Pecan Street Inc. Student Research Competition

Through the generous support of the Alfred P. Sloan Foundation, Pecan Street Inc. is hosting its second student research competition to foster innovative, high impact research that helps the energy and water industries solve public interest problems.

Pecan Street Inc. created and operates the world’s largest research database of customer and distribution-level electricity, natural gas and water use. To facilitate research in areas of interest to industry, Pecan Street and its Data Advisory Board members and industry partners have developed a list of recommended research topics. Focusing on these research topics is not required but is strongly recommended.

Awards will be made to the students that develop the most impactful research using Pecan Street’s unique dataset to answer a question of critical importance to industry. Pecan Street will help disseminate the research findings through presentation at its annual research conference in Austin, Texas and publication on Pecan Street’s website. Information about available datasets can be found at www.dataport.cloud.

Competition Requirements

Submitted research must comply with the following requirements:

- Research must be conducted by a full-time undergraduate or graduate student actively enrolled at a university;
- Research must use Pecan Street’s data, available through Dataport at www.dataport.cloud;
- Submissions must follow the format and content requirements provided below;
- Papers must cite Pecan Street data when used for analysis or visualizations;
- Complete papers must be submitted by January 30, 2018 to info@pecanstreet.org.

Authors of the four finalist submissions will present their research in a 30-minute presentation to industry and academic leaders at Pecan Street’s annual research conference in March 2018 (all travel and associated costs will be covered by Pecan Street Inc.).

Pecan Street Inc. reserves a non-exclusive right to publish and promote all research papers submitted as part of the final competition. Pecan Street encourages applicants to pursue peer-reviewed journal publication, as well. If the submission uses confidential information or methodology, the submission must clearly disclose confidential information to members of the research advisory panel who will select the winning research.

Questions about data access, competition rules or research content can be directed to Rachel Jenkins at rjenkins@pecanstreet.org.

www.pecanstreet.org
Awards

Submitted papers will be reviewed by a jury comprised of Pecan Street Inc. staff, academic and industry partners.

Four finalists will be selected and notified by February 15, 2018. Pecan Street Inc. will provide domestic flight, hotel accommodation and a per diem to the finalists to join its consortium members in Austin, Texas for the annual conference to present their research to industry leaders and academic researchers. The conference will be held in March 2018; the conference date will be announced November 15, 2017.

The finalists will be invited to join Pecan Street’s Industry and Research Consortiums for a private dinner the evening before the conference.

Cash prizes will be awarded at the conference in the following amounts:

- $5,000 for one first place submission
- $2,500 for one second place submission
- $1,250 for two semi-finalists

Required research paper components

Each research paper must include the following components.

1. Title

Submissions must list proposal primary author and secondary authors. Include project sponsor (ie, if the primary and secondary authors are PhD students, include the faculty sponsor). Title page should concisely indicate the nature of the submission.

2. Abstract (500 words or fewer)

Submissions must summarize the problem addressed by the applicant, identify the objectives and methods of the project, describe the Pecan Street datasets used for the project, and briefly describe the findings.

3. Introduction

Include statement of problem and purpose and significance of the research. The introduction should include the research topic from the list of recommended topics that is addressed, if applicable.
4. **Background**

Proposals must include a preliminary literature survey. Identify the research problem, give evidence of your unique expertise to add to the existing literature. Specify the unique contribution your work will add to and how it differs from the existing literature.

5. **Description of Research**

This comprehensive description should make a clear argument to the review panel about why your submission should compete for the finalist awards. It should make clear the focus of the research and how it differs from previous work. If the end result of your research is to conclude one phase and use the results to inform a second phase, be clear about the end results of each phase and how you will intend to use the funding in phase two.

6. **Methodology**

Describe the methodological approach that was applied, as well as the datasets used to carry out the research. Provide an explanation of how this methodology is uniquely suited to accurately answer the selected research question.

7. **Research Results**

Discuss the results of the research and how it applies to a direct industry or public interest challenge. If the results lead to additional research that should be undertaken to adequately answer the research question, include a proposed next step in the research.

8. **List of References**

Submission must include a list of references following a consistent style.

9. **Resumes**

Submission must include a resume and/or CV for each member of the research team. If the research team is composed of more than one individual, include an explanation of the roles and responsibilities of each team member and the collaborative approach, particularly if you plan to collaborate with other members of the Pecan Street Research Institute.

10. **Files and Format**

Papers should be submitted to Pecan Street in one PDF document that includes all the sections listed above, as well as any appendices or additional documentation. Microsoft Word, Apple Pages, Google Docs or other word processing files will NOT be accepted.

Exceptions to this requirement include appendices or additional documentation that do not conform neatly into PDF format (for example, large spreadsheets). For these exceptions, applicants should combine/compress submissions into one .zip file that contains the main PDF of the submission and any other files.
Recommended Research Topics

Following are recommended research topics developed in partnership with Pecan Street’s Data Advisory Board members, industry partners and staff for research competition paper topics using Pecan Street datasets. Focusing on these research topics is not required but is strongly recommended.

