Kevin J. Ketchman, Opinion Dynamics

Poster Title: Exploring the Question – Does Weather Matter? Implications of Changing Weather on Future Energy Efficiency Program Outcomes

Abstract: Global temperatures and the frequency of extreme weather events are expected to increase as a result of climate change, having a direct impact on building energy use, and ultimately energy efficiency program outcomes. Historically, lighting measures, which are not keenly sensitive to weather, have constituted the predominant source of savings in energy efficiency programs' portfolios across the United States. However, it is widely expected that the Energy Independence and Security Act of 2007 (EISA) backstop lighting standards, effective in 2020, will shift energy efficiency portfolio savings to non-lighting end-uses. One potential end-use that offers cost effective opportunities for replacing lighting savings is heating, ventilation, and air conditioning (HVAC); however, these measures are directly influenced by variability in weather.

A common approach to account for weather variations in energy savings calculations is to use typical meteorological year (TMY) weather data to derive energy savings or parameters, such as effective full load hours (EFLH) of HVAC equipment, for use in a technical reference manual (TRM). TMY weather data uses weather station observations over a duration of time – the most recent version (TMY3) covered the years from 1980 to 2005 – to develop a statistically representative year of typical daily climatic conditions, including, but not limited to temperature, humidity, and rainfall. However, according to the National Oceanic and Atmospheric Administration, since 2005, the contiguous U.S. has observed the five hottest years on record, while also observing increases in the number of annual extreme heat events, posing the question of whether TMY3 is still representative of a typical meteorological year under changing climates.

In response, this study takes a step to answering the question of whether or not weather matters in evaluating energy efficiency program outcomes. To achieve this, the study replaces TMY3 data used in a mid-west state's approved TRM EnergyPlus models with actual meteorological year (AMY) weather data and assesses the impacts on weather-sensitive parameters and energy savings. The study focuses on four building types commonly engaged through energy efficiency programs: medium offices, mid-rise apartments, stand-alone retail, and warehouses. Results are available now and will demonstrate the impact of actual weather data on program savings along with a discussion on the broader implications of this research, including long-term program planning in the context of EISA 2007 backstop adjustments and climate change.

Alexandra Bothner, Eversource

Poster Title: Net Energy Use of Behind-the-Meter Battery Storage Systems

Abstract: Battery energy storage systems are of particular interest to the utility industry as a way to reduce peak demand, resulting in cost savings for both the utility and its customers. By charging batteries during times of lower demand, and discharging during peak hours, overall demand can be smoothed. Potential savings resulting from battery storage systems would come largely from reduced capacity charges (ICAP) and lowered demand charges for customers. However, due to the inefficiencies associated with battery cycling and maintaining charge, storage systems also result in an overall higher net use of energy. As such, there is interest in examining the tradeoff between peak demand savings and the increase in net energy usage for these systems.

A large investor-owned utility is currently running two demonstration projects with two different vendors for commercial-scale, behind-the-meter batteries. Each demonstration project uses a different strategy for optimizing battery use: one is focused on providing longer-duration dispatches to address local and system peak hours, while the other is geared toward more continuous use to address customer-specific peaks. An independent evaluation of these demonstration projects will utilize a combination of battery charging and discharging data, and facility interval data to determine the frequency, magnitude, and timing of discharge of the batteries. The evaluation team will analyze how effectively the different dispatch patterns reduced customer peak and utility peak demand, and the net energy usage implications of the battery solutions. The evaluation commenced in the summer of 2018 and will conclude in the winter of 2020. The first evaluation dataset and report containing the results from the summer of 2018 will be available at the end of 2018.

Early results suggest that partial charge and discharge of a battery may result in lower round-trip efficiency, as compared to full discharge. This poster will assess whether discharge strategies focused on full discharge are more efficient. Specifically, it will examine the total peak demand reduction that each demonstration project achieved, and compare this to the net increase in energy usage that resulted from operation of the batteries. This may help determine what types of battery storage systems and methods of operation would prove most effective for demand management programs, and which may result in the greatest level of savings for customers. Graphic content for this poster will include graphs and tables of site, grid, and battery energy usage for the demonstration projects, and will also include photos of the installed battery systems.

The results of this evaluation may also be relevant in assessing other effects of battery storage. Although they will not be the key focus of this poster, these topics could include:

- Assessment of peak energy savings against the potential costs of increased total energy usage
- Potential implications on carbon emissions based on the timing of peak load reduction and the net difference in energy usage
- Cost-effectiveness of the two strategies for battery operation

Jennifer Chiodo, Cx Associates

Poster Title: Energy Intensity Matters - Calculating EUIs to Guide Programs for the Future

Abstract: Zero Energy Buildings are the holy grail of energy efficiency. These buildings consume little and generate at least as much energy as they use over the course of the year. However, most buildings are far from the efficiency levels required to cost effectively generate enough energy to satisfy their annual consumption requirements. Efficiency programs, therefore, are increasingly seeking ways to achieve deeper energy savings. Impact evaluations can help to direct such efforts by collecting and presenting data that help program administrators understand:

- How their current suite of measures is impacting total building energy consumption
- Where participants are on the path to low energy consuming buildings
- What the most effective investments are in moving the market toward Zero Energy Buildings

This poster will look at three recent applications of benchmarking to assess program effectiveness as a component of impact evaluations. These studies analyze the impact of energy efficiency measures on building energy use intensity (EUI). EUI is like a car's miles per gallon rating for a building (except the lower the EUI, the more efficient the building). EUI measures annual energy consumption per square foot of building area and is often reported as kBtu/sf/year. Benchmarking is widely used in the building industry to rate and compare building performance, but has not been consistently incorporated in impact evaluation. The poster will demonstrate methods and outcomes for benchmarking savings and the benefit of EUI analysis to informing program impacts on total building energy use.

Graphics will include data from three rigorous commercial, new construction, and multifamily retrofit program impact evaluation studies. Data presented will include:

- Graphs of savings factors (kBtu/sf/year of savings) for energy end uses addressed by a C&I new construction program in the northeast
- Graphs of whole building energy use intensity from recent C&I program participating new construction projects in comparison to the 2012 CBECS average for each building type
- Data showing EUI impacts of a multi-family retrofit program at the building level

Developing an industry standard for including EUI analyses in impact evaluation and building a library of data on the savings factors associated with various measures will provide a solid basis for the next generation of programs which are likely to focus on moving buildings toward minimum practical consumption levels. One question that the energy efficiency industry must answer is "how low can we go in terms of energy intensity?" As programs mature, savings factors and EUI analyses will be necessary tools in understanding program impacts and opportunities.

Joseph Clark, Evergreen Economics

Poster Title: Come One, Come All! Innovative Recruitment Strategies for Residential Fieldwork

Abstract: Utilities across the country are increasingly looking to improve the accuracy of their energy savings claims, in particular to update measure load shapes as they seek to better integrate energy efficiency with increasing renewables penetration. Some are conducting primary load shape research, including on-site surveys and equipment monitoring. These research efforts help to ensure peak savings claims are accurate.

This poster will present information on how we successfully managed complicated recruitment efforts for two large-scale residential metering studies undertaken in California and the Pacific Northwest. The main objective of this poster will be to share successes and challenges associated with various recruitment practices across the two studies. We will also share lessons learned associated with adapting recruitment processes, being proactive and using up-to-date software and IT to develop innovative tracking tools.

We developed tailored strategies to meet the recruitment and retention challenges of each study. In both cases the strategies were created to be adaptable to unforeseen circumstances or changes to the study design or schedule. This flexibility allowed us to adjust our procedures based on revelations from the actual recruitment implementation.

