New Opportunities from Data
Board Learning Paper

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April 2018

Energy Trust of Oregon

Preface

This paper is part of a series that describes a variety of topics identified by Energy Trust of Oregon's Board of Directors as potentially influential to the organization during the time period of its next strategic plan (2020-2024). This series of papers will educate and inform the Board about the potential impact of these topics and enable its Directors to better to assess risk, identify opportunity and guide the direction and goals of Energy Trust.

Remaining current on potentially significant and influential developments in the clean energy industry is critical to the fundamental role of the Board. These topics have been identified because of their potential to influence, impact or otherwise affect Energy Trust's ability to serve the ratepayers of Oregon and Southwest Washington. These papers should not be interpreted as policy proposals or recommendations for roles in which Energy Trust intends or desires to be directly involved.

Introduction

Energy efficiency is the cleanest, cheapest and most important resource for the utilities and ratepayers of Oregon, and Energy Trust is the prime organization delivering that resource. Data is pertinent to Energy Trust because it is used to track, report on and evaluate its work. Acquiring additional data, as well as finding new and innovative ways to leverage existing data, can help Energy Trust better serve customers and save energy.

This paper is divided into four sections:

- Section I describes several broad trends in data that are important and salient for the energy industry;
- Section II summarizes trends specific to the energy industry;
- Section III provides an overview of the current state of data at Energy Trust, and describes planned work related to data in 2018 and 2019; and
- Section IV describes potential new opportunities related to data in 2020 and beyond.

I. Trends in Data

This paper is focused solely on **data**. Data represents and quantifies properties of real-world phenomena. Examples of data include the square footage or energy consumption of a building. Data is needed to get any insight, but it would be difficult for an average person to gain insight from looking at, for example, thousands of records of building square footage. Data needs to be organized and analyzed so that it yields meaning. Analyzed data is considered **information**, which can answer questions such as, what buildings consume the most energy in the 97204 zip code? **Knowledge** often requires multiple types of data and information and requires analytical thinking about the information obtained to make sound conclusions. Knowledge can answer questions that are predictive and forward-looking, such as, what is the expected electric demand for the 97204 zip code over the next 10 years? Once knowledge is acquired, then one can gain **wisdom**. Wisdom is not necessarily proven. It can be applied to situations where no data is readily available - for example, how can new emerging energy efficiency technology help lower the demand of energy in the businesses and residents in 97204 zip code?

As shown in Figure 1 below, data, information, knowledge and wisdom build on each other to form a hierarchy. The fundamental piece to the hierarchy is data that is managed properly and invested in to ensure that it is accurate, precise, and organized in a manner such that it can be consumed for a wide range of analysis. When the data is good quality, it can be used over and over again to create a myriad of information.

Figure 1. Data, information, knowledge and wisdom hierarchy1

The current information age is characterized by rapid technological advances and staggering amounts of data. According to one estimate, in 2013 ninety percent of the data in the world was created in the prior two years.[2] Technological advances have increased the amount of data that exists. Advancements also have enabled the collection, storage and analysis of data. While there are many broad trends in data that could be discussed, this paper will focus on three interrelated trends that are particularly important and salient for the energy industry: big data, internet of things and artificial intelligence and machine learning.

Big Data

The current expanse of data is often labeled "big data." IBM scientists characterize big data by any or all of three "V" words: volume, variety and velocity.[3] Volume is relatively straightforward, but variety and velocity merit some explanation. In this context, "variety" refers to different types of data, ranging from structured data (e.g., meter readings, survey responses, etc.) to unstructured data (e.g., tweets, images, etc.). "Velocity" refers to the frequency with which data is collected. The promise of big data is the potential to use it to gain insights and intelligence.

