# Water Heater Demand Response : Evaluation Plan and Analytics

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# Background

- There are not many established best practices when it comes to measuring demand response impacts
- There is no “right way” to measure impacts
- Our approach was to estimate impacts in several ways to see how they agree or disagree with one another
- If they come to same answer great, if not then judgement is required

# Roles & Responsibilities

- BPA developed evaluation plan and methodology
- PNNL is implementing analytics plan and will estimate impacts in an evaluation after events are no longer being called
- BPA independent evaluator has reviewed methodology and will review evaluation

# Sampling

- Unscientific recruitment using heat pump water heater rebate participants
- Resistance tank recruitment plan through plumbers was difficult, Tacoma getting some MF low income sites
- Currently 163 heat pump water heaters & 83 resistance tanks

# Surveys

- For evaluation purposes we asked participants to fill out a survey with questions about home characteristics, household size, water heater characteristics and location
- Every month (or so) we field a very short satisfaction survey to gauge if people are having issues with not enough hot water

# How to measure results?

- We measure results using 4 different methods:
  - Randomized Control Trial
  - Week before
  - All Weekdays/Weekends before
  - Regression Model

# Randomized Control Trial

- Treatment and control group switching week to week
- Challenge is to create groups that are balanced among numerous variables
  - Total kWh
  - Minutes > 1000 watts (resistance element usage)
  - Morning Use
  - Evening Use
  - HPWH (GE or AO Smith)
  - Location of HPWH

