UNIVERSITY OF MINNESOTA

Twin Cities Campus *Hubert H. Humphrey School of Public Affairs* *130 Hubert H. Humphrey Center*
301–19th Avenue South
Minneapolis, MN 55455

www.hhh.umn.edu

April 29, 2024

Will Seuffert
Executive Secretary
Minnesota Public Utilities Commission
121 7th Place East, Suite 350
Saint Paul, MN 55101

RE: In the Matter of a Petition by Citizens Utility Board of Minnesota to Adopt Open Data Access Standards (Docket No. E,G‑999/M‑19‑505)

RE: In the Matter of a Commission Inquiry into Privacy Policies of Rate-Regulated Energy Utilities (Docket No. E,G-999/CI-12-1344)

Dear Mr. Seuffert:

Assistant Professor **Elise Harrington** (Center for Science, Technology, and Environmental Policy, University of Minnesota) hereby provides reply comments regarding PUC Docket No. E,G-999/M-19-505 and E,G-999/CI-12-1344 on the consideration of open data access standards. These comments are in reference to the reply comment period published in Dockets E,G‑999/M‑19‑505 & E,G‑999/CI‑12‑1344 on December 1, 2023, and extended on February 23, 2024. **Gabriel Chan** (Associate Professor at the Center for Science, Technology, and Environmental Policy, University of Minnesota), **Bhavin Pradhan** (Postdoctoral Associate at the Center for Science, Technology, and Environmental Policy, University of Minnesota), and **Chloe Olson** (Research Assistants at the Center for Science, Technology, and Environmental Policy, University of Minnesota) join as co-signers of these comments.

These comments are provided on our individual behalf and do not represent the views of the Center for Science, Technology, and Environmental Policy or the University of Minnesota.

Of the topics open for comment, we respond to four questions based on interviews we conducted with two leading academic researchers who have conducted studies with CEUD (Section A) and a survey of nine prior academic research studies that have leveraged anonymized CEUD (Section B). In summary, we recommend:

- Anonymized data access contracts include a default minimum time of five years before deletion is required;
- Allow for requesters to pursue a modified data deletion date on a case-by-case basis;
- Adopt the approach outlined in the Citizens Utility Board of Minnesota's Initial Comments submitted on March 4, 2024, which allows researchers to request sub-hourly interval data on a case-by-case basis to align the data needs of different research questions; and
- Make no modifications to the "15/15 rule" that screens data for possible inferred identification.

- **What specific use cases for anonymized CEUD could the Commission use to continue incrementally applying the Standards while maintaining the balance between customer privacy and CEUD access?**

Based on prior studies, we identified four research use cases for high-resolution, anonymized CEUD. These research use cases help to answer fundamental questions about energy systems that contribute to practicable insights that advance knowledge about key public interest issues. We find use cases for analyzing rate design, consumption behaviors, DER integration, and program evaluation. Academic research questions can be answered by combining interval consumption data with other sources ranging from sociodemographic data to program participation data. Summaries of exemplary studies cited are available in **Section B**.

Rate Design

Analysis of high-resolution electricity consumption data can identify geographic and demographic patterns that provide insights into rate design questions, such as patterns of cross-subsidization and load-shifting opportunities achieved through time-varying rates. For example, research on the California Alternate Rates for Energy (CARE) subsidy program using hourly consumption data found that the program is associated with increased consumption (although with some seasonal and geographic variation). Additionally, the CARE program is associated with a 3% peak demand increase in the summer, suggesting that efforts to shift summer peak load associated with the program may have substantial financial benefits (see **Study 7**). Other studies assess load profiles more generally (see **Study 6**) to cluster different usage patterns, which can identify households potentially impacted by time-of-use rate designs.

Consumption Behaviors

High-resolution CEUD enables further study of a broad set of behavioral questions related to energy use and interventions like energy efficiency investments. Research on behavioral questions can contribute to debates over behaviors like the rebound effect (increases in energy efficiency may lead to increased consumption) or emerging focus areas such as energy burden and energy-limiting behaviors (see **Studies 1** and **2**). Such studies can identify consumption behaviors and impacts on energy burden associated with external shocks, such as COVID-19 (see **Study 8**).

Prior studies of consumption behaviors demonstrate the use of interval consumption data to study the impacts of extreme weather (historical and simulated future scenarios) on consumption patterns. Additionally, researchers can simulate estimated changes in energy burden under expected future climate scenarios to identify interventions, such as affordability programs, needed to reduce energy burden under more extreme conditions in the future (see **Study 3**). Consumption data can identify geographic and sociodemographic characteristics associated with higher vulnerability to extreme heat (see **Study 4**) and anticipated increases in consumption given extreme heat or cold (see **Study 6)**.

DER Integration

Studies have used household consumption data to assess hosting capacity and the impact of rooftop solar on the grid. Academic research that combines consumption data with circuit-level data on existing, queued, and total distributed generation and sociodemographic data can identify inequities in DER adoption and disparities in hosting capacity (see **Study 5**). Researchers can also use trends in consumption patterns (e.g., continued patterns of no/zero consumption during daytime hours) to identify patterns of rooftop solar penetration (see **Study 4**). Additionally, researchers have analyzed interval household consumption data to estimate the level of rooftop solar penetration that may be associated with reliability considerations (see **Study 6**).

Program Evaluation

Efficiency program evaluation may be enhanced by combining household consumption data with additional data (e.g., program participation data) on rebate or other utility programs. The use of interval consumption data enables researchers to compare when savings tend to occur and the value of electricity at that time (see **Study 9**). More granular, anonymized CEUD from smart meters can support more evidence-based policymaking based on a clearer understanding of market priorities and a better estimate of the value of energy efficiency programs (see **Study 9**).

- **What modifications, if any, should be made to the anonymized data access contract requirements set by ODAS section III.B.(2)(v)?**

The responses from researchers familiar with using anonymized CEUD in academic research indicated that given typical research timelines and external requirements for data retention, including a 12-month deletion requirement will limit the use for academic research purposes. **We recommend that anonymized data access contracts include a default minimum time of five years before deletion is required.**

Academic research often combines CEUD with other available data (e.g., sociodemographics, climate projections, utility program data, etc.), which requires cleaning CEUD and integration with other data sources. Responses from other researchers with prior experience with CEUD note that this cleaning process may take multiple years (see **Section A-4**). Further, publishing research findings in peer-reviewed academic journals often takes 1-2 years with several iterations and additional analysis; the publishing process would require continued use of CEUD.

Beyond the need to retain and reanalyze data during the publication process, academic research projects that seek are awarded funding (for example, to fund students to assist with data analysis) from federal agencies must comply with federal requirements to retain project records (including statistical records) for three years from the financial close of an award.[1,2] University researchers also comply with Institutional Review Board requirements which also include a requirement to retain records for at least three years after completion of research.[3] Requirements to retain data and related analyses ensure that, if needed, findings may be validated (see **Section A-4**). Research examples in Section 2 illustrate that researchers frequently use the same data for multiple analyses (see **Studies 2** and **3**) and often do so in collaboration with the utility providing the data such that CEUD is combined with data, such as a utility-led survey with sociodemographics, appliance information, and dwelling characteristics or efficiency program details for program evaluation (see **Studies 2, 3,** and **9**).

We recommend data access contracts be written to allow for compliance with applicable retention requirements that may be associated with research funders (such as the National Science Foundation), sufficient time to allow for data cleaning and analysis (about two years), the peer-review publication process process (often at least two years but in some cases longer)[4] and any subsequent review, and the exploration of follow-on research questions uncovered by the initial study enabled by CEUD that has been cleaned and likely merged with other data (as shown in the example studies in **Section B**).

Based on the experiences of researchers familiar with CEUD projects, we recommend a default minimum time of five years before deletion is required. We also recommend that requesters have the option to

[1] Retention requirements for records. 2 CFR 200.334. https://www.ecfr.gov/current/title-2/section-200.334.
[2] For examples see National Science Foundation Proposal and Award Policies and Procedures Guide, Chapter VII, Part E: Record and Retention Audit or National Institutes of Health Grants Policy Statement Section 8.4.2 Record Retention and Access.
[3] IRB Records. 45 CFR 46.115 (July 19, 2018). https://www.ecfr.gov/on/2018-07-19/title-45/section-46.115
[4] The timeline for submission to publication for the top academic journals in economics has a mean time of 34.31 months and more extreme cases (e.g., 90th percentile) may take 59 months. See Hadavand, Aboozar, Daniel S. Hamermesh, and Wesley W. Wilson. 2024. “Publishing Economics: How Slow? Why Slow? Is Slow Productive? How to Fix Slow?” Journal of Economic Literature, 62 (1): 269-93.

pursue a modified deletion date to ensure compliance with grant requirements or other extenuating circumstances. In situations where a modified deletion date is requested, the mutually agreed-upon date will be included in the contract. For an anonymized data access contract with either a five-year or modified deletion date, utilities may request to include a data management plan (common in research projects) that specifies a method of secure data storage until the agreed-upon deletion date.

- **What modifications, if any, should be made to the shortest allowable time interval for anonymized data set by ODAS section IV.A.?**

Responses from researchers experienced with CEUD emphasize that the appropriate interval for any given study depends on the research question. For example, appliance use or service interruptions that may be less than one hour may benefit from an interval of 30 minutes or less (see responses in **Section A-1**). From the studies included in **Section B**, six studies use one-hour intervals **(Study 2, Study 4, Study 6** - gas**, Study 7, Study 8, Study 9**), two use daily intervals (**Study 1, Study 3**), and one uses 5-minute intervals (**Study 6** - electric) (see summary **Table 1 in Section B**).

Our review identifies that research commonly uses hourly data, but select questions may benefit from more granular intervals. We recommend the approach outlined in the Citizens Utility Board of Minnesota's Initial Comments submitted on March 4, 2024, which allows researchers to request sub-hourly interval data on a case-by-case basis to align data with the needs of different research questions.

