Questions and Responses

Load Shifting: Market Potential for Carbon and Energy Savings
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Emission/Price Data Questions

1. Are you using Commission approved Integrated Resource Plans for Xcel, or are you using the proposed Integrated Resource Plan that is still under consideration. Follow up: the electric vehicle scenario indicated there would be more solar charging in non-Xcel utilities, however, Xcel is the only utility proposing a substantive amount of solar. Why the disconnect?

   We are using the proposed Integrated Resource Plan that is still under consideration for the statewide and Xcel emissions scenarios.

   The 2034 results for the electric vehicle scenario look more contradictory than they are. Both the statewide and Xcel emissions profiles show that either day or night charging offers an emissions benefit over unmanaged charging by avoiding charging during the late afternoon/early evening peak. Additionally, as the Xcel 2034 emissions are lower overall, the results are more sensitive to changes as a percent of baseline.

   Lastly, Xcel's nighttime emissions are better than the statewide's nighttime emissions, most likely because nuclear plants are a higher share of supply for Xcel compared to the entire state.

2. I did want to cross-check one assumption that I've been holding onto for ISO-NE: Locational marginal prices are a good proxy for greenhouse gas emissions and could be a good starting point for high-level planning efforts. Did this hold up for you in Minnesota?

   This assumption does hold up in Minnesota. We found that locational marginal prices and greenhouse gas emissions were highly correlated – meaning that optimizing on price was a good starting point. However, this only held for <u>average</u> emissions and not for marginal emissions.

3. Did you/can you use hourly marginal emissions rates rather than day versus night? The EPA AVERT tool would enable estimation on a regional basis (based on historic dispatch--not future though). I'd think Xcel might have finer hourly data.

   All of our models were at the hourly level, including both emissions data and price data. To clarify, we used forecast methods similar to the AVERT tool, but not the tool itself. We used EPA historic dispatch data just for the state of MN and made forecasts that were state specific, on an hourly basis.

Technology-Specific Questions

4. Electric vehicle charging seems a bit out of context, the cost savings is diluted to the individual car owner if public. If privately held with the property owner paying for the electric (like an office) the cars aren't present during the night, so little ability to shift.

   The baseline for this measure is an uncontrolled residential charging profile. So the project team did not include any consideration of fleet charging (although this would be interesting to investigate). This is a correct assessment of who bears the cost. Costs should be incurred to the driver with this charging model and cost comparison. An office could pass these costs through to the driver for an apples to apples comparison in this modeling scenario.

5. Please clarify the difference between phase change materials and thermal storage

   The thermal storage abbreviation in some of the graphs refers to active ice thermal storage. It attaches to a chilled water system, to allow chillers to stay off during peak times. Chillers make ice or chilled water at night to prepare for the next day. Phase change materials for space conditioning consists of melting and freezing the phase change material at temperatures near the setpoint to shift load in conditioned places. A full description of each of these measures is provided in the report.

6. I am curious about what your team sees around the major energy savings opportunities for smart energy strips. We've thought a lot about them on our team, but always seem to run into obstacles with difficulty turning off equipment. Has your team seen the same thing?

   We've found that advanced power strips can still be cost effective anywhere that plug load usage is significant on nights or weekends. This includes kitchen equipment with standby loads, printers, some vending equipment, and workstations that have more than just a laptop. The threshold for workstations is not something we have a simple rule of thumb on, but workstations with desktop computers, multiple monitors, OR peripherals like fans or oft-used media equipment are all good candidates. Workstations that have very few plug loads, such as some we've observed with basically one laptop and one monitor and nothing else, are not good candidates.

   If interested in more detail, Slipstream conducted a field study on plug loads. https://www.cards.commerce.state.mn.us/CARDS/security/search.do?documentId={325590F5-D6CA-4AD5-B1AD-069579B612C5}

7. Can you elaborate on heat pump performance during a winter peak? Are you assuming the heat pump can meet the load on really cold mornings, or the heat pump reverts to electric resistance heating?

   We are assuming that the heat pump reverts to electric resistance heating under very cold temperatures. If interested in more detail, we used the performance curve published in previous field studies of cold climate heat pumps in MN.

https://www.mncee.org/MNCEE/media/PDFs/86417-Cold-Climate-Air-Source-Heat-Pump-(CARD-Final-Report-2018).pdf

8. Why are the electricity savings from the deep envelope retrofits + air source heat pump less than the electricity savings from the air source heat pump alone?

   DER makes DR better for ASHP with fewer total customers for the same savings to scale to 500 kW. This results in fewer aggregate kWh savings for ASHP with DER.

   The study method to scale to 500 kW leads to these results, for which we have a longer discussion in the report. The results for just a ***single*** *MN home's electricity use under the three scenarios, for both heating and cooling, are: 25,000 kWh for an electric resistance heating and SEER13 air conditioning, 11,000 kWh for an air source heat pump, and 6,200 kWh for an air source heat pump with deep energy retrofits.*

9. Did your definitions of the air source heat pump measure include the air source heat pump plus envelope efficiency improvements?