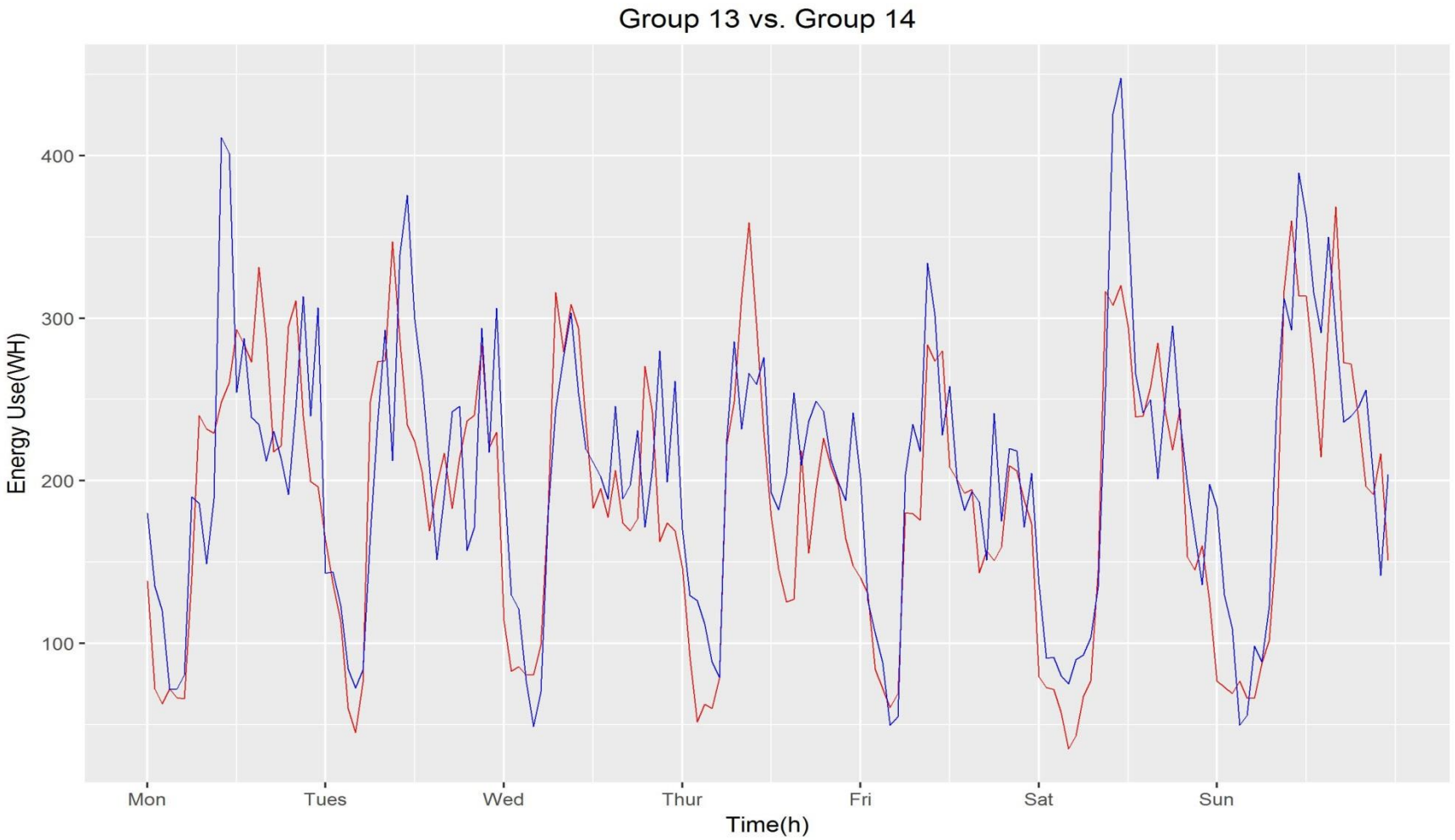
# Balancing the Groups

- Using 6 variables create a k-means clustering model
- Clustering creates homogeneous groups based on data given
- Try different numbers of clusters