Internet of Things

Recent, rapid technological advances have contributed to a growing number of "smart devices." Such devices contain sensors, are internet-connected and have the ability to communicate and interact with each other and with other systems. Smart devices themselves, as well as the systems that support and connect to them, are referred to as the "internet of things". These ultra-connected devices contribute to the growth of big data.[4] A 2014 Forbes article imagines what a future of the internet of things could look like:

> "Say for example you are on your way to a meeting; your car could have access to your calendar and already know the best route to take. If the traffic is heavy your car might send a text to the other party notifying them that you will be late. What if your alarm clock wakes up you at 6 a.m. and then notifies your coffee maker to start brewing coffee for you?"[5]

A key challenge is interoperability of equipment and systems; currently there is no market standard to ensure smart devices can communicate and interact. In addition, privacy and security are key challenges. Data gathered from smart devices can contain, or could be used

to infer, private information that users do not wish to be made public. Furthermore, smart devices and systems appear to be vulnerable to hacking.

Artificial Intelligence & Machine Learning

Artificial intelligence refers to technologies that enable machines to replicate human intelligence in terms of learning, evolving and decision-making absent human intervention. The advent of big data, as well as technological advances enabling data collection, storage and analysis, have allowed machines to access large volumes of data. In turn, machines can analyze data to identify patterns and learn ("machine learning").

Companies currently use machine learning in a variety of ways. For example, credit card companies use machine learning to proactively identify potential fraudulent charges and contact customers for verification. Ride-sharing companies use machine learning to estimate arrival times for customers and assess optimal pick-up locations.

II. Energy Industry & Data

The trends described in Section I also apply to the energy industry. However, there are several additional trends specific to the energy industry that are important to mention. This section first summarizes the current state of data in the energy industry, and then identifies emerging trends.

A. Current State

- **The collection of more granular usage and consumption data through advanced metering infrastructure (AMI). "**Smart meters" (meters that record hourly or sub-hourly energy consumption and quickly relay that information back to the utility for billing) are not new. PG&E first started installing them in 2006. By 2012, the three largest investor-owned utilities in California had almost fully deployed smart meters. In Oregon, PGE has almost fully deployed smart meters, while Pacific Power is in the process of deploying smart meters and expects to be fully deployed by the fall of 2019.[6]
- **Utility investments in IT systems to manage billing and customer engagement.** Utilities are moving from outdated billing systems to more advanced systems called customer information systems (CIS) or customer care and billing (CC&B) systems. These systems enable utilities to better segment customers, which in turn enable the

utility to deliver both traditional services (bill pay, outage reporting, etc.) and new services to customers.[7] These systems can support personalized, self-service portals that aggregate services in a single, customer-centric online marketplace.[8] Many of these portals integrate smart meter data where available.[9]

- **Investments in data and analytics services for demand-side management (DSM) program planning.** DSM program administrators strive to accomplish a variety of objectives, such as customer engagement, customer segmentation and targeting, campaign tracking, energy benchmarking, load disaggregation and program evaluation.[10] To reach these goals, program administrators have begun investing in and integrating data systems and tools. Some investment is internal, while some investments are for products and services provided by vendors such as Oracle (formerly Opower), EnergySavvy, Bigdely, FirstFuel and TROVE. These vendors' business models are often based on a software-as-a-service (SaaS) fee structure rather than a time and materials structure. SaaS vendors are less reliant on consulting hours and more focused on data processing and analytics products that have a component of self-service access for their clients.[11]
- **Real-time evaluation.** For a variety of reasons, evaluation has significantly lagged behind program implementation. This delay disappoints those eager to shape program design and optimization using insights and information about impacts. In recent years, there has been a push for more real-time, automated, and ongoing evaluation, sometimes referred to as M&V 2.0. Vendors such as EnergySavvy and Open EE Meter have developed products and services designed to rapidly analyze large amounts of data and estimate energy savings using data in monthly, daily, hourly and 15-minute increments. Early studies have shown that the energy savings estimated by these products and services align with those estimated using traditional billing analysis approaches. The difference is that these evaluation products and services can do so on a much quicker timeline. Currently, these products and services have not fully replaced traditional billing analysis approaches, although they could in the future, if approved by regulators.
- **New and expanding program designs.** Energy efficiency programs are investing in and scaling program designs that require data and analysis. Examples include pay-for-performance, retro-commissioning and strategic energy management. Programs are

also leveraging vendor-provided products and services such as thermostat setback and demand response programs provided by Nest, and personalized energy reports provided by Oracle (formerly Opower), FirstFuel, Simple Energy and others.

