City of Chicago

Accenture

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Analytics Case Competition 2014

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Energy Usage Fluctuation & Retrofit Chicago

The Problem

Residential units account for about half of Chicago's energy consumption

Unexpected fluctuations in energy usage challenge urban energy grids

"Residential customers cost the most to serve. Because of the **wide range** in [usage], utilities must be equipped to serve peak demand."

- U.S. Energy Information Administration

The Context

Sustainable Chicago 2015 and Retrofit Chicago aim to **improve energy efficiency and reduce energy consumption** in the city

Retrofit Chicago provides audits and action plans for residential units in need of higher energy efficiency

"**Conservation** is the sixth energy source…What we're doing here can help a building become much more energy-efficient."

- Mayor Rahm Emmanuel, regarding Retrofit Chicago

Stable Energy Usage Improves City Services

Good for The City

- Reduced risk of outages
- Reduced need for electricity and gas capacity additions
- Lower cost of energy maintenance

Good for Its Residents

- Lower energy bills
- Incentives for energy efficiency investments
- Stable energy supply

Project Goals

1. **Methodology:** develop a data use-case that identifies residential areas with unexpected energy fluctuations

2. **Evaluation:** analyze Chicago neighborhoods based on their residents' energy usage fluctuation

3. **Segmentation:** determine characteristics of census blocks with unstable energy use

4. **Action:** match Retrofit Chicago initiatives with potential residential partners

Derived Metrics Enable New Data Use-Case

Existing Data Set

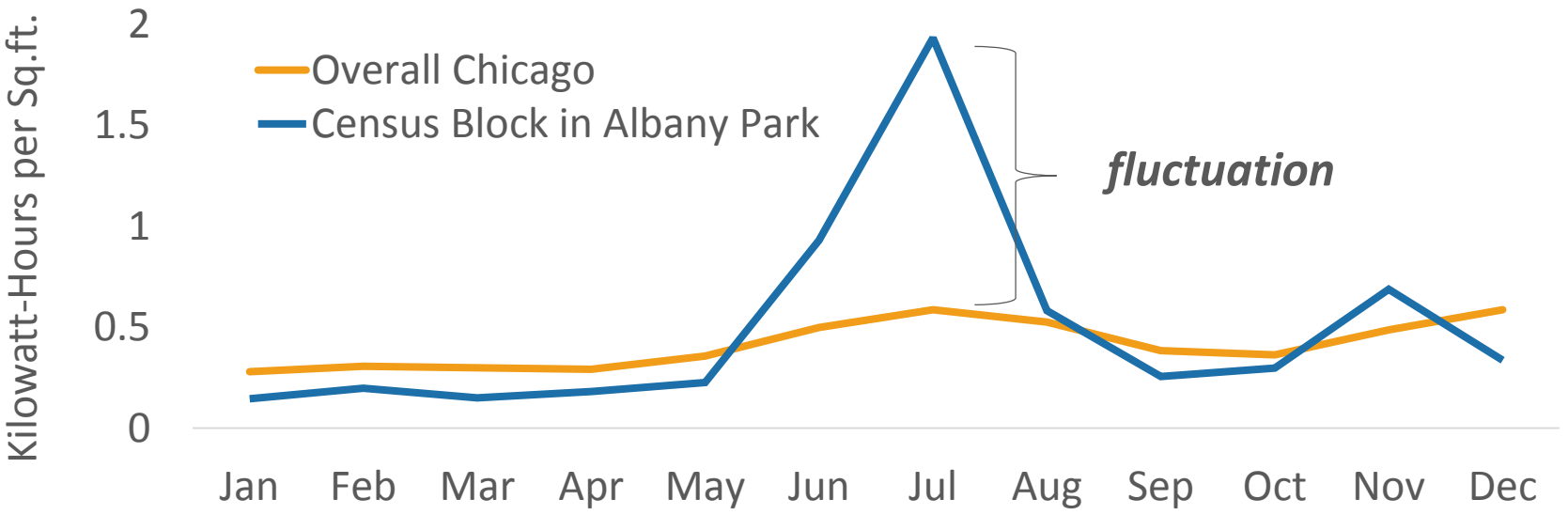
- City of Chicago Data Portal: Energy Usage
- Electricity (kwh) and Natural Gas (therms)
- Monthly, January – December 2010
- Residential Building Types (e.g. *Single Family Home*)
- All Identified Census Blocks

