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ENERGY

Expanding the Value of SmartMeter Data for Energy Efficiency Savings Estimation

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Acknowledgements and Presentation Outline

- **California Public Utilities Commission**
  - **Carmen Best and Mona Dzvova**
- **DNV GL (formerly KEMA) Team**
  - Paper: Andrew Stryker, Paula Ham-Su, Kathleen Gaffney
  - Project: Romilee Emerick, Kristi Otto, and Jon Farland

- **Presentation Guide**
  - Overview of paper – "Rapide" – 2-3 minutes
  - Plots – Don't try to read the small text, focus on the picture
  - Discussion Points
    - We have more slides if time permits, goal is discussion first

Introduction

- Analysis of monthly energy bills underpins many evaluations of US energy efficiency interventions.
- Monthly consumption data has allowed evaluators to estimate impacts of energy efficiency interventions, consistently, for decades.
  - Program-level analyses (residential and small business)
  - Site-specific simulation calibration (large business)
- Now, New evaluation techniques are needed to expand into non-extreme climates and include technologically-advanced measures.
- In the US and Europe, the adoption of interval utility meters promises new opportunities for energy efficiency evaluation

Recent Study

- CPUC Whole House Impact Evaluation
  - Monthly billing analysis, pre-post with comparison group
  - Follow-up using SmartMeter data
  - Measures: Added Insulation, Air Sealing, Duct Sealing, HVAC system replacement, hardwired lighting
  - Program contractors enter characteristics in simulation models
  - Savings evaluated were much lower than modeled
    - electric worse than gas, paper focuses on electric
- NEXT
  - A colorful map
  - Compare Monthly and Hourly
  - Variability – We can come back to these

Building Climate Zones (Referenced in Slides)

CZ3 = San Francisco ACEEE

CZ12= Sacramento

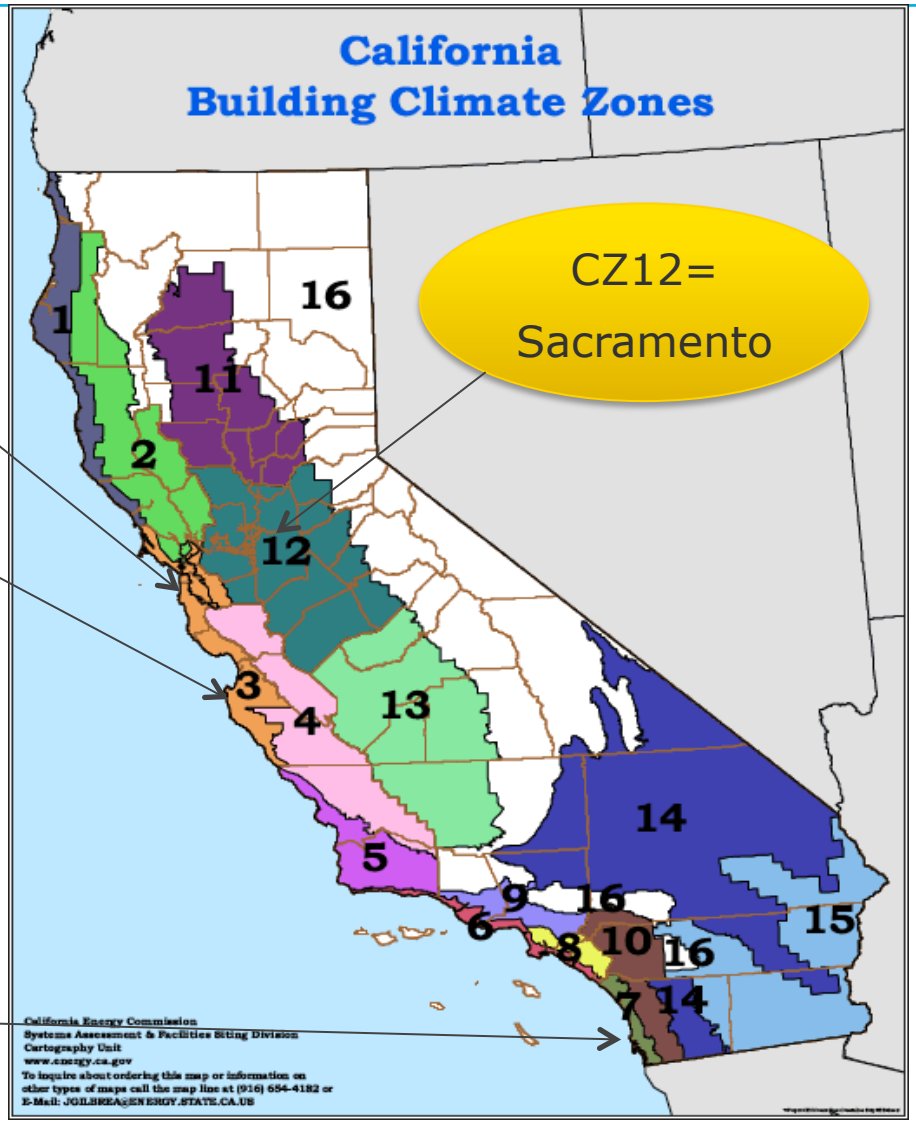
CZ 1 is coolest

CZ 15 is hottest

CZ 16 is mountains

Los Angeles Area – 6,8,9,10

CZ7 = San Diego



Fundamental Difference going from Monthly to Hourly

- Typically we have 12 bills before and after retrofit, each data point is total consumption in a month
  - Next slide shows data volume issue
- **Pro's -** Rather than looking at cooling degree days in a month summarized from hourly weather data, we can use the hourly weather data directly
- **Con's** - In some places Data may not be available, Data storage and handling issues, lot's of secure data, all requested at once for an evaluation creating logistical challenges
- In California, we struggle with the variation in the use of air conditioners
  - We will quickly review some figures to show this

