electricity and water is being used in Boulder residences; and to understand what tools and information homeowners and renters need to better manage their resource use and contribute to innovative community solutions. What Boulder officials learn from the energy monitoring could shape the programs and services offered by a future city-run electric utility.

Other project goals include:

- Begin to build an anonymous, aggregated database of circuit-level energy usage data for residential, small business and institutional customers in Boulder
- Test the ability of the City to bypass Xcel Energy to access anonymized energy usage data
- Work with Pecan Street's other US research communities to begin to understand the usefulness of circuit-level energy and water usage data for the purposes of:
  - Community Climate Action Planning
  - Designing communitywide energy products and services
  - Measuring the effectiveness of energy products and services
  - Increasing energy literacy in the community
  - Promoting behavior change in terms of energy usage and investment in energy products and
  - services
  - Engaging youth in the community's climate action efforts
- Identify the most useful format to customers for the delivery of energy and water usage data

What is the overall timeframe for the program/project from beginning to end?

The initial program will run for two years beginning in 2014, but the monitors could stay on the homes for longer if residents and the city find the information useful.

How many residential customers are involved in the program?

50 homes

What end uses are being researched through the program?

X	Individual circuits

	Individual appliances
	HVAC
	Water Heating
	Lighting
	Washer/Dryer
	Plug-in Electric Vehicles (PEV)
	Computer/Entertainment systems
	Other
Notes: Generally monitors have been installed on individual circuits, however, some homes have major appliances and some small appliances (coffee makers, etc.) monitored.	
What technology is being used?	
X	Clamp on CTs
	Separate submeters downstream of main meter
	Plug Load Monitor (plugs into wall, appliance plugs into it)
	Other
Who is the manufacturer of the submeter technology used?	
The submeters, which will be placed on the circuit box, are made by a Boulder-based company, eGauge. eGauge provides up to 12 circuit level monitoring devices per premise, and a flexible, secure, web-based interface for viewing energy usage. The electric energy information is retrieved in one-minute intervals and is able to provide real time, appliance or equipment level data to the users.	
Will homehowners use data management and analysis software or web platform in conjunction with the submeter hardware?	
Customers have access to an online or mobile app energy monitoring portal which allows them to: • Access real-time information about how much electricity and water is being used in the home; • Monitor resource use and how it impacts monthly bills; • Receive practical tips for reducing use, costs and environmental impact; and • Measure efficiency and conservation measures, such as changes in lifestyle or routine, and new appliances or devices, and other upgrades. eGauge provides the web-based interface for viewing energy usage.	

What type of data is being collected?	
	kW
X	kWh
	Voltage
	kVar
	Other
Notes:	
At what interval are the above data points being measured?	
The eGauge submeters provide real time data in one minute intervals at the level of individual circuits.	
At what interval are the above data points being stored?	
Unknown at this time.	
What communication system is being used? **Describe what equipment is installed in the house to move data from the house to the utility/program administrator**	
	BACnet
	LonWorks
	ModBus
	Zigbee
	Wireless communication (Wi-Fi)
	On-site recording devices (logger) with or without storage
	Others
Notes: Unknown at this time.	
Where is the data housed at the utility/program administrator?	
Unknown	
Who owns the data being collected?	

	Customer
	Utility/Company
	Both
Notes:	
Is there a process in place for customers to obtain the data?	
Is there a process in place for third parties to obtain the data?	
At what interval are data provided to customers/third parties (if applicable)?	
Name and contact information of the person or office with utility who is knowledgeable with this data	
Name of Office or Division:	
Name of Contact Person:	
Phone Number:	
Email:	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	
Sources	

- Pecan Street Research Institute: http://www.pecanstreet.org/2014/01/boulder-to-track-energy-use-in-50-homes-25-businesses-over-next-2-years/
- City of Boulder: https://bouldercolorado.gov/community-power
- City of Boulder, City Council Session: https://www-static.bouldercolorado.gov/docs/July_30_FINAL_Study_Session_Packet-1-201307240919.pdf
- eGauge Configuration Guide: http://www.egauge.net/docs/config-guide.pdf

California Public Utilities Commission

Utility Name and Contact: California Public Utilities Commission (CPUC)
Date of Contact: No interview conducted. Information obtained online.
Name of submeter program or pilot and location
Pilot Program under the Plug-in Electric Vehicle (PEV) Submetering Protocol (CPUC Decision 13-11-002 November 14, 2013)
What are the overall goals of this submeter program?
The California Public Utilities Commission (CPUC) released a proposed decision on October 1, 2013 to require utilities and electric vehicle (EV) service providers to carry out two pilot projects for the installation and maintenance of electricity submeters for EV charging units at residences. The first phase will test "single customer of record submetering using a utility-grade submeter," according to the proposal. Single customer of record submetering is intended to be tested within three types of customers -- single family homes, multi-dwelling units and commercial facilities. The Phase 2 pilot will test "multiple customers of record using a utility grade submeter," the plan says. Multiple customers of record submetering is intended to be tested within two types of customers -- multi-dwelling units and commercial facilities. The projects will be carried out primarily by California's three major electric investor-owned utilities -- Pacific Gas & Electric Co., Southern California Edison and San Diego Gas & Electric Co. -- and companies that install and service EV charging equipment. The primary goals of the project are to: • Evaluate customer demand under different submetering scenarios • Evaluate billing integration and communication costs under different submetering scenarios • Evaluate the customer experience to determine customer benefits under submetering • Evaluate the potential impacts submetering can have on supporting the state's zero-emission vehicle (ZEV) goals
What is the overall timeframe for the program/project from beginning to end?

The first phase pilot program was set to begin in March 2014 and continue for about one year. The second phase of the pilot should start no later than December 1, 2014. The proposal also requires the utilities to submit a final submetering protocol by August 31, 2015.	
How many residential customers are involved in the program?	
The pilot program is open to any commercial or residential customer but is capped at 500 participants per utility (referring to the three large California IOUs).	
What end uses are being researched through the program?	
	Individual circuits
	Individual appliances
	HVAC
	Water Heating
	Lighting
	Washer/Dryer
X	Plug-in Electric Vehicles (PEV)
	Computer/Entertainment systems
	Other:
Notes: The pilot program is specific to submetering of PEV load	
What technology is being used?	
	Clamp on CTs
	Separate submeters downstream of main meter
	Plug Load Monitor (plugs into wall, appliance plugs into it)
X	Other: Technology for the pilot is still being determined.
Who is the manufacturer of the submeter technology used?	