- **Growth in building energy management systems (EMS), energy management information systems (EMIS) and other smart devices.** There has been a proliferation of EMS and EMIS to manage and monitor buildings, and a proliferation of other smart devices such as thermostats, advanced power strips, etc. Increasingly, EMS and EMIS, as well as other smart devices, are connected to, and communicate with, other systems and devices, including smart meters.

B. Emerging Trends

- **More insight into locational load management.** Advances in data and analytics capabilities provide new, more granular insight into capacity constraint analyses across transmission and distribution systems. For example, data and analytics can help identify the optimal technologies to offset grid operation challenges and system planning for specific locations.[12]

- **Greater connectivity.** Utilities may begin communicating with EMS, EMIS and other smart devices. Further, they may directly control these devices to shift load and/or possibly incentivize (using rates, for example) load shifting. Analytics platforms with machine learning capabilities are already consuming this information and using machine learning to identify patterns and learn more about energy consumption habits.

- **Non-intrusive load metering (NILM).** Load shapes describe how much energy a piece of equipment or a building uses over a period of time – e.g., a day or a year. For example, Figure 2 shows a sample daily load profile. Typically, obtaining load shapes involves installing sub-metering that is invasive and costly. There is interest in NILM, which involves using computer algorithms to identify load shapes for equipment without the need for sub-meters. NILM relies on smart meter data to provide the inputs for the algorithms that disaggregate meter-level energy usage into its component parts. Figure 3 provides an example of disaggregated smart meter data for a variety of equipment at a single location. The more granular data are, the more useful they are for NILM.
    - A related trend is the collection of extremely granular data (i.e., from one minute to one-second or sub-second intervals) to support NILM. Recent studies

comparing sub-metered data to NILM estimates show accuracy varies greatly and require further refinement.[13]