- **What considerations should the Commission make regarding the application of the 15/15 anonymization screen to the shortest allowable time interval (currently one-hour intervals)? Does each interval of time need to pass the 15/15 anonymization screen?**

Researchers we spoke with did not know the details of how other utilities carried out their screening tests but were familiar with similar requirements (see **Section A-2**). The primary issue highlighted was cases when screening results in geographic areas with too few households to include in an analysis, resulting in gaps in the spatial resolution of the data, which is key to identifying regional disparities. We did not find evidence to support changing the screening rules from what is already in the standard, given an interpretation of the 15/15 rule to mean at least 15 customers, with no customer's use accounting for more than 15% of consumption across the total period for the data requested.

A. Responses on Using Anonymized CEUD for Research

We asked two university researchers familiar with using anonymized utility data in academic research to provide insight into their experience. We summarize their responses to key questions below.

1. **Data Interval**: *How granular should the data be? Is there value in short intervals?*
    - Data granularity depends on the research question.
    - While a difference between 60-minute and 30-minute intervals might not affect estimates of overall demand, data with higher frequency intervals are better for analyzing appliance-level demand.
    - To assess issues like outages and disconnections, data at 30-minute intervals is better than 60-minute intervals.
2. **Screening Rules**: *Have you seen and/or worked with data in compliance with a rule like the 15/15 rule?*

- Both the researchers were unfamiliar with the specific 15/15 screening rule for the data used.
- However, they have worked with analogous privacy screening rules pertaining to their work. One major challenge they noted is that such rules can lead to gaps in the analysis since some locations (e.g., rural areas) may have few households. One of the most important considerations is to have a spatial resolution tied to the data, as location information at the census level is vital to identifying disparities in a region.

3. **Resources Required for Data Processing and Cleaning**: *Have you encountered challenges with the computational resources required for data processing and cleaning?*

   - Addressing issues like false or abnormal readings in meters, missing data, and other data issues may require substantial computational resources for large datasets.
   - Once the process is done the first time, it can be automated. In their experience, processing ten years of household data took ~200 hours.
   - Utilities require significant time and computational resources to process and clean the data.
   - Each utility will share the data in a different format.

   Note: researchers could describe the time it took them to clean and analyze data after receiving it from a utility, not the time it took a utility to process and share meter data.

4. **Deleting Data**: *Based on your experience, would a requirement to delete data after one year impact research use of CEUD?*

   - Deleting the data after a year is not realistic.
   - Research using CEUD takes more than three years, with the initial two years spent on cleaning, identifying, and verifying missing data and discrepancies within the data.
   - Analyzing the data for initial research questions leads to other research questions that require further historical analysis for comparison. Projects may be ongoing after three or four years.
   - Some utilities did not require the data to be deleted.
   - External research funding may, at times, also require the data to be stored to validate the research findings.

B. Research Studies Using Anonymized CEUD

We summarize nine research studies that use customer consumption data to answer a variety of key questions. These nine studies complement the nine studies shared in our previous comment filed on September 6, 2022. Our previous summary is included in Appendix A for reference. These nine studies demonstrate policy-relevant research using CEUD focused on energy-limiting behaviors and energy burden, extreme weather (including heat and cold), COVID-19, rate design, and demand response.

Table 1. Summary of nine selected studies using consumer utility data.

Study #	Citation	Energy Data	Key Finding
1	*Huang, L., Nock, D., Cong, S., & Qiu, Y. L. (2023). Inequalities across cooling and heating in households:*	Household daily total electricity usage (kWh) consumption data from Commonwealth Edison's (ComEd) Anonymous Data Service (ADS).	• This study found energy-limiting behaviors demonstrated by gaps in heating and cooling for low-income and black households. • Energy-limiting behaviors may mask energy

	Energy equity gaps. Energy Policy, 182, 113748. (Link)	Combined with other data for analysis (temperature, demographics, building performance).	poverty in some low-to-middle-income households given the traditional income-based energy burden measure.
2	*Kwon, M., Cong, S., Nock, D., Huang, L., Qiu, Y. L., & Xing, B. (2023). Forgone summertime comfort as a function of avoided electricity use. Energy Policy, 183, 113813. (Link)*	Hourly electricity consumption (kWh) from May 2015 to April 2019 for 6,000 households and the billing plan for each household. An additional household survey from 2017 of the same households including sociodemographic and dwelling characteristics. Data are from the Salt River Project in Arizona.	● Low-income households limit their electricity use for cooling by 1.03 kWh/°F and these differences hold across residence characteristics and appliances. ● Assessing patterns across the cooling season finds that for some behavioral patterns, early-season limiting behavior may not reduce energy burden over time. ● Findings can inform targeting for energy efficiency or assistance programs and inform extreme heat outreach efforts.
3	*Jones, A., Nock, D., Samaras, C., Qiu, Y. L., & Xing, B. (2023). Climate change impacts on future residential electricity consumption and energy burden: A case study in Phoenix, Arizona. Energy Policy, 183, 113811. (Link)*	Total daily household smart meter electricity data from May 2015 to April 2019 from Salt River Project in Phoenix, Arizona. Additional data from a random survey of customers in 2017 including appliance information, residence characteristics, and demographics. Combined with temperature data and climate projections for Phoenix, AZ.	● This study estimates how future warming trends will impact the energy burden of low-income households. Elderly and low-income households are likely to be most energy-burdened by increased cooling demand. ● Improving air conditioning efficiency reduces cooling consumption by up to 70% for vulnerable groups. ● Even with improved efficiency, racial minorities still face challenges in reducing energy burden. ● This research can inform heat resilience and energy assistance programs, especially those that serve vulnerable populations.
4	*Chen, M., Ban-Weiss, G. A., & Sanders, K. T. (2020). Utilizing smart-meter data to project impacts of urban warming on residential electricity use for vulnerable populations in Southern California. Environmental Research Letters, 15(6), 064001. (Link)*	Hourly residential electricity data records from 2015-2016 for ~200,000 randomly selected households in Southern California (data from Southern California Edison). Consumption data combined with near-surface air temperature data and census data.	● The authors found that air conditioners are less prevalent in low-income census tracts. ● Census tracts identified as most vulnerable are likely to experience extreme heat. 30% of the most vulnerable census tracts are expected to experience at least 32 extreme heat days each year. ● The authors also predict how temperature increases impact electricity demand in different census tracts. Rates of air conditioning penetration also impact this. ● This data can be used to best target resilience strategies, especially to help low-income census tracts prepare for extreme heat events. ● Data can also be used to anticipate electricity demand on the electric grid during extreme heat events.
5	*Brockway, A. M., Conde, J., & Callaway, D. (2021). Inequitable access to distributed energy resources due to grid infrastructure limits in California. Nature Energy, 6(9), 892-903. (Link)*	Used the 2009 hourly electricity consumption profiles of households in California to estimate the peak per-household maximum hourly electricity demand to then estimate the amount of circuit capacity needed to accommodate generation and load DERs.	● The study identifies significant disparities in the distribution grid's circuit hosting capacity. ● Over half of the households in the study area lack the capacity to support sufficient PV solar to offset their annual electricity consumption. ● Black-identifying and disadvantaged communities have access to disproportionately lower hosting capacities. ● There is a notable correlation between hosting capacity and race, highlighting systemic inequities in grid accessibility.

6	*Iyengar, S., Lee, S., Irwin, D., & Shenoy, P. (2016). Analyzing Energy Usage on a City-scale using Utility Smart Meters. Proceedings of the 3rd ACM International Conference on Systems for Energy-Efficient Built Environments, 51–60.* [(Link)]()	Smart meter data from 14,836 meters (at a resolution of 5 minutes for electricity and hourly for gas) from a small city in New England from October 2014 through 2015 (15 months).	● Extreme heat and cold can increase energy use by 36% and 11.5%, ● Solar penetration of above 20% can impact utility reliability. ● Used data to identify 700 homes as very energy inefficient. ● Helps understand the energy usage and variability that comes with adding renewable energy to the system. ● Could be used to inform potential changes in energy demand during extreme weather events. This can be helpful when planning for peak load demand. ● Data on homes with high energy use fluctuations could be used to better target energy efficiency and weatherization programs.
7	*Sherwin, E. D., & Azevedo, I. M. L. (2020). Characterizing the association between low-income electric subsidies and the intra-day timing of electricity consumption. Environmental Research Letters, 15(9), 094089.* [(Link)]()	Hourly electricity consumption data from a random sample of ~30,000 households in northern California (Pacific Gas & Electric Company service territory). Consumption data was combined with program enrollment information and participation in energy-efficient appliance rebate programs.	● Households who enroll in CA's electricity rate subsidy program see a 13% increase in their electricity demand. ● This increases by an additional 3% during summertime peak times. ● These increases in peak demand associated with CA's electricity subsidy program lead to customers paying $45 million in demand costs. ● This data could be used to better design CA's electricity subsidy program to better meet the needs of customers and the electric grid.
8	*Lou, Jiehong, Yueming (Lucy) Qiu, Arthur Lin Ku, Destenie Nock, and Bo Xing. "Inequitable and Heterogeneous Impacts on Electricity Consumption from COVID-19 Mitigation Measures." iScience 24, no. 11 (November 2021): 103231. (*[Link]()*)*	The study analyzed anonymized smart meter data from Arizona and Illinois, covering ~47,000 residential and ~64,000 commercial customers from January 1, 2019, to April 30, 2020. Data is reported in the study as hourly changes in consumption.	● COVID-19 measures of school closures and limiting business operations increased electricity consumption by 4-5% in the residential sector and decreased electricity consumption by 5-8% in the commercial sector. ● Low-income and ethnic-minority populations experienced a larger electricity consumption increase.
9	*Boomhower, J., & Davis, L. (2020). Do energy efficiency investments deliver at the right time?. American Economic Journal: Applied Economics, 12(1), 115-139. (*[Link]()*)*	Hourly electricity consumption data from 5,973 participating households in Southern California Edison's Quality Installation Program from January 2012 to April 2015. Additional data included details on program participants, including appliance selection.	● Energy savings from efficient air conditioners peak during July and August and in the late afternoon, aligning with high-demand periods. ● Accounting for the timing of savings increases the value of energy-efficient programs by 40%, introducing significant 'timing premiums'. ● Investments in energy efficiency have varying timing premiums, with residential air conditioning showing the highest, unlike refrigerators and lighting. ● Policies should consider the timing of energy savings to more accurately value and optimize energy efficiency programs.