SmartMeter Challenge

Monthly Billing Analysis

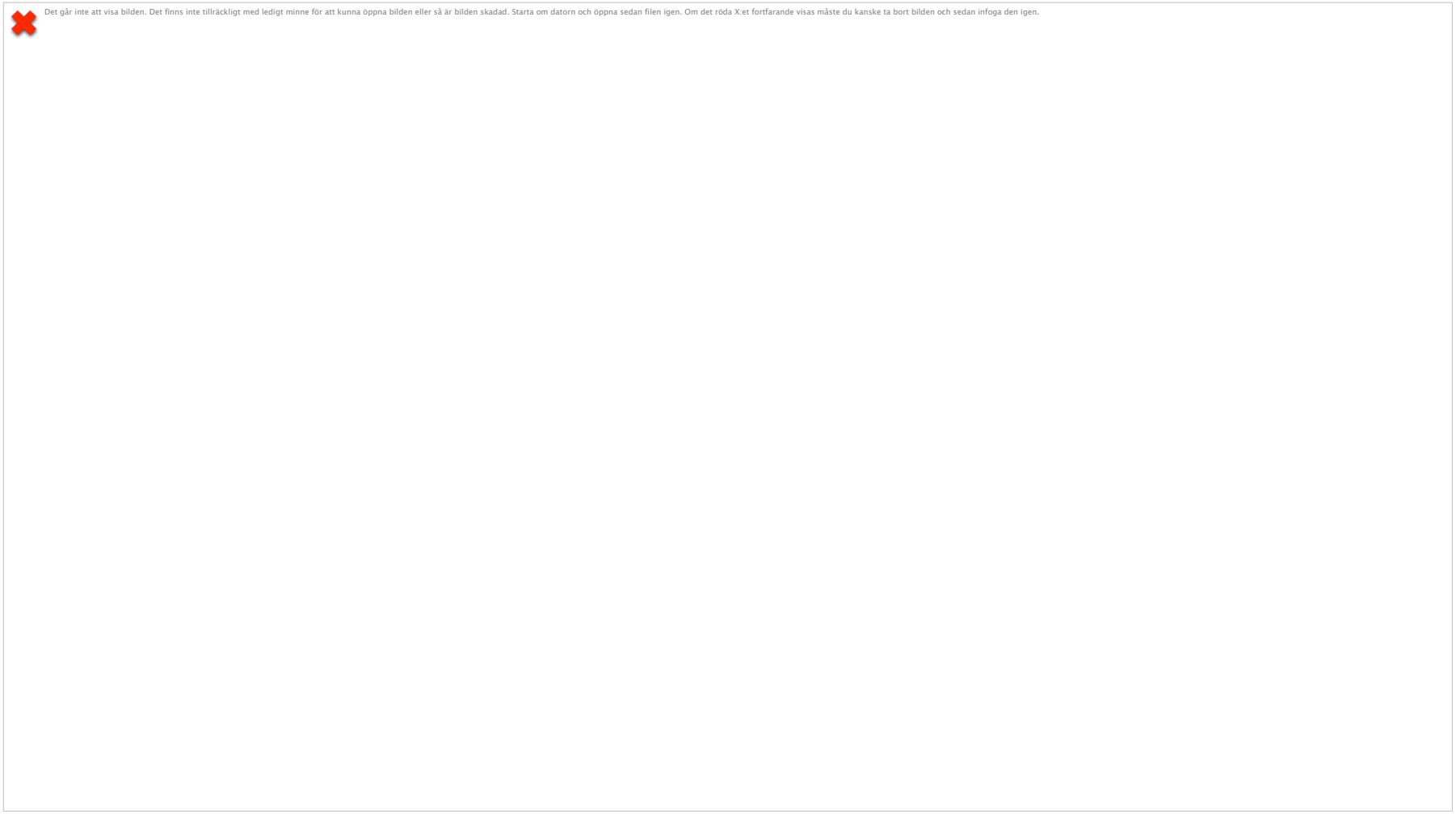
	10,000	premises
×	12	obs per year
×	2	years
	480,000	obs
×	3	variables
	1,440,000	data points

Hourly Interval Billing Analysis

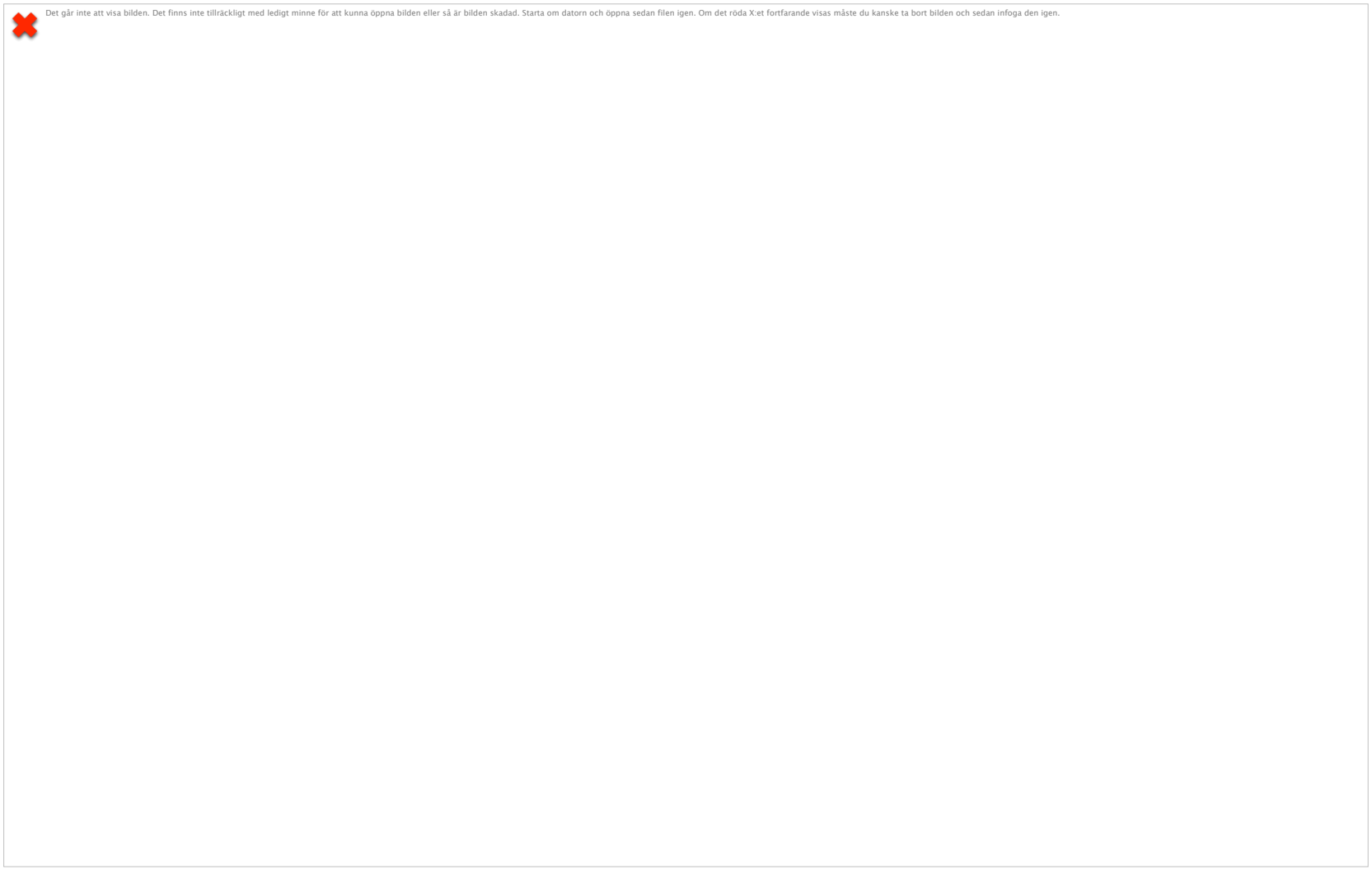
	10,000	premises
×	8760	obs per year
×	2	years
	175,200,000	obs
×	6	variables
	1,051,200,000	data points