- When a final clustering model is selected, distribute the tanks randomly in each group into two different groups

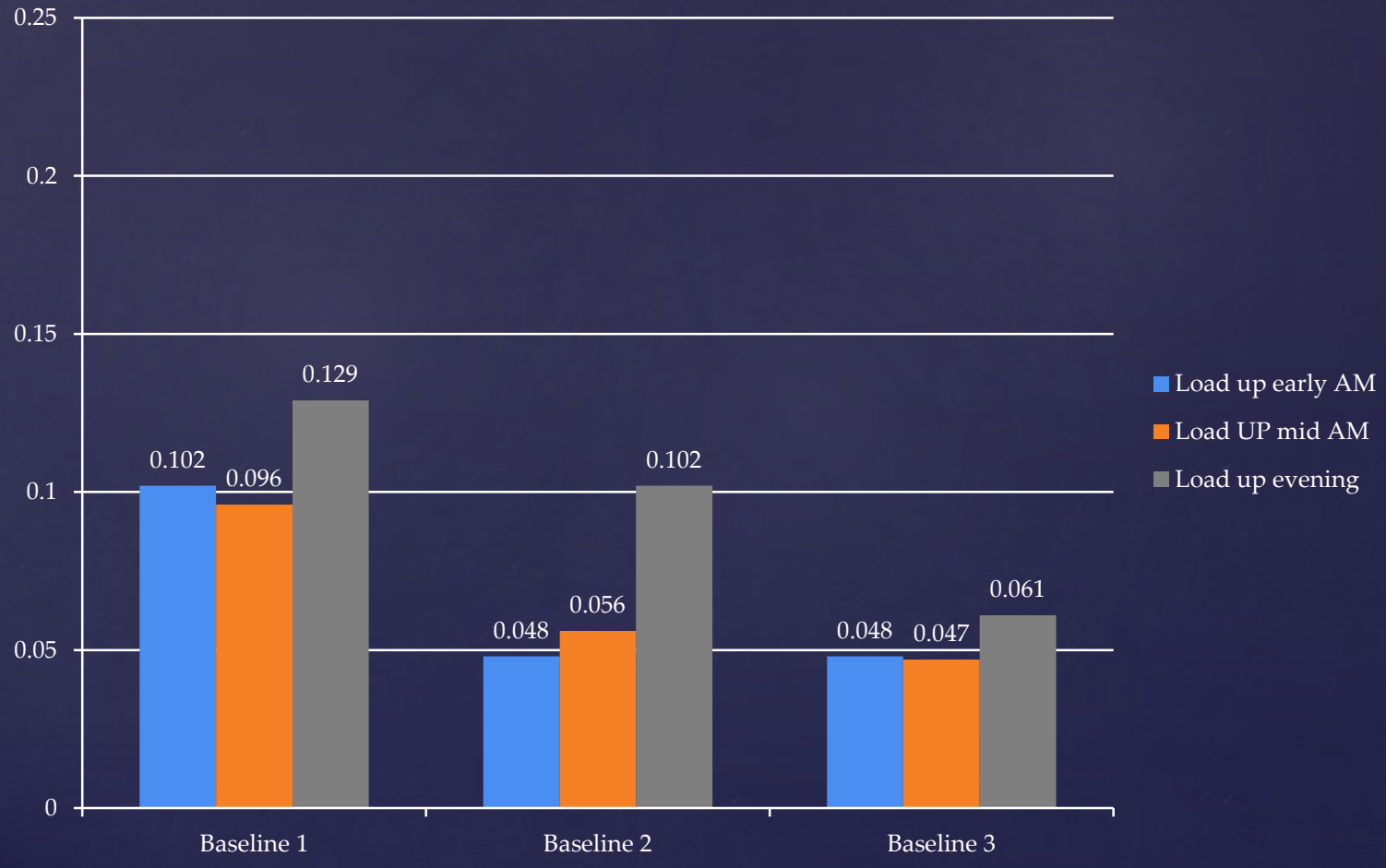
# Are The Groups Balanced?