Detailed Summary of Research Studies Using Anonymized CEUD

Study 1:
Huang, L., Nock, D., Cong, S., & Qiu, Y. L. (2023). Inequalities across cooling and heating in households: Energy equity gaps. Energy Policy, 182, 113748.

Summary of Study Findings
The authors used daily household anonymized energy use data to identify gaps between the times when low- and high-income households turn on their home heating and cooling systems. Low-income households use less electricity in both the heating and cooling seasons and wait longer to turn on their cooling systems. This gap is especially pronounced in black-majority census blocks.

Data Used:
This study uses 12 months of (June 1, 2020–May 31, 2021) anonymized residential household data from Commonwealth Edison (ComEd). The sample used included 418,255 households for cooling and 22,628 households for heating. The dataset included the nine-digit ZIP Code, delivery class (indicating whether electricity is used for heating by single-family or multi-family), and the daily total electricity usage (kWh) for the household. Anonymized CEUD was combined with outdoor temperature profiles (zip-code level), census data for demographics (zip-code to block group level), and electricity use intensity from Lawrence Berkeley National Lab (zip-code level).

Policy Relevance:
- This study provides insights into "energy limiting behavior" (when households make tradeoffs between energy consumption and comfort), which can inform the design of weatherization programs to better identify vulnerable households beyond other measures of energy poverty.
- The authors highlight that their analysis and developed metrics use customer consumption data while also protecting data privacy. Measures can be used by utilities and program providers to better target vulnerable households and by regulators to assess the impact of utility and other program (weatherization, energy assistance) investment on multiple measures of energy poverty.

Study 2:
Kwon, M., Cong, S., Nock, D., Huang, L., Qiu, Y. L., & Xing, B. (2023). Forgone summertime comfort as a function of avoided electricity use. Energy Policy, 183, 113813.

Summary of Study Findings:
This study quantified disparities in household use of cooling units by income level. They found that low-income households limit their electricity use for cooling by 1.03 kWh/°F. Households are continuously using coping strategies throughout the cooling season to reduce financial energy poverty but may be putting themselves at a heat-illness risk. For policymakers, the cooling slope information can potentially be used to evaluate how a region and its residents are using their cooling systems, needs for investments in energy-efficient infrastructure, long-term energy-limiting behavior over the course of the cooling and heating season, as well as overall efficiency of the residential cooling infrastructure.

Data Used:
This study uses household data provided by the Salt River Project in Arizona. The data include hourly electricity consumption in kilowatt-hours (kWh) from May 2015 to April 2019 for 6000 households, with details about their billing plans. Additionally, the dataset includes survey data from 2017 that contains sociodemographic information about the households and characteristics of the dwellings, including age, size, and type. This comprehensive dataset was obtained by combining smart-meter data with regression analysis.

Policy Relevance:

- This study highlights the unintended consequences of energy policies that focus on reducing consumption. Some low-income households have lower energy consumption due to behavior (limiting energy use due to high energy costs) and may not be easily identifiable for programs solely using an income-based energy burden measure.
- Cooling slope information (showing which households turn on their air conditioning at certain temperatures) can show the need for investments in energy-efficient infrastructure for houses that limit their energy intake during hotter or colder seasons. This will become increasingly important when considering climate change mitigation and adaptation.

Study 3:
Jones, A., Nock, D., Samaras, C., Qiu, Y. L., & Xing, B. (2023). Climate change impacts on future residential electricity consumption and energy burden: A case study in Phoenix, Arizona. Energy Policy, 183, 113811.

Summary of Study Findings:
This study assesses the implications of increased air conditioning use given the impacts of a warming climate. Using two future climate scenarios, the authors simulate future consumption changes, finding that low-income and elderly households have increased cooling needs under RCP8.5 (more extreme temperature increase). With the anticipated increases in the energy efficiency of air conditioning, results suggest that efficiency savings will have substantial impacts on consumption (up to 70%). However, efficiency savings alone are not estimated to reduce the energy burden below the 6% and 10% thresholds for minority households. Additionally, the authors highlight the compounding effects of income and age on energy burden. The authors highlight that compounding effects across demographics are an important area for future research.

Data Used:
This study uses total daily household consumption data from smart meters in Phoenix, Arizona (Salt River Project) from May 1, 2015, to April 30, 2019. The sample analyzed includes 5881 households from a sample of over 13,000 households that were randomly surveyed in 2017 for appliances, residence characteristics, and demographics. Consumption data was combined with observed temperature data from the National Oceanic and Atmospheric Administration (NOAA) and projected future temperatures using the Coupled Model Intercomparison Project 5 (CMIP5). The study focuses on two emissions scenarios, moderate (RCP4.5) and more extreme (RCP8.5).

Policy Relevance:
- Elderly and low-income households are likely to be most energy-burdened by increased cooling demand. The compounding effect of income and age may exacerbate energy burden in the future.
- The findings from this research highlight the importance of efficiency standards as cooling demand grows in the future. However, efficiency standards must be paired with efforts to ensure affordability and targeted financial support to minimize the expected energy burden associated with increased cooling demand.

Study 4:
Chen, M., Ban-Weiss, G. A., & Sanders, K. T. (2020). Utilizing smart-meter data to project impacts of urban warming on residential electricity use for vulnerable populations in Southern California. Environmental Research Letters, 15(6), 064001.

Summary of Study Findings:
This study addresses the challenges of increasing heat events that challenge electricity infrastructure in Southern California. The authors use a measure of “electricity-temperature sensitivity” that aims to capture change in consumption associated with a one-degree Celsius change in temperature. The study

finds that this electricity-temperature sensitivity is associated with both geographic (hotter, cooler climactic zones) and economic factors. More affluent areas have higher air conditioning penetration rates and also have a higher electricity-temperature sensitivity, meaning they more readily adjust their consumption given hotter temperatures. Overall, those most vulnerable to extreme heat have low access to air conditioning and are less affluent.

Data Used:
This study uses hourly smart meter data from Southern California Edison for 200,000 randomly selected households for 2015 and 2016. The sample size was selected to be representative of the 4.5 million residential households served in that region. Each household was anonymized and given a Census Tract ID. Based on hourly consumption patterns, the researchers determined that any households with one hour of no consumption from 10:00-16:00 hours and positive consumption from 17:00-23:00 hours for over 36 days had solar generation, and those households were removed from the dataset resulting in 180,476 households analyzed. Consumption data was used with near-surface air temperature data for the same years from the California Irrigation Management Information System (CIMIS) and the National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information (NCEI). Projections of extreme heat days were derived from Cal-Adapt data. Census data was used to determine geographic boundaries and socioeconomic variables from CalEnviroScreen 3.0, including measures of poverty and pollution.

Policy Implications:
- This data can be used to best target resilience strategies, especially to help low-income census tracts prepare for extreme heat events.
- Data can also be used to anticipate electricity demand on the electric grid during extreme heat events.

Study 5:
Brockway, A. M., Conde, J., & Callaway, D. (2021). Inequitable access to distributed energy resources due to grid infrastructure limits in California. Nature Energy, 6(9), 892-903.

Summary of Study Findings:
Using the distribution grid's circuit hosting capacity, the study finds significant disparities in grid hosting capacity, with over half of households in the study area unable to support enough PV solar to offset their annual electricity consumption. The study also finds that Black-identifying and disadvantaged communities have disproportionately lower hosting capacities, with a notable correlation between hosting capacity and race.

Data Used
The study primarily used electric distribution grid data from California's two largest investor-owned utilities, Pacific Gas and Electric (PG&E) and Southern California Edison (SCE), who report existing, queued, and total distribution generation on each circuit. To calculate the potential offsetting of electricity demand by adding DER to the grid, the study estimated peak per-household electricity demand using household energy consumption data from the 2009 California Residential Appliance Saturation Study and hourly electricity consumption profiles from Energy and Environmental Economics.

Policy Implications
- The study highlights how constrained grid capacity can exacerbate existing inequities in DER adoption and how policies need to focus on expanding grid hosting capacity in underserved areas when planning upgrades.
- Limited grid capacity can hinder electrification programs, EV adoption, or increased

air-conditioning demands.
- To reduce inequities, grid investments should be made in communities with historically low DER adoption and limited grid capacity.
- As DER adoption increases, grid limits will become a more pressing issue, nationwide. Policymakers and regulators will need to evaluate and address these limits to ensure that the transition to renewable energy is both timely and equitable.

Study 6:

Iyengar, S., Lee, S., Irwin, D., & Shenoy, P. (2016). Analyzing Energy Usage on a City-scale using Utility Smart Meters. Proceedings of the 3rd ACM International Conference on Systems for Energy-Efficient Built Environments, 51–60.

Summary

This study used smart meter data to assess multiple trends within the case study city, including electricity and gas consumption patterns (geographically and temporally), daily load profiles, the relationship between consumption and dwelling characteristics, the distribution of inefficient homes within the geographic area, and the impact of DER (e.g., rooftop solar) on the grid. The authors find three distinct load profiles or use patterns (bimodal, unimodal, and nocturnal use) within the city, that extreme heat and cold can increase energy use by 36% and 11.5%, and that solar penetration of above 20% can impact reliability. They also find high energy use in older homes, and while newer homes tend to consume less, the newest homes actually consume more. Based on higher rates of energy use variability, authors identified 700 homes deemed to be very inefficient.

Data Used:

Data was from a small city in New England in the US, including 14,836 electricity and gas meters from 11,431 residential customers. Data provided was in 5-minute intervals for electricity and hourly intervals for gas usage. The data included a 15-month period from October 2014 through the end of 2015. Data also include the approximate age and size of each home. Consumption data was combined with weather data from Weather Underground.

Policy Relevance

- Helps understand the energy usage and variability that comes with adding renewable energy to the system.
- May inform potential changes in energy demand during extreme weather events. This can be helpful when planning for peak load demand.
- Consumption data can help identify households with high energy use fluctuations to target energy efficiency and weatherization programs better.