Different scale of computational complexity

Variation in Monthly Data – All Customers

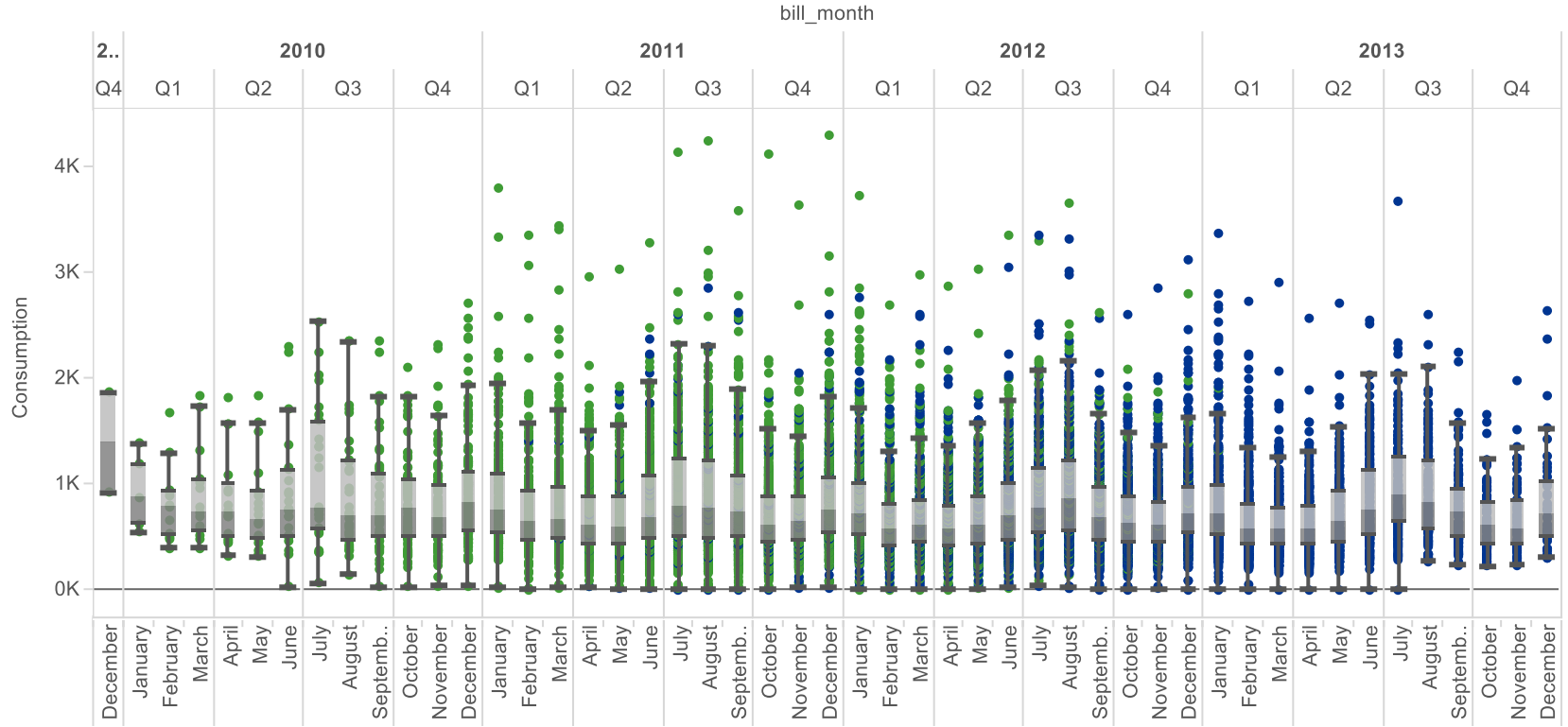


Variability for San Francisco Area (less than 50% have AC)



Variability for Sacramento Area (Inland, Everyone has AC)

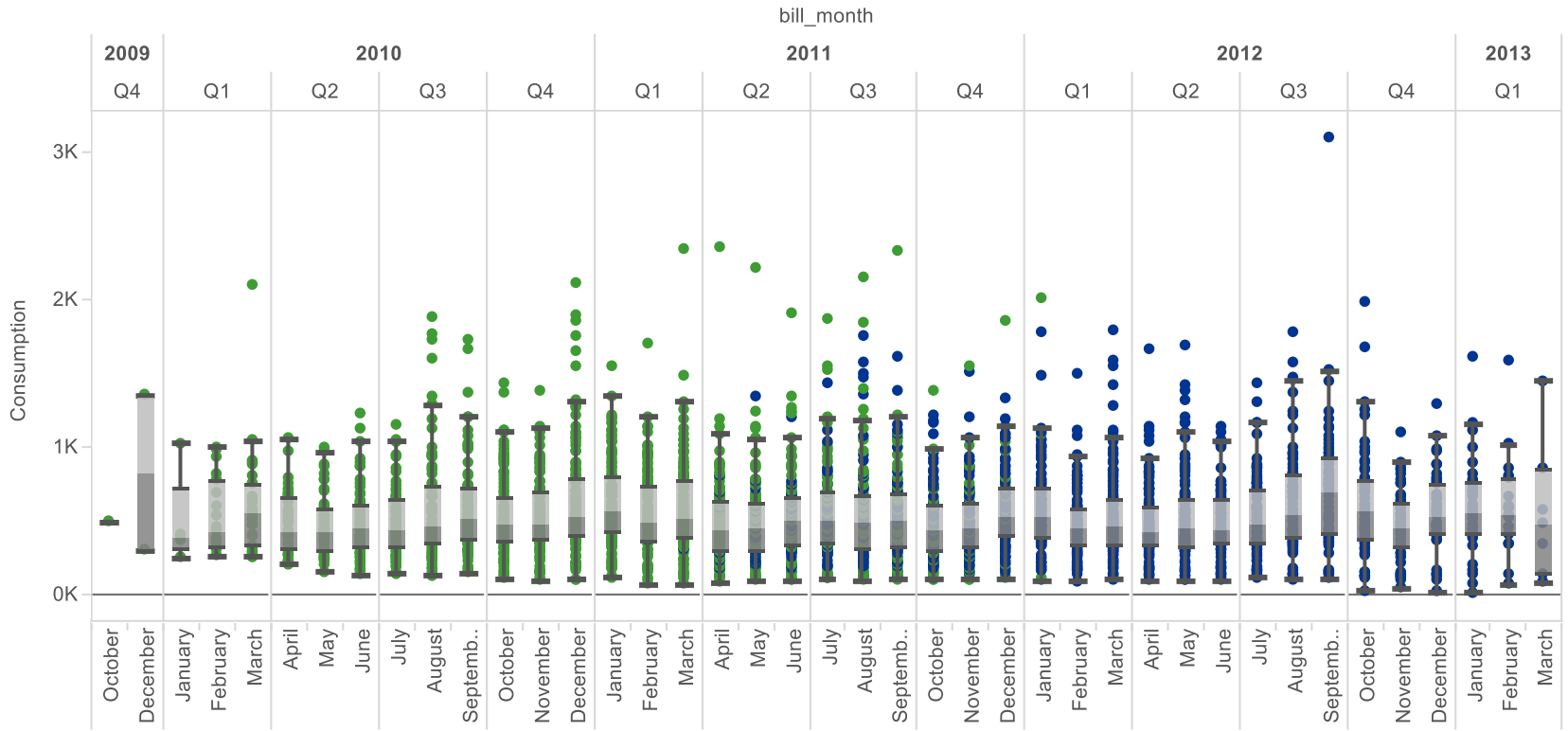
PGE Box and Whisker Plots



Month_use for each Month of bill_month broken down by Year of bill_month and Quarter of bill_month. Color shows post. Details are shown for Climate Zone. The data is filtered on fuel and net_meter_flag. The fuel filter keeps e. The net_meter_flag filter keeps Null and 0. The view is filtered on Climate Zone, which keeps 12.