| Group | Statistic | Total Use | Minutes > 1000 W | AM Use | PM Use |
|---|---|---|---|---|---|
| 13 | Min | 5.84 | 0.00 | 193.33 | 298.43 |
| | Mean | **26.97** | **168.66** | **2040.47** | **2414.13** |
| | Max | 87.32 | 958.26 | 7923.37 | 7746.98 |
| 14 | Min | 3.20 | 0.00 | 360.21 | 428.09 |
| | Mean | **30.03** | **203.60** | **1999.20** | **2611.49** |
| | Max | 214.37 | 2998.50 | 10232.55 | 11561.14 |

- Group 13
- Group 14



# Results – Week of 2/5



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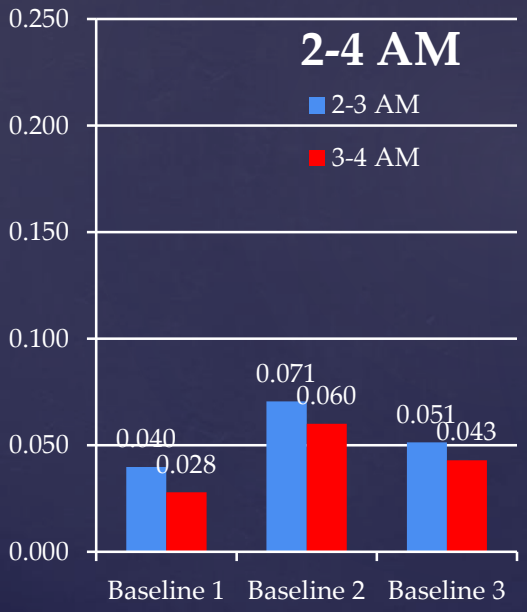
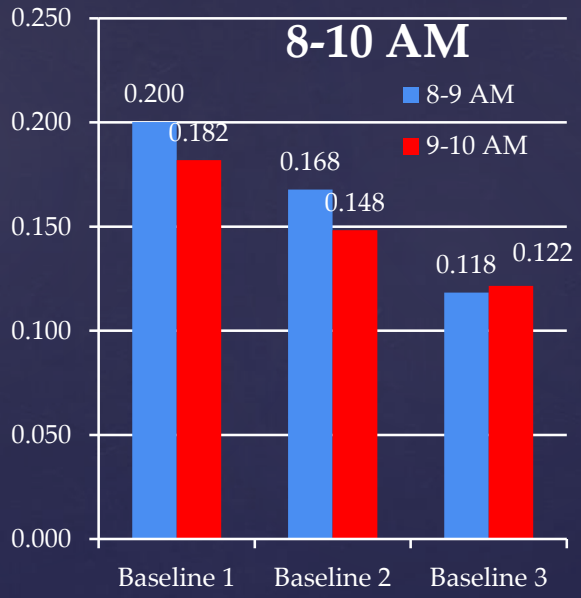
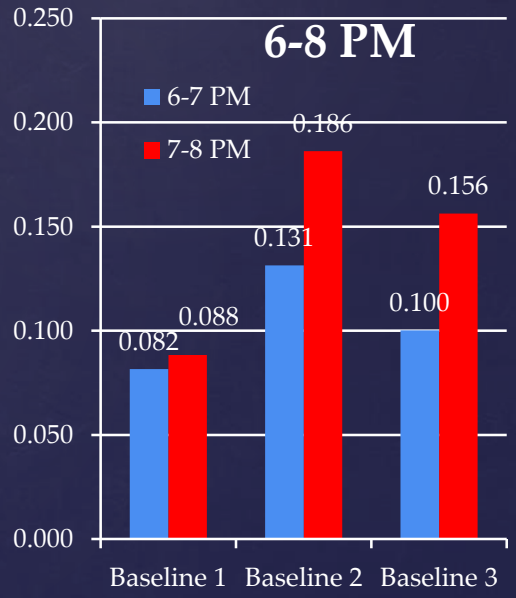
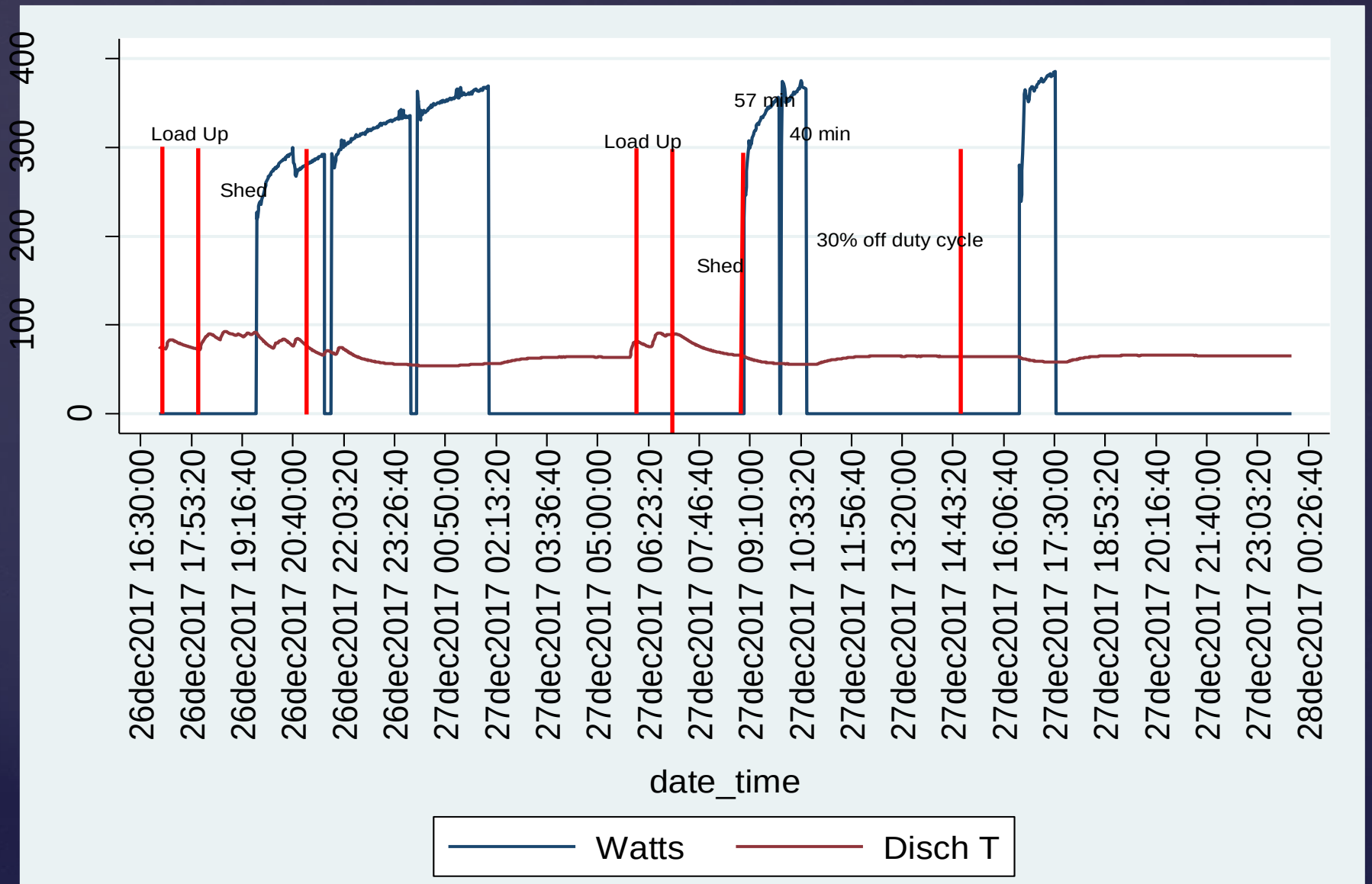