Study 7:

Sherwin, E. D., & Azevedo, I. M. L. (2020). *Characterizing the association between low-income electric subsidies and the intra-day timing of electricity consumption*. Environmental Research Letters, 15(9), 094089.

Summary

This study uses a difference-in-difference regression with hourly electricity consumption data from about 30,000 Northern California homes. This data is used to estimate the increase in energy consumption that is correlated with being enrolled in the California Alternate Rates for Energy (CARE) subsidy program. The study found that there was a 13% increase in energy consumption with some variability over regions and seasons. During the summer months, an additional 3% peak demand is associated with CARE enrollment. Although the peak demand associated with the CARE program is estimated to cost about $45 million a year, data suggests that peak shifting to level demand could cut costs by one-third.

Data Used:
Hourly electricity consumption data was obtained from 30,000 households in Northern California Interval consumption data was from Pacific Gas & Electric Company and accessed through the Wharton Customer Analytics Initiative via a non-disclosure agreement. Advanced Metering Infrastructure (AMI) was installed at each household and reported hourly data staged across three regions of the Central Valley, Inland Hills, and Coast. The data also included the enrollment and disenrollment dates for the CARE and other utility programs. Program data from CARE (enrollment dates) and rebate programs for energy-efficient appliances and services were also analyzed. The study also used household census block data to match neighborhood-level demographics and was paired with local weather station data.

Policy Relevance

- This study was conducted to understand the effects of the CARE subsidy on energy consumption within low-income households. The analysis showed that energy use increased correlated with CARE participation. This suggests that energy subsidies increase access to energy that can improve people's quality of life.
- The study also emphasizes the importance of understanding time variation in household consumption to better inform resource adequacy planning and procurement of energy services. Utilities may be able to provide robust energy services to low-income households with time-varying electric rates, ideally shifting consumption away from high-externality times.

Study 8:

Lou, Jiehong, Yueming (Lucy) Qiu, Arthur Lin Ku, Destenie Nock, and Bo Xing. "Inequitable and Heterogeneous Impacts on Electricity Consumption from COVID-19 Mitigation Measures." iScience 24, no. 11 (November 2021): 103231.

Summary:
Lockdown measures applied during the COVID-19 pandemic contributed to a shift in energy consumption that exacerbated energy burdens. Residential energy consumption increased by 4-5%, while commercial energy consumption decreased by 5-8%. Energy use increases were larger for non-white homes, possibly due to the energy efficiency of homes and household size. The study identified an increase in energy burden for all households but larger increases for low-income households.

Data Used:
The analysis used anonymized smart meter data from utilities in Arizona and Illinois. It included 7,004 residential and 23,117 commercial accounts in Arizona, and 40,771 residential and 40,757 commercial accounts in Illinois from January 1, 2019, to April 30, 2020.

Policy Relevance:

- Shifts in energy consumption patterns brought about by an increase in work-from-home can be used to inform time-of-use rates.
- Increased energy burden for customers during the pandemic can also be used to inform funding levels for energy assistance programs or more general pandemic assistance programs.
- Since work from home creates more peak demand during times when solar production is at its highest, this data could be used to inform subsidies for low-income solar.

Paper 9:

Boomhower, J., & Davis, L. (2020). Do energy efficiency investments deliver at the right time?. American Economic Journal: Applied Economics, 12(1), 115-139.

Summary:
Using hourly electricity consumption data for ~6,000 household participants of the *Quality Installation Program,* a rebate program administered by Southern California Edison, this paper shows that accounting for the timing of the use of energy efficiency measures (such as air conditioning) increases the value of the investment by about 50%. They show that savings usually occur during hours when the value of electricity is high– this increases the overall value of the energy efficiency program once the large capacity payments to the generators are accounted for.

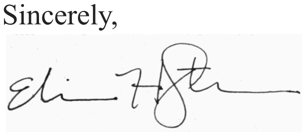
Data Used:
The study uses hourly electricity consumption data from 5,973 participating households in Southern California Edison's Quality Installation Program.

Policy Relevance:
- This paper highlights the range of timing premiums across energy efficiency investments to optimize the portfolio of programs.
- By taking into account when the highest savings occur, the authors also note the "enormous potential of smart-meter data," as "high-frequency data can facilitate smarter, more evidence-based energy policies that more effectively address market priorities" (24).

C. Conclusion

Thank you for this opportunity to comment. If you have any questions regarding the information or opinions provided in this filing, please contact me at 612-624-5719 or eliseh@umn.edu.

Sincerely,



Elise Harrington (eliseh@umn.edu)
Assistant Professor, University of Minnesota

Gabriel Chan (gabechan@umn.edu)
Associate Professor, University of Minnesota

Bhavin Pradhan (pradh048@umn.edu)
Postdoctoral Researcher, University of Minnesota

Chloe Olson (ols00440@umn.edu)
Graduate Research Assistant, University of Minnesota

Appendix A. Research Summaries from Prior Comment

Table 2. Summary of selected studies that rely on utility data for research with implications that support policymaking in the public interest.

	Study	Study Context	Energy Data	Policy Finding
1	**Six unique load shapes: A segmentation analysis of Illinois residential electricity consumers**. Zethmayr, J., & Makhija, R. S. (2019).	ComEd and Ameren Illinois (IL).	Anonymous hourly electric consumption data from individual smart meters (AMI) for 2.5 million residential customers Adoption of the Illinois Open Data Access Framework by the Illinois Commerce Commission in 2017 enabled AMI data access. Utility data matched with ACS data at the Census Block Group level.	Authors identified six distinct load profiles allowing for a more granular understanding of which customers may benefit from programs such as energy efficiency or where reductions in consumption may have the greatest impact on the system. Low-income households have flatter load profiles than others and are therefore overpaying their fare share of utility fixed costs and could benefit from time-varying rates.
2	**Using electricity customer profiles to combat GHG emissions: New evidence from ComEd AMI data.** Zethmayr, J., & Makhija, R. S. (2021).	ComEd (IL)	Anonymous hourly energy-usage data from ComEd's Advanced Metering Infrastructure, PJM marginal emissions data, and demographic data from the U.S. Census Bureau's American Community Survey of 2017. Adoption of the Illinois Open Data Access Framework by the Illinois Commerce Commission in 2017 enabled AMI data access.	The authors argue that it is important to understand the impact on marginal rather than average emissions when determining the efficacy of policies on reducing climate pollution. AMI data is essential to calculating and understanding residential household energy consumption load shapes that influence marginal emissions.
3	**Unveiling hidden energy poverty using the energy equity gap**. Cong, S., Nock, D., Qiu, Y. L., & Xing, B. (2022).	Salt River Project (AZ)	Hourly residential electricity consumption data for 6,000 households in Arizona from May 2015 to April 2019. Consumption data combined with survey data collected in 2017 that included sociodemographic and dwelling characteristics. Data obtained under a nondisclosure agreement with a large utility.	Low-income and racial minority households limit the use of appliances (air conditioning) relative to wealthier households, revealing "hidden" energy poverty. Authors use consumption data to build a metric called the "energy equity gap" to measure the relative difference between high and low income households. Compared to the more common absolute measure of energy burden, the authors find a larger number of energy insecure and energy poor households.
4	**Changes in hourly electricity consumption under COVID mandates: A glance to future hourly residential power consumption pattern with remote work in Arizona.** Ku, A. L., Qiu, Y. (Lucy), Lou, J., Nock, D., & Xing, B. (2022).	Salt River Project (AZ)	Hourly electricity consumption data for 6,549 individuals in Arizona from March 2019 to April 2020. Data obtained under a nondisclosure agreement with a large utility.	Different demographic groups had differing power consumption patterns during the COVID mandates. A more permanent transition to remote work following the pandemic could primarily occur in high-income groups and result in changes to the power infrastructure and utility rates that benefit the high-income groups while negatively impacting low-income households. Since vulnerable groups may be unable to shift electricity

	Study	Study Context	Energy Data	Policy Finding
				consumption to the same degree as their wealthier counterparts, equity concerns regarding TOU pricing remain.
5	**Inequitable and heterogeneous impacts on electricity consumption from COVID-19 mitigation measures.** Lou, J., Qiu, Y. (Lucy), Ku, A. L., Nock, D., & Xing, B. (2021).	Salt River Project (AZ) and ComEd (IL)	Hourly electricity consumption data for 7,004 residential and 23,117 commercial accounts in Arizona, and 40,771 residential and 40,757 commercial accounts in Illinois from January 2019 to April 2020. Data obtained under a nondisclosure agreement with a large utility.	A shift in energy consumption from commercial electricity consumption to residential electricity consumption in response to COVID mandates disproportionately impacted low-income and ethnic minority populations as well as small businesses, pointing to the need for more equitable and effective policies for energy poverty assistance.
6	**Better sustainability assessment of green buildings with high-frequency data**. Qiu, Y., & Kahn, M. E. (2018).	Salt River Project (AZ)	Account-level hourly electricity demand data of commercial electricity customers for 2013-2016. The data was obtained under a nondisclosure agreement with a large utility.	Green-certified buildings can reduce energy consumption during system peaks, suggesting a role for targeted demand-response incentives and a potential for more accurate environmental impact evaluation.
7	**A new method utilizing smart meter data for identifying the existence of air conditioning in residential homes.** Chen, M., Sanders, K. T., & Ban-Weiss, G. A. (2019).	Southern California Edison (CA)	Hourly residential electricity data records, including household street address, for 180,476 households in the Greater Los Angeles Area for the years 2015 and 2016. The data was obtained from Southern California Edison, an investor owned utility, and is not available publicly.	Household level smart meter data and reliable, high-resolution weather data enable a new method to characterize and quantify penetration of air conditioning technology, suggesting new ways to understand energy planning and communities that may be vulnerable to heat.
8	**Measuring social equity in urban energy use and interventions using fine-scale data**. Tong, K., Ramaswami, A., Xu, C. (Kewei), Feiock, R., Schmitz, P., & Ohlsen, M. (2021).	St. Paul (MN), Tallahassee (FL)	Monthly residential energy use and Energy Sector Investments in Conservation and Efficiency (ESICE) data provided by electric utilities at the census block level in St. Paul for 2016 and the premise level in Tallahassee under nondisclosure agreements for 2015.	There is significant spatial heterogeneity in energy usage patterns that correlate with race and ethnicity, suggesting a role for more targeted energy programs to address disparities.
9	**Analysis of High-Resolution Utility Data for Understanding Energy Use in Urban Systems: The Case of Los Angeles, California**. Pincetl, S., Graham, R., Murphy, S., & Sivaraman, D. (2016).	Los Angeles Department of Water and Power (CA)	Address-level monthly residential electricity demand data from July 2005 to June 2012 was collected for the City of Los Angeles through a nondisclosure agreement with the municipal utility company. Data was aggregated to census-block level.	Authors find significant spatial variation in energy consumption at the census block level that was previously hidden at a more aggregated level. This allows for identifying areas of high and low consumption to better target programs and policies.