Variability for San Diego (Southern Coast, Many have AC)

SDGE Box and Whisker Plots



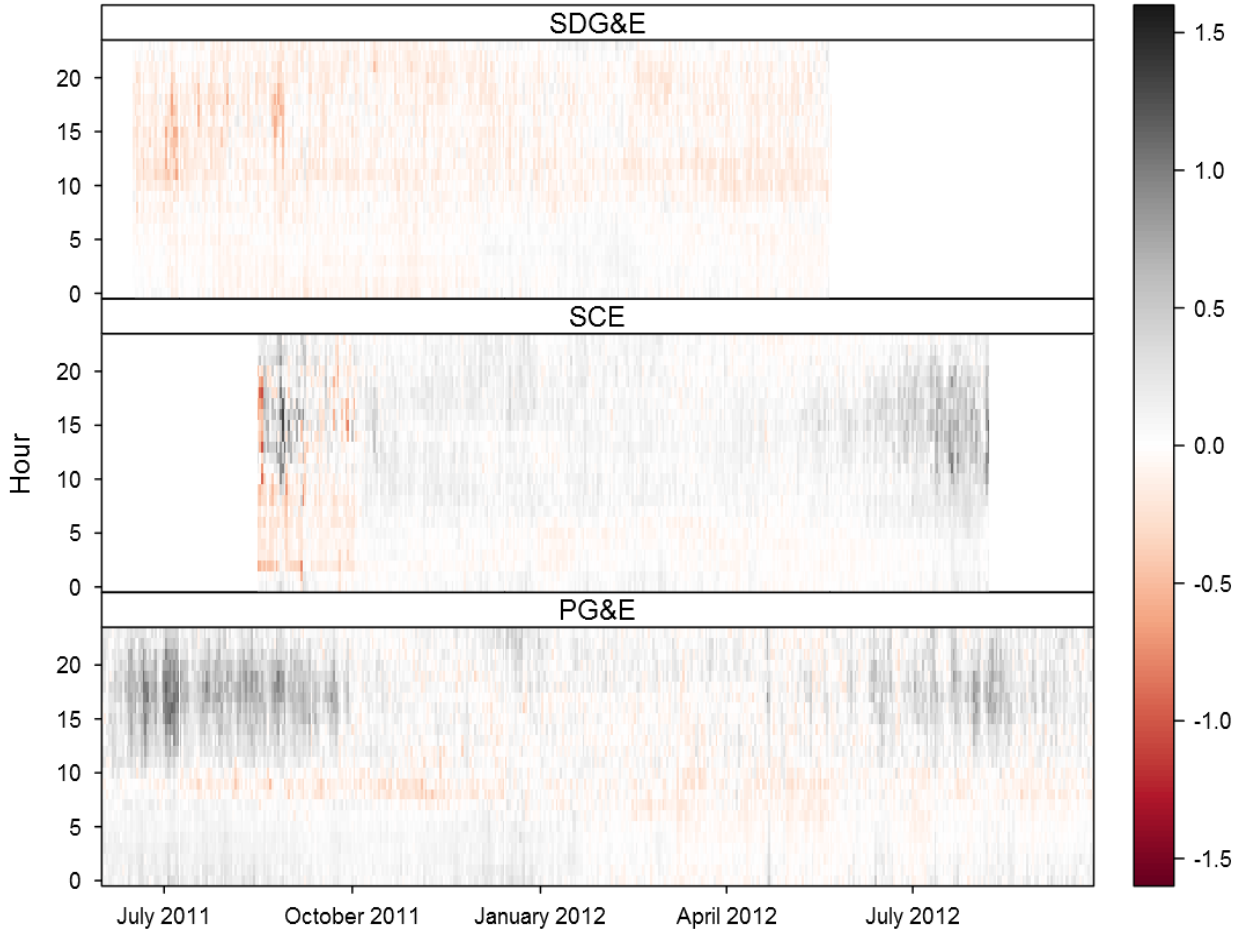
Bill_use for each Month of bill_month broken down by Year of bill_month and Quarter of bill_month. Color shows post. The data is filtered on Climate Zone, fuel and EDFilledClimateZone. The Climate Zone filter keeps 7, 10 and 14. The fuel filter keeps elec. The EDFilledClimateZone filter keeps 7.

SmartMeter Data Discussion

- Why use SmartMeter data?
- What are the benefits?
- When can it be applied?
- Which analysis approaches can be used?
- What is the appropriate platform?

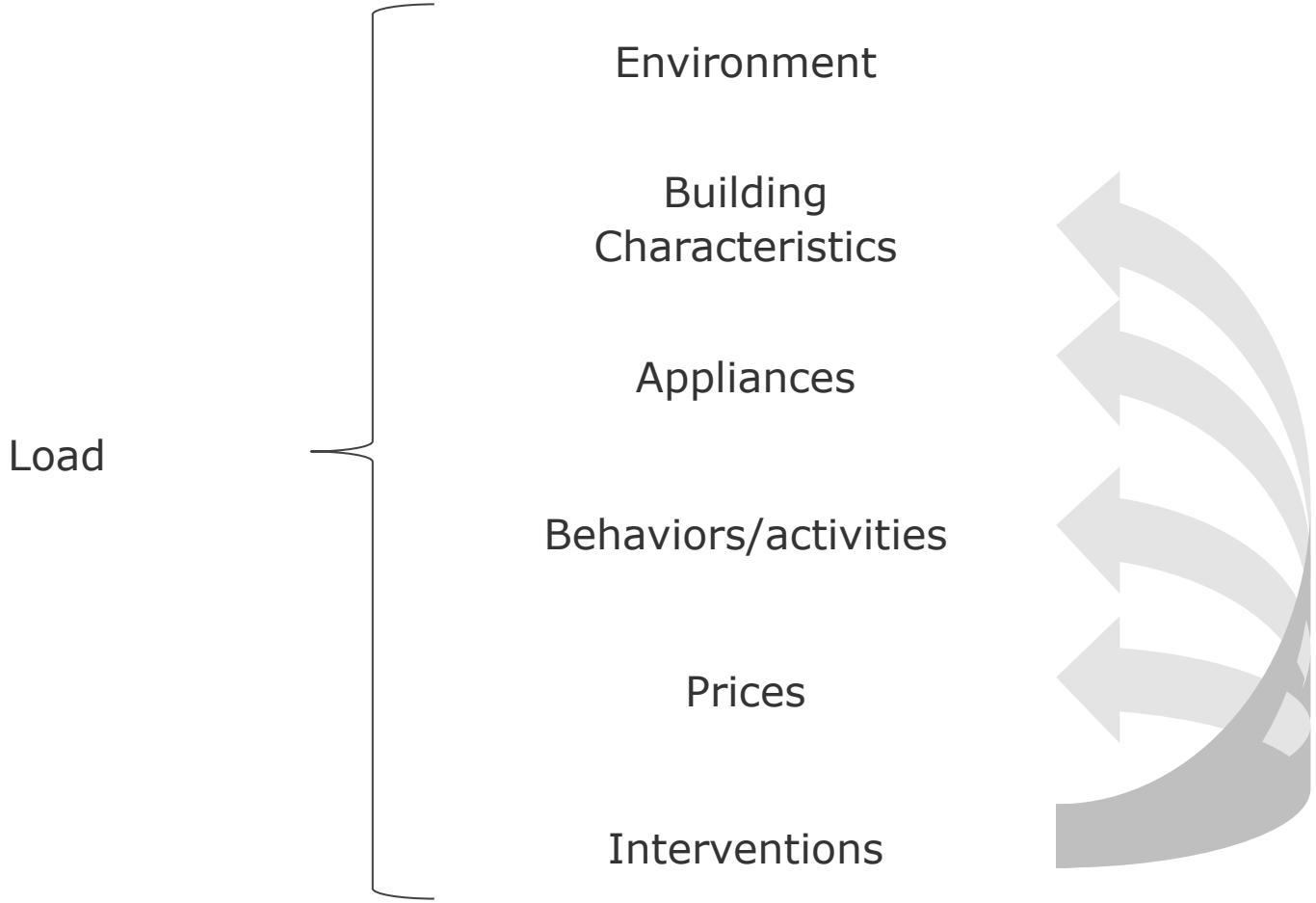
Why use SmartMeter data?