The pilots will test submeters in various physical locations including stand-alone customer-owned submeters or in Electric Vehicle Supply Equipment (EVSE). The technology is still being determined, however, the decision states that "submeters used within the pilot must meet the meter data accuracy and communications standards that are developed as part of this pilot program".	
Will homehowners use data management and analysis software or web platform in conjunction with the submeter hardware?	
If yes, who is the developer?	
What type of data is being collected?	
	kW
	kWh
	Voltage
	kVar
	Other
Notes: Unknown, however, the main focus is on metering electric vehicle load.	
At what interval are the above data points being measured?	
The CPUC is currently investigating standards for metering products, including accuracy and intervals, as well as standards for validating editing, and estimating interval data.	
At what interval are the above data points being stored?	
Not yet determined.	
What communication system is being used? **Describe what equipment is installed in the house to move data from the house to the utility/program administrator**	
	BACnet
	LonWorks
	ModBus
	Zigbee

	Wireless communication (Wi-Fi)
	On-site recording devices (logger) with or without storage
	Others

Notes:
The CPUC is currently investigating a standard way to communicate submetering data from the Submeter Submeter Meter Data Management Agent (Submeter MDMA) to the utility.

Where is the data housed at the utility/program administrator?

To be determined.

Who owns the data being collected?

	Customer
	Utility/Company
	Both

Notes:
This is still being determined.

Is there a process in place for customers to obtain the data?

The CPUC is still reviewing Customer Data Accessibility issues.

Is there a process in place for third parties to obtain the data?

Unknown at this time.

At what interval are data provided to customers/third parties (if applicable)?

Name and contact information of the person or office with utility who is knowledgeable with this data

Name of Office or Division:

Name of Contact Person:

Phone Number:

Email:
Anecdotal description of process (may be standardized if enough similarity):
How long does the process take from first contact to delivered data: NOTE - All information obtained online
How many calls/emails were made: NOTE - All information obtained online
How many different people were involved: NOTE - All information obtained online
Sources
• http://insideepa.com/Inside-Cal/EPA/Inside-Cal/EPA-10/18/2013/cpuc-sets-plan-for-utility-submeters-considered-vital-to-ev-success/menu-id-1097.html • http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M081/K786/81786001.PDF

Duke Energy

Utility Name: Duke Energy	
Date of Contact: 4/14/2014	
Name of submeter program or pilot and location	
Duke Energy Residential Energy Research Project, Charlotte, NC	
What are the overall goals of this submeter program?	
The goal of this project is to understand how residential customers use energy in their homes, to help Duke Energy develop optimization algorithms and strategies for their electric distribution grid operations.	
How many residential customers are involved in the program?	
61 customers, all served by one substation in Duke Energy's smart grid test area.	
What end uses are being researched through the program?	
	Individual units of larger multi-unit building
	Discreet spaces within a single home
X	Individual circuits – 24 circuits in total
	Individual appliances
	Other
Notes:	
What technology is being used?	

X	Clamp on CTs
	Separate submeters downstream of main meter
	Other
Notes: They are using the SiteSage solution from Power House Dynamics.	
What type of data is being collected?	
X	kW
X	kWh
X	Voltage
	kVar
X	Other - Energy costs (calculated using the utility rates)
Notes: They are also collecting socioeconomic and weather data to be analyzed with the energy data	
What data points are being collected and at what interval?	
kW, kWh, $ by circuit; voltage for the whole house. Data is being collected at 1 minute intervals. The project is scheduled to collect information for the 2014-2015 calendar years.	
What communication system is being used?	
	BACnet
	LonWorks (Homplug PLC)
	ModBus
	TCP/IP
X	Wireless communication (Wi-Fi)
	On-site recording devices (logger)
Notes: The SiteSage system uses wireless technology through the house to the customer's cable modem or router. The information is then sent back using the customer's broadband service.	
If a utility, is the submeter data incorporated into your MDMS?	

	Yes
X	No

Notes:
The data is being collected in SiteSage's host system, then periodically downloaded to a analytics platform residing in the Duke Energy Data Center.

Name and contact information of the person or office with utility who is knowledgeable with this data (if available)

Name of Office or Division: Emerging Technologies

Name of Contact Person:

Phone Number:

Email:

Anecdotal description of process (may be standardized if enough similarity):

How long does the process take from first contact to delivered data:

How many calls/emails were made:

How many different people were involved:

Pecan Street Energy

Utility Name: Pecan Street Energy	
Date of Contact: 3/26/2014	
Name of submeter program or pilot and location	
Pecan Street Energy - A non-profit research consortium. Pecan Street has over 700 circuit panel installations. The majority of these are in Austin; however, they will be installing these in Boulder CO, and San Diego as well.	
What are the overall goals of this submeter program?	
To provide installation, operations, technical support and data for research and analysis by its members and academic institutions.	
How many residential customers are involved in the program?	
700+; They have already collected 60 billion records worth of data.	
Notes: Most of them today are located in Austin. However, they are developing relationships with other utilities and organizations across the United States, when additional units will be installed.	
What end uses are being researched through the program?	
	Individual units of larger multi-unit building
	Discreet spaces within a single home
X	Individual circuits
	Individual appliances
	Other
Notes:	

What technology is being used?	
X	Clamp on CTs
	Separate submeters downstream of main meter
	Other
Notes: They are using the eGauge technology.	
What type of data is being collected?	
X	kW
X	kWh
X	Voltage
	kVar
X	Other - Energy costs (calculated using the utility rates)
Notes: They are also collecting meta data (social media, socioeconomic, etc) to analyze with the usage data.	
What data points are being collected and at what interval?	
kW, kWh, $ by circuit; voltage for the whole house. Data is being collected at 1 minute intervals.	
What communication system is being used?	
	BACnet
X	LonWorks (Homplug PLC)
	ModBus
	TCP/IP
	Wireless communication (Wi-Fi)
	On-site recording devices (logger)

