



Pecan Street Inc. : A Test-bed for NILM

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Background

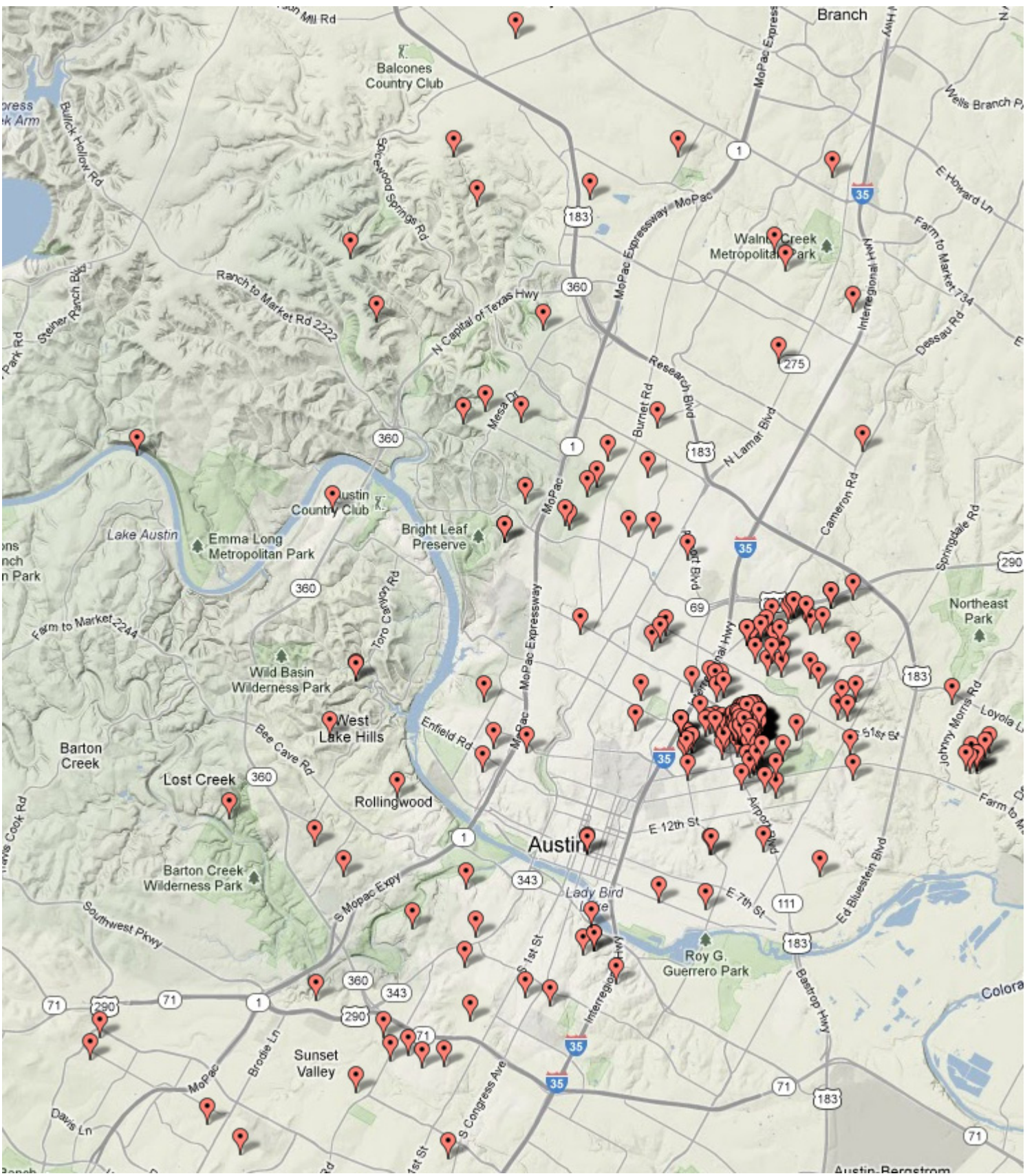
Headquartered at The University of Texas at Austin, Pecan Street Inc. is a research and development organization focused on developing and testing advanced technology, business model, and customer behavior surrounding advanced energy management systems. We provide participating companies and researchers access to a large number of residential participants for future research in addition to our existing research trials and data.

