Is More Always Better? A Comparison of Billing Regression Results Using Monthly, Daily, and Hourly AMI Data

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Presentation Outline

Comparison of Billing Regression Results Using Monthly, Daily and Hourly AMI Data

- Research Overview & Background
- Methodology
- Results
- Discussion

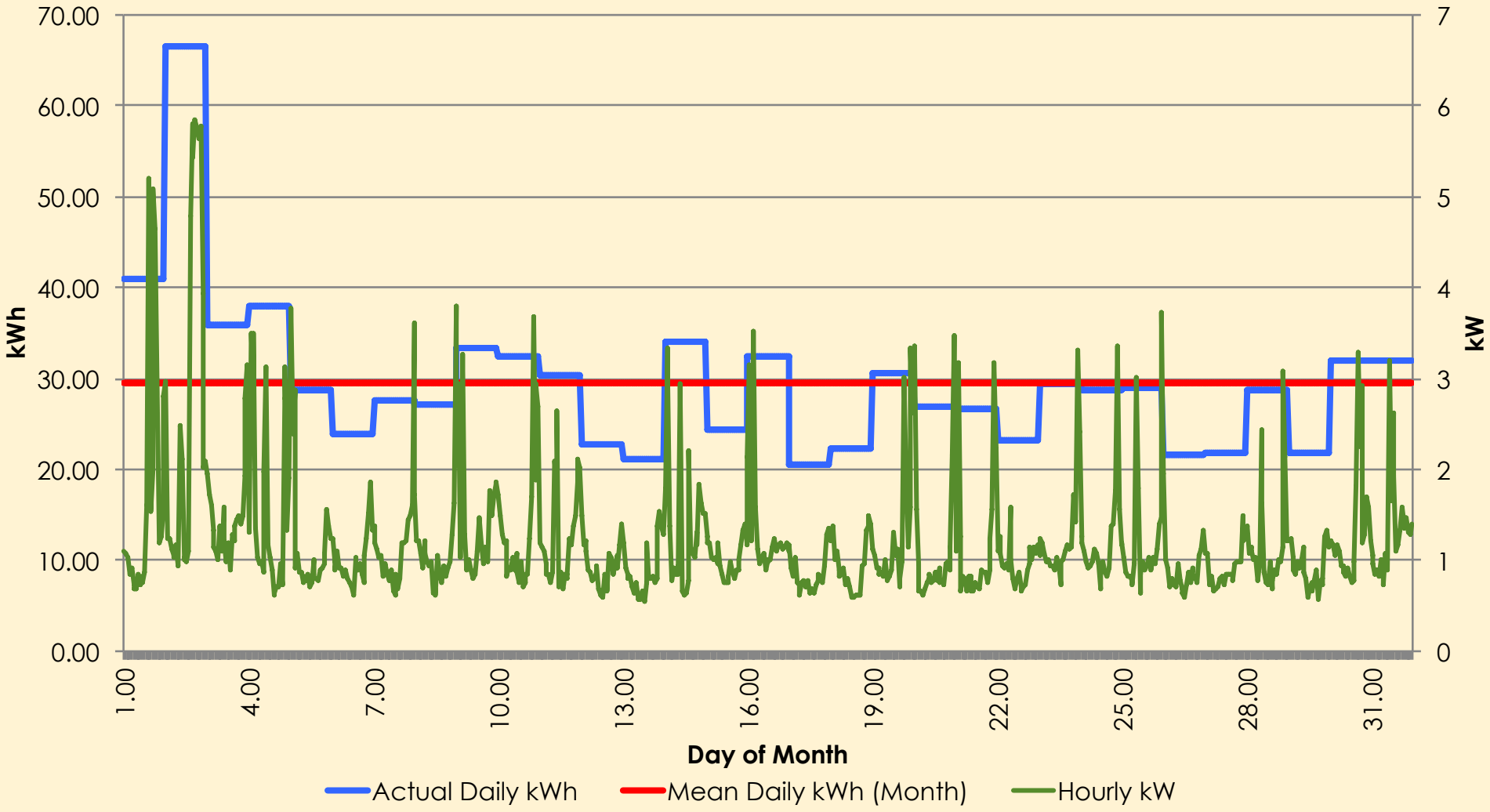
Research Overview

- **Goal:** Compare billing regression models using data aggregated at monthly, daily and hourly levels from a single AMI data source.
- **Research Questions:**
  - Do savings estimates change across different aggregation levels?
  - Does the precision of savings estimates change across different aggregation levels?

