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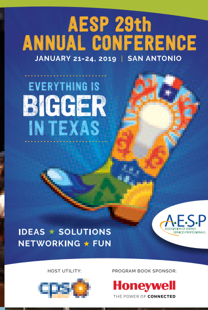

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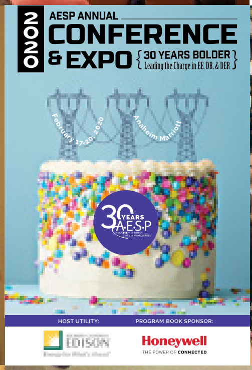





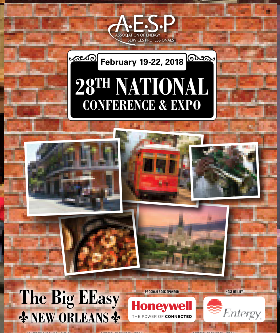

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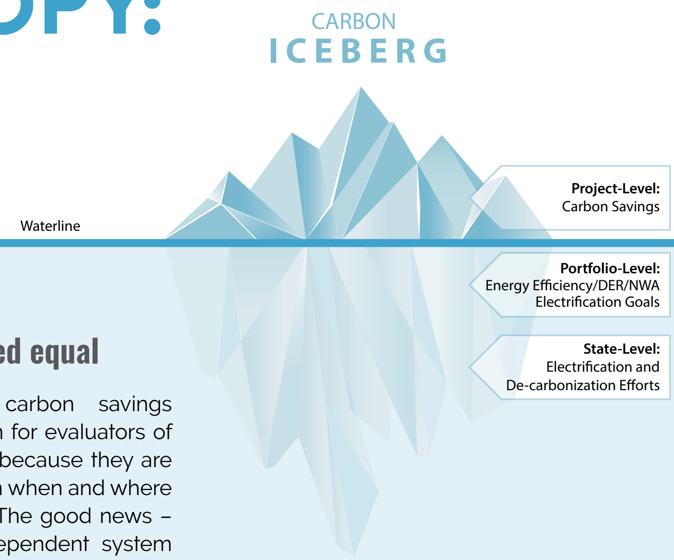
NOT A CARBON COPY: NAVIGATING THE AGE OF CARBON



By Jake Millette and Elizabeth Titus with contribution from Brian Uchtmann

Introduction

Electrification and decarbonization are coming, and utilities, regulators, and the energy efficiency industry must adapt to this reality. Think of the future of utility energy efficiency programs like an iceberg. Carbon reduction sits visible above the waterline – it will become an explicit target and major performance metric for utilities. What we don't know is how utilities and states will carry out electrification and decarbonization and what programs, incentives, and metrics will be used to drive it forward. These complex issues remain below water and out of sight. A valuable contribution evaluators can make is to help stakeholders better assess the impact current energy efficiency programs have on carbon emissions now, so that we are better prepared for the age of quantifying carbon.

Implementers and evaluators have established methods to measure energy savings, and it is time to adapt these processes to measure carbon impacts. Through an iterative approach that continuously refines savings attributed to certain equipment, the evaluation industry has become adept at fine-tuning the energy savings from light bulbs, air conditioners, and a variety of other equipment upgrades provided through energy efficiency programs. The assumptions about how the efficient equipment operates and what baseline equipment has been displaced are stated in technical reference manuals and DSM program documents. At the end of a program year or cycle, these savings assumptions are often revisited and updated. The end result is that we broadly understand energy savings resulting from DSM programs. Program administrators, utilities, and regulators can plan and rely on energy efficiency activities to generate the expected results. As utility and state goals evolve beyond specific kWh or therm targets, the iterative estimation approach that has allowed mass-market DSM programs to flourish must be modified. It is not sufficient to simply assume that installing high efficiency equipment is enough to reduce carbon emissions.

All kWh are not created equal

Accurately quantifying carbon savings can be a significant problem for evaluators of energy efficiency programs because they are highly variable depending on when and where the energy savings occurs. The good news – power generators and independent system operators (ISOs) provide the information needed to assess the carbon emission intensity of electric generation. For example, a recent study on consumption-based carbon intensity found that the average carbon emission intensity of electricity consumed in the United States in 2016 was approximately 1 lb/kWh. However, this carbon intensity varied from as low as 0.2 lb/kWh in the Pacific Northwest, to 0.5 lb/kWh in NY ISO, to as high as 2 lbs/kWh in parts of the Great Plains.[1] This variability means that the effect of energy efficiency programs on carbon emissions is highly dependent on the location where the programs are active. The relative carbon intensity and total energy consumption for balancing authorities in the mainland U.S. are shown in Figure 1.

This geographical carbon intensity variance is further complicated by the fact that the carbon intensity in each region varies over time. The hourly carbon emissions for the MISO Central and MISO North regions are shown in Figure 2.[2] The overall emissions factor for the North region is highly variable relative to the Central region because of the intermittent contribution of wind generation into the grid.