Notes: They powerline carrier through the house to the customer's cable modem or router. The information is then sent back using the customer's broadband service.	
If a utility, is the submeter data incorporated into your MDMS?	
	Yes
X	No
Notes: They have their own Hadoop/Apache server at their headquarters.	
Name and contact information of the person or office with utility who is knowledgeable with this data (if available)	
Name of Office or Division: Market Research	
Name of Contact Person:	
Phone Number:	
Email:	
Anecdotal description of process (may be standardized if enough similarity):	
How long does the process take from first contact to delivered data:	
How many calls/emails were made:	
How many different people were involved:	
Additional Comments	

1. Pecan Street was initial funding through an ARRA grant from the DOE.
2. Their mission is to collect data for others to use for analysis
3. They are looking to expand their presence throughout the United States
4. They have the technology, implementation and operations experience to run these pilots on behalf of utilities or other organizations like the EIA.
5. Pecan Street would be glad to speak to the EIA if they have any additional questions about their company or projects.
6. They allow access to their data through their WikiEnergy portal for academic institutions looking to develop models and algorithms. For others, they are willing to discuss setting up a license relationship.

San Diego Gas & Electric "Smart Energy Community" in Civita, California

Utility Name: San Diego Gas & Electric (SDG&E) "Smart Energy Community" in Civita	
Date of Contact: No interview conducted. Information obtained online.	
Name of submeter program or pilot and location	
Civita Smart Energy Community Project. The project is a smart grid demonstration project in San Diego, CA resulting from collaboration between Pecan Street Inc., San Diego Gas and Electric, and Sudberry Properties LLC.	
What are the overall goals of this submeter program?	
The project will help SDG&E to develop an understanding of how customers use electricity at the circuit level with hopes to identify ways to help tailor future utility programs related to home area networks, energy efficiency and demand response. This new knowledge could also allow SDG&E to recommend specific measures customers can take to both reduce usage and cost. The research is supported by the Pecan Street Research Institute.	
What is the overall timeframe for the program/project from beginning to end?	
The research launched in August 2013 and will last for "several months", and potentially longer.	
How many residential customers are involved in the program?	
Approximately 30-50 SDG&E customers living in the Civita master-planned development in Mission Valley. Each participant will have "Home Systems Deployment" equipment installed at their home which includes energy monitors and a data router.	
What end uses are being researched through the program?	
X	Individual circuits
	Individual appliances
	HVAC
	Water Heating
	Lighting

	Washer/Dryer
	Plug-in Electric Vehicles (PEV)
	Computer/Entertainment systems
	Other
Notes:	
What technology is being used?	
	Clamp on CTs
	Separate submeters downstream of main meter
	Plug Load Monitor (plugs into wall, appliance plugs into it)
X	Other:
Who is the manufacturer of the submeter technology used?	
Pecan Street and its agents will install home energy data router equipment at homes. The equipment will be provided by Pecan Street through an agreement between Pecan Street and an equipment provider selected by Pecan Street. The manufacturer of the equipment is not known at this time.	
Will homehowners use data management and analysis software or web platform in conjunction with the submeter hardware?	
Pecan Street will provide volunteer participants with a free website and mobile application that provides real-time information on the customer's electricity use down to the appliance and circuit level as well as information on appliance, rooftop solar panel and home energy performance. The service is powered by an "energy data router" installed at the customer's circuit panel.	
What type of data is being collected?	
	kW
X	kWh
	Voltage
	kVar
	Other

Notes:	
At what interval are the above data points being measured?	
Unknown	
At what interval are the above data points being stored?	
Unknown	
What communication system is being used? **Describe what equipment is installed in the house to move data from the house to the utility/program administrator**	
	BACnet
	LonWorks
	ModBus
	Zigbee
	Wireless communication (Wi-Fi)
	On-site recording devices (logger) with or without storage
	Others
Notes: "Home Systems Deployment" involves the installation of an energy data router in the home. The specific communication platform is not known at this time.	
Where is the data housed at the utility/program administrator?	
Pecan Street stores the Home Systems Deployment Data on "internal computer systems".	
Who owns the data being collected?	
	Customer
	Utility/Company
X	Both

Notes: "Joint ownership of Resident's legal interest to the data that Pecan Street collects from Resident's home, including Home Systems Deployment Data and data from any systems that are the subject of any addenda to this Agreement. Pecan Street may exercise its legal interest in the data without additional approval from Resident subject to the terms of this Agreement, including executing a license with third parties for commercial and/or research use of the data, provided that the data in no way identifies any individual Resident's identity or the address of Resident's home." http://www.pecanstreet.org/projects/smart-grid-demonstration/san-diego-civita-enrollment/ Pecan Street will treat Resident's home Systems Deployment Data as Confidential Information and will provide participants with free home energy reporting services available over a password-protected website.
Is there a process in place for customers to obtain the data?
Pecan Street will provide volunteer participants with a free website and mobile application that provides real-time information on the customer's electricity use down to the appliance and circuit level as well as information on appliance, rooftop solar panel and home energy performance. The service is powered by an "energy data router" installed at the customer's circuit panel.
Is there a process in place for third parties to obtain the data?
"Pecan Street may include Home Systems Deployment Data as part of required reporting to Department of Energy, in academic papers and in presentations so long as the Home Systems Deployment Data so included in no way identifies any individual Resident's identity or the address of Resident's home, or as part of any other disclosures required by law." http://www.pecanstreet.org/projects/smart-grid-demonstration/san-diego-civita-enrollment/
At what interval are data provided to customers/third parties (if applicable)?
Unknown
Name and contact information of the person or office with utility who is knowledgeable with this data
Name of Office or Division: SDG&E Communications or Pecan Street
Name of Contact Person:
Phone Number:
Email:
Anecdotal description of process (may be standardized if enough similarity):