2. Detailed Analysis of Research Studies

Below, we provide detailed summaries of the studies, their research questions, methodologies, and policy-relevant findings.

2.1. Zethmayr, J., & Makhija, R. S. (2019). Six unique load shapes: A segmentation analysis of Illinois residential electricity consumers. The Electricity Journal, 32(9), 106643. https://doi.org/10.1016/j.tej.2019.106643

Nature of Customer Energy Use Data

This study uses anonymous electric consumption data for 2.5 million residential customers of ComEd and Ameren Illinois, two large utilities in Illinois. The data includes daily observations of hourly interval volume readings from individual smart meters which are identified by customer class, random ID number, and geographic location. To keep the data anonymous as required by the Illinois Commerce Commission, a customer's location cannot be provided if there are 15 or fewer customers in the given geographic area, or if they represent 15% or more of that area's load. Because of this rule, geographic data was matched to customer demographic census data at different levels of specificity, either the Census Block Group level or at a municipal level (aggregated census blocks). The Census Block Group data used the 2017 American Consumer Survey (ACS) and included information on the age of head of household, construction year of residence, educational attainment, heating fuel, household makeup, home values, density, and number of rooms in residence. A commercially available dataset from geographic data services company, Melissa, was also used to relate postal codes to census block groups.

Policy-Relevant Findings

This study demonstrates that low-income households are overpaying their fair share on electric utilities. Since they tend to have flatter load shapes, they avoid driving up system costs with high peak usage. This finding indicates utilities should offer dynamic rate designs that better reflect a customers' cost of service. Another finding from this study is that programs encouraging energy efficiency and distributed energy resources are most effective in urban areas while demand response and time-variant pricing programs have greater impact on system costs in suburban and ex-urban areas. These findings point to how utilities can maximize cost-effectiveness and reduce bills for all customers.

2.2. Zethmayr, J., & Makhija, R. S. (2021). Using electricity customer profiles to combat GHG emissions: New evidence from ComEd AMI data. The Electricity Journal, 34(3), 106922. https://doi.org/10.1016/j.tej.2021.106922

Nature of Customer Energy Use Data

This study uses both residential Advanced Metering Infrastructure (AMI) data from ComEd (a large utility in Illinois), and PJM marginal emissions data. The AMI data was made available through the Illinois Commerce Commission's approval of a plan making utility customers' usage data available to third parties and includes anonymized daily observations of half-hour kWh usage for individual households identified by subclass and location at the 9-digit zipcode level. The emissions data contains the hourly emission rate of the marginal generator in the PJM power stack for each hour. The AMI data is used to identify distinct clusters of residential customers with unique usage patterns. Then, the hourly usage data is combined with the marginal emissions data to calculate the marginal emissions impact of each cluster. Demographic and socioeconomic data is from the U.S. Census Bureau's American Community Survey of 2017.

Policy-Relevant Findings

The authors argue that it is important to understand the impact on marginal rather than average emissions when determining the efficacy of policies on reducing climate pollution. Customer facing programs and messaging intended to reduce residential electricity consumption at times when marginal emissions are highest should be tailored to fit different household load shapes. The authors conclude that "the results provide new evidence to inform regulators, consumer advocates, policymakers and utilities on how best to customize energy efficiency, weatherization, customer education, and demand response programs for maximum benefit."

2.3. Cong, S., Nock, D., Qiu, Y. L., & Xing, B. (2022). Unveiling hidden energy poverty using the energy equity gap. Nature Communications, 13(1), 2456. https://doi.org/10.1038/s41467-022-30146-5

Nature of Customer Energy Use Data

This study looks at a residential electricity consumption dataset provided by Salt River Project, a large utility company in Arizona. The data set includes information for 6000 Arizona households and is composed of two parts. The first part is the hourly electricity consumption for each household in kWh from May 2015 to April 2019 as well as the billing plan for that household. Salt River Project billing packages have different pricing rules and conditions but can be categorized into three billing plans: Basic Rate Plan, Time-of-Use Plan, and Prepaid Plan. The second part is a comprehensive Residential Equipment and Technology Survey conducted in 2017 for those households, including information on household sociodemographic information and dwelling characteristics.

Policy-Relevant Findings

This study shows that current metrics for energy poverty overlook many households that are unable to meet their energy needs. By analyzing hourly consumption data, the researchers were able to identify that more than twice the amount of households could be considered energy poor or energy insecure compared to an income-based metric for energy insecurity (energy burden 10% threshold). The researchers used high-resolution utility data to identify households that demonstrate energy-limiting behavior: reducing their energy consumption relative to wealthier households, specifically by avoiding using their cooling systems. These findings point to the multidimensional nature of poverty and increase the options for policy interventions. The researchers were also able to identify racial and other demographic correlates, finding that Black households are disproportionately affected by price shifts compared to other ethnicities and that elderly households require additional targeting.

2.4. Ku, A. L., Qiu, Y. (Lucy), Lou, J., Nock, D., & Xing, B. (2022). Changes in hourly electricity consumption under COVID mandates: A glance to future hourly residential power consumption pattern with remote work in Arizona. Applied Energy, 310, 118539. https://doi.org/10.1016/j.apenergy.2022.118539

Nature of Customer Energy Use Data

The dataset used for this analysis came from the utility company Salt River Project in Arizona and contained hourly electricity consumption data for 6,549 individuals from March 2019 to April 2020. This study also drew on demographic and technology information (e.g., income, race, and the number and type of household electronic devices) from the Residential Equipment and Technology Survey conducted by Salt River Project in 2017.

Policy-Relevant Findings

The authors found that COVID mandates increased afternoon power consumption by 13% and shifted the power consumption pattern in winter from a two-peaked shape to a one-peaked shape. Additionally, they found that different demographic groups had differing power consumption patterns during the COVID mandates. Low-income groups within American Indian/Alaska Natives and Native Hawaiian consumed less power during all hours, while African American and Asian low-income groups consumption patterns changed less than their wealthier counterparts. These findings indicate that the transition to remote work could primarily occur in high-income groups and result in changes to the power infrastructure and utility rates that benefit high-income groups while negatively impacting low-income households. Since vulnerable groups may be unable to shift electricity consumption to the same degree as their wealthier counterparts, equity concerns regarding TOU pricing remain. This study also suggests that the maximum load of power consumption may be lowered if government and utilities adjust TOU rates.

2.5. Lou, J., Qiu, Y. (Lucy), Ku, A. L., Nock, D., & Xing, B. (2021). Inequitable and heterogeneous impacts on electricity consumption from COVID-19 mitigation measures. IScience, 24(11), 103231. https://doi.org/10.1016/j.isci.2021.103231

Nature of Customer Energy Use Data
The researchers used hourly electricity consumption data from the Salt River Project of Arizona and the Commonwealth Edison (ComEd) of Illinois, representing electric services in a warmer and a colder climate zone. The dataset included 7,004 residential and 23,117 commercial accounts in Arizona, and 40,771 residential and 40,757 commercial accounts in Illinois from January 2019 to April 2020. The study also drew on a Residential Equipment and Technology Survey conducted in 2017 for demographic data on the residential accounts in Arizona, and the American Community Survey of the United States Census Bureau for demographic data in Illinois. Hourly meteorological data from the National Oceanic and Atmospheric Administration (NOAA) Local Climatological Database and mobility data from SafeGraph, based on cell phone location data, were also used.

Policy-Relevant Findings
This study found that policies enacted during the COVID-19 pandemic (e.g, school closures and limiting business operations) increased residential electricity consumption by 4 to 5% while decreasing commercial electricity consumption by 5 to 8%. The authors found that this shift in energy consumption disproportionately impacted low-income and ethnic minority populations, in comparison to high-income and white populations, as well as small businesses. These findings point to the need for more equitable and effective policies for energy poverty assistance.

2.6. Qiu, Y., & Kahn, M. E. (2018). Better sustainability assessment of green buildings with high-frequency data. Nature Sustainability, 1(11), 642–649. https://doi.org/10.1038/s41893-018-0169-y

Nature of Customer Energy Use Data
Researchers used account-level hourly electricity demand data of individual commercial electricity customers for 2013 through 2016. The data were obtained through Salt River Project (SRP), a major utility company in the Phoenix metropolitan area. The dataset also includes information such as monthly electricity pricing plans, customer locations and industry codes. Researchers also used LEED and Energy Star certification data from the US Green Building Council and Environmental Protection Agency websites to characterize the buildings. This dataset includes things like building names, industry types, building owners, property managers, addresses, Energy Star ratings, Energy Star label years, LEED system versions, LEED points achieved, certification levels, registration dates, and certification dates. Researchers also matched each customer with the nearest weather station and obtained the hourly temperature data, including both dry-bulb and wet-bulb temperatures, for each electricity customer from National Oceanic and Atmospheric Administration (NOAA) Climate Data Online.

Policy-Relevant Findings

The researchers find that traditional assessments of green commercial buildings (Energy Star and LEED certified) underestimate the environmental benefits of the buildings by 95%. This is because traditional methods rely on aggregated (typically monthly) electricity consumption data, which do not take into account marginal emissions factors that vary throughout the day. Their data suggests that the majority of electricity savings for Energy Star and LEED certified buildings in summer happen during electric load system peak hours. Because the mix of fuel for electricity generation differs by time of day, policymakers should adopt more sophisticated methods for examining the environmental benefits of green buildings. In addition, the researchers find that green-certified buildings can help reduce peak-hour electricity demand, and hence reduce utility costs by lowering idle generation capacity. This presents an opportunity for utility companies to provide demand-side management incentives of green certification to commercial customers. Lastly, their study contributes to literature on rebound effects (i.e. actual energy savings of energy efficiency upgrades are lower than theoretical savings) by showing that the magnitude of the rebound effect may differ by time of day as well.