Of interest to NILM algorithm developers; we are monitoring sub-circuits inside hundreds of homes in Austin, Texas. We also conduct audits and surveys to find out more about what’s going on each home. We have dozens of homes with electric vehicles and photovoltaic systems. We are also collecting gas and water data for dozens of homes, and system-wide measurements including solar insolation.

Our heavy monitoring of signed participants enable the development and validation of NILM algorithms that identify valuable information for customers, utilities, and third-parties. Our platform also enables testing of new energy monitoring and measurement equipment. We want to help identify the optimal equipment, data processing, and visualization that will maximize the value of customer-side and utility-side energy monitoring and measurement, upon which NILM algorithms play a large role.

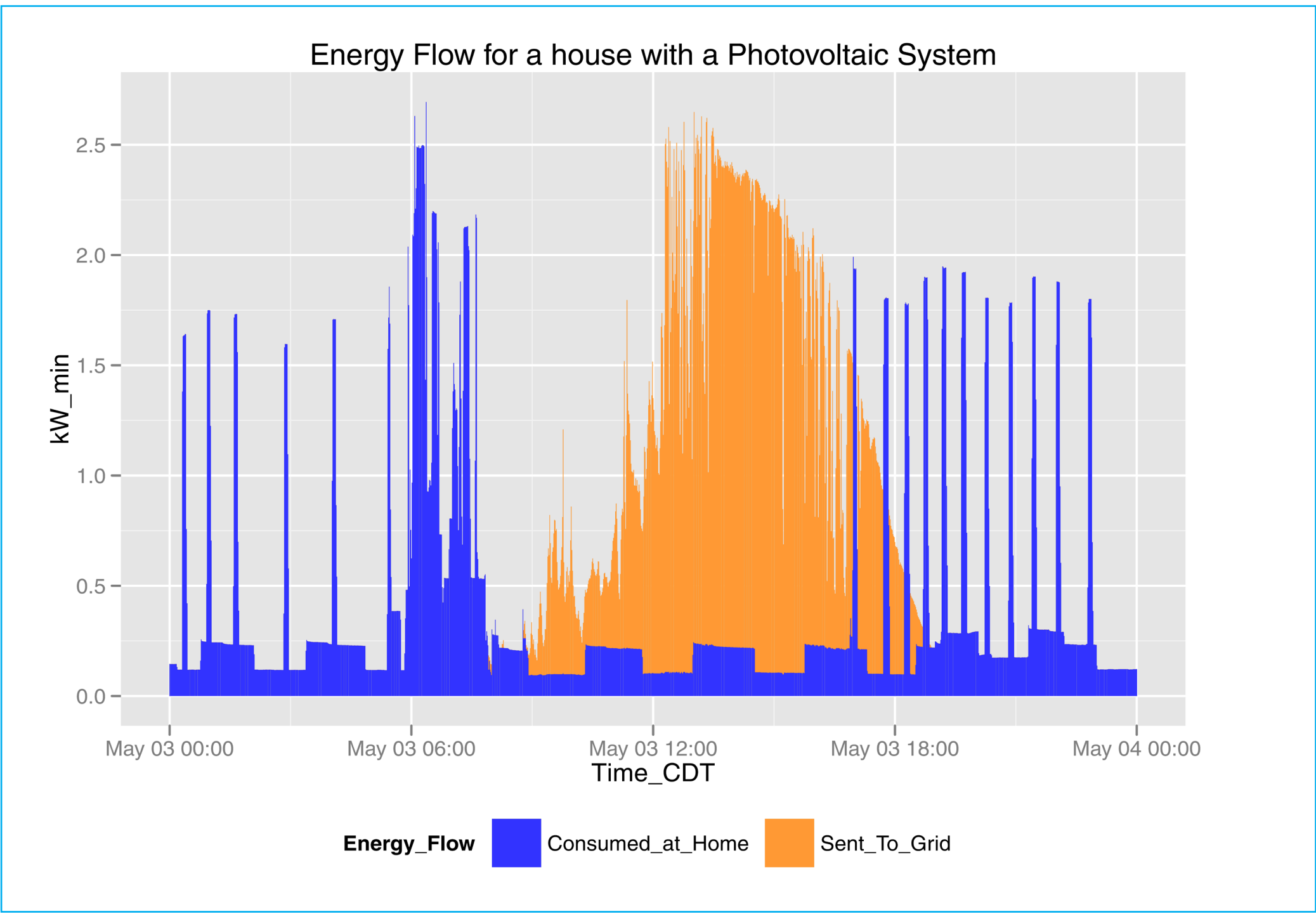
Location

We are conducting research in Austin, Texas as a whole, have a high density deployment the Mueller development area, and we are building a lab to conduct research and testing on emerging technologies before they are deployed broadly. We have 407 households in our study at this time and will have many more in the future. The following map shows their location.



As shown on the previous map, the majority of our current participants are in the same area in Austin - a green-built community called Mueller. This is where we have densely deployed photovoltaic systems and electric vehicles, and where Sony is deploying hundreds of HEMS (50 of which will have residential storage). Also located in Mueller, the Pike Powers Commercialization Lab will enable researchers and companies to test, refine and demonstrate products including products that enable NILM such as Intel’s WEST system.