How long does the process take from first contact to delivered data: All data specific to SDG&E Smart Energy Community obtained through internet research, see sources below.
How many calls/emails were made: See data collection template for Pecan Street
How many different people were involved: See data collection template for Pecan Street
Sources
• http://www.pecanstreet.org/2013/08/sdge-research-study-to-dig-down-to-circuit-level-usage/ • http://www.civitalife.com/2012/09/sdge-smart-energy-community/ • http://www.sdbj.com/news/2012/sep/25/sdge-sudberry-announce-smart-energy-plans-civita/ • http://www.pecanstreet.org/projects/smart-grid-demonstration/san-diego-civita-enrollment/

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Appendix E: Residential AMI Data Summary

Data from the Energy Information Administration (EIA) Form EIA-861, Annual Electric Power Industry Report, for the year 2012 (latest year available) was used to identify utilities with AMI meters installed for residential customers. The following tables provide an overview of residential AMI data in 2012 from the EIA-861 data sets.

EIA-861 2012 AMI SUMMARY
535 Utilities with residential AMI
40.1 million residential AMI meters reported
72 IOUs account for 77% of AMI meters

Residential AMI by Utility Ownership Type			
Ownership Type	**Count of Ownership Type with AMI**	**Sum of Residential AMI Meters by Ownership Type**	**Percent Share**
Investor Owned	72	30,900,724	77%
Cooperative	342	5,968,832	15%
Political Subdivision	18	1,521,395	4%
Municipal	98	1,708,451	4%
State	4	34,455	0%
Transmission	1	207	0%
Total	**535**	**40,134,064**	**100%**

Residential AMI by NERC Region			
NERC Region	**Count of Utitlies in NERC Region with AMI**	**Count of AMI Meters by NERC Region**	**Percent Share**
WECC	102	13,851,879	35%
SERC	135	7,012,457	17%
TRE	30	6,336,501	16%
RFC	91	4,973,366	12%
FRCC	12	4,422,250	11%
SPP	54	1,310,999	3%
NPCC	28	1,277,930	3%
MRO	80	945,259	2%
AK	3	3,423	0%
Grand Total	**535**	**40,134,064**	**100%**

Residential AMI by State		
State	**Count of Utilities with AMI**	**Count of AMI by State**
CA	10	9,469,164
TX	34	5,985,403
FL	15	4,488,941
GA	19	3,064,021
PA	18	1,669,959
AZ	10	1,593,254
AL	12	1,423,989
NV	4	919,971
OR	16	899,934
MI	9	872,991
OK	16	822,013
OH	14	689,883
NC	22	657,055
ME	2	654,512
MD	2	468,664
WI	12	463,455
ID	8	456,913
TN	15	450,089
VA	10	353,586
KY	11	333,335
VT	5	294,918
MO	20	284,225
IL	12	282,479
IN	24	278,470
DE	2	265,217
AR	6	252,629
MS	8	250,299
SC	12	233,838
DC	1	230,705
CO	17	210,701
LA	6	191,091
KS	16	159,897
NH	2	132,415
CT	6	125,932
IA	28	125,602
MN	18	114,104
SD	14	108,734
NE	16	77,075
WA	10	76,076
NM	9	71,512
ND	4	66,855
WY	7	66,150
MA	7	51,256
NY	8	20,025
UT	7	19,977
MT	5	15,174
NJ	1	11,454
AK	3	3,423
WV	1	81

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Appendix F: AMI and Submeter Sample Data Screenshots

This appendix provides screenshots of sample data from AMI utilities and submeter technology companies. The purpose of this sample data is to provide EIA with examples of the various AMI and submeter data currently collected by utilities and technology companies. AMI data came from online customer data platforms while submeter data were provided by the technology companies themselves.

Sample AMI data comes from the following utilities:

- Austin Energy
- Oncor
- Pepco
- San Diego Gas and Electric

The following submeter technology companies provided sample data:

- eGauge Systems, LLC
- PowerWise Systems
- Energy, Inc. (The Energy Detective)
- Think Tank Energy Products

AMI Utility Sample Data

Austin Energy

	A	B
1	**Date**	**Daily Energy usage ($)**
2	19-Mar	$1.28
3	20-Mar	$1.49
4	21-Mar	$1.36
5	22-Mar	$1.51
6	23-Mar	$1.60

Figure 1. Austin Energy sample daily AMI cost data in Excel format.

Oncor

	A	B	C	D	E	F	G
1	ESIID	USAGE_DATE	USAGE_START_TIME	USAGE_END_TIME	USAGE_KWH	ESTIMATED_ACTUAL	CONSUMPTION_GENERATION
2	1.04437E+16	1/1/2014	00:00	00:15	0.091	A	Consumption
3	1.04437E+16	1/1/2014	00:15	00:30	0.094	A	Consumption
4	1.04437E+16	1/1/2014	00:30	00:45	0.09	A	Consumption
5	1.04437E+16	1/1/2014	00:45	01:00	0.346	A	Consumption
6	1.04437E+16	1/1/2014	01:00	01:15	0.626	A	Consumption
7	1.04437E+16	1/1/2014	01:15	01:30	0.629	A	Consumption
8	1.04437E+16	1/1/2014	01:30	01:45	0.757	A	Consumption
9	1.04437E+16	1/1/2014	01:45	02:00	1.048	A	Consumption
10	1.04437E+16	1/1/2014	02:00	02:15	1.096	A	Consumption
11	1.04437E+16	1/1/2014	02:15	02:30	1.079	A	Consumption
12	1.04437E+16	1/1/2014	02:30	02:45	1.072	A	Consumption
13	1.04437E+16	1/1/2014	02:45	03:00	1.076	A	Consumption
14	1.04437E+16	1/1/2014	03:00	03:15	1.072	A	Consumption
15	1.04437E+16	1/1/2014	03:15	03:30	1.073	A	Consumption
16	1.04437E+16	1/1/2014	03:30	03:45	1.07	A	Consumption
17	1.04437E+16	1/1/2014	03:45	04:00	1.072	A	Consumption
18	1.04437E+16	1/1/2014	04:00	04:15	1.075	A	Consumption
19	1.04437E+16	1/1/2014	04:15	04:30	1.069	A	Consumption
20	1.04437E+16	1/1/2014	04:30	04:45	1.076	A	Consumption
21	1.04437E+16	1/1/2014	04:45	05:00	1.068	A	Consumption
22	1.04437E+16	1/1/2014	05:00	05:15	1.148	A	Consumption
23	1.04437E+16	1/1/2014	05:15	05:30	1.093	A	Consumption
24	1.04437E+16	1/1/2014	05:30	05:45	1.098	A	Consumption
25	1.04437E+16	1/1/2014	05:45	06:00	1.066	A	Consumption
26	1.04437E+16	1/1/2014	06:00	06:15	1.064	A	Consumption
27	1.04437E+16	1/1/2014	06:15	06:30	0.836	A	Consumption
28	1.04437E+16	1/1/2014	06:30	06:45	0.636	A	Consumption
29	1.04437E+16	1/1/2014	06:45	07:00	0.433	A	Consumption