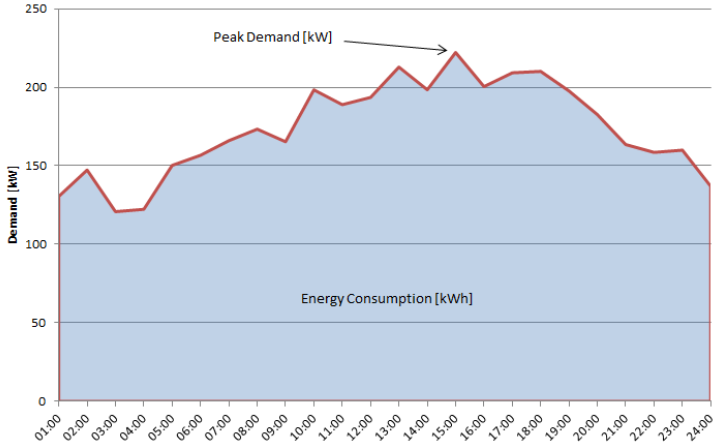

Figure 2. Example daily load profile14

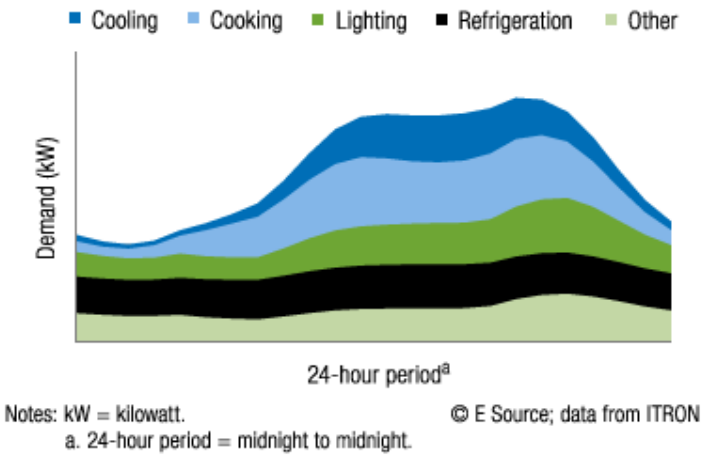

Figure 3. Example of load disaggregation for a commercial restaurant15

III. Energy Trust & Data

This section provides an overview of the current state of data at Energy Trust and describes planned work related to data in 2018 and 2019.

A. Current State

Energy Trust collects a wealth of data, including information about customers, sites and projects. These data are collected to track, report on and evaluate its work. Data collected by

Energy Trust are entered and stored in three key applications: Project Tracking (PT), a Customer Relationship Management System (CRM) and Great Plains.

As shown in Figure 4, PT stores data about Energy Trust's product offerings and details about incentives and savings associated with measures. Project Tracking also facilitates the tracking of projects from beginning to end, and enables the organization to forecast future savings from large commercial and industrial projects. The various project players (e.g. a customer, their contractor, their program delivery contractor) are also tracked in PT, but their details (e.g., address, etc.) are stored in CRM. CRM stores information about people (contacts) and companies (accounts), as well as information about sites. Great Plains is the system that stores information about Energy Trust's annual budget as well as transactional payment information that supplements data stored in PT.

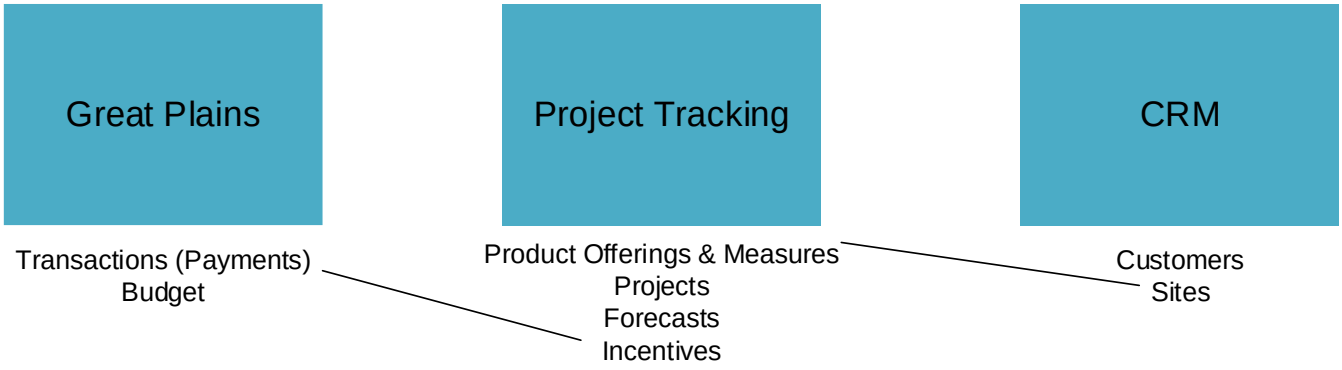

Figure 4. Relationship between Great Plains, Project Tracking and CRM

Data entered into PT and CRM come from a wide variety of sources, such as program management contractors (PMC) and program delivery contractors (PDC). Data are available to be viewed, extracted and analyzed by staff. Staff can view and extract data using a variety of tools, including these applications' user interfaces, various reporting platforms and structured query language. Staff may have access to one or more of these tools, depending on their role.

Energy Trust has invested in a variety of third-party datasets to provide points of comparison to, or to complement, data collected by Energy Trust. In the past, PMCs have primarily procured and used third-party data. A concerted effort in 2017 brought the procurement of third-party data in-house.