Key differences between the two studies led to changes in our initial plans as well as different adaptations over the course of recruitment to-date. Some of the key differences between studies that we will contrast in the poster included:

- Full day vs. half day equipment installations
- Incentive amounts
- Equipment obtrusiveness on in-home aesthetics
- Study objectives
- Initial recruitment outreach (letter versus post card)

Furthermore, both studies involved the same type of initial research pool from which we recruited from – in home equipment and building characteristic surveys. However, for one of the studies the research team was consistent from the survey effort to the energy monitoring effort; in the other study the initial in-home survey was managed and conducted by a different firm. Our initial concern that the a lack of familiarity with our research team would lead to lower recruitment rates (and thus higher costs and potentially increased self-selection bias) led our team to devise new strategies to meet this particular challenge.

This poster will include a flow chart that walks through the two recruitment processes and highlights key differences between the two field studies and recruitment efforts. We will highlight what was adapted and why it was adapted from one field study to the other. We will also share an overview of how we successfully tracked our onsite appointments using an in-depth tool to coordinate all appointment activities including: onsite visit scheduling, engineers schedules and assignments, and electrician coordination. Identifying new and innovative strategies to engage residential customers can help ensure future recruitment efforts are efficient, thereby ensuring efficacious use of resources and reducing concerns about study bias. By comparing two study contexts, the results will be even more useful for other jurisdictions since the contextual considerations vary greatly for field studies.

Terese Decker, Navigant

Poster Title: Taking the Long View: Insights from a Longitudinal Saturation and Load Research Study

Abstract: A statewide residential saturation and load research measurement project is now in its third year of data collection. By May 2019, the team will have analyzed two years' worth of data which allows interested parties to understand the change in saturation and load shapes year over year. This poster would communicate the findings from this study, plus the value of conducting a longitudinal panel study of this nature.

The data collection team has collected saturation data from 6,500 statewide residents in a sample that is statistically significant across several demographics. The first survey was administered online in the spring of 2017. This survey asked respondents about the presence, quantity, and characteristics of over 100 end uses. The results, finalized in August 2017, showed that the equipment stock in the state had changed since the last statewide Residential Appliance Saturation Survey (RASS) had been finalized in 2009. However, because the two saturation studies used different data collection and analysis methods, the team was unable to measure the true change between 2009 and 2017. With that in mind, the program administrators decided to extend the data collection period to ask the same respondents about equipment changes in their homes in the last year via an online survey with the same overall approach. This allowed the team to minimize error related to methods and focus on insights gained from the research, such as the explicit measurement of stock and flow of equipment and the adoption of emerging technologies. Additionally, maintaining a robust panel with various significant demographic groups provides a population of non-participants to use as subjects for future research efforts, such as seeking to understand barriers to program participation. By utilizing email recruitment, this effort has not added significantly to the overall cost of the study.

Within the survey sample, the team recruited more than 350 sites to participate in the metering portion of the study. At these homes, field technicians characterized and metered the energy usage of 25 key end uses in the homes. The meters were installed in the spring of 2017. After one year of data collection, the evaluation team was able to develop annual load shapes for all end uses, specifying annual energy consumption and peak demand during multiple peak periods. After two years of data collection, the team can compare the load shapes over multiple years to illustrate the impact of different weather events and how the changing energy landscape affects the load.

At a minimum, the poster will graphically depict:

- Saturation, characterization, and load shape results for key end uses for each year of measurements
- Impacts on the load shapes due to extreme weather events compared with mild weather
- Stock and flow changes after one year

Optionally, the dynamic dashboard of results from this study could be displayed during the poster session for attendees to explore. From this poster, the evaluation community will be able to quickly understand the results of this rigorous study and the value of conducting a longitudinal study of this nature.

Michael Goldman, Eversource Energy

Poster Title: Driving Down the Peak - Using Load Shape Data to Develop Demand Reduction Programs

Abstract: Objective: The objective of this poster is to demonstrate how the overall system peak for a Northeast utility is not set by an accumulation of absolute customer peaks, but rather is the aggregation of "shoulder" peaks. It was the Company's assumption that certain conditions, namely a combination of heat and humidity, cause each individual customer's load to spike which in aggregate then creates a system peak. Through this analysis it was possible to see that the system peak was not the result of every customer peaking at the same time and in fact was not the result of many customer's top load hours at all.

Results/Achievements/Concepts: Peak load is a driver for capacity requirements, capacity cost allocation, transmission and distribution infrastructure, and high energy prices. For this reason, reducing system peak demand is a key objective for many utilities and public utility commissions. The analysis presented in the poster is an effort by the utility to disaggregate system peak demand in New England. The utility examined the issue following a top down approach. ISO level – the Company carefully examined when the ISO peak was occurring, noting that the peak has progressively moved further back in the day, likely due to the penetration of solar. Distribution level – the Company reviewed load shapes by rate class and how coincident those load shapes were with the overall system peak. Customer level – Lastly, the Company took a random sample of 300 C&I customers and reviewed how coincident each individual customer's load shape was with the overall ISO system peak.

The poster will present customer and rate class load shapes and a comparison of those load shapes to the overall system load shape. This will show that the overall system load shape does not exactly resemble the load shape of any individual rate class or customer. We then delve further into the system and show that many customers do not peak at the same time as the system peak. Rather the system peak seems to be an aggregation of customer "shoulder" peaks. However, the analysis did show that certain industry verticals tended to be more coincident than others. Data will be presented on individual customer's load shapes and to what extent their top 40 or 100 load hours are coincident with the overall system peak.

The ultimate goal of this analysis is to help utilities understand which customers to pursue for peak load reductions. Understanding when the peak is occurring, and how coincident an individual type of customer is with that peak, helps show which types of customers to pursue and which solutions might be best for them.

Worthiness: This analysis will help other program administrators (PA) as they develop demand focused programs to help reliability and ensure positive grid impacts from energy efficiency and demand response programs. By understanding what and who is driving system peaks, PAs can develop a portfolio of solutions that can effectively address demand at each level of the system and for each customer type.

Arman Golrokhian, DTE Energy

Poster Title: Assessing the Impact of Three-Part Rates on Residential Electric Customers

Abstract: The volumetric rate structure is the most predominant rate construct in the utility industry in the United States. Under the rapidly growing emergence of Behind-the-Meter (BTM) technologies such as rooftop solar, storage, etc., this rate structure is widely found to be incapable of supporting and sustaining the power and utility business model. This rate construct will lead to inaccurate compensation technologies, unfair cost shifts between electric customers, or will create complicated grid challenges such as the Duck-Curve (through false price signals). Three-part rates—rates with demand charges—have been identified as a promising option to overcome these challenges.

In this study we are evaluating the impact of three-part electric rates on (1) customer bills and (2) low-income customers. In addition, we evaluate the (3) competitiveness of various emerging technologies under three-part rates. To understand the impact of three-part rates, we designed multiple three-part rate constructs with varying level of energy, demand, and fixed charges based on the projected utility cost structure in 2030.

To further understand the implications of three-part rates, we are testing these rates against multiple criteria.

- First, we are studying the impact of these rates on ~1.5 million residential customer bills with smart electric meters to understand (1) how significant these bill impacts are, and (2) which customer groups will be most/least affected by these rates.
- Second, given the importance of impact on low-income customers for any rate proposal, we isolated the low-income customers from the rest of population to thoroughly evaluate the impact of three-part rates on this group.
- Third, we are going to select a representative sample of residential customers, identified based on energy use, monthly peak demand, and their daily energy use profile, to study the competitiveness of various technology scenarios under these proposed rates.