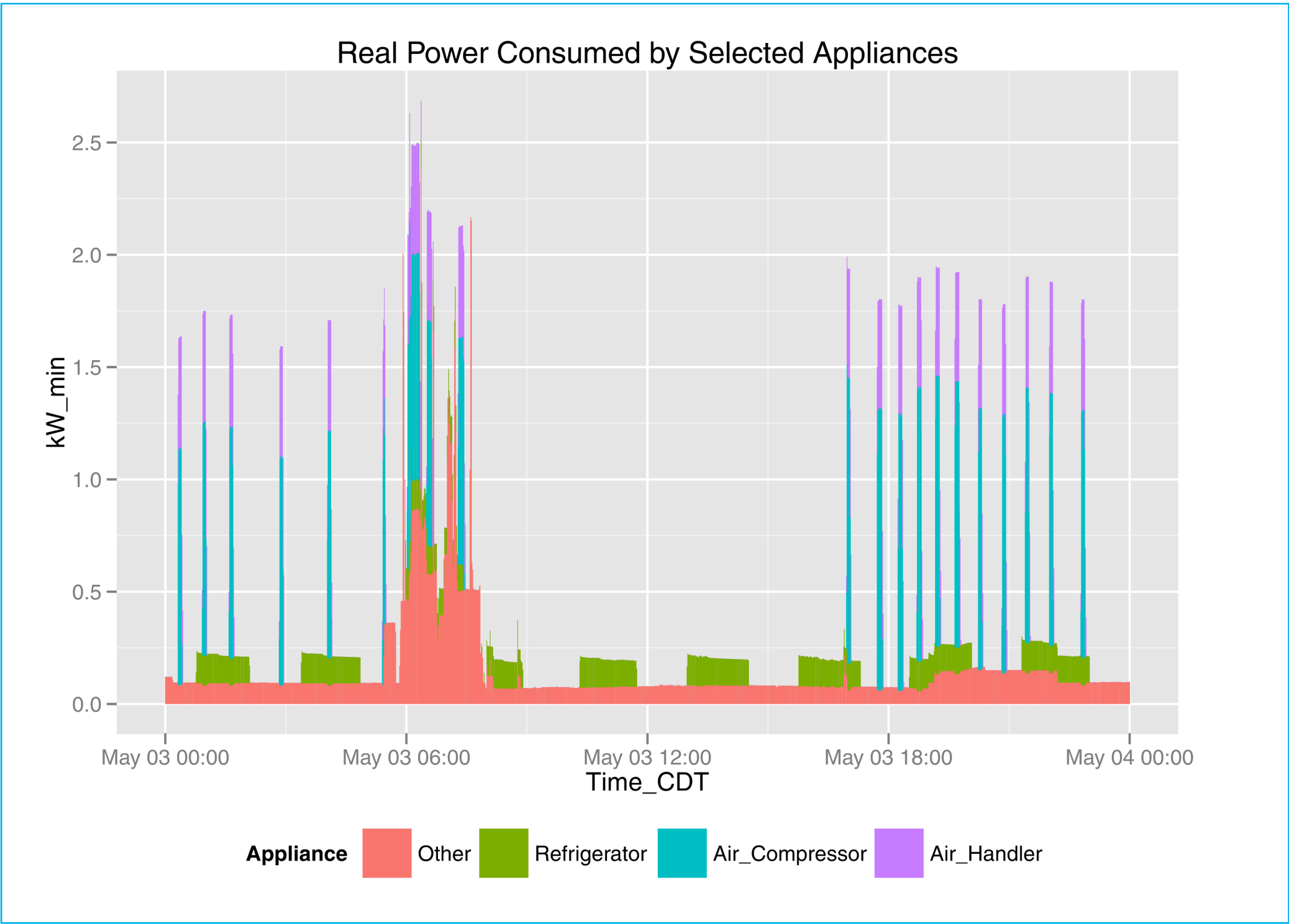
Direct Measurements: A Sample House-Day



For this sample house, we are monitoring 24 circuits with an eGauge system that has been tested in a university lab for accuracy. We are also