Advanced Metering Infrastructure (AMI)

- What is AMI?
- AMI data allow investigation of consumption at finer time intervals
- 30% homes have AMI nationally
- Rapidly expanding to more homes
- Will (hopefully) become standard data available to evaluators

Levels of Aggregation



AMI Billing Regression Research Project

- Compare FE billing regression based on hourly, daily, and monthly data
- Hourly AMI data for 678 homes in California
- New air conditioner installed between January 2013 and December 2014
- Each home has at least 9 months of billing data pre and post installation

Data Aggregation

- Hourly Dataset:
  - Hourly kW for 678 homes
  - Hourly temperature data (NOAA)
  - Hourly cooling / heating degree hours (Base 65°)
- Daily Dataset:
  - Daily kWh = Σ(Hourly kW)
  - Daily degree days = Σ(Degree hours)
- Monthly Dataset:
  - Monthly kWh = Σ(Daily kWh)
  - Monthly degree days = Σ(Degree days)

Data Aggregation

	Observations	Households	Average kWh	Average CDD	Average HDD
Monthly	15,921	678	785.87 (25.85)	191.98	162.10
Daily	471,534	678	26.54	7.65	6.53
Hourly	11,311,219	678	1.10	.27	.23

Fixed Effects Model Specification

$$kWh_{i,t} = \alpha_i + \beta_1(Post_{i,t}) + \beta_2(C_{i,t}) + \beta_3(H_{i,t}) + \beta_4(C_{i,t} * Post_{i,t}) + \beta_5(H_{i,t} * Post_{i,t}) + \sum_{j=6}^{16} \beta_j(M_t) + \varepsilon_{i,t}$$

- Monthly Model:
  - kWh = Average Daily kWh
  - Weather = Monthly HDD / CDD (Base 65°F)
- Daily Model:
  - kWh =Actual Daily kWh
  - Weather =Daily HDD / CDD (Base 65°F)
- Hourly Model:
  - kWh =Actual Hourly kW
  - Weather =Hourly HDH / CDH (Base 65°F)