As the utility industry explores the entire set of rate design options, we expect studies like this to lay the foundation for future decisions. Based on our preliminary findings; we expect this study to be informative for utility companies around the country

Tim Guiterman, InfiSense

Poster Title: Embed, Enhance and Evolve - Real World Iot for the New World of EM&V

Abstract: Description This poster will be a visually enticing display directly aimed at utility EM&V staff, evaluators and any implementers who may have mistakenly wandered into the event. The poster will use photos and data visualizations from actual deployments and analyses that demonstrate why embedded M&V via IoT can bridge the gap between implementation and evaluation, how this will enhance utilities and the field of evaluation, and what actual, embedded M&V looks like in practice.

The poster will revolve around three concepts: (1) How IoT is changing the way evaluators obtain the data necessary for M&V (defined here as cost effective sensors and meters providing access to detailed data sets with occupancy, system state, energy usage information, space conditions, etc. coupled with advanced analytical tool sets and frameworks), (2) How this data can provide actual value to the customer while satisfying the need for implementation data gathering and rigorous M&V, and (3) How flexible IoT systems can successfully operate in diverse building types and operating conditions.

Value to evaluation community For evaluators, seeing is believing and real world proof is king. This poster will provide actual examples from recent and ongoing IoT deployments where the objective is gathering energy, power and operational parameters for baselining, implementation and M&V purposes. The poster will be of particular interest to evaluators because of the diversity of facility types represented: industrial, manufacturing, retail and indoor cannabis. Additionally, attendees will be able to have a much more hands-on experience as we will have the sensors and related gear on-hand as well as a real-time streaming of data from select facilities (if allowed by IEPEC) - empowering visitors to ask hard questions and walk away understanding how this evolution can fit into the work they do.

Graphic content This topic naturally lends itself to visual presentation, and this poster will include photographs of particularly interesting applications, including sensors installed in indoor agriculture and heavy industry. The poster will also have bold, colorful charts that immediately display the value of having multiple parameters of data from numerous sensors. For example, identifying the load profile for multiple pieces of energy-using equipment and correlating that with work shifts and actual verified occupancy - enabling a baseline that can be used to measure savings against and then be easily adjusted for any schedule changes during post-energy efficiency installation M&V periods. Or energy and power coupled with temperature, humidity and light levels over a long time series for the burgeoning indoor cannabis market. If allowable with the IEPEC we could arrange to have a tablet or laptop displaying real time data from select facilities featured n the poster presentation.

Mike Heng, Itron

Poster Title: Realizing the Full Capacity of Energy Storage Data: Critical Steps in Evaluating Behind-the-Meter Battery Data

Abstract: Advanced energy storage (AES) devices have seen increased proliferation in California, Hawaii, Massachusetts, and many other jurisdictions. AES devices are filled with promise – the ability to charge/discharge behind-the-meter (BTM) AES devices allows for potential layering of benefits to customers, distribution utilities, and transmission system operators. In California, the Self-Generation Incentive Program (SGIP) provides rebates for qualifying distributed energy technologies including AES. To date, the program has issued incentives to almost 1,000 AES projects, with increased funding on the horizon.

SGIP impact evaluation efforts have unearthed a trove of AES performance data collected at the sub-second level. To uncover meaningful insights such as environmental impacts, bill impacts, and distribution system deferral opportunities, metered data from multiple sources must be standardized and verified to ensure the accuracy and reliability of impact estimates. Through SGIP impact evaluation, algorithms were developed and tested to investigate the myriad issues that can arise. These algorithms combine the physical characteristics of AES technologies and the relationship between storage systems and customer load to identify suspicious observations.

The visual display will comprise text, tables, graphs, and interactive dashboards conveying how the various sources of data are manipulated and how the associated quality control process flows. Data sources include project tracking information and sub-hourly interval data from energy storage devices and utility AMI. The visualization will describe the data validation process: verifying data sources against each other, correcting timestamps to ensure time syncing, and stitching data from multiple sources throughout the evaluation period. The interactive dashboards will allow users to display the metrics used to ascertain the quality of data after extensive cleaning exercises are conducted.

As more utilities begin to deploy BTM AES technologies, evaluators must understand the possible pitfalls existing in the data and learn how to overcome them in order to provide sound policy recommendations. Failure to address these data issues can and will hinder the adoption of this promising technology. This interactive display will show in detail the critical steps required when sampling, metering, validating, and analyzing BTM AES performance data.

Sanem Kabaca, Oracle

Poster Title: Randomized Controlled Trials and Propensity Score Matching: A Comparison of Savings Estimates

Abstract: The credibility of behavior-based energy efficiency (BEE) programs relies on unassailable, verifiable, and accurate measurement. Randomized Controlled Trials (RCTs) are the gold standard measurement methodology for evaluating BEE programs because they yield unbiased estimates of savings. In cases where RCT implementation is practically challenging, evaluators turn to observational methods of program evaluation whose estimates may include unknown levels of bias. Propensity score matching is one such observational method that is used to evaluate BEE programs. This study considers the potential for group imbalances in unobserved customer-level factors and, leveraging historical Opower Home Energy Report experiments, compares the accuracy of energy savings estimates from multiple propensity score matching models to unbiased estimates of those same programs by RCT.

Kim Kraunz, ADM Associates

Poster Title: Where does it come from? Identification of the components of a Home Energy Report that generates savings

Abstract: The number of Home Energy Report programs being used by utilities to increase energy efficiency savings has increased dramatically over the last few years. The components (for example, neighbor comparisons and year-over-year energy use) and language used in the reports vary across programs. At this point, very little is known about which components of the reports generate the savings.

In this quantitative meta-analysis study of over 300,000 participants, the reports will be broken into their individual components for each participant and included in the analysis. A post-only regression model will be used to determine savings, while controlling for heating and cooling degree days and pre-program year usage. Whether or not a component is included in the participants' reports will be designated using a dummy variable. This will allow the savings for each component to be determined as an individual component of each report. The findings will be presented as an "ideal" report, which would be predicted to generate the most savings.

Hans Lehndorff, Evergreen Economics

Poster Title: Quality and Quantity: An Innovative Approach to the Quality Control of Metering Data

Abstract: As the energy landscape shifts and program planners look for new energy efficiency savings potential and to better integrate distributed generation, more attention is being placed on load shapes. Studies are being funded to update load shapes since most of the available data are either not robust or dated. This poster will focus on analytics and visualization tools being used on data from a large-scale residential metering study to ensure that the quality of the metering data will support rigorous measure savings analysis and make reductions real. This poster presents a multi-stage, highly visual approach to the quality control of metering data that produces datasets that are defensible and thoroughly validated.

While the primary goal of metering quality control (QC) is to ensure an accurate dataset at the end of the metering study, this is only possible through regular and thorough inspection of the incoming metering data. In our approach, we utilize up-to-the-minute data and a flexible charting platform to create QC reports that guide our analysts as they investigate and correct any extant data quality issues. We will demonstrate a 21st century approach to a very critical process that is usually done behind the scenes.

Mike Matheus, ADM Associates

Poster Title: Override Trends in Commercial DR programs

Abstract: Customer overrides or opt-outs can have a significant impact on kW reductions associated with commercial DR programs. This poster looks at long term trends (4 years) in customers willingness to continue to participate in DR events. We explore whether the likelihood that a customer opts out of an event changes over time and if initial opt outs are an indication of a customer's long term program performance.

Melissa Meek, NMR Group, Inc.