Derived Metrics

- *Control for dwelling size:* kwh and therms per square foot
- *Control for seasonality:* treat energy usage as a z-score (standardized), compared against city mean for each month
- *Calculate range of fluctuation* for a census block

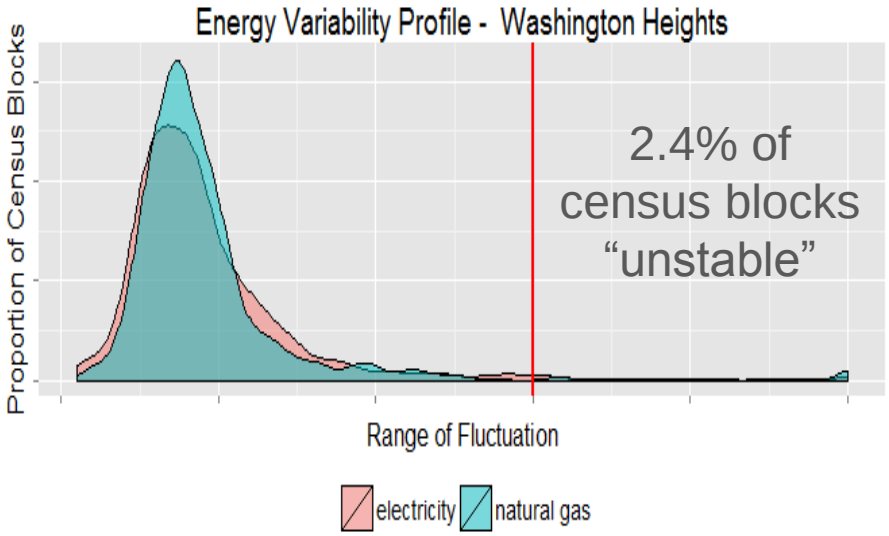
Controlling for Seasonality: An Example

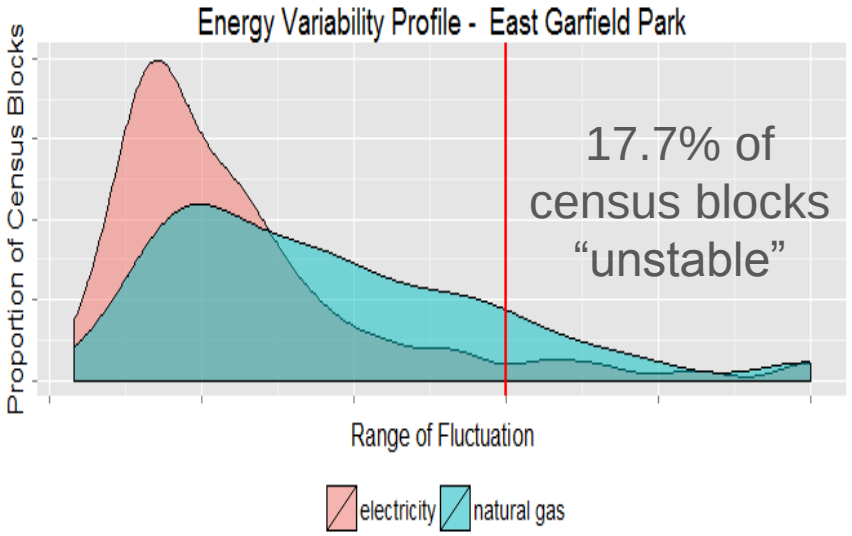
- Energy usage varies seasonally—this is the baseline
- We identify the census blocks that strongly deviate from normal seasonality
- For example, this census block in Albany Park handles electricity in the summer poorly in comparison to the rest of the city



Neighborhoods Show Unique Energy Patterns

- We classify census blocks by the amount of fluctuation in energy usage, controlled for seasonality
- A fluctuation of >3 standard deviations from the overall Chicago mean throughout the year is “unstable”
- Some neighborhoods show minimal energy fluctuations…
- …while others have wildly fluctuating energy patterns