2.7. Chen, M., Sanders, K. T., & Ban-Weiss, G. A. (2019). A new method utilizing smart meter data for identifying the existence of air conditioning in residential homes. Environmental Research Letters, 14(9), 094004. https://doi.org/10.1088/1748-9326/ab35a8

Nature of Customer Energy Use Data

Researchers used hourly residential electricity data records for 180,476 households for the years 2015 and 2016. The dataset also included household street addresses, which enabled a geospatial analysis. The data was obtained from Southern California Edison, an investor owned utility. Weather information including daily average ambient temperature was gathered from the California Irrigation Management Information System (CIMIS) and the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI). Publicly available geographic and climate information like census tract boundaries and building climate zone boundaries were acquired from the US Census Bureau website and the California Energy Commission.

Policy-Relevant Findings

The study demonstrates a method for how to characterize and quantify air conditioning (AC) penetration in the Greater Los Angeles Area with unprecedented resolution. The authors claim that understanding the AC penetration rates would be particularly useful for a few reasons including informing policy for vulnerable communities as well as grid planning. Understanding where ACs are could help identify communities that might be vulnerable to extreme heat events because of lack of AC or high energy costs. Also, AC penetration patterns could be useful for identifying peak energy hotspots or areas prone to large increases in future AC adoption, which could be leveraged for grid planning. The authors emphasize that "Above all, such methods cannot be applied without an abundance of household level smart meter data, as well as reliable, high-resolution weather data."

2.8. Tong, K., Ramaswami, A., Xu, C. (Kewei), Feiock, R., Schmitz, P., & Ohlsen, M. (2021). Measuring social equity in urban energy use and interventions using fine-scale data. Proceedings of the National Academy of Sciences, 118(24), e2023554118. https://doi.org/10.1073/pnas.2023554118

Nature of Customer Energy Use Data

This study drew on monthly residential electricity and gas use and Energy Sector Investments in Conservation and Efficiency (ESICE) data provided by electric utilities at the census block level in St. Paul for 2016 and the premise level in Tallahassee under nondisclosure agreements for 2015. Energy use data for St. Paul were anonymized and aggregated by the utility to the census block level to meet current data privacy criteria. Data for Tallahassee are already in the public record. The energy use and ESICE data were then spatially joined with sociodemographic data (e.g., race and income) from the same year as the energy data (2016 for St. Paul and 2015 for Tallahassee) to conduct an analysis at the block group level. There were 233 block groups in St. Paul and 133 in Tallahassee.

Policy-Relevant Findings

This study demonstrates that the energy use intensity (EUI) disparities by income and race are up to five times greater than were previously reported. A previous analysis suggested that the EUI disparity between low-income and high-income homes was roughly 25%. This analysis found that EUI disparities by income were between 27 and 167% and were between 40 and 156% by race. These findings help reveal energy use inequality by race and income and can inform spatial prioritization for equitable energy efficiency investments.

2.9. Pincetl, S., Graham, R., Murphy, S., & Sivaraman, D. (2016). Analysis of High-Resolution Utility Data for Understanding Energy Use in Urban Systems: The Case of Los Angeles, California. Journal of Industrial Ecology, 20(1), 166–178. https://doi.org/10.1111/jiec.12299

Nature of Customer Energy Use Data

Address-level monthly residential electricity demand data from July 2005 to June 2012 was collected for the City of Los Angeles through a nondisclosure agreement with the municipal utility company. The data includes monthly usage by account number, the street address, city, zip code, census block FIPS code, and latitude-longitude coordinates, as well as identifiers for lifeline and low-income customers. The electricity data was aggregated to the city council district, neighborhood, and census-block level to ensure customer privacy, following a 15/15 rule: no less than 15 accounts in a geographical area, and no user that consumes 15% or more of the electricity in that area. County tax assessor data was used to provide building attributes like size and age. Utility tariff data was used to estimate the price of monthly electricity consumption, and the 2010 electricity mix was used to calculate the life cycle GHG emissions from electricity consumption.

Policy-Relevant Findings

The researchers uncovered significant variation in energy consumption across the urban landscape at the census block level that was previously hidden at a more aggregated level. This increased level of specificity and ability to identify areas of high and low consumption can be used to create programs, policies, and strategies for reducing carbon emitting flows. The address-level specificity which allows consumption to be matched to the parcel on which it occurs means the building-size analysis can also be used to help cities develop targeted design of energy management programs, appropriate building energy disclosures, optimization of energy investments, and appropriate energy disclosure policies for the city's building profiles.

Twin Cities Campus *Hubert H. Humphrey School of Public Affairs* *130 Hubert H. Humphrey Center*
301–19th Avenue South
Minneapolis, MN 55455

www.hhh.umn.edu

RE: In the Matter of a Petition by Citizens Utility Board of Minnesota to Adopt Open Data Access Standards (Docket No. E,G‑999/M‑19‑505)

RE: In the Matter of a Commission Inquiry into Privacy Policies of Rate-Regulated Energy Utilities (Docket No. E,G-999/CI-12-1344)

CERTIFICATE OF SERVICE

I, Elise Harrington, served a true and correct copy of the following documents to all entities/persons at the addresses indicated on the attached Service List(s) by electronic filing, electronic mail, courier, interoffice mail, or by depositing the same enveloped with postage paid in the United States Mail at St. Paul, Minnesota.