Poster Title: What's in a Label? Major Retailer Websites Reveal Rampant Efficiency Mislabeling

Abstract: Research reveals that most shoppers examine appliances online before purchasing (Forbes, "Customers Like to Research Online but Make Big Purchases in Stores, Says New Retailer Study", May 2016), and the percentage of consumers buying appliances online is on the rise (NPD, "Online Major Home Appliance Sales Are On the Rise," February 2017). With so many consumers seeking information online about appliances, it is critical that they have access to accurate energy efficiency labeling. However, preliminary results from a study utilizing web scraping to collect product data from two major home improvement retailers reveals that many ENERGY STAR- and CEE-qualified products have missing labels. Perhaps even more troubling is the finding that other non-qualified products are often mislabeled as ENERGY STAR- or CEE-qualified. If consumers shopping online do not have access to accurate information about energy efficiency, they could inadvertently select inefficient products.

This study examines labeling for numerous appliances. For a products pricing study, the authors utilized web scraping to collect data on pricing and features on washers, dryers, air conditioners, dehumidifiers, and air cleaners from two home improvement retailers. In several cases, a comparison of products as listed on websites and current ENERGY STAR products lists found only six in ten products to be labelled correctly. While some appliances showed correct labeling in the majority of cases, notably dryers (93%) and top-loading washers (92%), only 63% of front-loading washers and 61% of dehumidifiers had the correct ENERGY STAR label.

This poster will provide the results of a more systematic investigation into the discrepancy between ENERGY STAR status on retailer websites and the ENERGY STAR database, due for completion in Spring 2019. The authors will focus on common residential appliances that consumers can purchase at a home improvement retailer and are often included in energy efficiency programs: washers, dryers, refrigerators, room air conditioners, through-the-wall air conditioners, air cleaners, dehumidifiers, and LED lighting. The authors will utilize web scraping to efficiently and accurately collect data from retailer websites and will compare the ENERGY STAR status of these products to the ENERGY STAR database released on the same date. In addition, the authors will investigate CEE Tier qualifications for washers, which preliminary research found to be largely incorrect for most products advertised.

The authors will identify any patterns among incorrectly labeled products and discuss implications for consumers and energy efficiency programs. While ENERGY STAR databases are updated daily, it is unclear how often product information on retailer websites is reviewed. For products available at more than one retailer, the authors will investigate whether they are labeled consistently and correctly across sites.

Given the growing number of people using the internet to research or purchase appliances, incomplete or incorrect information about a product's energy efficiency is a major concern for consumers, retailers, and program administrators. This poster seeks to help improve the labeling so consumers can more easily and accurately select energy efficient products.

Liza Minor, E Source

Poster Title: Trends in Utility Evaluation Spending

Abstract: What does utility evaluation spending look like today, how has it changed over time, and what can we learn from these trends? By collecting data from regulatory filings and annual reports, we can track how much utilities are spending on evaluation as a percentage of their DSM budgets. This analysis will help identify any long-term trends in evaluation spending from 2012-2018, and help us understand if we are becoming more efficient at evaluation over time or not. Using our proprietary database, we can dissect data across a multitude of factors, including by utility type, program type, region, and year. We will also compare planned and actual spending and determine which types of programs are more expensive to evaluate. This analysis demonstrates the bigger picture of the audience's work and how it fits into the broader DSM industry spending in 2018. Utilities can also benchmark their recent spending on evaluation compared with their peers. For the poster, we would have charts and graphs illustrating the evaluation spending by:

- Portfolio size
- Program administrator
- Program type
- Region
- Years (2012-2018)

We will be able to demonstrate, on screen, many ways to sort the data, drill down into more detail-or layer other factors on top of the data-in real-time. This is the only source in the industry to aggregate all this data into one place. It provides the most accurate representation of the size of the evaluation industry.

Claire Miziolek, NEEP

Poster Title: EISA 2020 or Bust. A Reexamination of DOE Rulemaking, Developments, and Implications for Programs

Abstract: At IEPEC 2017, the authors presented on implications of the General Service Lighting standard for programs and evaluators. At the time, we thought it was a done-deal, without more to say in the future. Boy were we wrong! Since then, things have heated up and gotten even more interesting. Doesn't every great (IEPEC) party deserve at least one poster on EISA 2020!?

As we know, over the past several years the residential lighting market has been going through unprecedented change. Consumers are swapping out inefficient incandescent and halogen lamps for CFLs and LEDs in record numbers. These changes are being spurred largely by two separate but related efforts: programs funded by program administrators and federal efficiency standards. Program administrators have been leading the way to a brighter future by providing incentives to help bring down the cost of energy-efficient bulbs. Starting with CFLs and transitioning now to LEDs, program administrators have worked hard to introduce customers to energy-efficient alternatives and persuade them to turn away from the familiar traditional incandescent lamps they grew up with. A lot has changed over the years, but program administrators have remained committed to seeing the market transform.

In parallel with these efforts, the federal government introduced lighting efficiency standards intended to transform the residential lighting market. The Energy Independence and Security Act (EISA), signed into law in 2007, set a three-phase path to change the lighting market, starting in 2012 with the phase out of traditional incandescent bulbs. The first phase was largely successful, but there was room for additional savings with super-efficient LEDs now available in the market. The second phase of EISA, as outlined in the 2007 law, sets a path to transform the lighting market even further by 2020; as we get closer to the deadline, however, things have gotten more interesting. The EISA law directed DOE to complete a rulemaking by a critical deadline, which they failed to do; thus, a backstop has been triggered and a 45 lumen per watt standard is set to go into effect on January 1, 2020. The backstop would essentially leave LEDs as the only general service lamp for sale in the market. However, there is debate as to how things will really play out, with stakeholders on all sides set to file suit. This means the outcome of Phase 2 will likely be decided in court.

In this poster, we will present the latest news and findings related to EISA and carefully examine the various elements of this complex issue. The poster will be of extreme interest to program administrators and regulators as they prepare for the future. The poster will detail specific program strategies in the face of Phase 2, including effective strategies for capturing savings prior to 2020 and opportunities post 2020. Insights and data will be drawn from careful examination of the underlying laws and rulemaking, in-depth interviews with a variety of industry stakeholders, and recently completed shelf-stocking and saturation studies to demonstrate the impact of new federal regulations on the market. The party never stops for EISA!

Monica Nevius, NMR Group, Inc.

Poster Title: Visualizing Net-to-Gross: Where is my Google Map?

Abstract: Evaluators and program administrators agree that net-to-gross (NTG) can be a murky topic which requires accounting for varying perspectives that must be considered individually and in aggregate. NTG studies typically go through many turns, twists, and detours. Unfortunately, Google Maps cannot give NTG directions--but wouldn't it be helpful to have a map? This poster will provide a map for assessing NTG using self-report surveys with installation contractors and participants.

The study on which this poster will be based was published in 2018. It estimated measure-level retrospective and prospective NTG ratios for residential HVAC and water heating equipment rebated by a program in a Northeastern state. The rebated equipment comprised heat pump water heaters, central heat pumps, central air conditioners, ductless mini-split heat pumps, gas furnaces, and gas boilers. After balancing answers to NTG questions from participating customer and contractor surveys, it relied on a consensus group to develop and recommend the final NTG ratios.

This poster will guide viewers through the process by which evaluators accounted for the varying dynamics that play into NTG – largely, end-user decision making and contractor strategies. The poster will lay out attractive and easy-to-navigate flowcharts illustrating (1) complex algorithms, (2) sensitivity analyses, and (3) iterative adjustments needed to marry customer free-ridership to contractor free-ridership.