- Direct evidence of peak period savings
- Hours and Days; Color is change in demand
  - Black = Decreased
  - Red = Increased



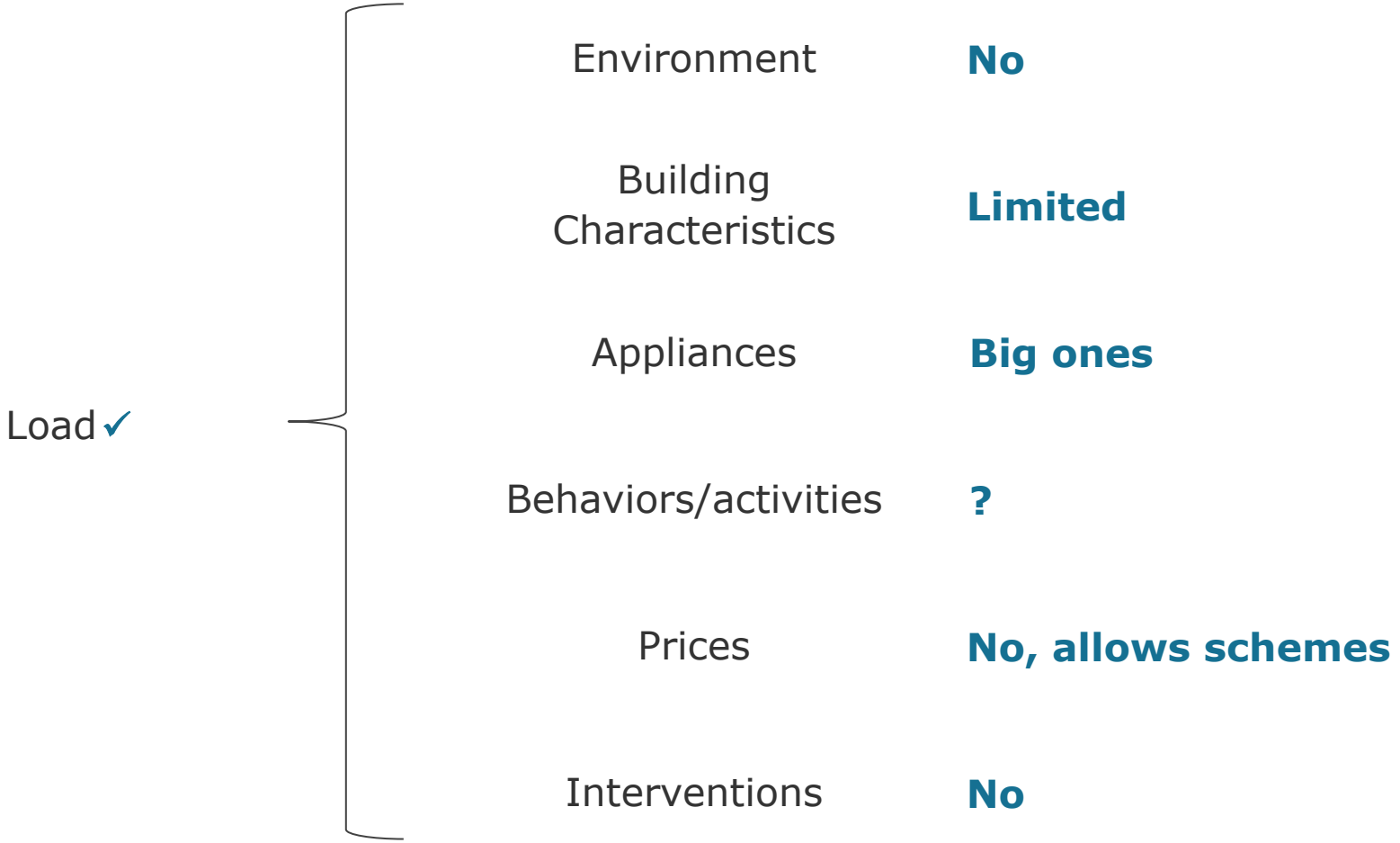
We can Show and quantify peak saving

Energy use is the result of…



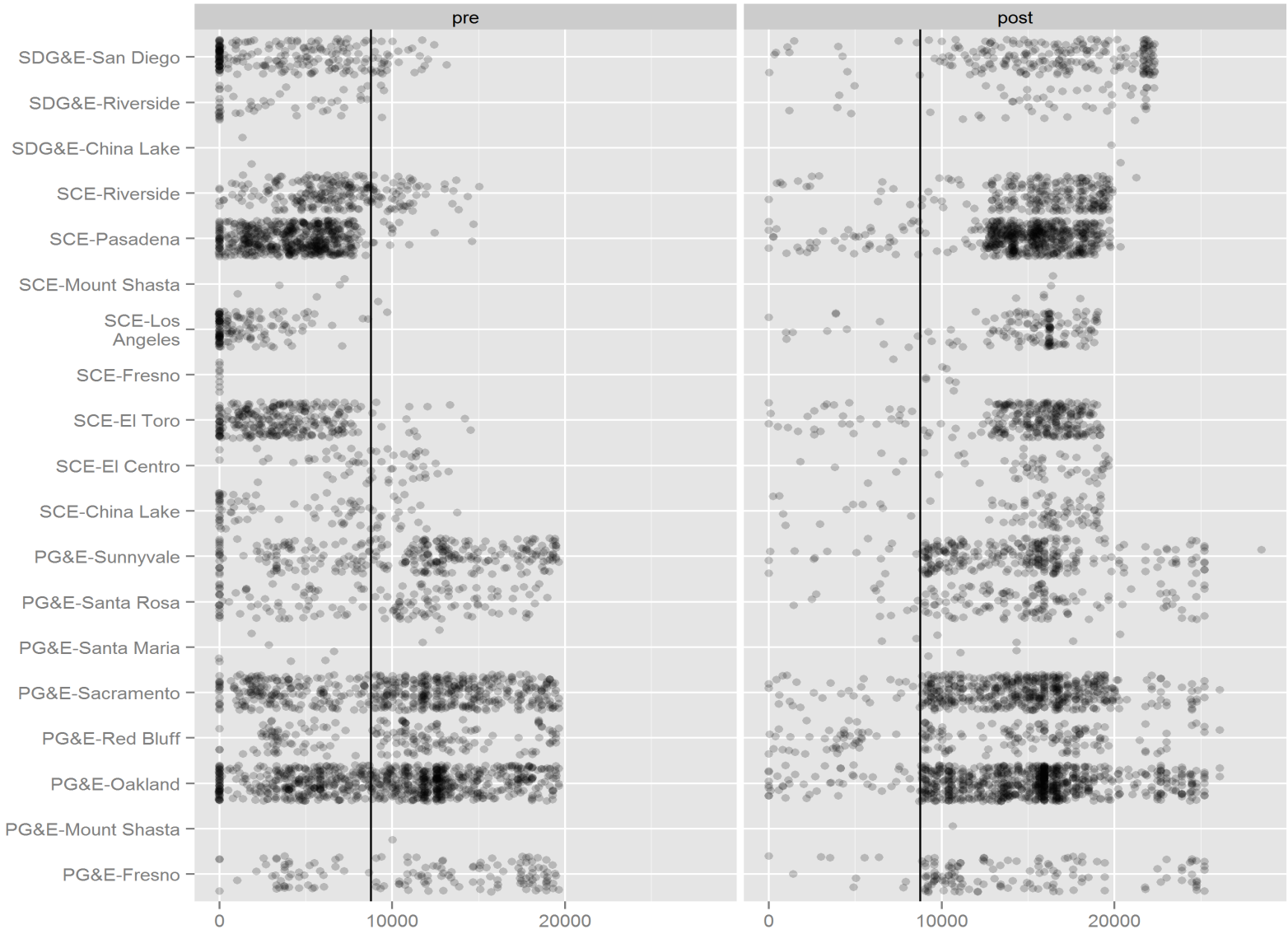
Complex set of interactions

Visibility gains from SmartMeter