Figure 2. Oncor sample 15-minute AMI data in CSV format.

Pepco

Q18

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Name													
2	Address													
3	Account Number													
4	Disclaimer	The information contained in this file is intended for the personal and confidential use of the recipient(s) named above. Any unauthorized use is prohibited.												
5	Title	CSV Export Electric Meter(s)												
6	Resource	Electric												
7	Meter Number													
8	Interval UOM	Minute(s)												
9	Readings Start	3/28/2014 0:00												
10	Readings End	5/26/2014 23:00												
11	Total Duration	86400 Minute(s)												
12	Total Usage	774.0536												
13	UOM	kWh												
14	Multiplier	1												
15	Meter Number	Date	Start Time	Duration	Value	Edit Code	Flow Direction							
16	[redacted]	3/28/2014	12:00 AM	60	0.243	Direct								
17		3/28/2014	1:00 AM	60	0.2445	Direct								
18		3/28/2014	2:00 AM	60	0.2715	Direct								
19		3/28/2014	3:00 AM	60	0.369	Direct								
20		3/28/2014	4:00 AM	60	0.3	Direct								
21		3/28/2014	5:00 AM	60	0.246	Direct								
22		3/28/2014	6:00 AM	60	0.471	Direct								
23		3/28/2014	7:00 AM	60	0.51	Direct								
24		3/28/2014	8:00 AM	60	0.9645	Direct								
25		3/28/2014	9:00 AM	60	0.78	Direct								
26		3/28/2014	10:00 AM	60	0.642	Direct								
27		3/28/2014	11:00 AM	60	0.6435	Direct								
28		3/28/2014	12:00 PM	60	0.7305	Direct								
29		3/28/2014	1:00 PM	60	0.7365	Direct								
30		3/28/2014	2:00 PM	60	0.6075	Direct								
31		3/28/2014	3:00 PM	60	0.8055	Direct								
32		3/28/2014	4:00 PM	60	0.8325	Direct								

PEPCO_Electric_60_Minute_03-28-

Figure 3. Pepco sample hourly AMI data in CSV format.

San Diego Gas and Electric

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Name													
2	Address													
3	Account Number													
4	Disclaimer	The information contained in this file is intended for the personal and confidential use of the recipient(s) named above. Any unauthorized use is prohibited.												
5	Title	CSV Export Electric Meter(s)												
6	Resource	Electric												
7	Meter Number													
8	Interval UOM	Minute(s)												
9	Readings Start	8/1/2013 0:00												
10	Readings End	3/31/2014 23:00												
11	Total Duration	349920 Minute(s)												
12	Total Usage	3492.25												
13	UOM	kWh												
14	Multiplier	1												
15	Meter Number	Date	Start Time	Duration	Value	Edit Code	Flow Direction							
16	[redacted]	8/1/2013	12:00 AM	60	0.37	Direct								
17		8/1/2013	1:00 AM	60	0.27	Direct								
18		8/1/2013	2:00 AM	60	0.27	Direct								
19		8/1/2013	3:00 AM	60	0.295	Direct								
20		8/1/2013	4:00 AM	60	0.275	Direct								
21		8/1/2013	5:00 AM	60	0.275	Direct								
22		8/1/2013	6:00 AM	60	0.415	Direct								
23		8/1/2013	7:00 AM	60	0.545	Direct								
24		8/1/2013	8:00 AM	60	0.41	Direct								
25		8/1/2013	9:00 AM	60	0.42	Direct								
26		8/1/2013	10:00 AM	60	0.395	Direct								
27		8/1/2013	11:00 AM	60	0.655	Direct								
28		8/1/2013	12:00 PM	60	0.535	Direct								

Figure 3. SDG&E sample hourly AMI data in CSV format.