With touches of text and tables, the poster will share the hurdles faced in interpreting responses and explain why no single result could be examined in isolation from other factors that demonstrate a program's true impact. The largest hurdle was contractors' misinterpretation of complex questions. For example, when asked to estimate the percentage of units that would have been installed in absence of the program, some said all units would have been installed but when asked why in an open-ended question, they explained with responses such as "too expensive" that implied the respondent did not understand the logic of the question. Therefore, evaluators needed to justly and qualitatively revise the free-ridership rates that were based on numeric responses. The poster will offer suggestions of how to handle these scenarios. Another hurdle was addressing differences between replace-on-failure and early-retirement rebates. In this state, the latter are much higher than the former, so distinguishing between them is important. This study focused on rebates for replace-on-failure equipment and worked in collaboration with another team studying early-retirement rebates, both through the same survey instrument. This involved thoughtful question development and careful coordination of questions to ensure that contractors reflected on their experiences for replace-on-failure and early retirement installations separately.

Finally, the poster will recount the consensus group's rationales for its final recommendations and why the group chose the "route" it took. This poster will be accessible to all audiences, helping new evaluators learn the ropes and offering clarity to seasoned professionals.

Jerrad Pierce, NMR Group

Poster Title: EF, MEF, and IMEF, Oh My!

Abstract: This poster will address the question of how to account for older equipment of unknown efficiency or efficiency reported in deprecated units when conducting analyses with modern software or a sample of mixed vintage.

Evaluation work frequently requires searching for efficiency details of specific models of lighting, appliances and HVAC equipment. While information is often publicly available, there is no comprehensive repository. This means that analysts must comb through data maintained by a variety of different stakeholders and purveyors, all of whom use different tools with distinct features. This can make extracting the desired data tedious and costly. In addition, data sources are often incomplete due to the frequent archiving of older models. Finally, when efficiency standards and specifications are revised, not only are permissible levels tightened but sometimes the regulated units change as well. For example, in the past two decades clothes washers have switched from energy factor (EF) to modified energy factor (MEF) and then to integrated modified energy factory (IMEF). How should one account for older equipment of unknown efficiency or efficiency reported in deprecated units when conducting analyses with modern software or a sample of mixed vintage?

The authors have developed an internal equipment efficiency data warehouse drawing on sources such as the EPA's ENERGYSTAR Product Finder, AHRI's Certification Directory and the California Energy Commission's MAEDBS, as well as direct observations from field studies. We are using this archive of hundreds of thousands of devices to explore summary statistics of equipment efficiency by ENERGY STAR status over time, compare these to federal minimum standards, and assess whether average efficiencies or federal minima are a better proxy for missing data. This analysis may also reveal if there are standards which lag behind manufacturers' abilities. Finally, we are deriving conversion factors for altered efficiency standards of clothes washers & dryers, room air conditioners (RACs), and water heaters, and comparing these to the few official conversion formulae available for these equipment types. Preliminary results suggest that CEER and EER ratings for RACs may be treated as equivalent for legacy equipment.

The database has already been compiled and the analysis is underway. The results will be ready by March 2019. The findings will be brief but of immediate use to evaluators working on studies that address any of these equipment types. The poster will feature numerous charts, particularly histograms and scatter plots, to help viewers interpret the analysis.

Shirley Pon, NMR Group

Poster Title: Age Before Beauty? Stability and Change in Recycling Program Savings Over Time

Abstract: Appliance recycling programs have long held a place in efficiency portfolios. These programs produce energy savings by using incentives and outreach to encourage participants to retire inefficient secondary appliances. In addition, recycling programs provide a valuable service by facilitating the pickup of bulky appliances. However, as efficiency standards have increased, program administrators, regulators, and evaluators have raised concerns about the energy savings being realized by the current vintages of recycled appliances. They also have questions about what participants realistically would have done with the appliances in the absence of the program. In short, do the current savings continue to justify a place for appliance recycling programs in program portfolios?

In this poster, the authors will explore the stability and change in factors that affect energy savings resulting from an appliance recycling program over time. In addition, we will provide details on customer satisfaction and experience, including how customer experience varies based on key demographic factors.

Following an approach advocated by the Uniform Methods Project (UMP), the authors used a combination of program tracking data, responses from an on-line survey of 365 appliance recycling participants, and the Residential Energy Consumption Surveys (RECS) to update gross and net energy savings. Updated parameters include appliance age and date of manufacture, size, door configuration, location in unconditioned space, partial use, and free-ridership. The poster will use tables and charts to compare the current parameter values and savings to those obtained in a 2011 study of the same program and to other recent appliance recycling program evaluations. The poster will discuss factors that have affected refrigerator and freezer savings over time. For example, physical factors such as the increased size and prevalence of side-by-side door configuration have countered the efficiency gains achieved by younger units.

The poster will use informational graphics to explore issues related to the physical and financial feasibility of program alternatives, program satisfaction, and demographic differences in the participant experience. We will compare refrigerator with freezer respondent actions taken prior to program participation, their belief of their likelihood to overcome the challenge of physically removing the appliance and likely actions in the absence of the program, and their willingness to pay for removal. The poster will conclude by highlighting demographic differences in the willingness to pay for removal or indicating the need for assistance from a hauler by age group as well as free-ridership impact.

We think presenting as part of the poster session will allow the authors to engage in one-on-one dialog with attendees about the nuances of appliance program evaluation, as well as the importance of recycling programs to customers. This poster will provide information that will help program administrators and regulators think through key issues about the future of appliance recycling programs, in a market where older appliances are more efficient than they have been in years past.

The research underlying this poster is complete and currently publicly available. The authors may have the opportunity to update savings using program results from 2018 prior to presentation.

Jared Powell, NMR Group

Poster Title: This Home Checks All the Boxes! Using On-Site Home Checklists to Assess Heat Pump Technical Potential

Abstract: Program administrators interested in efficient electric heating and cooling systems are increasingly focusing on ductless minisplit heat pumps (MSHP), but is it reasonable to expect MSHPs to replace many customers' existing systems? How much heating and cooling load can MSHPs reasonably offset in a typical home? A recent study in a Northeastern state developed a unique and flexible scoring system designed to help on-site inspectors estimate the proportion of a home's conditioned floor area suitable for an MSHP installation. Using the results of real-world home inspections, the study developed bottom-up estimates of the technical (rather than economic) potential of MSHP installations in the state, focusing on the parts of the home where MSHP installations were most feasible.

This study developed a checklist-style scoring rubric and used this tool at 75 on-site visits (single and multifamily homes) recruited for a residential appliance and mechanical system saturation survey. The scoring tool allowed technicians to make quick, systematic, and replicable assessments of a home's suitability for an MSHP installation based on room-level assessments. The rubric incorporated factors such as room type and size, age of the existing heating/cooling system, whether rooms were uncomfortable in the summer or winter, and the presence of electric resistance heating. Room-level scores were aggregated to create an overall MSHP feasibility score for each home. The poster will display an easy-to-follow decision tree that visually demonstrates the scoring criteria.

The on-site visits also included energy assessments based on HERS rating protocols, covering building envelope, mechanical systems, lighting, appliances, and qualitative assessments of air infiltration and duct leakage. Using these data, the study calculated Manual J heating and cooling loads for each home and apportioned the loads into high, medium, and low MSHP feasibility tiers using the room-level assessments made in the field. The study showed that 60% of the average home's floor area would be a strong candidate for MSHP installations. This represents tremendous technical potential for program sponsors to consider shifting homes to efficient, electric heating and cooling systems. The poster will also display the digital schematics the study created that color-coded each home's floor plan based on the room-level feasibility assessments.