   We included an air source heat pump measure that included envelope efficiency improvements and an air source heat pump measure that did not. This allowed for an interesting comparison between the two.

10. Is the heat pump in this analysis residential or commercial?

    Residential.

11. As I'm sure you would agree, the assumption that the "baseline" condition for assessing air source heat pump is electric resistance heating has a profound effect on the outcome, in terms of MWh energy savings, system costs, and carbon dioxide impacts. I can understand that assumption for Minnesota, due to your relatively high percentage of electrically heated homes (at least in some service territories), but that assumption doesn't fit very well for many other states (e.g., my home state of Michigan). My question/request is, did you (or could you) assess the following conditions, for impacts on MWh consumption, electric system costs, and CO2 emissions, if the assumed baseline is propane or oil heat or natural gas.

    Because fuel-switching is currently prohibited in Conservation Improvement Programs, we didn't include non-electric baseline measures to evaluate the impacts of air source heat pumps.

    However, this resource provides some cost and carbon comparisons of fossil systems: https://www.mncee.org/blog/september-2020/costs-and-emissions-calculator-heat-pumps-as-an-a/.

12. Do the savings from air source heat pumps in your study include electrification from natural gas?

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However, this resource provides some cost and carbon comparisons of fossil systems: https://www.mncee.org/blog/september-2020/costs-and-emissions-calculator-heat-pumps-as-an-a/.

13. How do you load shift lighting? Are you considering demand response to be load shifting? I had thought demand response was load shed - not shift.

    We included networked lighting as an event-based measure, meaning that it sheds energy on event days. It works by reducing lighting power in a fully occupied space through tuning or daylighting.

General Questions

14. What types of load shifting packages are the New Construction programs looking at? Is there a way to incorporate load shifting into code when it is updated?

    Our study didn't explicitly look at the new construction market or codes when evaluating load shifting measures.

    The short answer is that most new construction programs are not yet doing any significant load shifting focus. A leader nationally in this area is the GridOptimal new construction initiative being developed by NBI, which could be integrated into new construction programs.That said, a utility can offer load shifting regardless of whether a building is new or not; there may need to be components installed and those up-front costs were considered in our study.

    As for codes, at the national level there isn't currently any significant model code language developed. But there are certainly demand management elements being added to stretch and other localized codes.

15. Excellent presentation. This is perhaps outside of the scope, but in terms of practical implementation, do we have technical hurdles to load shifting based on cost savings or carbon emissions? Thinking about existing EV charging infrastructure without this capability (and retrofit needed) or even a lack of capabilities of new EV charging infrastructure.

    Thank you! There are technical hurdles to adoption. The technologies to enables shifting for these measures does exist, but does sometimes require a retrofit of current equipment. The full report includes retrofit cost estimates. More details can be found there.

    For example, not all EV charging infrastructure has managed charging capabilities. In terms of how we modeled our results, a utility could implement a time-based strategy (e.g. daytime or nighttime shift) through a managed charging program that is optimized

based on cost or emissions. To further expand on the EV example, utilities such as Great River Energy in MN already offer this type of managed charging solution for electric vehicles for a reduced charging rate.

16. How are you recommending shifting - in a commercial setting?

    We include several commercial measures in the study, focused around space conditioning or refrigeration. We also include a demand-response commercial lighting measure. Each of the measures shift or shed energy use based on when prices or emissions are high. For further information on these assumptions, see the full report.

17. Given that the biggest cost and emissions impacts were from energy efficiency, would you agree that it would be important that any addition of load shifting not detract from EE efforts (e.g., displace budget and/or goals)?

    We agree with this based on the results of the study. Energy efficiency has larger cost and emissions benefits than load shifting alone, and should be pursued as a primary strategy. Load shifting does have clear benefits when coupled with energy efficiency.

18. Very interesting study and well presented. I would encourage you to align your terminology with industry recognized terminology to avoid confusing people. The more we can align the better we can move the industry forward on these important but complex topics.

    The "shift, shed, shimmy" terminology is well known, but our study needed an explicit distinction between load changes that could happen every day, and changes that happened as the result of an event signal. This distinction drives the cost and emissions savings in our results. We used "event based" and "regularly occurring" to meet these distinctions.

    We evaluated "shift" measures that were both event based and regularly occurring, so use of that term alone did not capture this distinction. (For example, refrigeration PCM is a shift measure that happens every day, whereas smart thermostats with pre-cooling and pre-heating are shift measures that happen only when events are called.)

19. What kind of data is considered secondary data and where does this data come from?

    Secondary data is any data that did not come directly from field studies. It required modeling of energy consumption rather than direct use of empirical data. For example, we used the load shapes in the Minnesota TRM combined with literature on the expected savings networked lighting can deliver to generate the baseline and measure load shapes.

20. Which demand-side measures can most effectively deliver peak demand savings during the winter?

    Air source heat pumps are an excellent example of this. Networked lighting for demand response and water heaters controls also work effectively across the year, allowing for peak demand savings in the winter.