To date, Energy Trust has procured the following third-party datasets:

- *US Census* – Provides demographic data at the state, county, tract, block, and block-group levels from the American Community Survey and Decennial Census;
- *Weather* – Daily weather data from the National Oceanic and Atmospheric Administration can be used to "normalize" energy consumption data, ensuring that energy consumption across time periods with different weather are comparable;
- *Geospatial* – Energy Trust has a variety of geospatial data, including school and legislative districts, Census geographies and heating and cooling zones, which can be used in reporting and analysis;
- *CoStar* – Provides building-level information about commercial and industrial facilities in Oregon, including facility ownership, square footage and year constructed;
- *InfoUSA* - Provides customer-level information about Oregon businesses, including square footage, industry type, number of employees and contact information;
- *County Tax Assessor* – Provides information parcel-level information about residential, commercial and industrial properties for 16 counties in Oregon, including square footage, year constructed and zoning;
- *Utility Customer Information (UCI)* – Energy Trust's funding utilities provide monthly energy consumption data on a regular basis;
- *City of Portland Commercial Benchmarking* – The City of Portland requires commercial facilities over 20,000 square feet to submit information about energy consumption, energy performance ratings, square footage, year constructed and building use type; this building-level data is publicly available from the City of Portland.

In addition, Energy Trust is in the process of procuring the following dataset:

- *COBID* – Provides information about certified emerging small businesses, minority-owned businesses and women-owned businesses.

While third-party datasets are useful on their own, combining them with data collected by Energy Trust enhances their usefulness. In 2017, Energy Trust developed a robust, automated process to link third-party datasets containing site addresses to data collected by Energy Trust, which has allowed staff to use third-party data in many different ways. As the organization

considers future uses, the terms and conditions of many of these datasets preclude Energy Trust from sharing or selling the data.

Staff with varying levels of data-related knowledge and analytical capabilities work with and use the datasets described above. Staff can visualize and analyze all of the data described above using multiple tools, ranging from Microsoft Excel to more sophisticated statistical and visualization software, such as Stata, R, ArcGIS and PowerBI.

In addition to using data to track, report on and evaluate Energy Trust's work, staff are increasingly using data to identify and assess potential new savings opportunities (for example, high energy users with specific housing characteristics). Staff are also using data to support cross-organizational initiatives such as the Diversity, Equity and Inclusion (DEI) initiative and locational load management pilots with Pacific Power and NW Natural.

B. 2018-2019 Roadmap

Work to improve data happens on an ongoing basis. Energy Trust's IT Steering Committee reviews and prioritizes large investments of IT time and resources into enhancements. The Business Systems Prioritization Team reviews and prioritizes smaller investments of IT time and resources into enhancements.

The IT Steering Committee and Business Systems Prioritization Team have helped set the course for planned data-related work in 2018 and 2019. The work plan takes into account Energy Trust's 2015-2019 Strategic Plan, annual goals and feedback from users received as part of the Reporting Outreach Project (completed in 2017) and the UCI Data Project (also completed in 2017). Key work in 2018 and 2019 is listed below.

Data ownership

- **Establishing data ownership** by empowering staff to develop expertise regarding a specific piece of Energy Trust's data and systems. Data owners will apply their expertise by monitoring and curating data in order to ensure its accuracy and integrity. They will also participate in developing standardized, "sanctioned" datasets that can be used by other staff in the organization. This will ensure the appropriate use of the data by users. Energy Trust staff will also develop automated data integrity checks, where appropriate, to assist data owners in proactively monitoring data.

- **Creating meaningful metrics to track data quality**. Such metrics will allow data owners to quickly assess data quality so that they can address incomplete or inaccurate data.

- **Updating guidelines for UCI data** to support staff in new and innovative uses of UCI data while ensuring compliance with utility data sharing agreements.