This poster will show program administrators and evaluators how to use the MSHP scoring system to analyze their housing stock to make assessments of the likely MSHP potential in their territories. A key focus of the poster will be to include suggestions for other customizable scoring criteria that researchers can use to develop their own modular scoring systems, depending on their electrification priorities. Program stakeholders can readily incorporate these tools in on-site visits for evaluations or weatherization programs and also in surveys that supplement on-sites. The poster will show how to systematically implement these tools in the field and turn the results into home-level scores. Finally, for studies without on-site visits, this poster will also suggest simple tools that can be used to inform MSHP potential efforts in other states, based on the room and home-level results of this study.

Keith Rivers, Evergreen Economics

Poster Title: I Can See Clearly Now: Visualizing the Market for Residential Window Retrofits

Abstract: There exists significant energy savings potential from retrofitting residential windows, yet there are market barriers that have yet to be addressed to lead to widescale upgrades. This poster will present graphical information on current technical innovations and market conditions and offer a jumping off point for strategizing how to address this saving opportunity. Using R statistical software's charting capabilities (e.g., ggplot2), we will create innovative graphics to illustrate barriers to increasing market penetration, heat maps showing where efficient window market adoption is most prevalent, and line graphs which will chart where future market share is expected to be in five years. As utilities are faced with challenges when designing their energy efficiency portfolios (such as higher cost-effectiveness targets and inability to count on highly cost effective and high volume measures such as CFLs), gathering current market data is crucial to allow a fresh look at program offerings to support the development of innovative and cost-effective program strategies.

The poster will rely on data from a market research study conducted for a large west cost utility to inform a number of key topics related to 0.20 U-factor windows in residential applications, including:

- Market availability
- Regional variations in window performance
- Incentive programs aimed at increasing window technology adoption
- Barriers to increasing market penetration

Research for this study included interviews with experts and manufacturers as well as an extensive literature review of previous residential windows research and recent publications on the efficient windows market. This review included a deep dive into two well-known programs, including the Department of Energy's R5 Volume Purchase Program and the ENERGY STAR Most Efficient Program.

The Department of Energy's R5 Volume Purchase Program is a market transformation program that aims to reduce the incremental cost of highly insulated windows compared to ENERGY STAR windows, and raise the public's and buyers' awareness of efficient windows technologies. Similar to the R5 Program, albeit with differences in the specifics, the ENERGY STAR Most Efficient Program goes beyond the standard ENERGY STAR requirements, recognizing products that provide the most energy efficiency through the latest technological innovations.

This poster will be of interest to researchers wishing to understand the underlying barriers to market penetration in the efficient windows market, as well as those seeking to understand expert opinions on where the market will be within the coming years. As energy efficiency program providers look to find new and innovative program strategies to achieve their goals in a changing landscape, current and robust market data are critical to support those efforts. The poster's use of visuals will be an effective method to convey a range of technical and market data for a wide variety of conference attendees.

Nicole Rosenberg, NMR Group, Inc.

Poster Title: Do You Know What's in Your Basement? Comparing Knowledge with Reality

Abstract: Is that a boiler or a furnace? As energy-efficiency evaluators, we quickly learn that homeowners often have little knowledge about the energy using equipment in their home or the characteristics of the building. However, visiting homes to inspect and catalog equipment is expensive. This poster will explore how we can overcome customers' knowledge gaps about their homes and cost effectively leverage existing data to make effective use of customer self-reports for baseline studies.

In 2017 and 2018, the authors fielded web-based residential appliance saturation surveys (RASS) with thousands of customers in two neighboring Northeast states – 900 surveys in the smaller state and over 2,400 in the larger state. Respondents reported on a wide variety of end-use equipment in their homes, enabling us to measure end-use penetration and characterize other energy-related details in their homes. Our trained technicians then visited subsets of those customers' homes where they verified and supplemented customers' reports based on actual observations. Comparing the subset of on-site-visit customers' survey responses with our on-site observations yielded adjustment factors (i.e. observed penetration divided by reported penetration). Applying these factors to the full web-survey sample refines the full population's self-reports. Looking at the results from one state, it was clear that for some end uses, customers provided good data on the equipment in their homes. For example, customers correctly reported water heating fuel type and presence of cooling systems. For other end uses, verification visits revealed that customers simply were unaware of the types of equipment in their homes – especially types of heating and water heating systems. Most notably, customers over-reported the presence of advanced power strips, even after being shown images of them.

These differences are very informative for evaluation purposes. This poster will (1) include comparative charts to identify the types of information that customers simply do not know and should be omitted from customer surveys to conserve survey "real estate" and (2) illustrate how to use adjustment factors for years to come by applying adjustment factors to relatively inexpensive web survey results. All data collection is complete. The report in one state has been finalized, and the other will be finalized in January or February 2019.

Zach Ross, Opinion Dynamics

Poster Title: “Gassing Up” Savings: Emerging Natural Gas Technologies

Abstract: "As the market for energy-using technologies nationwide continues to evolve, energy efficiency program administrators and product manufacturers continue to search for new technologies to produce energy savings into the future. The majority of nationwide energy efficiency spending is focused on electric energy, and unsurprisingly, the majority of commonly-discussed emerging technologies are electric measures. However, a number of new or repurposed technologies present significant potential for natural gas savings moving forward. With traditional gas energy efficiency measures (e.g. high efficiency furnaces and boilers) beginning to saturate the market, program administrators will need to turn to these new technologies to maintain their energy efficiency portfolios. This poster will present a number of these emerging natural gas technologies, their unique characteristics, and key nuances to be considered in future evaluations.

We will cover:

- Venturi steam traps
- Gas-fired heat pump hot water heaters
- Rooftop gas HVAC
- Combination gas space and water heating systems

For each technology, we will provide an assessment of the market potential for these technologies based on publicly available research studies to provide the audience with an understanding of how significant the impacts from these technologies could be. We will then describe their current status in the market to clarify the time horizon for the potential impacts from these measures. Finally, we will identify key areas where these technologies will require evaluation focus moving forward. For example, the majority of the measures identified above require significantly more complex installations than baseline options to yield their full savings potential, and so careful evaluation of installation practices and quality will be crucial to ensure that these technologies are seamlessly integrated into energy efficiency portfolios moving forward.

Chris Russell, NMR Group

Poster Title: If You've Got It, Flaunt It: Maximizing Inhouse Data for Purposes Beyond Program Evaluation

Abstract: Energy efficiency programs produce a wealth of data, but at a considerable price. The data sets serve program tracking, savings verification, and evaluation needs, but rarely do programs repurpose data for other innovative uses. This poster will describe results from an analysis that will mine program tracking and other data sets to answer two pressing questions: What combinations and magnitudes of home retrofits can help achieve net-zero home energy use? Can existing data be used to identify homes that are good candidates for net zero retrofits?

Net zero energy use has traditionally been the exclusive province of new construction programs. The assumption that existing homes cannot be cost effectively retrofitted to net-zero energy use excludes millions of homes nationwide and necessitates a focus on new homes, depleting vital resources and producing externalities and negative non-energy impacts. One program administrator (PA) in the Northeast believes that some home styles and vintages may be well suited for deep retrofits that, alone or paired with typical residential renewable systems, could yield net zero energy use. The PA further posits that a segmentation study that combines internal program and baseline data, third-party data, and state and federal data could possibly identify the characteristics of those homes, their locations, and the profiles of their occupants. The PA envisions density maps of these homes to display target areas that could be utilized by a net-zero retrofit pilot program.