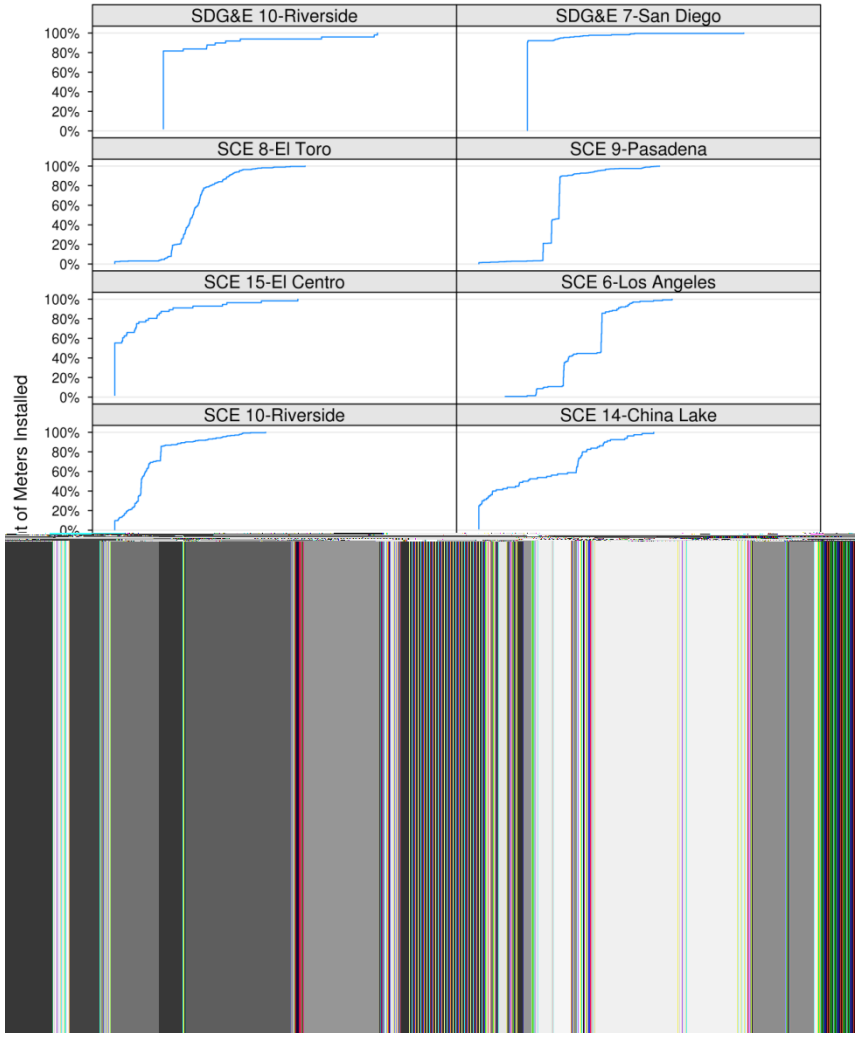
Same fundamental evaluation issues

When Do we have enough Data? 8760 Hours = 1 Year

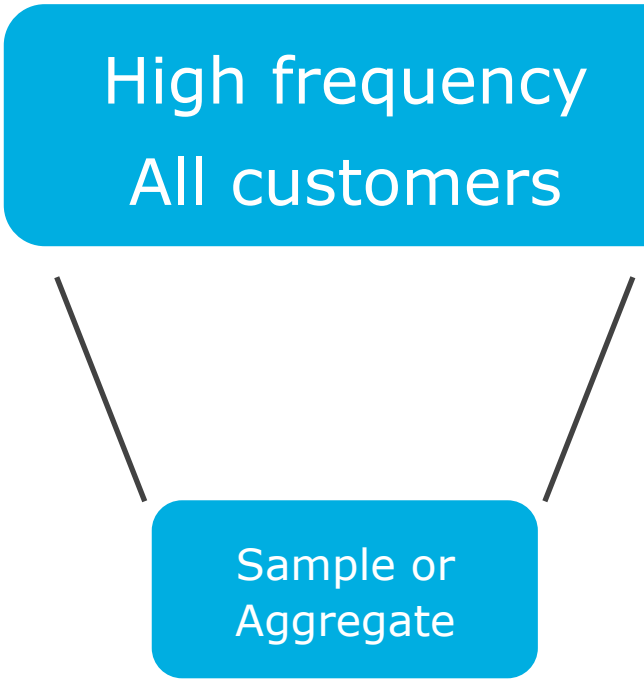


SmartMeter Installation Timeline

- SmartMeters Installed 2011-2012
- Program ran 2011-2012
- Pre retrofit period incomplete for many participants AND comparison group
- Non-issue for future studies