Heat Pump Water Heater Example

Consider the heat pump water heater (HPWH). As heat pump technology improves, HPWHs represent a significant opportunity for energy efficiency programs to continue

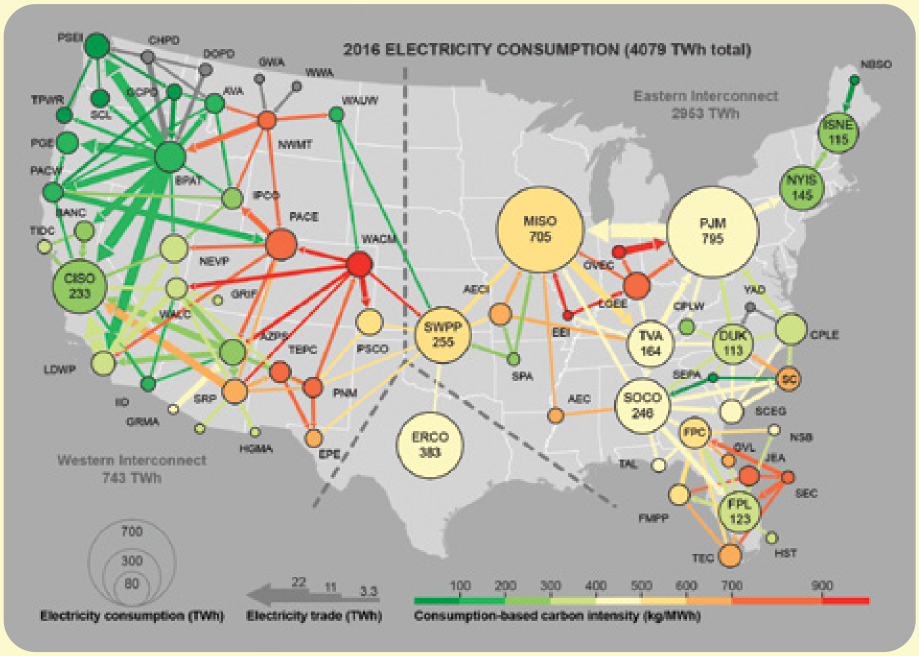


Figure 1: Carbon emissions in the U.S. electricity system.
Source: Tracking Emissions in the U.S. Electricity System[1]

BASELINE EQUIPMENT	CARBON EMISSION CHANGE	ELECTRIC DEMAND CHANGE
Electric Resistance Water Heater Baseline	**400 pound CO2 emission reduction**	**0.10 kW demand reduction**
Gas Water Heater Baseline	**263 pound CO2 emission increase**	**0.34 kW demand Increase**

to deliver savings and value to energy users. The overall energy savings from HPWHs are well documented for conversions of electric resistance heating to HPWHs. They present an attractive measure for mass-market utility energy efficiency programs.

In Minnesota, the installation of a HPWH in a commercial space is estimated to save 440 kWh[3] per year assuming that the new HPWH is installed instead of a code-compliant electric resistance water heater. The average emission factor in the MISO North region is approximately 0.92 lb/kWh. It is tempting to assume that reducing energy consumption in MISO North will reduce carbon emissions by approximately 400 lbs (440 kWh x 0.92 lb/kWh). This value is reasonable if we restrict ourselves to looking at the electric-only impacts of moving from one electric heating technology to a more efficient one.

Considering merely electric-only impacts presents a challenge as utility programs shift toward electrification and have to assess the impact of fuel switching on carbon emissions. The carbon impacts of energy efficient equipment vary widely when fuel switching occurs. Estimating electric energy impacts while neglecting reduced fossil fuel use does not provide enough information to determine what the installation of a HPWH is actually having on carbon emissions or grid loads.

To illustrate this point, consider a worst-case emissions scenario where a relatively efficient gas water heater in an internal space is replaced with a HPWH. A simple e-Quest model was constructed to determine the actual carbon emissions impacts from the installation of a HPWH in a commercial space in Minnesota. The negative heating load on the space was included in the analysis. The energy savings from the installation of a HPWH were modeled using the actual weather in Minneapolis in 2016. The hourly results of this model and hourly emissions factor of electricity generated in MISO North in 2016 were used to determine the impact on carbon emissions from the installation of this measure. The savings were then scaled to reflect the same annual hot water use and efficiencies used in the deemed savings. The results may surprise you: Installing the HPWH instead of a gas water heater actually increases emissions by approximately 263 lbs and may increase the load on the grid by 0.34 kW during maximum draw periods.[4] This information is not typically captured in TRMs or reported by energy efficiency programs.