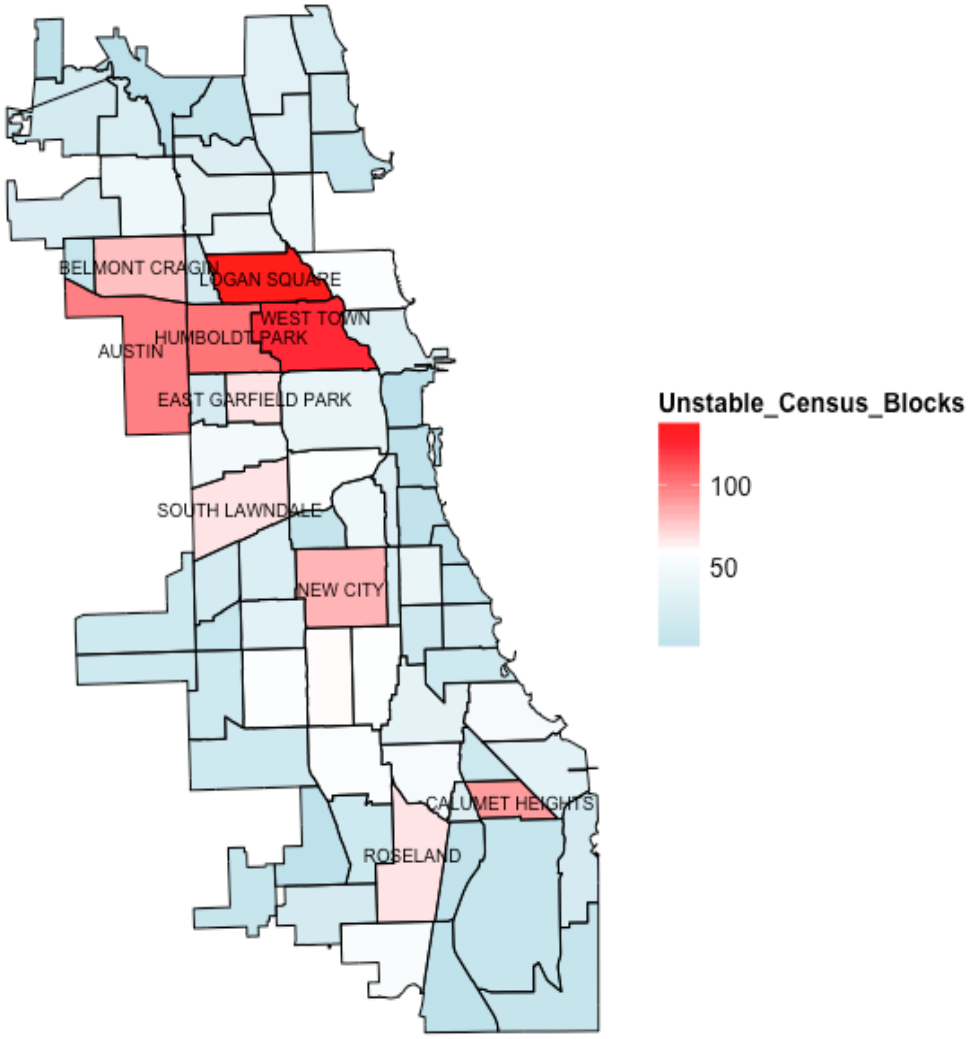




Geographical Areas of Focus Emerge

- Of all Chicago census blocks and building types,
  - **1,255** have highly-fluctuating electricity
  - **1,092** have highly-fluctuating natural gas
  - **286** have fluctuations in both energy sources