Submeter Sample Data

eGauge Systems, LLC

	A	B	C	D	E	F	G	H	I	J	K
1	Date & Time	use [kW]	gen [kW]	Solar 1 [kW]	Solar 2 [kW]	Net.Usage [kW]	Net.Generation [kW]	Grid [kW]	Grid* [kVA]	Solar [kW]	Solar+ [kW]
2	4/2/2014 12:00	0.139425	0.461129	0.225591944	0.235536944	-0.321703889	0	-0.321704	0.597069722	0.4611289	0.46112889
3	4/2/2014 11:00	1.183528	0.423239	0.206024722	0.217213889	0.760289722	0	0.76029	1.3298025	0.4232386	0.42323861
4	4/2/2014 10:00	2.710201	0.228593	0.104196944	0.124396111	2.481607222	0	2.481607	2.871193056	0.2285933	0.22859333
5	4/2/2014 9:00	1.199633	0.017443	-0.00526528	0.022708611	1.172117778	0	1.172118	1.312603333	0.0174433	0.02751472
6	4/2/2014 8:00	0.078832	-0.01219	-0.00718194	-0.005009722	0.078831944	0	0.078832	0.147291111	-0.0121917	0
7	4/2/2014 7:00	0.09473	-0.00907	-0.00405056	-0.005019444	0.094729722	0	0.09473	0.145626389	-0.00907	0
8	4/2/2014 6:00	0.114786	-0.00914	-0.00408611	-0.00505	0.114786389	0	0.114786	0.163579444	-0.0091361	0
9	4/2/2014 5:00	0.072104	-0.00916	-0.00388917	-0.005271389	0.072104167	0	0.072104	0.126281667	-0.0091606	0
10	4/2/2014 4:00	0.103165	-0.00923	-0.00415583	-0.005069167	0.103165278	0	0.103165	0.153546389	-0.009225	0
11	4/2/2014 3:00	0.118781	-0.00923	-0.00401083	-0.0052225	0.118780833	0	0.118781	0.167089722	-0.0092333	0
12	4/2/2014 2:00	1.470842	-0.00982	-0.00375611	-0.006065556	1.470842222	0	1.470842	1.525738611	-0.0098217	0
13	4/2/2014 1:00	0.941201	-0.00981	-0.00424306	-0.005571111	0.941201389	0	0.941201	1.017936944	-0.0098142	0
14	4/2/2014 0:00	0.623533	-0.00978	-0.00429194	-0.005483056	0.6235325	0	0.623533	0.695067222	-0.009775	0
15	4/1/2014 23:00	0.280223	-0.00966	-0.00434139	-0.005323333	0.280223333	0	0.280223	0.351108889	-0.0096647	0
16	4/1/2014 22:00	0.299496	-0.01006	-0.00441111	-0.005651389	0.299496389	0	0.299496	0.366912778	-0.0100625	0
17	4/1/2014 21:00	0.761268	-0.01427	-0.01060083	-0.003672778	0.760560278	0	0.76056	0.8571	-0.0142736	0.0007075
18	4/1/2014 20:00	0.227309	0.204025	0.080976667	0.123048333	0.023284167	0	0.023284	0.500464444	0.2040247	0.20402528

Figure 4. Sample data collected from the eGauge circuit-level monitor. Note that this is the first of two sample data screenshots.

	A	L	M	N	O	P	Q	R	S
1	Date & Time	H2O Heater	Drier [kW]	Range Stove [kW]	Solar XANTREX [kW]	Solar PVP [kW]	Grid Power Factor []	CT1 AMPS [A]	CT2 AMPS [A]
2	4/2/2014 12:00	-1.667E-05	-0.0000275	0.000036667	0.235536944	0.225591944	568.9275	2.222401944	2.828047778
3	4/2/2014 11:00	0.00002	-1.722E-05	0.000066667	0.217213889	0.206024722	518.7505556	7.194512778	4.190650278
4	4/2/2014 10:00	-2.778E-06	-1.278E-05	0.000058333	0.124396111	0.104196944	462.5411111	12.94762778	12.10710556
5	4/2/2014 9:00	3.611E-06	-5.56E-07	0.000039722	0.022708611	-0.005265278	819.3494444	7.796518056	3.527401667
6	4/2/2014 8:00	-1.972E-05	-1.111E-06	0.000041944	-0.005009722	-0.007181944	533.6327778	0.768958056	0.486029167
7	4/2/2014 7:00	-2.222E-05	-0.0000025	0.000041944	-0.005019444	-0.004050556	596.7186111	0.8295575	0.401655278
8	4/2/2014 6:00	-3.111E-05	-0.0000025	0.000042778	-0.00505	-0.004086111	644.3716667	0.970263056	0.401904444
9	4/2/2014 5:00	-0.0000325	-2.222E-06	0.000043056	-0.005271389	-0.003889167	539.1944444	0.657626111	0.401799444
10	4/2/2014 4:00	-3.889E-05	-1.944E-06	0.000046667	-0.005069167	-0.004155833	615.0188889	0.887096111	0.400616389
11	4/2/2014 3:00	-3.917E-05	-1.667E-06	0.0000475	-0.0052225	-0.004010833	658.2597222	0.997024444	0.402447222
12	4/2/2014 2:00	-4.556E-05	-1.667E-06	0.0000475	-0.006065556	-0.003756111	604.9988889	6.851495	6.345257778
13	4/2/2014 1:00	-4.972E-05	-1.111E-06	0.00005	-0.005571111	-0.004243056	733.7752778	5.182485	3.59106
14	4/2/2014 0:00	-4.778E-05	-5.56E-07	0.000049167	-0.005483056	-0.004291944	807.2663889	3.585546667	2.338706944
15	4/1/2014 23:00	-0.000045	1.667E-06	0.000053889	-0.005323333	-0.004341389	794.8741667	1.836356111	1.140786944
16	4/1/2014 22:00	-5.139E-05	1.944E-06	0.000059167	-0.005651389	-0.004411111	781.5841667	2.506418889	0.618514722
17	4/1/2014 21:00	-5.083E-05	3.889E-06	0.000055833	-0.003672778	-0.010600833	755.9230556	4.094850833	3.364958056
18	4/1/2014 20:00	-8.361E-05	-3.333E-06	0.000081111	0.123048333	0.080976667	207.5763889	2.0864675	2.152682222

Figure 5. Sample data collected from the eGauge circuit-level monitor. Note that this is a continuation of the data from the first screenshot.