Fixed Effects Model Specification

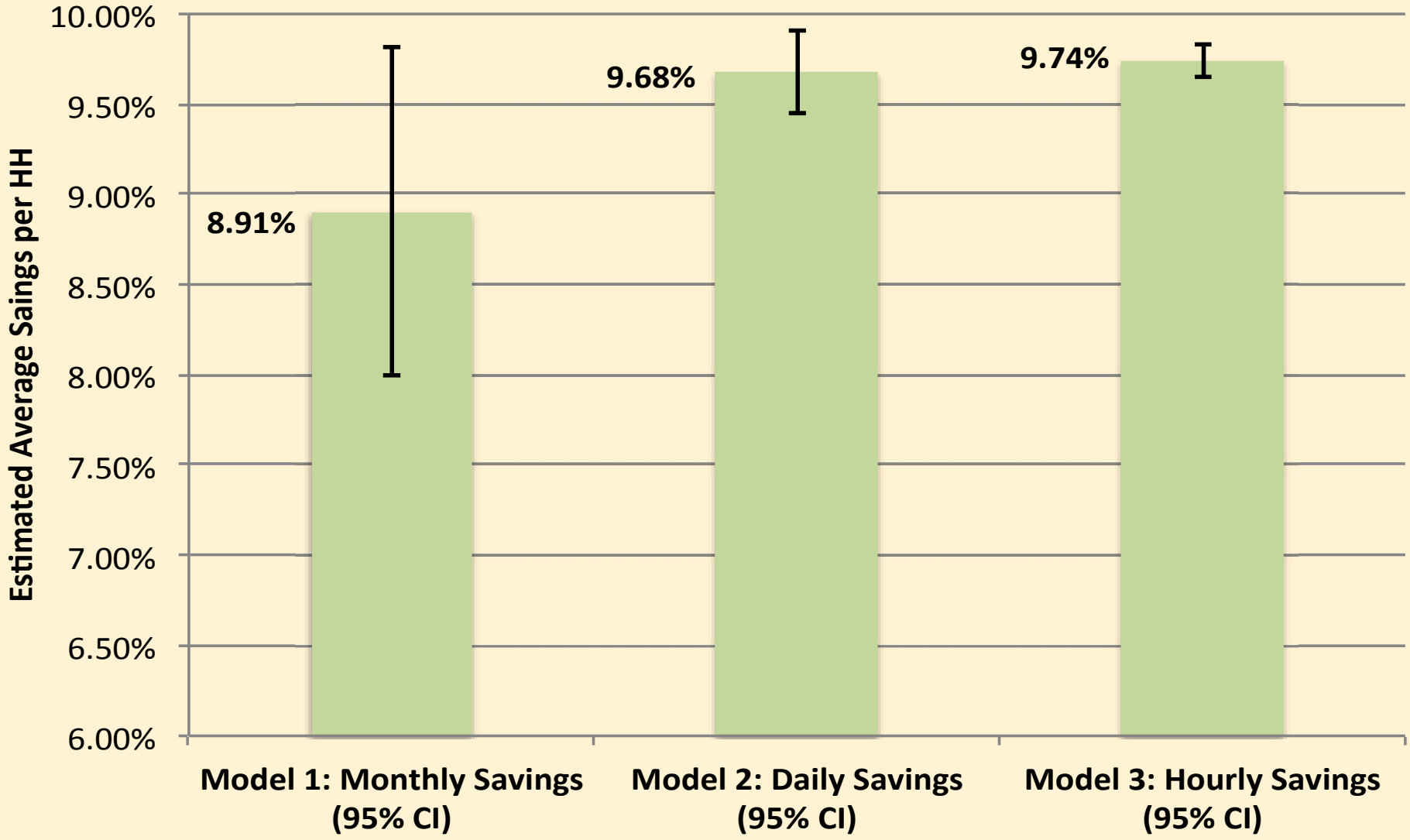
$$kWh_{i,t} = \alpha_i + \beta_1(Post_{i,t}) + \beta_2(C_{i,t}) + \beta_3(H_{i,t}) + \beta_4(C_{i,t} * Post_{i,t}) + \beta_5(H_{i,t} * Post_{i,t}) + \sum_{j=6}^{16} \beta_j(M_t) + \varepsilon_{i,t}$$

- Savings Equation:

$$kWh\_Savings_{i,t} = \beta_1 + \beta_4 * \overline{C} + \beta_5 * \overline{H}$$