Creating new datasets and linking datasets

- **Creating new datasets**. The data collected and procured by Energy Trust often requires processing before it can be used for analysis. For example, the monthly meter readings provided by the utilities would be more usable as monthly or annual estimates of energy consumption aggregated across multiple meters.

- **Linking multiple, disparate datasets together**. Developing standardized methods for linking datasets is critical for analysis. Energy Trust's Project Tracking, CRM and Great Plains applications link together by design. However, third-party datasets are more difficult to link to the data stored in these systems, because they may be at a different "levels." For example, a site record in CRM represents a floor in a building, while a record in a third-party dataset may represent a tax lot or a whole building. Work is underway to develop methods and rules for linking these datasets together so that they can be effectively analyzed.

Delivering training on data analysis and visualization tools

- **Expanding organizational knowledge** on key Energy Trust concepts, processes and datasets for both internal staff and external contractors, by creating documentation, delivering trainings and facilitating meetings focused on knowledge sharing and collaboration on the proper use of data.

- **Training, enabling and empowering staff who have a wide range of data-related knowledge and analytical capabilities to use Microsoft PowerBI.** PowerBI is a dashboard and data visualization tool. Once staff are trained on this tool, Energy Trust can use PowerBI to fulfill reporting needs without having to engage outside assistance. Successful utilization of PowerBI will require greater understanding of Energy Trust's

data through expanded documentation and staff training and establishing sanctioned datasets.

- **Training, enabling and empowering staff to visualize and analyze data in a geo-spatial context**. Staff can use tools such as PowerBI and ArcGIS to visualize and analyze data in a geo-spatial context. To do this will require staff training and establishing sanctioned geo-spatial datasets.

Performing and making use of data analysis

- **Leveraging data for Energy Trust's DEI Operations Plan**. Energy Trust's DEI Operations Plan contains ten goals. The first step toward reaching these goals is to understand the current state, which can be done through a comprehensive analysis of data from PT, CRM and Great Plains, as well as third-party data.
- **Leveraging data for program targeting**. Energy efficiency and renewable energy opportunities that are easiest to obtain have been depleted. The wealth of data collected and procured by Energy Trust could be mined in new ways to identify potential opportunities – for example:
    - Large energy users
    - Customers that have completed a walk-through survey, site assessment or technical energy study but who did not follow-through with recommended activities or projects
    - Customers who have already installed energy-efficient lighting systems could be targeted with HVAC efficiency offers
- **Providing more timely impact evaluation results**. Energy Trust is currently working with Open EE Meter to develop a billing analysis dashboard. The hope is that this will allow more billing analysis to occur on a much quicker timeframe. Energy Trust staff are reviewing Open EE Meter's methods and comparing them to the billing analysis methods currently used by Energy Trust. Staff plan to test and validate the energy savings estimated by Open EE Meter against traditional billing analysis methods. In the future, the products and services of Open EE Meter (or another similar vendor) could

potentially replace the current billing analysis tools and methods (pending approval from the board evaluation committee and regulators)**.**

Exploring opportunities to collect and/or receive additional data

- **Enhancing systems to track project opportunities.** Currently opportunities and forecasts are tracked at the project-level only. However, Energy Trust is developing recommendations for how to enhance its systems to track more project opportunities and forecasts at the measure level across all programs. This change could increase the organization's collective ability to provide detailed analyses on technical services delivered and measure-level trends, and enable staff to provide even more detail for utility integrated resource planning.

- **Exploring opportunities to collect and store more data from customers and/or market actors**. Examples of new opportunities to collect data include data from customers' smart devices and data about customers and facilities from online Home Energy Reviews, walk-through surveys and site assessments and studies. Another opportunity includes collecting full-category (inefficient and efficient) data from midstream and upstream program partners.

- **Exploring opportunities to receive more data from customers and market actors**, for example, obtaining access to interval data from the electric utilities.