1. Reply Comments of Elise Harrington, Gabriel Chan, Bhavin Pradhan, and Chloe Olson.

Dated April 29, 2024

/s/ Elise Harrington
Assistant Professor, University of Minnesota

cc: Service Lists

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Chad	Adams	ChadA@swmhp.org	Southwest Minnesota Housing Partnership	2401 Broadway Ave Slayton, MN 56172	Electronic Service	No	OFF_SL_12-1344_Official
Michael	Ahern	ahern.michael@dorsey.com	Dorsey & Whitney, LLP	50 S 6th St Ste 1500 Minneapolis, MN 554021498	Electronic Service	No	OFF_SL_12-1344_Official
Kristine	Anderson	kanderson@greatermngas.com	Greater Minnesota Gas, Inc.& Greater MN Transmission, LLC	1900 Cardinal Lane PO Box 798 Faribault, MN 55021	Electronic Service	No	OFF_SL_12-1344_Official
Arnie	Anderson	ArnieAnderson@MinnCAP.org	Minnesota Community Action Partnership	MCIT Building 100 Empire Drive, Suite 202 St. Paul, MN 55103	Electronic Service	No	OFF_SL_12-1344_Official
Sarah	Anderson	sa@bomampls.org	Greater Minneapolis BOMA	Suite 610 121 South 8th Street Minneapolis, MN 55402	Electronic Service	No	OFF_SL_12-1344_Official
Martin S.	BeVier	bevi0022@umn.edu		4001 Grand Ave South # 3 Minneapolis, MN 55409	Electronic Service	No	OFF_SL_12-1344_Official
Nichol	Beckstrand	Nichol.beckstrand@mmha.com	Minnesota Multi Housing Association	1600 W 82nd St Ste 110 Minneapolis, MN 55431	Electronic Service	No	OFF_SL_12-1344_Official
Brian	Bowen	bbowen@firstfuel.com	FirstFuel	420 Bedford St, Suite 200 Lexington, MA 02420	Electronic Service	No	OFF_SL_12-1344_Official
Jon	Braman	jbraman@brightpower.com	Bright Power, Inc.	11 Hanover Square, 21st floor New York, NY 10005	Electronic Service	No	OFF_SL_12-1344_Official
Sheri	Brezinka	sbrezinka@usgbc.org	USGBC-Minnesota Chapter	701 Washington Ave. N Suite 200 Minneapolis, MN 55401	Electronic Service	No	OFF_SL_12-1344_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Richard	Carter	rick.carter@lhbcorp.com	LHB	2780 Shadywood Rd Excelsior, MN 55331-9599	Electronic Service	No	OFF_SL_12-1344_Official
Brent	Christensen	brentc@mnta.org	Minnesota Telecom Alliance	1000 Westgate Drive, Ste 252 St. Paul, MN 55114	Electronic Service	No	OFF_SL_12-1344_Official
Andrew	Clearwater	N/A	Future of Privacy Forum	1400 I St NW Ste 450 Washington, DC 20005-6503	Paper Service	No	OFF_SL_12-1344_Official
Roger	Colton	roger@fsconline.com	Fisher, Sheehan and Colton	34 Warwick Road Belmont, MA 02478	Electronic Service	No	OFF_SL_12-1344_Official
Sheri	Comer	Sheri.comer@ftr.com	Frontier Communications Corporation	1500 MacCorkle Ave SE Charleston, WV 25396	Electronic Service	No	OFF_SL_12-1344_Official
Generic Notice	Commerce Attorneys	commerce.attorneys@ag.state.mn.us	Office of the Attorney General-DOC	445 Minnesota Street Suite 1400 St. Paul, MN 55101	Electronic Service	Yes	OFF_SL_12-1344_Official
Stacy	Dahl	sdahl@minnkota.com	Minnkota Power Cooperative, Inc.	5301 32nd Ave S Grand Forks, ND 58201	Electronic Service	No	OFF_SL_12-1344_Official
Steve	Downer	sdowner@mmua.org	MMUA	3025 Harbor Ln N Ste 400 Plymouth, MN 554475142	Electronic Service	No	OFF_SL_12-1344_Official
Trent	Fellers	Trent.Fellers@windstream.com	Windstream	1440 M St Lincoln, NE 68508	Electronic Service	No	OFF_SL_12-1344_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Sharon	Ferguson	sharon.ferguson@state.mn.us	Department of Commerce	85 7th Place E Ste 280 Saint Paul, MN 551012198	Electronic Service	No	OFF_SL_12-1344_Official
Janne	Flisrand	janne@flisrand.com		2112 Dupont Ave S Minneapolis, MN 55405	Electronic Service	No	OFF_SL_12-1344_Official
Jenny	Glumack	jenny@mrea.org	Minnesota Rural Electric Association	11640 73rd Ave N Maple Grove, MN 55369	Electronic Service	No	OFF_SL_12-1344_Official
Bill	Gullickson	wdgvc76@yahoo.com		1819 Colfax Avenue S Minneapolis, MN 55403	Electronic Service	No	OFF_SL_12-1344_Official
Adam	Heinen	aheinen@dakotaelectric.com	Dakota Electric Association	4300 220th St W Farmington, MN 55024	Electronic Service	No	OFF_SL_12-1344_Official
Joylyn C	Hoffman Malueg	Joylyn.hoffmanmalueg@wecenergygroup.com	Minnesota Energy Resources	2685 145th St W Rosemount, MN 55068	Electronic Service	No	OFF_SL_12-1344_Official
Luke	Hollenkamp	luke.hollenkamp@ci.minneapolis.mn.us	City of Minneapolis	350 S. Fifth St. Room 301M Minneapolis, MN 55415	Electronic Service	No	OFF_SL_12-1344_Official
Caroline	Horton	chorton@aeonmn.org	Aeon	901 N 3rd St Ste 150 Minneapolis, MN 55401	Electronic Service	No	OFF_SL_12-1344_Official
Craig	Johnson	cjohnson@lmc.org	League of Minnesota Cities	145 University Ave. W. Saint Paul, MN 55103-2044	Electronic Service	No	OFF_SL_12-1344_Official
Nicolle	Kupser	nkupser@greatermngas.com	Greater Minnesota Gas, Inc. & Greater MN Transmission, LLC	1900 Cardinal Ln PO Box 798 Faribault, MN 55021	Electronic Service	No	OFF_SL_12-1344_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Cheri	Lenzmeier	cheril@mvec.net	Minnesota Valley Electric Cooperative	125 Minnesota Valley Electric Dr Jordan, MN 55352	Electronic Service	No	OFF_SL_12-1344_Official
Todd	Liljenquist	todd.liljenquist@mmha.com	Minnesota Multi Housing Association (MHA)	1600 West 82nd Street, Suite 110 Minneapolis, MN 55431	Electronic Service	No	OFF_SL_12-1344_Official
Alison	Lindburg	alindburg@mwalliance.org	Midwest Energy Efficiency Alliance	20 Lower Wacker Drive Suite 1301 Chicago, IL 60606	Electronic Service	No	OFF_SL_12-1344_Official
Jason	Loos	jason.loos@centerpointenergy.com	CenterPoint Energy Resources Corp.	505 Nicollet Mall 3rd Floor Minneapolis, MN 55402	Electronic Service	No	OFF_SL_12-1344_Official
Sarah	Marquardt	smarquardt@mcknight.org	The McKnight Foundation	710 S 2nd St Minneapolis, MN 55401	Electronic Service	No	OFF_SL_12-1344_Official
J.B.	Matthews	N/A	Cushman & Wakefield/NorthMarq	3500 American Blvd W - #200 Minneapolis, MN 55431	Paper Service	No	OFF_SL_12-1344_Official
Craig	McDonnell	Craig.McDonnell@state.mn.us	MN Pollution Control Agency	520 Lafayette Road St. Paul, MN 55101	Electronic Service	No	OFF_SL_12-1344_Official
David	Moeller	dmoeller@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022093	Electronic Service	No	OFF_SL_12-1344_Official
Andrew	Moratzka	andrew.moratzka@stoel.com	Stoel Rives LLP	33 South Sixth St Ste 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_12-1344_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Kristin	Munsch	kmunsch@citizensutilityboard.org	Citizens Utility Board of Minnesota	309 W. Washington St. Ste. 800 Chicago, IL 60606	Electronic Service	No	OFF_SL_12-1344_Official
Ted	Nedwick	tnedwick@nhtinc.org	National Housing Trust	1101 30th Street NW Ste 100A Washington, DC 20007	Electronic Service	No	OFF_SL_12-1344_Official
Samantha	Norris	samanthanorris@alliantenergy.com	Interstate Power and Light Company	200 1st Street SE PO Box 351 Cedar Rapids, IA 524060351	Electronic Service	No	OFF_SL_12-1344_Official
Greg	Palmer	gpalmer@greatermngas.com	Greater Minnesota Gas, Inc. & Greater MN Transmission, LLC	1900 Cardinal Ln PO Box 798 Faribault, MN 55021	Electronic Service	No	OFF_SL_12-1344_Official
Audrey	Partridge	apartridge@mncee.org	Center for Energy and Environment	212 3rd Ave. N. Suite 560 Minneapolis, MN 55401	Electronic Service	No	OFF_SL_12-1344_Official
Ben	Rabe	rabe@fresh-energy.org	Fresh Energy	408 St Peter St Ste 220 St. Paul, MN 55102	Electronic Service	No	OFF_SL_12-1344_Official
Phyllis	Reha	phyllisreha@gmail.com		3656 Woodland Trail Eagan, MN 55123	Electronic Service	No	OFF_SL_12-1344_Official
Generic Notice	Residential Utilities Division	residential.utilities@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012131	Electronic Service	Yes	OFF_SL_12-1344_Official
Christine	Schwartz	Regulatory.records@xcelenergy.com	Xcel Energy	414 Nicollet Mall FL 7 Minneapolis, MN 554011993	Electronic Service	No	OFF_SL_12-1344_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Will	Seuffert	Will.Seuffert@state.mn.us	Public Utilities Commission	121 7th Pl E Ste 350 Saint Paul, MN 55101	Electronic Service	Yes	OFF_SL_12-1344_Official
Janet	Shaddix Elling	jshaddix@janetshaddix.com	Shaddix And Associates	7400 Lyndale Ave S Ste 190 Richfield, MN 55423	Electronic Service	No	OFF_SL_12-1344_Official
Brendon	Slotterback	bslotterback@mcknight.org	The McKnight Foundation	710 S 2nd St Minneapolis, MN 55401	Electronic Service	No	OFF_SL_12-1344_Official
Peggy	Sorum	peggy.sorum@centerpointenergy.com	CenterPoint Energy	505 Nicollet Mall Minneapolis, MN 55402	Electronic Service	No	OFF_SL_12-1344_Official
Cary	Stephenson	cStephenson@otpco.com	Otter Tail Power Company	215 South Cascade Street Fergus Falls, MN 56537	Electronic Service	No	OFF_SL_12-1344_Official
Caitlin	Straabe	caitlin.straabe@mdu.com	Great Plains Natural Gas Co.	400 N 4th St Bismarck, ND 58501	Electronic Service	No	OFF_SL_12-1344_Official
Jason	Topp	jason.topp@lumen.com	CenturyLink Communications, LLC	200 S 5th St Ste 2200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_12-1344_Official
Patricia	Whitney	patricia@pwhitneylaw.com	St. Paul Assn of Responsible Landlords	627 Snelling Avenue South St. Paul, MN 55116	Electronic Service	No	OFF_SL_12-1344_Official
Robyn	Woeste	robynwoeste@alliantenergy.com	Interstate Power and Light Company	200 First St SE Cedar Rapids, IA 52401	Electronic Service	No	OFF_SL_12-1344_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Chad	Adams	ChadA@swmhp.org	Southwest Minnesota Housing Partnership	2401 Broadway Ave Slayton, MN 56172	Electronic Service	No	OFF_SL_19-505_Official
Michael	Ahern	ahern.michael@dorsey.com	Dorsey & Whitney, LLP	50 S 6th St Ste 1500 Minneapolis, MN 554021498	Electronic Service	No	OFF_SL_19-505_Official
Arnie	Anderson	ArnieAnderson@MinnCAP.org	Minnesota Community Action Partnership	MCIT Building 100 Empire Drive, Suite 202 St. Paul, MN 55103	Electronic Service	No	OFF_SL_19-505_Official
Kristine	Anderson	kanderson@greatermngas.com	Greater Minnesota Gas, Inc.& Greater MN Transmission, LLC	1900 Cardinal Lane PO Box 798 Faribault, MN 55021	Electronic Service	No	OFF_SL_19-505_Official
Sarah	Anderson	sa@bomampls.org	Greater Minneapolis BOMA	Suite 610 121 South 8th Street Minneapolis, MN 55402	Electronic Service	No	OFF_SL_19-505_Official
Martin S.	BeVier	bevi0022@umn.edu		4001 Grand Ave South # 3 Minneapolis, MN 55409	Electronic Service	No	OFF_SL_19-505_Official
Nichol	Beckstrand	Nichol.beckstrand@mmha.com	Minnesota Multi Housing Association	1600 W 82nd St Ste 110 Minneapolis, MN 55431	Electronic Service	No	OFF_SL_19-505_Official
Jon	Braman	jbraman@brightpower.com	Bright Power, Inc.	11 Hanover Square, 21st floor New York, NY 10005	Electronic Service	No	OFF_SL_19-505_Official
Sheri	Brezinka	sbrezinka@usgbc.org	USGBC-Minnesota Chapter	701 Washington Ave. N Suite 200 Minneapolis, MN 55401	Electronic Service	No	OFF_SL_19-505_Official
Richard	Carter	rick.carter@lhbcorp.com	LHB	2780 Shadywood Rd Excelsior, MN 55331-9599	Electronic Service	No	OFF_SL_19-505_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Gabriel	Chan	gabechan@umn.edu	University of Minnesota	130 Hubert H. Humphrey Center 301 19th Ave S Minneapolis, MN 55455	Electronic Service	No	OFF_SL_19-505_Official
Brent	Christensen	brentc@mnta.org	Minnesota Telecom Alliance	1000 Westgate Drive, Ste 252 St. Paul, MN 55114	Electronic Service	No	OFF_SL_19-505_Official
Andrew	Clearwater	N/A	Future of Privacy Forum	1400 I St NW Ste 450 Washington, DC 20005-6503	Paper Service	No	OFF_SL_19-505_Official
Roger	Colton	roger@fsconline.com	Fisher, Sheehan and Colton	34 Warwick Road Belmont, MA 02478	Electronic Service	No	OFF_SL_19-505_Official
Sheri	Comer	Sheri.comer@ftr.com	Frontier Communications Corporation	1500 MacCorkle Ave SE Charleston, WV 25396	Electronic Service	No	OFF_SL_19-505_Official
Generic Notice	Commerce Attorneys	commerce.attorneys@ag.state.mn.us	Office of the Attorney General-DOC	445 Minnesota Street Suite 1400 St. Paul, MN 55101	Electronic Service	Yes	OFF_SL_19-505_Official
Stacy	Dahl	sdahl@minnkota.com	Minnkota Power Cooperative, Inc.	5301 32nd Ave S Grand Forks, ND 58201	Electronic Service	No	OFF_SL_19-505_Official
Steve	Downer	sdowner@mmua.org	MMUA	3025 Harbor Ln N Ste 400 Plymouth, MN 554475142	Electronic Service	No	OFF_SL_19-505_Official
Trent	Fellers	Trent.Fellers@windstream.com	Windstream	1440 M St Lincoln, NE 68508	Electronic Service	No	OFF_SL_19-505_Official