The PA asked the authors to conduct the analysis needed to determine if net-zero retrofits are possible, and, if so, generate profiles of those homes and occupants and describe the combinations of measures that could make net zero retrofits a reality. To accomplish this, the authors will use building energy optimization software to identify multiple packages of measures that could achieve net zero energy use for selected home types. The modeled home type characteristics will then be matched to existing housing stock to identify geographic areas with the highest concentration of homes with the most net zero potential. Existing homes will be matched using free publicly available data. Once the actual homes have been identified and matched the results will be mapped at the ZIP Code and county levels to display the concentrations of homes that would best be served by a net zero energy retrofit pilot program. The maps will maximize the use of color and shading to clearly exhibit the results.

This poster offers two important contributions to the energy efficiency field. First, it will demonstrate how existing program and similar data can be mined to answer pressing planning and evaluation questions. Reanalysis of existing data costs far less than net primary data collection and analysis. In short, PAs potentially have a wealth of available data that can be productively mined. Second, the study will provide insights into whether certain types of existing homes can achieve net zero energy use through deep retrofits and results reviewed through data visualization. The work on this research has already begun and will be concluded by March of 2019.

Morgan Smith, Itron

Poster Title: Seeing is Believing: Visualizing Customer and Utility Impacts of Emerging Technologies

Abstract: The electric grid is in the midst of a dramatic shift, facing new volatile pressures. These pressures arise from a variety of technological shifts, including increasing behind-the-meter (BTM) distributed energy resources (DERs). Now more than ever, utilities seek to shift load from low-generation/high-consumption time periods to high-generation/low-consumption time periods. In the residential sector, utilities are working to incentivize this shift by implementing residential time-of-use (TOU) rates. Beginning in 2019, California is implementing a mandated default TOU rate for all residential customers. To better plan for the electric grid of the future it is imperative to understand how new rate structures and the adoption of BTM DERs might impact the annual energy costs and load shapes of utilities and their residential customers.

As part of a smart home pilot, we developed an interactive dashboard to illustrate how both customer and utility costs, as well as underlying load profiles, shift as emerging technologies and TOU rates are implemented. Customer costs are measured by their electric bills while utility costs are measured by Locational Marginal Prices (LMP). The dashboard allows the user to visualize the various impacts from a variety of potential tariff and technology shifts including changing from a tiered to a TOU rate, adopting alternative electric vehicle charging schedules, implementing solar photovoltaics (PV), and adopting advanced energy storage (AES).

The dashboard helps the user visualize how a potential problem can be turned into a win-win situation with appropriate rates and smart controls. For example, wide spread adoption of electric vehicles may lead to an increase in peak demand, increasing costs to both the consumers and the utility. If smart EV chargers are applied, the increased load shifts to early morning (midnight to 6am). This results in drastically lower costs to the utility. The timing of EV charging, however, does not impact the customer's bill on a tiered rate. Combining a smart charger with a TOU rate leads to significant customer bill savings, leading to the win-win situation that utilities are searching for in the future. Adding an AES system, the utility is able to increase savings by shifting load from hours with high LMP to cheaper hours during the day. Customers on a TOU rate are also able to realize cost savings from an AES system.

The rate analysis dashboard will be displayed as a live demo allowing the user to visualize the expected impact of combining different rate structures and a variety of emerging technologies. The dashboard will illustrate select residential and technology load shapes, presenting the dramatic shift in load that is possible under alternative technologies and price signals. One of the strongest forces available to alter existing and future pressures on the grid are price signals. The dashboard presents calculations of residential bills and utility costs under these alternative scenarios. Visualizing how costs and load profiles change under a variety of rate structures and technology combinations will help utilities plan strategically for the grid of the future.

Michael Strom, NMR Group

Poster Title: Anything They Can Do We Can Do Better: Examining Major Retailer's Pricing Trends to Optimize an Efficiency Marketplace

Abstract: New products enter the market daily and traditional evaluation methods cannot account for the rapidly changing options available to consumers. Webscraping is an innovative and inexpensive tool that can be used to provide frequent updates on pricing, features, and regional availability of appliances and other products of interest to program administrators. This tool can be used to monitor price changes for products in existing programs as well as collect data in advance of planning for future programs or other market interventions. Utilizing webscraping in place of manual data collection procedures cuts time and resources by 75%; for other applications, it expands the scope and efficiency of a project beyond what is feasible through traditional collection methods.

The authors harnessed this tool for a Northeastern utility, which provides an online marketplace for its customers where customers may purchase energy-saving products, or claim rebates offered for a variety of products covered by their programs. This utility periodically surveys the market to collect pricing information on these products. The authors identified online retailers that also sold products available on the marketplace and automated the data collection, providing price updates more frequently and efficiently than prior manual efforts. In this case, the authors confirmed the stated retail price on most products in the utility's marketplace catalog is similar to the average price at other retailers, affording a measure of confidence that the online platform was offering products at competitive prices. For the small portion of products with an average retail price lower than the marketplace, the authors recommended these products as candidates for a price reduction.

The authors also utilized webscraping to collect data on pricing and features from six product categories at two major home improvement retailers. Because these major retailers offer location-specific services to their customers, notifying them of in-store sales and availability, the authors collected product data from retailer locations within the utility's service area. The authors analyzed trends in pricing and features which revealed some notable findings, including: • The relationship between price and ENERGY STAR qualification is imprecise for air conditioners, air cleaners, and dehumidifiers. For clothes washers, dryers, and ductless mini-splits, ENERGY STAR-qualified products and products with higher CEE Tier qualifications are more expensive than less efficient products with similar features. • For accurate price comparisons, products with smart features (Wi-Fi enabled, connected, or learning devices) should be considered separately, regardless of ENERGY STAR status. Products that are Wi-Fi enabled or app-compatible are more expensive than products with similar sizes or functions that do not have smart features. Webscraping enabled the authors to collect all product data to see which features were most influential in predicting price; a traditional data collection approach would limit the number of variables to be considered for analysis. This project demonstrates that webscraping is a useful "big data" application that can be leveraged for projects, including questions about program design at the local level.

Jun Suzuki, Research Into Action

Poster Title: Multifamily Tier II Advanced Power Strip Pilot Evaluation

Abstract: The poster presents the evaluation findings of Multifamily Tier II Advanced Power Strip (APS) Pilot implemented in 2017.

Tier II APS augment the load sensing control outlet that characterizes Tier I APS with an external infrared (IR) sensor or motion sensor located near the TV. Tier II devices turn off power either when the household turns off the master load or when the device detects the user has left the area. The pilot recruited 250 tenants from 21 multifamily properties (both market-rate and affordable) in Oregon. Study participants were randomly assigned to one of the two treatment groups that received Tier II APS (to one of the two manufacturers – Embertec or TrickleStar) or to the control group that received a standard power strip. These devices were delivered as a 'leave-behind' with an instruction for users to install using the TV as the master control and plugging peripheral entertainment devices into other outlets. Field staff returned about two weeks later to collect the meter and capture information on how tenants had connected their entertainment devices to the APS.

The poster content will include: a description of the pilot and the study design; energy savings findings; device configurations findings; post-pilot participant survey findings; and a series of recommendations to enhance the design of similar pilot studies and program implementation. The poster will be filled with visual contents such as photos of APS devices, graphs and tables of findings.

Additionally, these findings will be compared against the literature of other Tier II APS studies, especially the White Paper "Tier 2 Advanced Power Strips: Examining Energy Savings Potential in a New and Changing Market" by Johnson Consulting Group (September 2017), in which savings and field-testing methodologies of eleven recent Tier 2 APS studies are documented. The findings of this study will add values to the literature given that the testing method used for this study – comparing savings of the treatment groups with Tier II APS devices and the control group with standard power strip – is unique among studies.