The Take-away

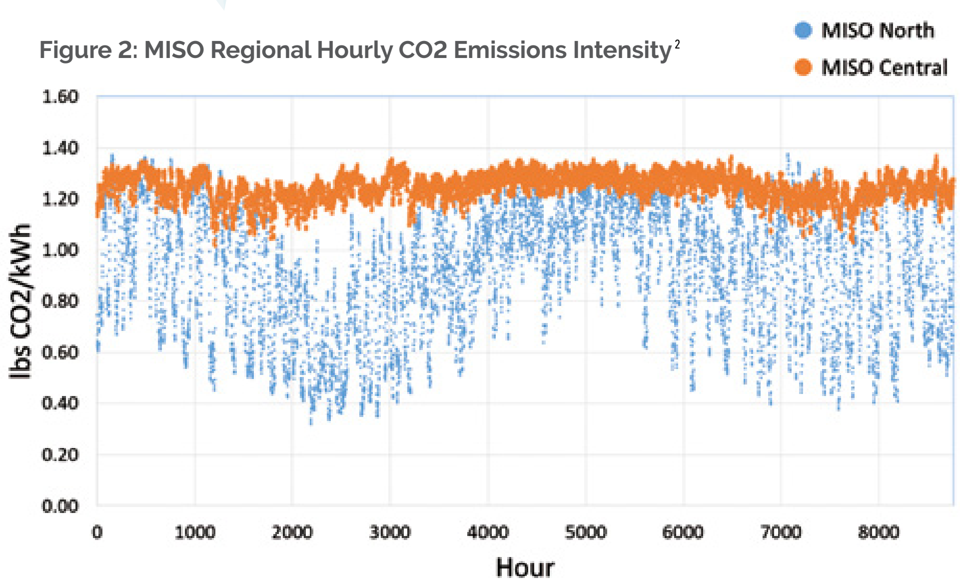
The take-away is simple. Our industry must begin to consider fuel switching and holistic building energy consumption to provide the information needed to integrate carbon goals into existing utility-funded energy efficiency programs. We can't adapt our current programs to meet future carbon goals without taking inventory of all emissions back to the source.

Throughout the Northeast as well as other regions, state and utility energy plans are beginning to respond to broadened policy goals that establish longer term carbon reduction targets, such as the "80 x 50" goal (reduce carbon emissions 80% by 2050) in Massachusetts. These policies are counting on strategies to decarbonize buildings. How can TRMs evolve and how can evaluation more broadly evolve to meet the needs of the evolving policy environment? When we start to think about the implications for energy program planning and evaluation, the TRM issue is just the tip of the iceberg; it invites us to take a deeper look and devote thought to where energy program evaluation needs to be headed.

Furthermore, strategic electrification and integration of energy efficiency with distributed energy resources and non-wires alternatives are impacting the electric grid. States could benefit from modernized approaches to savings calculations of energy efficiency programs that enable them to link more accurately with carbon impacts. Some suggestions include:

1. **Adoption of standardized simulation-based calculation methods** supporting an expanding range of state-of-the-art energy efficiency technologies that support electrification and grid modernization. These methods will produce credentialed impacts that are specific to location and time.
2. **Updates of data management techniques.** To ensure successful grid modernization and program delivery, data processing, data storage and data access must be updated to manage an overall increase in data volume, as well as an increase in third-party data requests. California developed data sharing protocols in 2011. New Hampshire and New York are currently developing frameworks to enable online storage and safe data sharing with third parties.

Figure 2: MISO Regional Hourly CO2 Emissions Intensity[2]



3. **Implementation of reporting that help states track and respond effectively** to information about short-term progress toward our long-term carbon goals. This likely involves expanding the metrics that are used. For example, add carbon emissions metrics, including a $/metric ton avoided carbon as recommended in California, and include a fuel-neutral metric such as BTUs saved for efficiency program impacts. NYSERDA's data dashboard that reports New York's energy efficiency program performance is an example of more comprehensive and transparent program reporting. In addition, a shift in focus from annual to lifetime impact assessment and tracking may be appropriate.

Moreover, to be successful in tracking energy efficiency programs environmental and energy impacts and ensuring that the impacts are aligned with policy goals, EM&V for EE should not take place in a vacuum or within a silo. Some things that are needed:

- **Integration or embedding of evaluation with implementation** to enable rapid feedback for program optimization. This would be enabled by the advanced M&V tools noted above, particularly when combined with smart technologies to deliver data.
- **Building-level as well as technology-specific accounting.** Carbon-reduction policies, such as building performance standards that set energy consumption or emissions targets, are one example. Building energy labeling is another.
- **Revisiting baselines, attribution, and benefit-cost assessment within an integrated DER framework.** It will be important to take DERs into account to capture and understand load shapes in the context of shifting system peaks. An update to the National Standard Practice Manual is under development to provide guidance on cost-effectiveness testing for DERs. Homes with rooftop solar versus homes with grid-supplied power differ in impacts. ISO-NE is currently examining its PV forecast and the implications of behind-the-meter PV on its system peaks.

Conclusion

Back to the iceberg. By taking a look at how TRMs could capture carbon savings, we start to see that this invites thinking about what else is possible and needed for a more nuanced and complete understanding of program impacts on relevant policies. Hopefully, it helps us avoid crashing into an iceberg, and rather navigates us in the direction of a more holistic framework of methods founded on metrics, coordination and transparency across disciplines and nimbleness.

About the authors

Jake Millette is the Associate Director of Research & Evaluation at Michaels Energy. He leads impact and process evaluations, and conducts research supporting clients in the energy industry across North America.

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Contributor Brian Uchtmann is a partner and senior engineer at Driftless Energy.

References

For the list of References, go to aesp.org/page/Magazine2020references