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Sharon	Ferguson	sharon.ferguson@state.mn.us	Department of Commerce	85 7th Place E Ste 280 Saint Paul, MN 551012198	Electronic Service	No	OFF_SL_19-505_Official
Anna	Giesting	giest002@umn.edu	University of Minnesota	N/A	Electronic Service	No	OFF_SL_19-505_Official
Jenny	Glumack	jenny@mrea.org	Minnesota Rural Electric Association	11640 73rd Ave N Maple Grove, MN 55369	Electronic Service	No	OFF_SL_19-505_Official
Bill	Gullickson	wdgvc76@yahoo.com		1819 Colfax Avenue S Minneapolis, MN 55403	Electronic Service	No	OFF_SL_19-505_Official
Katherine	Hamilton	katherine@aem-alliance.org	Advanced Energy Management Alliance	1701 Rhode Island Ave, NW Washington, DC 20036	Electronic Service	No	OFF_SL_19-505_Official
Elise	Harrington, PhD	eliseh@umn.edu	University of Minnesota	N/A	Electronic Service	No	OFF_SL_19-505_Official
Adam	Heinen	aheinen@dakotaelectric.com	Dakota Electric Association	4300 220th St W Farmington, MN 55024	Electronic Service	No	OFF_SL_19-505_Official
Luke	Hollenkamp	luke.hollenkamp@ci.minneapolis.mn.us	City of Minneapolis	350 S. Fifth St. Room 301M Minneapolis, MN 55415	Electronic Service	No	OFF_SL_19-505_Official
Caroline	Horton	chorton@aeonmn.org	Aeon	901 N 3rd St Ste 150 Minneapolis, MN 55401	Electronic Service	No	OFF_SL_19-505_Official
Craig	Johnson	cjohnson@lmc.org	League of Minnesota Cities	145 University Ave. W. Saint Paul, MN 55103-2044	Electronic Service	No	OFF_SL_19-505_Official
Sarah	Komorosi	lacro041@umn.edu	University of Minnesota	N/A	Electronic Service	No	OFF_SL_19-505_Official
Nicolle	Kupser	nkupser@greatermngas.com	Greater Minnesota Gas, Inc. & Greater MN Transmission, LLC	1900 Cardinal Ln PO Box 798 Faribault, MN 55021	Electronic Service	No	OFF_SL_19-505_Official

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Cheri	Lenzmeier	cheril@mvec.net	Minnesota Valley Electric Cooperative	125 Minnesota Valley Electric Dr Jordan, MN 55352	Electronic Service	No	OFF_SL_19-505_Official
Annie	Levenson Falk	annielf@cubminnesota.org	Citizens Utility Board of Minnesota	332 Minnesota Street, Suite W1360 St. Paul, MN 55101	Electronic Service	No	OFF_SL_19-505_Official
Todd	Liljenquist	todd.liljenquist@mmha.com	Minnesota Multi Housing Association (MHA)	1600 West 82nd Street, Suite 110 Minneapolis, MN 55431	Electronic Service	No	OFF_SL_19-505_Official
Jason	Loos	jason.loos@centerpointenergy.com	CenterPoint Energy Resources Corp.	505 Nicollet Mall 3rd Floor Minneapolis, MN 55402	Electronic Service	No	OFF_SL_19-505_Official
Sarah	Marquardt	smarquardt@mcknight.org	The McKnight Foundation	710 S 2nd St Minneapolis, MN 55401	Electronic Service	No	OFF_SL_19-505_Official
Gregg	Mast	gmast@cleanenergyeconomymn.org	Clean Energy Economy Minnesota	4808 10th Avenue S Minneapolis, MN 55417	Electronic Service	No	OFF_SL_19-505_Official
J.B.	Matthews	N/A	Cushman & Wakefield/NorthMarq	3500 American Blvd W - #200 Minneapolis, MN 55431	Paper Service	No	OFF_SL_19-505_Official
Craig	McDonnell	Craig.McDonnell@state.mn.us	MN Pollution Control Agency	520 Lafayette Road St. Paul, MN 55101	Electronic Service	No	OFF_SL_19-505_Official
David	Moeller	dmoeller@allete.com	Minnesota Power	30 W Superior St Duluth, MN 558022093	Electronic Service	No	OFF_SL_19-505_Official

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Andrew	Moratzka	andrew.moratzka@stoel.com	Stoel Rives LLP	33 South Sixth St Ste 4200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_19-505_Official
Ted	Nedwick	tnedwick@nhtinc.org	National Housing Trust	1101 30th Street NW Ste 100A Washington, DC 20007	Electronic Service	No	OFF_SL_19-505_Official
Samantha	Norris	samanthanorris@alliantenergy.com	Interstate Power and Light Company	200 1st Street SE PO Box 351 Cedar Rapids, IA 524060351	Electronic Service	No	OFF_SL_19-505_Official
Greg	Palmer	gpalmer@greatermngas.com	Greater Minnesota Gas, Inc. & Greater MN Transmission, LLC	1900 Cardinal Ln PO Box 798 Faribault, MN 55021	Electronic Service	No	OFF_SL_19-505_Official
Audrey	Partridge	apartridge@mncee.org	Center for Energy and Environment	212 3rd Ave. N. Suite 560 Minneapolis, MN 55401	Electronic Service	No	OFF_SL_19-505_Official
Ben	Rabe	rabe@fresh-energy.org	Fresh Energy	408 St Peter St Ste 220 St. Paul, MN 55102	Electronic Service	No	OFF_SL_19-505_Official
Phyllis	Reha	phyllisreha@gmail.com		3656 Woodland Trail Eagan, MN 55123	Electronic Service	No	OFF_SL_19-505_Official
Generic Notice	Residential Utilities Division	residential.utilities@ag.state.mn.us	Office of the Attorney General-RUD	1400 BRM Tower 445 Minnesota St St. Paul, MN 551012131	Electronic Service	Yes	OFF_SL_19-505_Official
Christine	Schwartz	Regulatory.records@xcelenergy.com	Xcel Energy	414 Nicollet Mall FL 7 Minneapolis, MN 554011993	Electronic Service	No	OFF_SL_19-505_Official

First Name	Last Name	Email	Company Name	Address	Delivery Method	View Trade Secret	Service List Name
Will	Seuffert	Will.Seuffert@state.mn.us	Public Utilities Commission	121 7th Pl E Ste 350 Saint Paul, MN 55101	Electronic Service	Yes	OFF_SL_19-505_Official
Janet	Shaddix Elling	jshaddix@janetshaddix.com	Shaddix And Associates	7400 Lyndale Ave S Ste 190 Richfield, MN 55423	Electronic Service	No	OFF_SL_19-505_Official
Brendon	Slotterback	bslotterback@mcknight.org	The McKnight Foundation	710 S 2nd St Minneapolis, MN 55401	Electronic Service	No	OFF_SL_19-505_Official
Peggy	Sorum	peggy.sorum@centerpointenergy.com	CenterPoint Energy	505 Nicollet Mall Minneapolis, MN 55402	Electronic Service	No	OFF_SL_19-505_Official
Richard	Stasik	richard.stasik@wecenergygroup.com	Minnesota Energy Resources Corporation (HOLDING)	231 West Michigan St - P321 Milwaukee, WI 53203	Electronic Service	No	OFF_SL_19-505_Official
Kristin	Stastny	kstastny@taftlaw.com	Taft Stettinius & Hollister LLP	2200 IDS Center 80 South 8th St Minneapolis, MN 55402	Electronic Service	No	OFF_SL_19-505_Official
Cary	Stephenson	cStephenson@otpco.com	Otter Tail Power Company	215 South Cascade Street Fergus Falls, MN 56537	Electronic Service	No	OFF_SL_19-505_Official
Caitlin	Straabe	caitlin.straabe@mdu.com	Great Plains Natural Gas Co.	400 N 4th St Bismarck, ND 58501	Electronic Service	No	OFF_SL_19-505_Official
Jason	Topp	jason.topp@lumen.com	CenturyLink Communications, LLC	200 S 5th St Ste 2200 Minneapolis, MN 55402	Electronic Service	No	OFF_SL_19-505_Official

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Jenna	Warmuth	jwarmuth@mnpower.com	Minnesota Power	30 W Superior St Duluth, MN 55802-2093	Electronic Service	No	OFF_SL_19-505_Official
Patricia	Whitney	patricia@pwhitneylaw.com	St. Paul Assn of Responsible Landlords	627 Snelling Avenue South St. Paul, MN 55116	Electronic Service	No	OFF_SL_19-505_Official
Robyn	Woeste	robynwoeste@alliantenergy.com	Interstate Power and Light Company	200 First St SE Cedar Rapids, IA 52401	Electronic Service	No	OFF_SL_19-505_Official
Jeff	Zethmayr	jzethmayr@citizensutilityboard.org	Citizens Utility Board	309 W. Washington, Ste 800 Chicago, IL 60606	Electronic Service	No	OFF_SL_19-505_Official