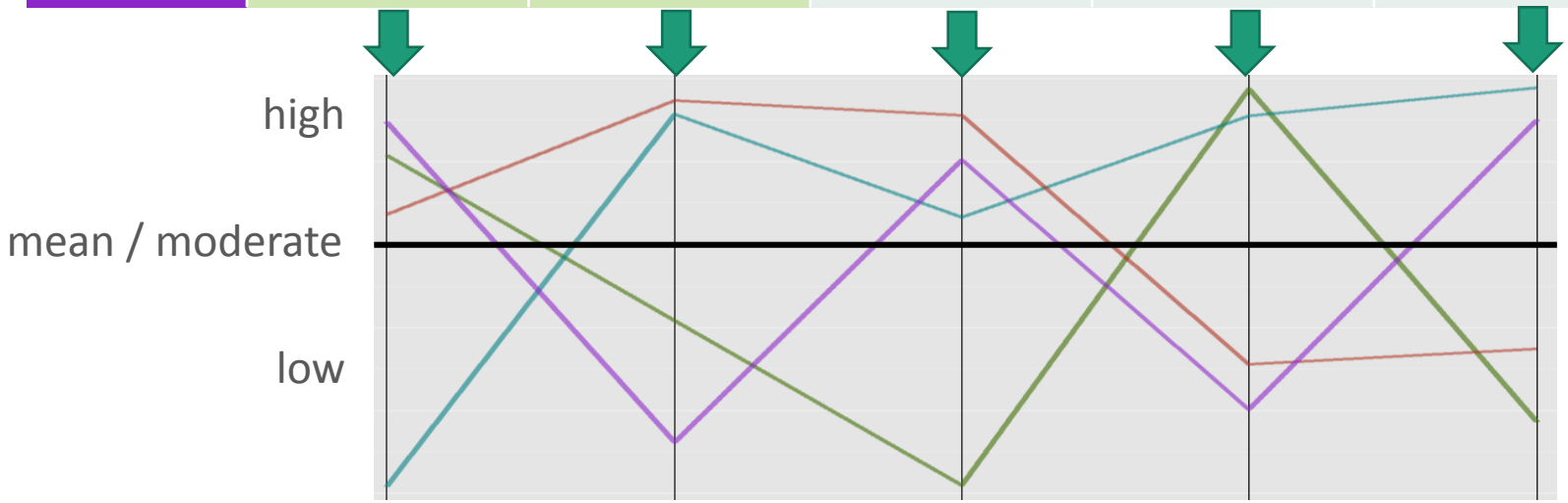
- **10** out of 77 neighborhoods contain **35%** of the city's census blocks with unstable energy usage



Profiles of the Unstable Energy Census Blocks

- Census blocks may require different retrofitting actions

Segment	Electricity Fluctuation	Natural Gas Fluctuation	Building Age	Population Density	Dwelling Size
1	HIGH	MODERATE	new	high	small
2	LOW	HIGH	moderate	high	large
3	HIGH	HIGH	old	low	small
4	HIGH	LOW	old	low	Large



Neighborhoods + Segments Lead to Actions

Segment 1

- High electricity fluctuation
- New, small dwellings
- High density areas

Action: Retrofit Chicago – Lite Upgrades

Example: **Humboldt Park**

Segment 3

- Highly unstable energy use
- Old, small dwellings
- Low density areas

Action: Evaluation of current infrastructure and building codes

Example: **West Town**

Segment 2

- High natural gas fluctuation
- Large dwellings
- High density areas

Action: Evaluation of infrastructure and building codes

Example: **South Lawndale**

Segment 4

- High electricity fluctuation
- Old, large dwellings
- Low density areas

Action: Retrofit Chicago – Full Upgrades

Example: **Calumet Heights**

Conclusion

- We recommend analyzing energy usage fluctuation, as a complement to raw energy usage metrics, to further refine the City of Chicago's energy efficiency intiatives
- We propose a methodology that isolates unexpected energy fluctuations by normalizing for seasonal change and a neighborhood's typical energy usage
- We identify an actionable subset of census blocks and neighborhoods with highly fluctuating energy usage
- We characterize these census blocks by the qualities that cater to specific city actions, such as those offerred by Retrofit Chicago

Sources

Homes show greatest seasonal variation in electricity use. U.S. Energy Information Administration. March 4 2013.
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http://www.cityofchicago.org/city/en/progs/env/retrofit_chicagoresidentialsinglefamily.html

Sustainable Chicago 2015. The City of Chicago's Official Site.
http://www.cityofchicago.org/city/en/progs/env/sustainable_chicago2015.html