

Smart Meters and Household Characteristics

Estimating load profiles and changes in consumption behavior

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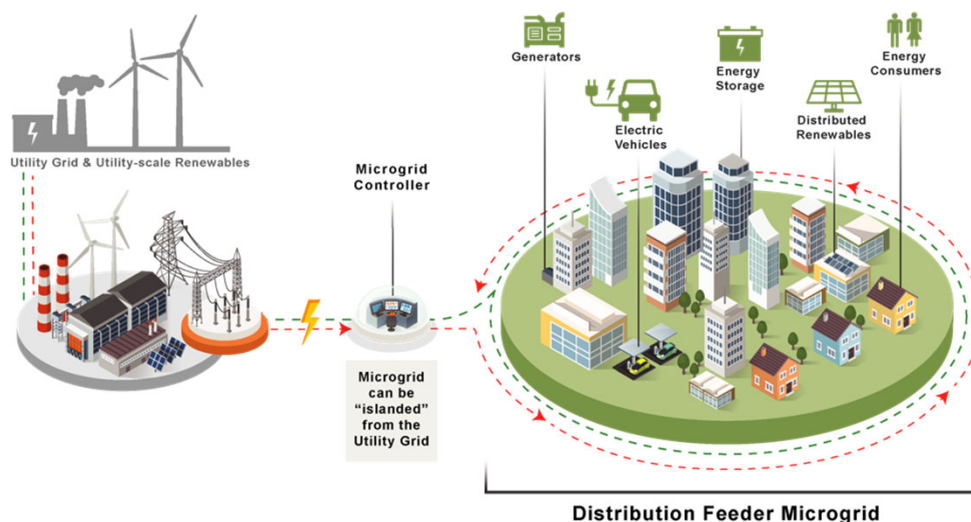
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The NM SMART Grid Center Overview

Sustainable, Modular, Adaptive, Resilient, Transactive



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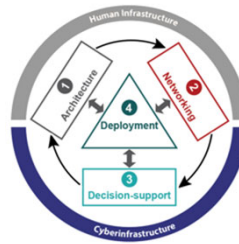
The NM SMART Grid Center Overview

Vision

A modern, secure, and sustainable electric grid supported by a diverse, next generation workforce.

Mission

Investigate the fundamental challenges to transition existing transmission and distributed energy infrastructure into a SMART* grid and develop supporting knowledge, national talent, and an informed public.



*Sustainable, Modular, Adaptive, Resilient, Transactive

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NM SMART Grid Center Team

34

Faculty

3

Post Docs

72

Graduate
Students

24

Undergraduate
Students

19

Staff/Other



8

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Participating Institutions & Roles

- 3 research universities 
- 1 community college 
- 2 national laboratories 
- 1 museum 
- 1 non-profit 
- 9 industry partners 

 Research

 Partnering and Sustainability

 Workforce Development & Education/Outreach

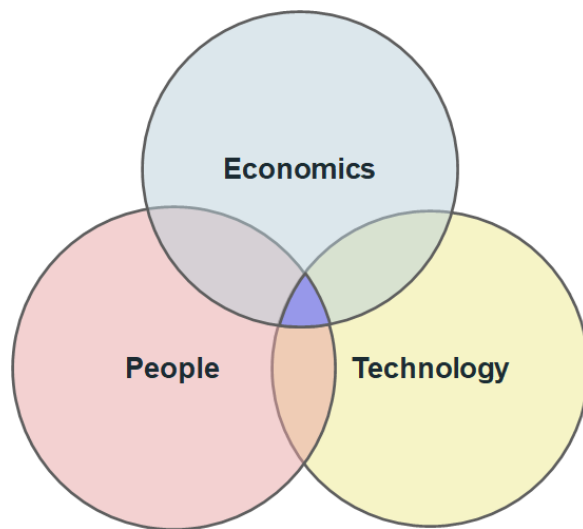


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Motivation

- We want to improve our understanding of electricity usage at the sub-hourly, household level to improve load forecasting
- Understand the impact of distributed energy resources on a household loads
- Gain insight into how people use electricity beyond the hour and season schedule



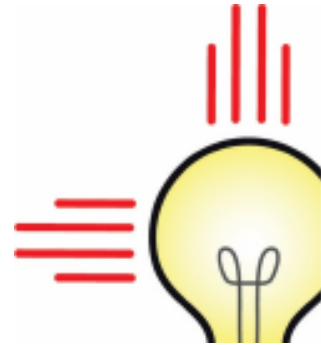
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Working with Circuit 16 Meter Data

What we have done so far

- Examined smart meter data from 2013-2019
- Calculating load attributes for meters
 - ▶ Morning and evening peak height
 - ▶ Width of peaks
 - ▶ Idle load
 - ▶ Average load
 - ▶ Average consumption
- Developed measures of relative consumption to identify outlier households



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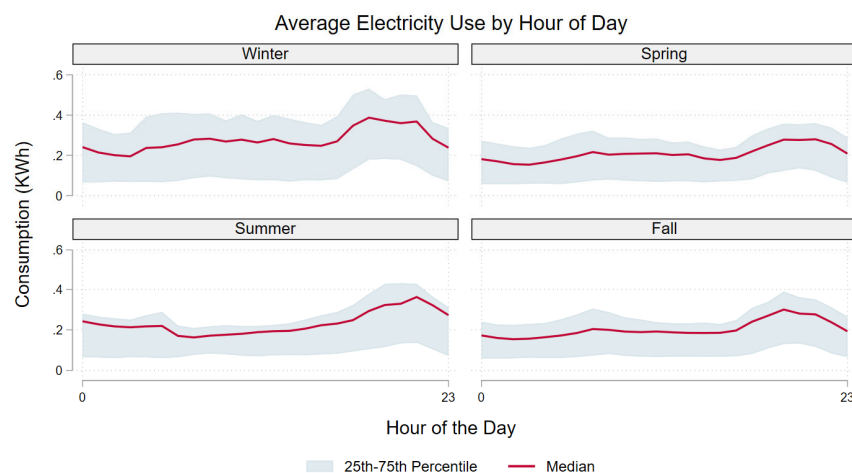
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Variability in Consumption