IV. Data-Related Opportunities for Energy Trust

A. 2020 and Beyond

In light of the data trends described in Sections I and II, Energy Trust can build on the current data foundation described in Section III and explore new opportunities.

Building on current work

- **Gather more data on internal processes.** These data could support analysis to identify opportunities for improvement in internal processes.
- **Utilize data to create more detailed, localized and targeted market assessments**, which could provide valuable insight to staff working on localized load management pilots.

- **Utilize data for program development, pilots and new initiatives.** Acquisition and analysis of appropriate data could benefit Energy Trust new product development methodologies like Lean Startup.
- **Expand customer visibility into activities with Energy Trust.** Business Customer Reports were developed to give these customers a better understanding of their engagement with Energy Trust. Expanding this type of offering (for example, by incorporating UCI data and working to make existing data more accessible by customers) could be very useful tools for customer engagement.
- **Establish metrics for participation and penetration rates.** In 2017, Energy Trust analyzed participation and penetration rates, which was a manual and resource-intensive process. Obtaining agreement on key metrics and developing automated processes to calculate such metrics could help assess and track on program effectiveness and resource potential on an ongoing basis.

New opportunities

- **Develop customer insights for on-going engagement.** Energy Trust could acquire consumer behavior data and combine that with participation and usage data. Energy Trust potentially could use this combined data for individualized customer engagement at various levels of granularity.
- **Utilize machine learning to lower acquisition costs.** Energy Trust could utilize some aspects of artificial intelligence and machine learning to uncover trends and modify program implementation based on those trends. This analysis occurs today but could be much faster and potentially automated with machine learning.
- **Capture or gain access to sensor and smart meter data.** With an explosion of data from controls, sensors and smart meters, Energy Trust could explore how acquiring, accessing and/or analyzing these data could benefit programs.
- **Serve in an advisory/consultative capacity to interested parties outside of energy efficiency and renewables.** Energy Trust is developing deep knowledge of demographic and firmographic data through its annual Customer Insights study, Fast Feedback surveys and the acquisition of third-party data. There could be an opportunity for Energy Trust staff to consult with other organizations (e.g., water conservation,

transportation, carbon & climate) seeking to utilize these types and other types of data in furthering their work.

B. Skills and Resources

Many of the activities and new opportunities listed above require new skills and resources. Below are several actions that could support those activities and new opportunities:

- **Adding staff with specialized data analysis skills.** There are specialized skills needed to analyze large datasets and make data out of data. Data scientists who possess these skills are increasingly common in data-driven companies.
- **Increasing the skill sets of current analysts and making time to focus on new opportunities.** Energy Trust analysts currently spend most of their time on ongoing production work. The activities and new opportunities listed above would demand time and energy and require the development of new skills.
- **Creating and implementing a plan for big data.** Utilizing big data effectively requires a comprehensive plan for storage and access.

About Energy Trust of Oregon

Energy Trust of Oregon is an independent nonprofit organization dedicated to helping utility customers benefit from saving energy and generating renewable power. Our services, cash incentives and energy solutions have helped participating customers of Portland General Electric, Pacific Power, NW Natural, Cascade Natural Gas and Avista save on energy bills. Our work helps keep energy costs as low as possible, creates jobs and builds a sustainable energy future.

Additional Resources

M&V 2.0

Advanced Measurement & Verification (M&V) Brief: An Evolving Industry. August 2017. Northeast Energy Efficiency Partnerships. http://www.neep.org/sites/default/files/resources/Advanced%20Measurement%20%26%20Verification%20%28M%26V%29%20Brief%20-%20An%20Evolving%20Industry.pdf

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NILM

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[3] https://www.ibm.com/developerworks/library/bd-bigdatacloud/index.html
[4] https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#2fd1f2a81d09
[5] https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#2fd1f2a81d09
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[7] Phone interview with Seattle City Light (2/20/2018).
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