Kiersten von Trapp, NMR Group

Poster Title: Are You Going to Use That? Understanding Lighting Purchase and Storage Patterns in a Transforming Market

Abstract: "The residential lighting market is undergoing dramatic changes brought on by new technologies and increases in efficiency standards. We can see the impact on sales through National Electrical Manufacturers Association (NEMA) shipment data as well as program tracking records. As LEDs are displacing CFLs on store shelves, what effect is this having on replacement and storage trends in both program and non-program states? This study will improve our understanding of customer behavior during and after purchase and enable us to accurately estimate long-term in-service rates and changes in behavior over time. Saturation studies have long revealed that customers have a large stockpile of bulbs in storage (enough to fill up to 30% of sockets), however few studies follow up with customers to learn what they actually do with stored lamps. This poster will explore stated customer intentions as well as observed behavior based on data collected over seven years. We will explore how the type and number of bulbs in storage impacts replacement decisions. The poster will present lighting inventory data from over 3,500 residential on-site visits conducted between 2013 and 2018 in six states that represent a mixture of program and non-program areas. Notably, the six states have been part of a panel study where we have returned to the same homes up to seven times, tracking installation, storage, and purchase trends over time. At each visit, we ask the homeowners:

- When did you purchase this installed or stored LED?
- What are your future plans for this stored bulb?
- (If plan to use) What type of bulb will this stored bulb replace?

While we record these stated intentions each visit year, we are also able to observe what has actually happened to these bulbs due to the nature of the panel study. The on-site lighting data will provide essential insights into a range of lighting decision-making issues, which will be valuable to those seeking a greater understanding of consumer purchasing habits including:

- Are homeowners stockpiling incandescent bulbs?
- What are customers choosing to install and purchase in the context of the incandescent bulb phase out (EISA)?
- How do installation and storage choices differ by demographics? Technology?

The poster will also present data purchased from a nationwide panel of mobile app users who upload their receipts and responded to triggered surveys to recent bulb purchasers. The surveys were distributed in two Northeastern states, one still running an active lighting incentive program, and one that formerly offered incentives but no longer does. In 2017 we fielded a survey to 100 panelists in the program state and 160 in the comparison state. The bulb purchase data and surveys provide essential insights into a range of lighting purchase decision-making issues, including:

- How often do shoppers intend to buy lighting when they visit a store, and how specific are their intentions?
- What bulb technology are shoppers choosing when they make the decision to purchase lighting before arriving in the store? During the shopping trip?
- How does awareness of efficient lighting choices differ by program/non-program state?

Eric Wilson, National Renewable Energy Laboratory (NREL)

Poster Title: Developing end-use load profiles for the U.S. building stock

Abstract: The U.S. Department of Energy's Building Technologies Office is funding a 3-year research effort to produce updated end-use load profiles for the entire U.S. building stock. Researchers from three national laboratories are collaborating with industry partners to collect and evaluate end-use and whole building load profile data from a wide range of existing sources. Critical gaps will be addressed with additional data collection and disaggregation techniques. Ultimately, the data will be used to calibrate national-scale building stock models and produce hourly end-use load profiles at bo-th aggregate (average) and individual (typical) building scales, for regions and building types across the U.S. building stock. Most importantly, the models can subsequently be used to generate time-of-savings shapes for both existing and emerging energy efficiency and demand response technologies.

This poster will highlight the various applications of end-use load profiles, available data sources, and critical gaps. The evaluation community will learn about what to expect from this new effort to understand load shapes and how big data and data science will be applied to the problem.

Lisa Wilson-Wright, NMR Group

Poster Title: Watt LED You to that Bulb?

Abstract: Energy-efficiency programs seek to increase the adoption of energy-saving measures by using incentives, outreach, and education to overcome market barriers and take advantage of market drivers. Program administrators and implementers design programs with an initial set of barriers and drivers in mind. But what happens if those barriers and drivers change? This poster explores the barriers and drivers to the purchase of Light Emitting Diodes (LEDs) as cited by active lighting buyers in one Midwest electricity service territory. The evaluators conducted in-store intercept interviews with 218 active lighting buyers of LEDs and other bulb types to learn more about what they consider when buying light bulbs and the influence of the program on their decision. All stores sold program LEDs incented using an upstream model. Some of the intercepts coincided with program promotional events, while others took place on non-promotional days. This poster will use graphs and other visuals to describe the current barriers and drivers cited by lighting buyers to the purchase of program LEDs, non-program LEDs, and other types of light bulbs. The poster will describe the results of research that is currently complete and under stakeholder review., so we provide an overview of planned poster content in this abstract. The results will be finalized and publicly reportable well in time for development of the poster and accompanying paper and presentation at IEPEC in 2019.

We will compare survey responses with the drivers and barriers that underlie the program design, including, but not limited to, LED price trends. The poster will draw distinctions between those responses and bulb sales that occurred during and outside of promotional events. The poster will address the importance that light bulb purchasers place on price, the ENERGY STAR label, program marketing materials, and energy efficiency more generally. The poster will conclude by addressing some of the challenges faced in conducting this research, primarily increased retailer reluctance to allow in-store surveys of their customers, and the implications for future use of this important evaluation methodology.

We anticipate that discussions during the poster session will spark open dialogue about the importance of in-store intercepts to program evaluation but will also identify viable alternatives that allow evaluators to gather similar types of information outside of retail locations.

Kai Zhou, Opinion Dynamics

Poster Title: Foundation for Data Automation

Abstract: "Poster Abstract Foundation in Data Automation for EM&V 2.0 Kai Zhou, Opinion Dynamics Research Area: EMV 2.0 One of the core differences between traditional EM&V and EM&V 2.0 is the ability to do real-time data analysis to get real time results through the implementation of repeatable, efficient and consistent data ingestion systems. Executing quick and accurate data analysis relies heavily on the quality of data we collect. However, obtaining good data—data in the right structure with the right information—is often time-consuming and requires a heavy upfront time investment. One solution to this problem could be streamlining and changing the multitude of ways that utilities, contractors, and smart devices collect data. However, this solution is not feasible in the short term, and instead, we need to build on top of the existing data systems in place. From the perspective of a developer, the foundation of an EM&V 2.0 system that can perform real-time analysis can be broken down into 5 key steps:

- Setup – Locating data sources, import, schedules for updating data, and data management
- Ingestion – Data cleaning, normalization, standardization, and adding auxiliary information
- Analysis – Combining data, performing various data aggregations and data reshapes
- Visualization – Creating interactive dashboards that allow users to explore and navigate the analysis data
- Reporting – Highlighting interesting findings from the dashboard and make sense of it in context of the research questions

This poster will focus on the data setup and ingestion aspect of the process and outline some of the challenges and issues to consider when developing a working and viable EM&V 2.0 product. Because this mechanism borrows knowledge from not only Energy Efficiency, but also computer science and data science, it will also introduce new concepts to consider including:

- How to think about and use meta-syntax and meta-data – By looking at characteristics of the data that we received in the past such as labeling, formatting, string complexion, numeric range, etc, we can build up expectations for what we think the data fields should be like.
- Thinking about coding less as a series of steps and more as a system where the code can assist the user in making decisions to meet those expectations.
- How to think about data systems – With automation processes, many of the decisions can seem like a black box. In a way, we are not working with just the data we want to process but rather we want to be able to store these steps in an additional dataset that can be leveraged in the future for doing similar work and for documentation purposes.

While nowhere near a complete system, this poster will lay out a solid foundation for future developers to consider when moving towards a future of data automation in the context of Energy Efficiency data and evaluation. By providing visual examples of processes that can be integrated into a more complex system, we hope this poster will be another first step in the EM&V 2.0 research area.