On the aggregate:

- Weather
- Time of day
- Seasons

Clear variation
at the household
level (noted by the
range in percentiles)



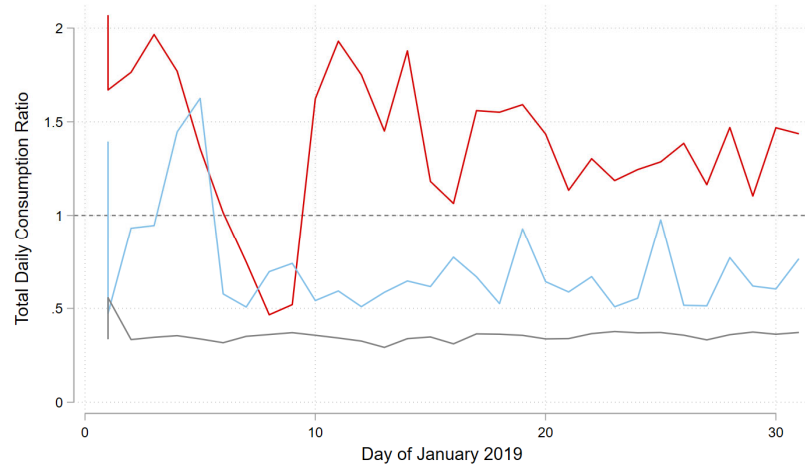
Graphs by season

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Example of Relative Consumption

- Total daily consumption of 3 households (relative to other single family residential meters)
- What is driving these differences between households?



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Predicting Variability in Consumption

At the household level, variation stems from:

- Socio-economic characteristics
 - Income, number of occupants, employment characteristics, etc.
- Dwelling characteristics
 - Number of bedrooms, bathrooms, year built, heating and cooling infrastructure, distributed energy resources, etc.
- Appliance stock
 - Number of appliances, energy efficiency of said appliances, etc.

Information that can best be obtained through original data collection

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Research Question

How are load attributes and measures of consumption outliers influenced by socio-economic, dwelling, and appliance characteristics?

Methods

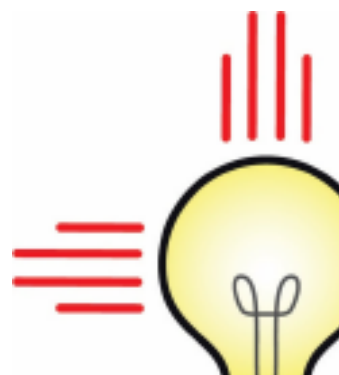
- Conduct a survey of LADPU residents on circuit 16 (10-15 minutes)
- Create load attributes and measures of relative consumption of those residents with 15-minute interval reads
- Use econometric techniques to determine the influence of surveyed characteristics on these load attributes and measures of relative consumption

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Survey Process

1. Obtain email addresses of account holders on circuit 16 and send digital survey (Qualtrics XM)
2. Obtain meter data of survey respondents
3. Conduct econometric research
4. Synthesize results for LADPU
5. Publish findings



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Survey Examples (Socioeconomics)

Are you of Spanish, Hispanic, or Latino origin?

☐ Yes

☐ No

Choose one or more races that you consider yourself to be

☐ White or Caucasian

☐ Black or African American

☐ American Indian/Native American or Alaska Native

☐ Asian

☐ Native Hawaiian or Other Pacific Islander

☐ Other

☐ Prefer not to say

What is the highest level of education you have completed?

☐ Some high school or less

☐ High school diploma or GED

☐ Some college, but no degree

☐ Associates or technical degree

☐ Bachelor's degree

☐ Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.)

☐ Prefer not to say

12:29

Are you of Spanish, Hispanic, or Latino origin?

Yes

No

Choose one or more races that you consider yourself to be

White or Caucasian

Black or African American

American Indian/Native American or Alaska Native

Asian

Native Hawaiian or Other Pacific

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Survey Examples (Dwelling Characteristics)

Which best describes your home?

☐ Mobile home

☐ Single-family house detached from any other house

☐ Single-family house attached to one or more other houses (duplex, row house, townhome, etc.)

☐ Apartment in a building with 2 to 4 units

☐ Apartment in a building with 5 or more units

Not including basements or attics, how many stories does your home have?

☐ One story

☐ Two stories

☐ Three stories

☐ Four or more stories

☐ Split-level

Does your home have an attached garage?

☐ No

☐ Yes

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Which best describes your home?

Mobile home

Single-family house detached from any other house

Single-family house attached to one or more other houses (duplex, row house, townhome, etc.)

Apartment in a building with 2 to 4 units

Apartment in a building with 5 or more units

Not including basements or attics, how many stories does your home have?

One story

Survey Powered By Qualtrics

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Survey Examples (Appliance Stock)

How is your home heated?

☐ Natural gas furnace

☐ Electric furnace

☐ Steam or hot water system with radiators or pipes

☐ Central heat pump

☐ Ductless heat pump (mini-split)

☐ Built-in electric heating units

☐ Built-in heater using fossil fuels

☐ Wood or pellet stove

☐ Portable electric heaters

☐ Other

→

Natural gas furnace

Electric furnace

Steam or hot water system with radiators or pipes

Central heat pump

Ductless heat pump (mini-split)

Built-in electric heating units

Built-in heater using fossil fuels

Wood or pellet stove

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