- Confidence Intervals developed using Delta Method

Model Results



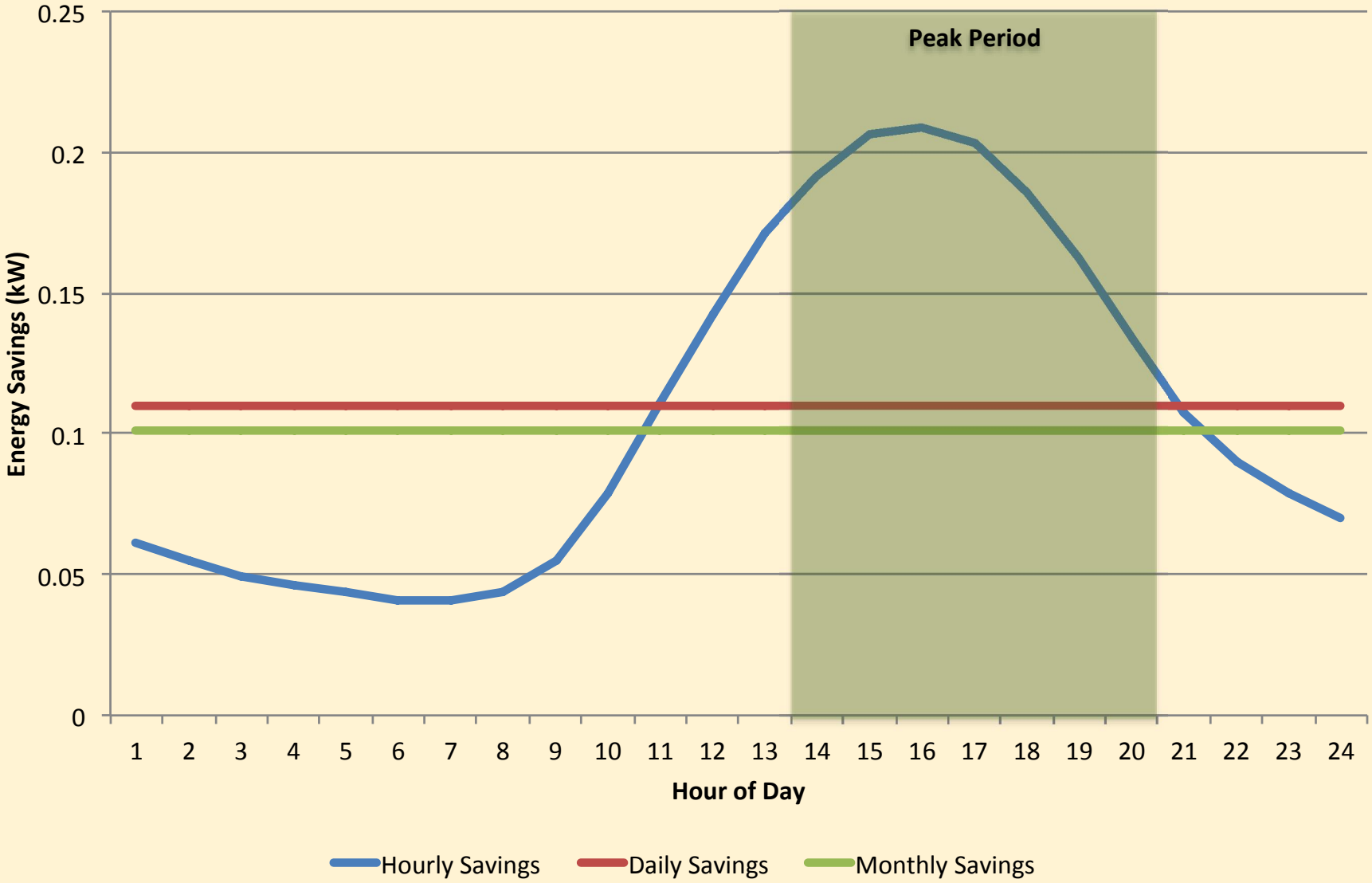
Discussion

- Do savings estimates change across different aggregation levels?
  - Yes. Estimates of savings increased approximately 9 percent from monthly to hourly data.
- Does the precision of savings estimates change across different aggregation levels?
  - Yes. We find more precision around our savings estimates with more granular data.

Discussion

- Limitations of models based on monthly or daily data:
  - Cannot reveal time of day savings:
    - Different measures may provide savings at different times of day
  - Cannot distinguish peak period savings
- Hourly interval data (or finer) - opportunity to identify time of day savings and peak period savings

Hourly Savings Estimates



Future Research

- Alternative modeling approaches for AMI data
  - Example: Random coefficients model:
    - Estimates hourly savings
    - Estimates savings across home types and day types
- Compare billing regression using traditional monthly bill data and monthly AMI data

Summary

- AMI data provide opportunity to estimate billing regressions at more granular time intervals
- Savings estimates increase when fixed effects billing regression models used more granular time interval data
- Precision of savings estimates improves when fixed effects billing regression models used more granular time interval data
- Hourly (or finer) AMI data provides opportunity to identify time of day savings / peak period savings

Questions?

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