pulling utility metered 15min data for validation.

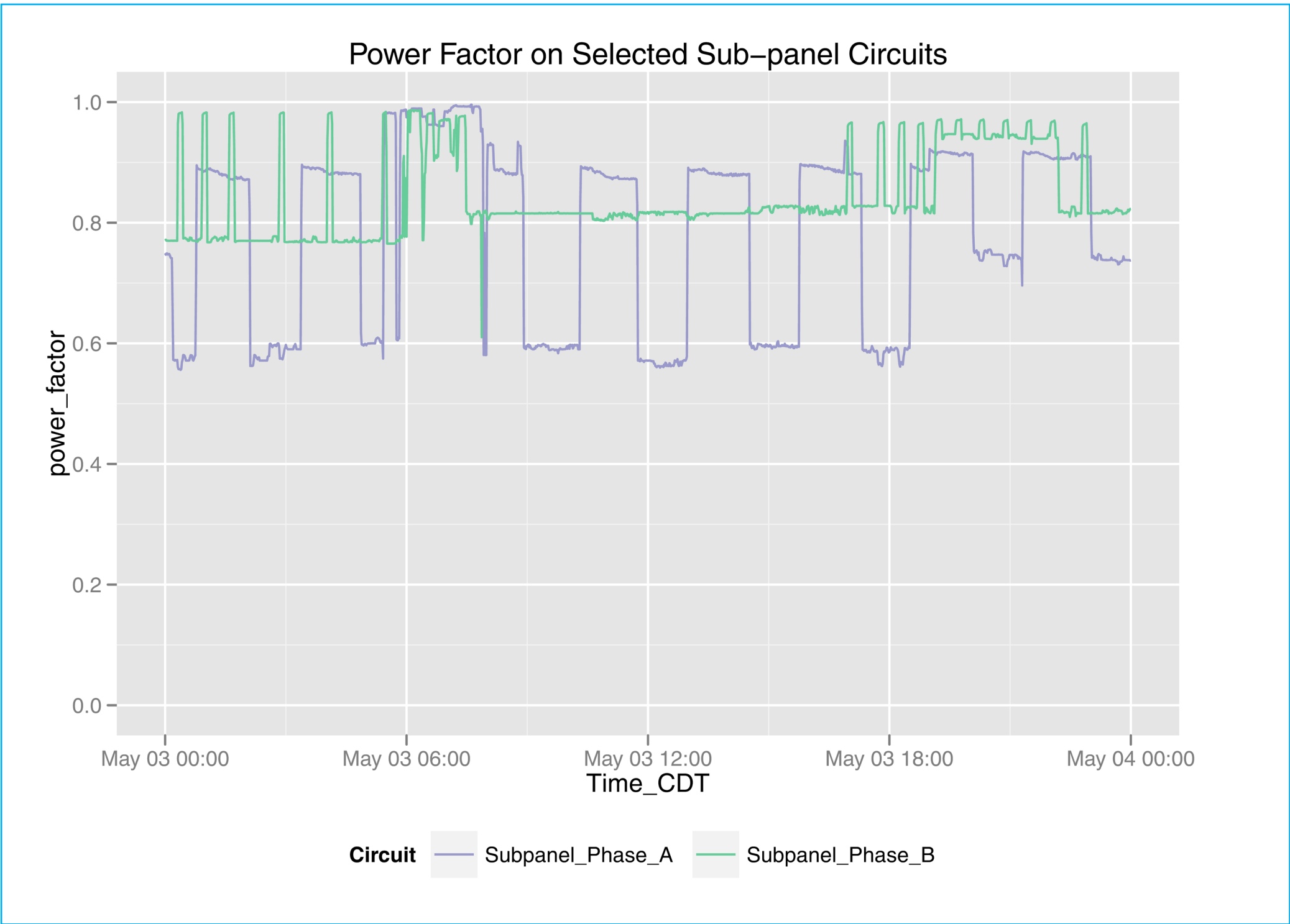
Many homes have dual South and West arrays and inverters that provide their own measurements including DC and AC power from each string.