HOW Meeting the AMI challenge: Approach 1

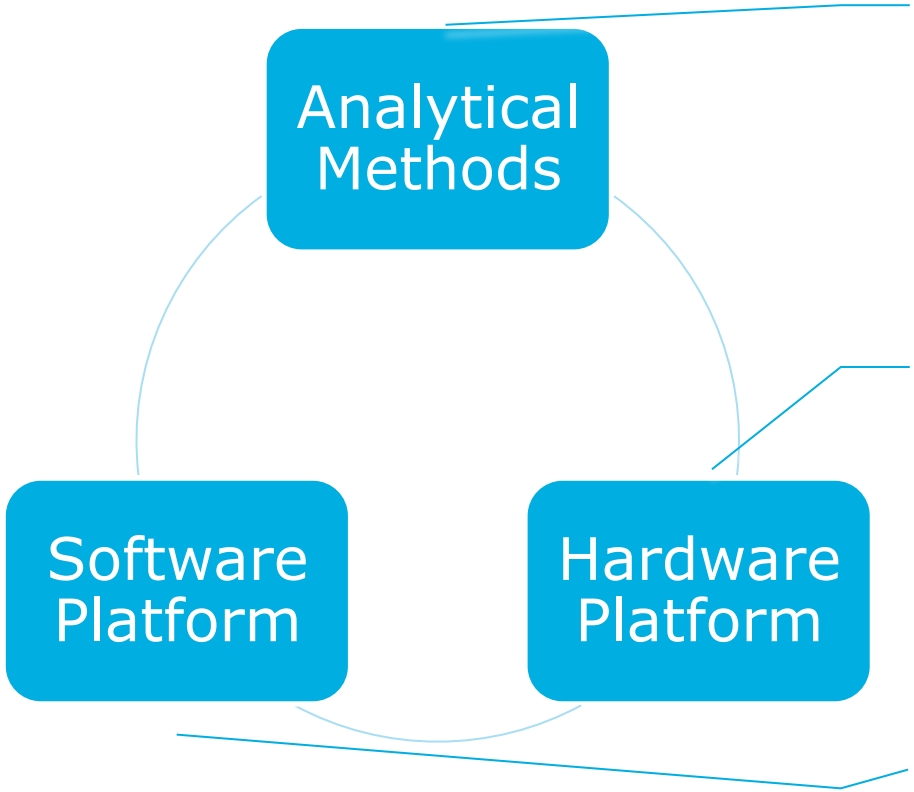


Limits the resolution

Resolution loss not always important

Naively reduce data size

HOW Meeting the AMI challenge: Approach 2



Pooled versus premise

Statistical learning

Clustering

Optimize for disk access or memory

Single very large computer

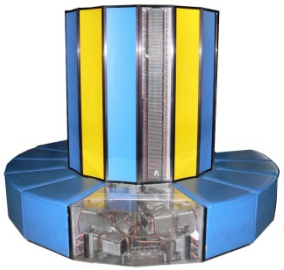
Cluster

Process and data management

Analytical platform

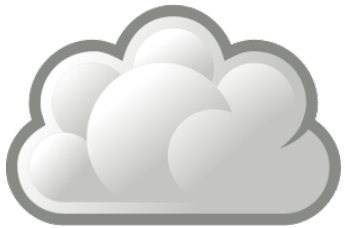
Rethink analysis approach

Which Computing Platforms: Options



Really big computer

Cluster of commodity computers



Deployable virtual computers

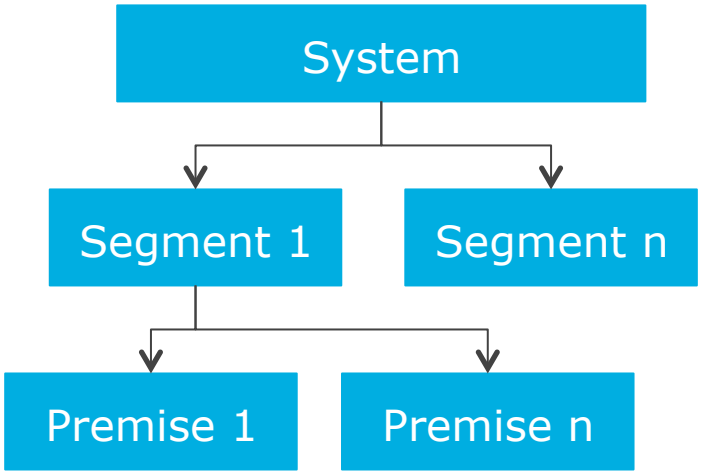
Scale horizontally to overcome size challenges

What Methods: Segmentation, Clustering, and Models

Customer segmentation	Groups of similar customers from a marketing/modeling perspective
Cluster analysis	Rigorous identification of "natural" groups