PowerWise Systems

	A	B	C	D	E	F
1			Minute Level SiteSage Data			
2						
3	Column name is Energy Monitor Serial Number/Energy Monitor Channel Number-Circuit Name					
4	Channel Columns contain average power usage(production) in watts for minute					
5	Voltage is average voltage for minute					
6						
7	Date/Time	12044/CH1-Inactive	12044/CH2-Main Power	12044/CH3-Main Power	12044/CH4-Kitchen GFI Right Side	12044/CH5-Refrigerator
8	active	12044/CH37-Inactive	12044/CH38-Inactive	12044/CH39-Inactive	12044/CH40-Inactive	12044/CH41-Inactive
9	12056/CH38-Inactive	12056/CH39-Inactive	12056/CH40-Inactive	12056/CH41-Inactive	12056/CH42-Inactive	12056/CH43-Inactive
10	3/20/2014 0:00	41	174	309	0	77
11	3/20/2014 0:01	41	172	309	0	77
12	3/20/2014 0:02	41	175	310	0	77
13	3/20/2014 0:03	41	174	311	0	78
14	3/20/2014 0:04	41	175	311	0	78
15	3/20/2014 0:05	41	175	311	0	78
16	3/20/2014 0:06	41	175	311	0	78
17	3/20/2014 0:07	41	175	311	0	78
18	3/20/2014 0:08	41	175	311	0	78
19	3/20/2014 0:09	41	175	311	0	78
20	3/20/2014 0:10	41	175	311	0	78
21	3/20/2014 0:11	41	175	311	0	78
22	3/20/2014 0:12	41	174	311	0	77
23	3/20/2014 0:13	41	176	310	0	76
24	3/20/2014 0:14	41	175	309	0	75
25	3/20/2014 0:15	41	175	308	0	74
26	3/20/2014 0:16	41	175	308	0	74
27	3/20/2014 0:17	39	176	295	0	61
28	3/20/2014 0:18	32	178	239	0	6
29	3/20/2014 0:19	31	177	236	0	3
30	3/20/2014 0:20	31	177	236	0	3
31	3/20/2014 0:21	31	177	236	0	3
32	3/20/2014 0:22	31	177	236	0	3

Figure 6. Sample raw 1-minute submeter data from PowerWise Systems' SiteSage circuit-level monitor.

	A	B	C	D	E	F	G	H
1	Electricity Usage by Load							
2								
3			from	3/1/2014	to:	3/26/2014	total days	26
4								
5	report generated 2014-03-27 10:43:00							
6								
7	Name		kWh	Cost	kWh/Day	Cost/Day		
8	Kids Room		113	15.91	4.3	0.61		
9	Family Room and Hall		46	6.48	1.8	0.25		
10	Stove		32	4.45	1.2	0.17		
11	Kitchen GFI Right Side		30	4.28	1.2	0.16		
12	Refrigerator		28	3.98	1.1	0.15		
13	Routers/Network		22	3.15	0.9	0.12		
14	Dryer		22	3.13	0.9	0.12		
15	Garage Sub-Panel Outside Lights		21	2.95	0.8	0.11		
16	Utility Room		21	2.94	0.8	0.11		
17	Kitchen GFI Left Side		21	2.91	0.8	0.11		
18	Master Bedroom and Hall		14	2.04	0.6	0.08		

Figure 7. Sample processed submeter data from PowerWise Systems' energy management platform for the SiteSage circuit-level monitor.

Energy, Inc. (The Energy Detective)

	B	C	D	E	F	G	H	I	J
1	Time	Power	Cost	Voltage	PF	Apparent Power	Reactive Power	Amps Average	
2	7/2/2013 15:23	14.229	1.43	122.4	95.8	14.853	3.388	41.3	
3	7/2/2013 15:22	14.196	1.42	122.4	95.8	14.818	3.380	41.2	
4	7/2/2013 15:21	14.291	1.43	122.4	95.8	14.918	3.403	41.4	
5	7/2/2013 15:20	14.738	1.48	122.4	95.7	15.400	3.427	42.8	
6	7/2/2013 15:19	15.76	1.58	122.3	95.6	16.485	3.582	45.8	
7	7/2/2013 15:18	15.745	1.58	122.4	95.5	16.487	3.499	45.8	

Figure 8. Sample data collected from Energy, Inc.'s, TED Pro Home circuit-level monitor.

Think Tank Energy Products

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	ROW	DATE/TIME	WATTS	VOLTS	AMPS	WATT HRS	MAX WATTS	MAX VOLTS	MAX AMPS	MIN WATTS	MIN VOLTS	MIN AMPS	PWR FACTOR	PWR CYCLE	FREQ	VOLT AMPS	RELAY	SAMP RATE
2	1	1/25/2014 20:36:59	0	122.6	0	0	0	122.7	0	0	122.4	0	100	0	60	0	0	32
3	2	1/25/2014 20:37:01	0	122.6	0	0	0	122.6	0	0	122.6	0	100	0	59.9	0	0	1
4	3	1/25/2014 20:37:09	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
5	4	1/25/2014 20:37:20	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
6	5	1/25/2014 20:38:21	0	122.5	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
7	6	1/25/2014 20:38:21	0	122.5	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
8	7	1/25/2014 20:38:22	0	122.5	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
9	8	1/25/2014 20:38:22	0	122.5	0	0	0	122.5	0	0	122.5	0	100	0	60	0	0	1
10	9	1/25/2014 20:38:23	0	122.5	0	0	0	122.5	0	0	122.4	0	100	0	60	0	0	1
11	10	1/25/2014 20:38:24	0	122.5	0	0	0	122.5	0	0	122.4	0	100	0	60	0	0	1
12	11	1/25/2014 20:38:25	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
13	12	1/25/2014 20:38:26	0	122.5	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
14	13	1/25/2014 20:38:27	0	122.5	0	0	0	122.6	0	0	122.5	0	100	0	59.9	0	0	1
15	14	1/25/2014 20:38:28	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
16	15	1/25/2014 20:38:29	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
17	16	1/25/2014 20:38:30	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	59.9	0	0	1
18	17	1/25/2014 20:38:31	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
19	18	1/25/2014 20:38:32	0	122.6	0	0	0	122.7	0	0	122.6	0	100	0	60	0	0	1
20	19	1/25/2014 20:38:33	0	122.6	0	0	0	122.6	0	0	122.6	0	100	0	60	0	0	1
21	20	1/25/2014 20:38:34	0	122.6	0	0	0	122.6	0	0	122.6	0	100	0	60	0	0	1
22	21	1/25/2014 20:38:35	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
23	22	1/25/2014 20:38:36	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
24	23	1/25/2014 20:38:37	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	59.9	0	0	1
25	24	1/25/2014 20:38:38	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
26	25	1/25/2014 20:38:39	0	122.6	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1
27	26	1/25/2014 20:38:40	0	122.6	0	0	0	122.6	0	0	122.6	0	100	0	60	0	0	1
28	27	1/25/2014 20:38:41	0	122.5	0	0	0	122.6	0	0	122.5	0	100	0	60	0	0	1