This stacked bar chart shows that generation is not coincident with load on this day and much of the energy is sent back to the grid.



Much of the energy consumed in the home is going to the refrigerator, air compressor and air handler. The air compressor is on the main panel and uses 240 Volts while the air handler is on the subpanel and uses 120 Volts.

Although this graph shows averaged real power, we also collect apparent power. We are in the process of introducing calculations for reactive power and THD for each circuit. Capturing power quality helps the development of NILM and estimation of these values is valuable to utilities.



This graph shows two of the many power quality measurements that we can acquire from this system. Here we looking at the power factor for each leg on the sub-panel.

By comparing this graph with the preceding graph, we can readily see the causality between the appliances used in the home and the power factor on each sub-circuit leg.

Visual inspection indicates that the air handler is on phase B and the refrigerator is on phase A.

Indirect Measurements: Our Sample House

In addition to the direct measurements made by sensors in the house, we collect information from the resident through surveys, work with PV installers to obtain PV system reports, and collect advanced audit results from auditors.

Surveys:

- Experiences with technologies
- Demographic information
- Registry of the electronic appliances in the home and their expected typical use

From our survey with this resident we know that they do not work at home during the week and there are 1 male and 2 females living in this home. The homeowner insulated their garage door as a result of their energy audit. They have two television sets and according to the respondent, they vacuum daily.

Audits:

- Detailed information about the building envelope
- Model numbers for dedicated appliances present at each home
- Results of audit tests

The audit states that this is a one story house with 3 bedrooms with around 1300 square feet of conditioned space. They use gas for heating and have a GE model #GSS25QSWC refrigerator. They have 143 total square feet of windows and an estimated 4.4% total duct leakage. These fields are useful when developing thermal home models to help disaggregate heating and cooling loads.

PV Installer:

- Inverter and module
- Orientation and wiring

The installer notes for this system state that the home has a 3.43 kW STC rated system with a Power-One PVI-3.0 inverter. The system is South facing (175 ° azimuth) with a tilt of 28°. This matches the measured values. To see how the system is performing, we could compare with other homes and nearby solar insolation.

Conclusions and Contact Information

The sample dataset shown here displays the applicability of the Pecan Street Test-bed for NILM research. As this information does not encapsulate the current and future work of Pecan Street and the Pecan Street Consortium, please go the following Website for more information:

<http://www.pecanstreet.org>

For inquiries related to research and data collaboration, feel free to contact me directly and for general inquires concerning our research trials and participation in our consortium please email:

info@pecanstreet.org