Homogenous group → **Straightforward models** → **More precise inferences**

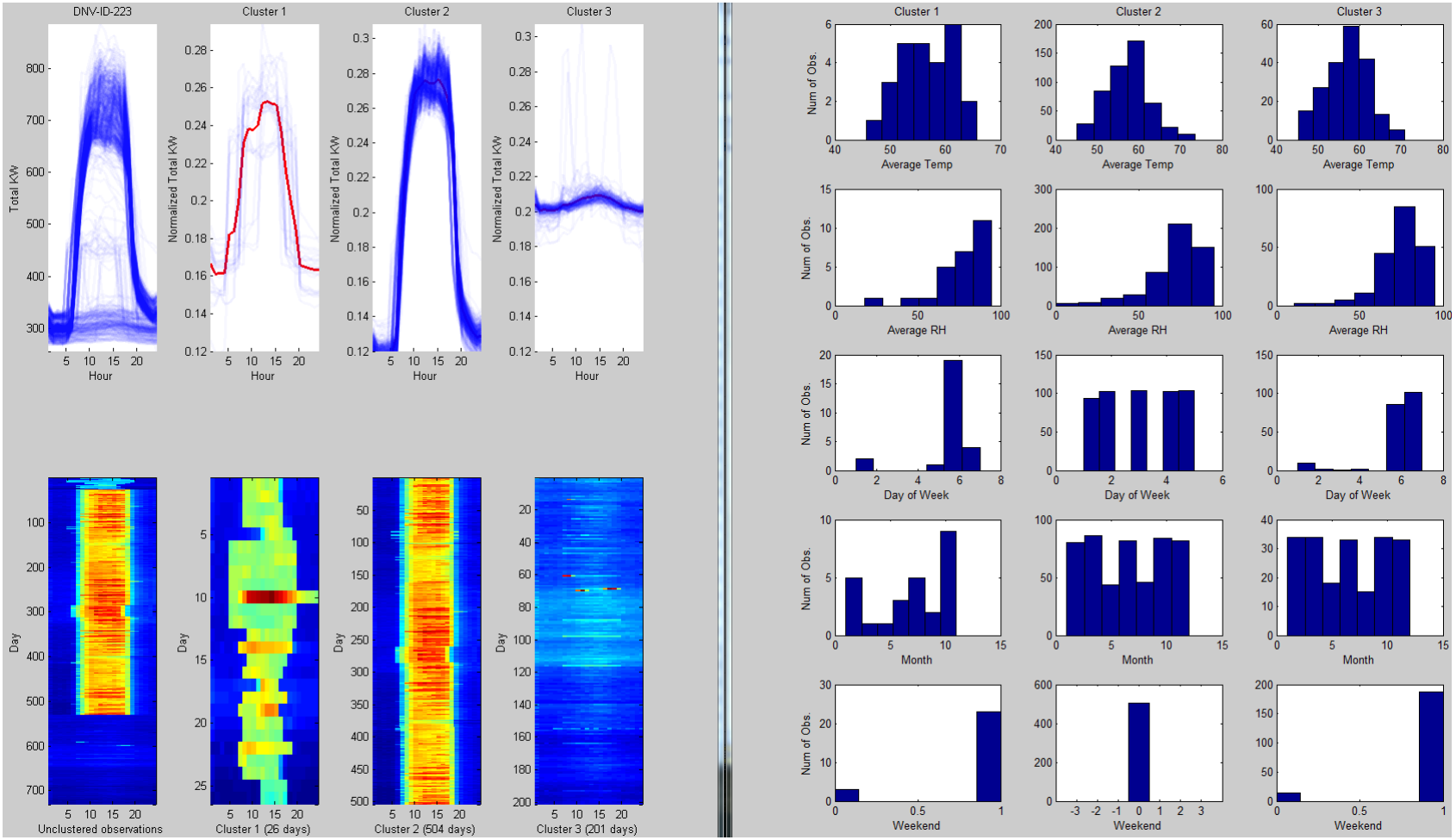
Models: Hierarchal models



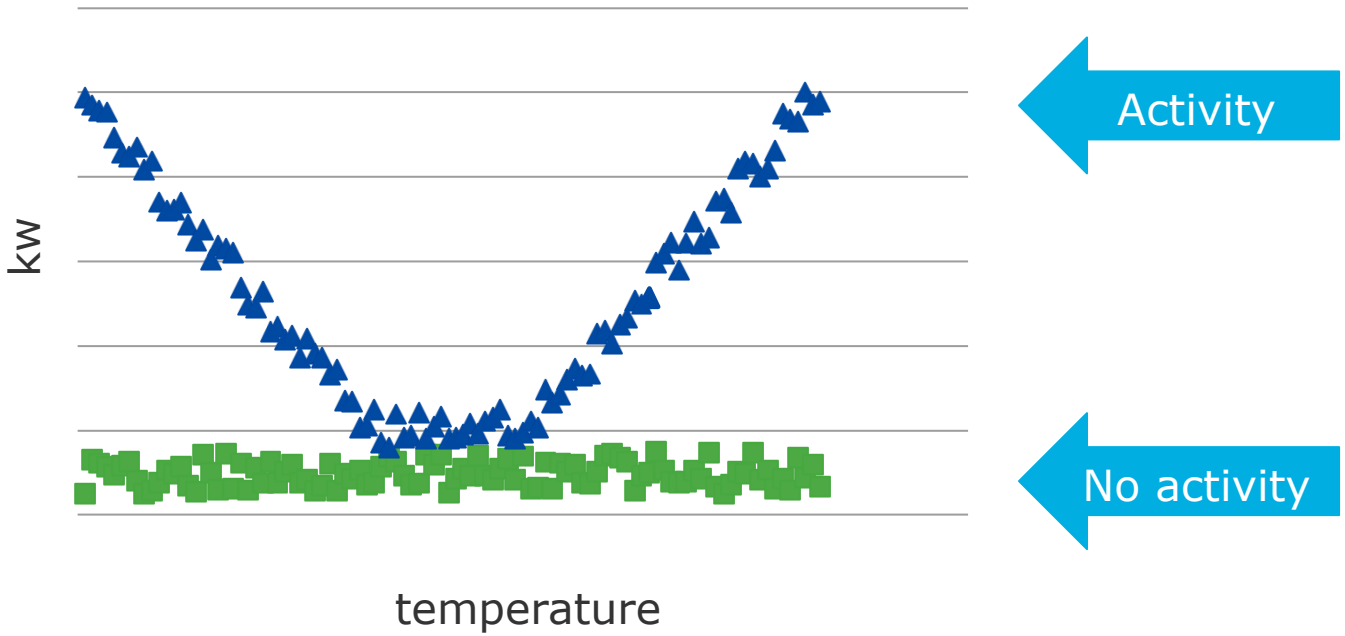
Aggregation	Benefit	Limitation
System level	Stable behavior	Resolution
Segment	Similar processes	Requires thoughtful identification
Premise	No pre-segmentation	Modeling a stochastic process

Combine information from hierarchal levels

Methods: Cluster Analysis

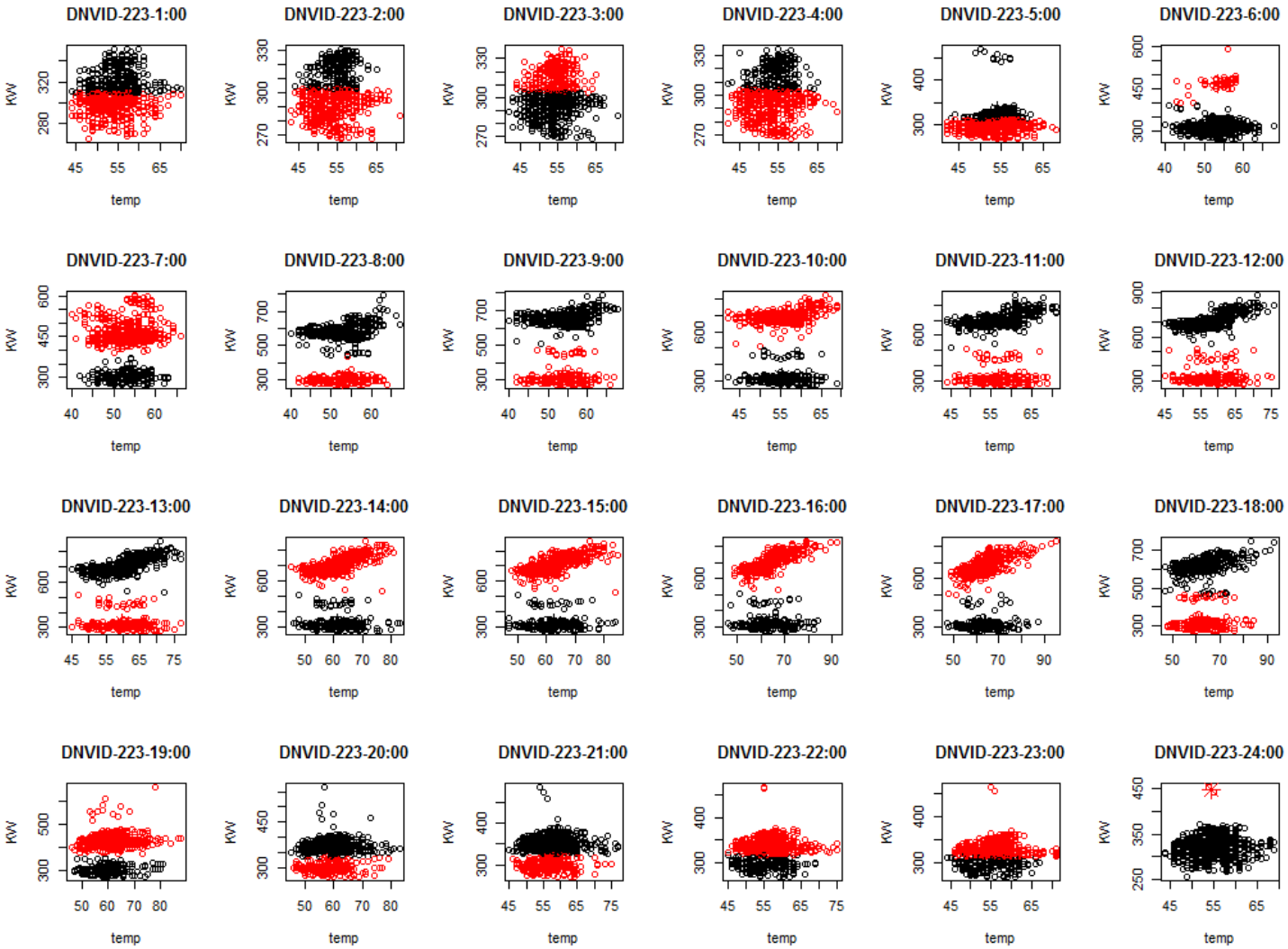


Methods: SmartMeter Data and Behavior



Indirect visibility into activity

Methods: SmartMeter Data and Behavior



Concluding Remarks

Evaluate *when* savings occur

Evaluate *who* saves

Tell the program implementers

SmartMeter fundamental shifts evaluation approach

Thank you. Questions?

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