Algorithmic Disaggregation

• Develop an algorithm that disaggregates whole home water use into individual end uses from Pecan Street’s water datasets (which report in water use as sub-minute and sub-gallon intervals) and verify the accuracy of the algorithm using Pecan Street’s electric data for homes with whole home water monitoring.

Energy-Water Nexus Research

• Create an energy-water nexus algorithm that calculates total (direct+embedded) energy and water for individual end uses in homes using Pecan Street’s unique energy and water datasets.

Power Systems Modeling

• Create an updated, predictive model of the impact of varying levels of EV and PV adoption on distribution system load balance and distribution system equipment (such as transformer, lateral feeder substation).

• Create an updated, predictive model of the impact of varying levels of EV and PV adoption on distribution system load balance and distribution system equipment (such as transformer, lateral feeder, substation) using IEEE 13 bus as the circuit model.

• Create a multivariable model or a theorized modeling approach of the impact on home peak profile and thermal performance of different HVAC system configurations (e.g., AC compressor sizing and SEER rating, thermostat setting) and thermal system conditions (R-value of insulation, building envelope leakage, duct leakage percentage).

• Create an updated approach for a data-driven model for Cooling Degree Days thresholds based on real world correlation of customer AC compressor use with ambient temperatures, solar insolation data, and humidity.
Residential Energy Use Characterization

- Bright spots characterization: identify and quantify the factors in homes that correlate with much lower peak demand impacts.
- Bright spots characterization: identify homes with much lower carbon impacts; characterize the factors in homes that correlate with much lower carbon impacts, using both marginal and average emissions factors.
- Calculate and describe the power factor impacts of different devices in homes and impact on overall residential power factor.
- Based on measured use patterns and using actual time-stamped device level data, calculate a model under % at rate and time-of-use rate pricing for device level annual electricity costs of different devices (e.g., cable boxes, refrigerators, HVAC compressor sizing, electric heating, etc.). Include formulas required to account for changing values due to alterations in climate conditions and implementation of maintenance and home improvements such as repairing leaking ducts and adding attic insulation.
- Model seasonal distribution system load profiles (individual customer level and aggregated system level) of distributions systems with time-of-use pricing coupled with varying adoption levels of west facing rooftop solar PV. The model resolution should be at time intervals of 15 minutes or less (e.g., every five minutes or every minute). The model should incorporate impacts from the above variables on loads at the substation, transformer and feeder between substation and transformer.
- Analyze the electric system peak and gas system peak shaving value of gas appliances vs. electric appliances (based on actual historic customer time of use and energy use levels)

Distributed Energy Resources Behavioral Profiles and Grid Impacts

- Based on measured data, develop a model to optimize storage system size for homes with existing PV systems and analyze storage size dependence on NEM rates, usage profiles and EV ownership. Using the model, develop a sizing recommendation engine based on measured data from similar homes.
- Based on measured data, develop a model to optimize PV + storage system size and analyze its dependence on NEM rates, usage profiles and EV ownership. Using the model, develop a sizing recommendation engine based on measured data from similar homes.
• Analyze the comparative power quality, peak reduction and cost of service impacts of west facing and south facing rooftop solar PV. Calculate the impact on this analysis of working from home vs. away from home.

• Calculate the peak demand reduction impacts and seasonal generation variation of different tilt azimuths for installed residential rooftop solar PV.

• Develop a model for describing the circumstances and calculating the price point at which solar rebates achieve a net positive value for shaving peak for a utility.

**Electric Vehicle Behavioral Profiles and Grid Impacts**

• Create a predictive model of residential EV charging at varying adoption levels. The model should include expected distributions of charging start and stop times, duration per charge and impact on the model of vehicle type (e.g., do Volts and Leafs have different charging profiles?).

• Develop a predictive model using actual customer charging data for evaluating the impacts of different penetration levels of Level 1 and Level 2 charging on utility transformer loads, cooling time and expected operating lifetime.

**Social Sciences and Behavioral Research**

• Examine homes with children to investigate the load flexibility of those households during peak periods (which also are often after school times where meals, homework and bathing are prevalent - some recent research in Australia indicates very little flexibility in homes with small children).

• Examine the relationships of electricity daily load shapes (i.e., energy use lifestyles), stability of those shapes and household demographics (as well as psychographic variables if available) to enrollment and responsiveness to DR and EE programs.

• Investigate the demographic and psychographic correlates of daily load shape and stability of shape over days of week (e.g. other lifestyle research reveals greater stability in habits/routines on Tuesday – Thursday), seasons, weekends, etc.

• Investigate the relationship of load shape and load shape features, such as stability of shape, baseload percent of consumption, and peak hour percent of consumption to other lifestyle factors such as number of people in household, presence of children, etc.

• Investigate the periodicity of overlapping water and electricity use, building an understanding of water and electricity nexus lifestyles.