Figure 9. Light bulb (60 watts) sample data collected from Think Tank Energy Products' "Watts Up?" circuit-level monitor.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Time	Watts	Volts	Amps	WattHrs	Cost	Avg Kwh	Mo Cost	Max Wts	Max Vlt	Max Amp	Min Wts	Min Vlt	Min Amp	Pwr Fct	Dty Cyc	Pwr Cyc	Freq	VA
2	1/21/2014 19:48:13	115.1	122.6	0.933	0	0	79.62	6.369	115.2	122.6	0.934	115.1	122.6	0.925	100	76	0	60	115.1
3	1/21/2014 19:48:14	115.2	122.6	0.931	0	0	81.13	6.49	115.2	122.6	0.936	115.1	122.5	0.93	100	86	0	60	115.2
4	1/21/2014 19:48:15	115.3	122	0.934	0	0	81.69	6.535	115.3	122.6	0.937	115.2	121.6	0.929	100	90	0	60	115.3
5	1/21/2014 19:48:16	115.3	122.4	0.928	0.1	0	81.93	6.554	115.3	122.4	0.934	115.3	122	0.928	100	93	0	60	115.3
6	1/21/2014 19:48:17	115.3	122.4	0.925	0.1	0	82.06	6.564	115.3	122.4	0.93	115.3	122.4	0.925	100	94	0	60	115.3
7	1/21/2014 19:48:18	115.2	122.4	0.93	0.1	0	82.1	6.568	115.3	122.4	0.93	115.2	122.4	0.924	100	95	0	60	115.2
8	1/21/2014 19:48:19	115.1	122.4	0.924	0.2	0	82.15	6.572	115.2	122.4	0.93	115.1	122.4	0.923	100	95	0	60	115.1
9	1/21/2014 19:48:20	115.1	122.4	0.927	0.2	0	82.19	6.575	115.1	122.4	0.931	115.1	122.4	0.924	100	96	0	60	115.1
10	1/21/2014 19:48:21	115.1	122.3	0.925	0.2	0	82.19	6.575	115.1	122.4	0.927	115.1	122.3	0.923	100	96	0	59.9	115.1
11	1/21/2014 19:48:22	115	122.4	0.922	0.3	0	82.18	6.574	115.1	122.4	0.925	115	122.3	0.921	100	97	0	59.9	115
12	1/21/2014 19:48:23	114.9	122.4	0.922	0.3	0	82.18	6.574	115	122.4	0.924	114.9	122.3	0.919	100	97	0	60	114.9
13	1/21/2014 19:48:24	114.8	121.7	0.923	0.3	0	82.14	6.571	114.9	122.4	0.924	114.8	121.6	0.917	100	97	0	60	114.8
14	1/21/2014 19:48:25	114.7	121.7	0.925	0.4	0	82.12	6.569	114.8	121.7	0.927	114.7	121.6	0.923	100	97	0	59.9	114.7
15	1/21/2014 19:48:26	114.6	121.7	0.926	0.4	0	82.11	6.568	114.7	121.7	0.93	114.6	121.6	0.923	100	97	0	60	114.6
16	1/21/2014 19:48:27	114.6	121.7	0.924	0.4	0	82.09	6.567	114.6	121.8	0.928	114.6	121.6	0.924	100	98	0	60	114.6
17	1/21/2014 19:48:28	114.5	122.4	0.922	0.5	0	82.08	6.566	114.6	122.4	0.927	114.5	121.7	0.922	100	98	0	60	114.5
18	1/21/2014 19:48:29	114.5	122.4	0.92	0.5	0	82.08	6.566	114.5	122.5	0.924	114.5	122.4	0.92	100	98	0	60	114.5
19	1/21/2014 19:48:30	114.5	122.4	0.919	0.5	0	82.08	6.566	114.5	122.5	0.926	114.5	122.4	0.919	100	98	0	60	114.5
20	1/21/2014 19:48:31	114.4	122.4	0.921	0.5	0	82.08	6.566	114.5	122.4	0.923	114.4	122.4	0.919	100	98	0	60	114.4
21	1/21/2014 19:48:32	114.3	122.4	0.918	0.6	0	82.06	6.564	114.4	122.4	0.921	114.3	122.4	0.916	100	98	0	60	114.3
22	1/21/2014 19:48:33	114.3	122.4	0.919	0.6	0	82.04	6.563	114.3	122.5	0.921	114.3	122.4	0.916	100	98	0	60	114.3
23	1/21/2014 19:48:34	114.2	122.4	0.916	0.7	0	82.03	6.562	114.3	122.5	0.92	114.2	122.4	0.916	100	98	0	60	114.2
24	1/21/2014 19:48:35	114.2	122.4	0.918	0.7	0	81.95	6.556	114.2	122.5	0.919	114.2	122.4	0.916	100	98	0	60	114.2
25	1/21/2014 19:48:36	114.1	122.4	0.921	0.7	0	81.95	6.555	114.2	122.4	0.922	114.1	122.4	0.915	100	98	0	60	114.1
26	1/21/2014 19:48:37	114.1	122.4	0.922	0.7	0	81.95	6.555	114.1	122.4	0.922	114.1	122.4	0.918	100	98	0	59.9	114.1
27	1/21/2014 19:48:38	114.2	122.4	0.922	0.8	0	81.95	6.555	114.2	122.4	0.925	114.1	122.4	0.92	100	98	0	60	114.2
28	1/21/2014 19:48:39	114.2	122.5	0.919	0.8	0	82.26	6.58	114.2	122.5	0.924	114.2	122.4	0.919	100	99	0	60	114.2
29	1/21/2014 19:48:40	114.2	122.4	0.92	0.8	0	81.95	6.556	114.2	122.5	0.921	114.2	122.4	0.918	100	98	0	60	114.2
30	1/21/2014 19:48:41	114.1	122.5	0.922	0.9	0	81.94	6.555	114.2	122.5	0.922	114.1	122.4	0.917	100	98	0	60	114.1

Figure 10. Refrigerator sample data collected from Think Tank Energy Products' "Watts Up?" plug-load monitor.