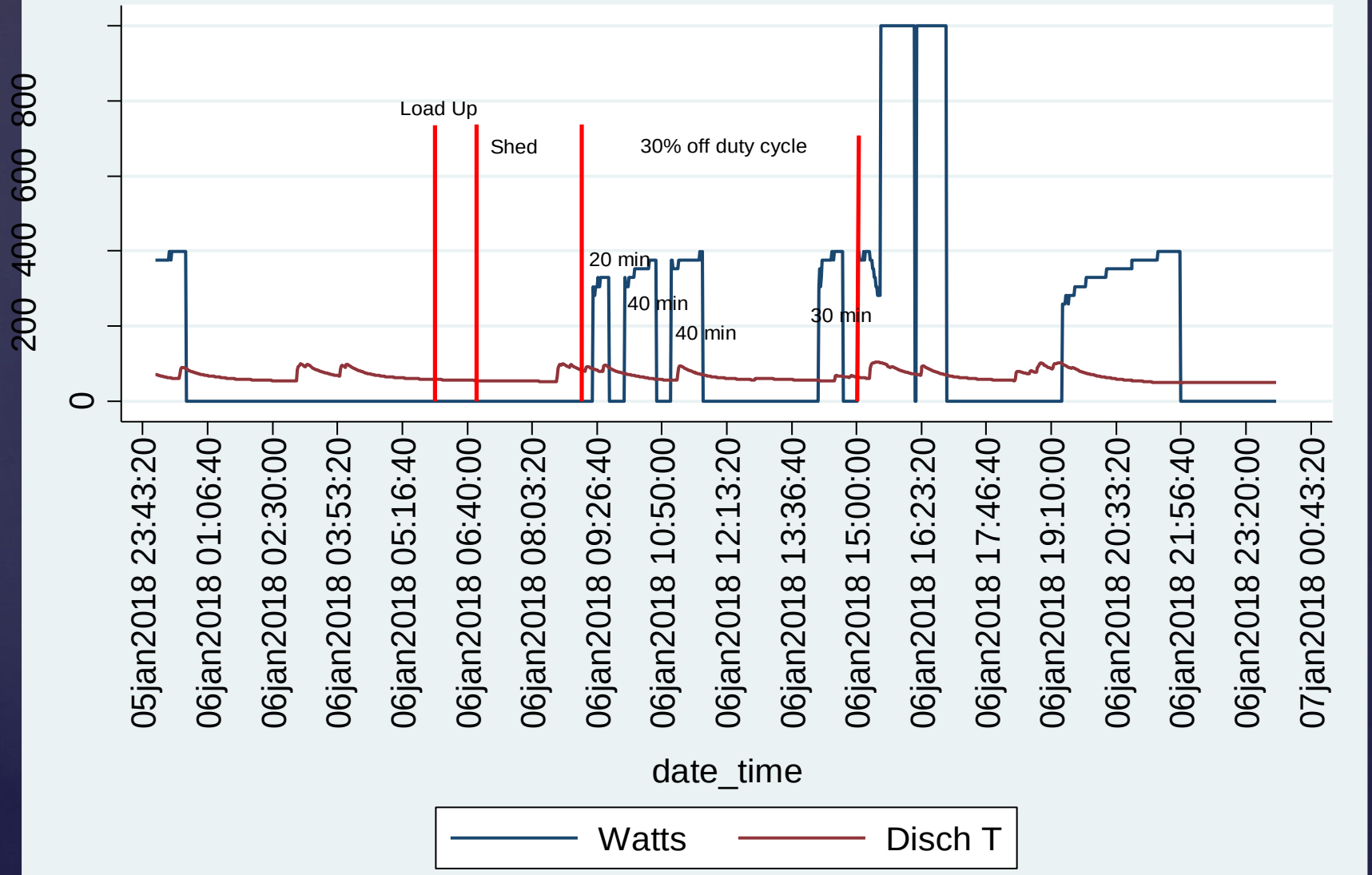



# GE Tank – Heat Pump Only Mode



# AO Smith Tank – Hybrid Mode



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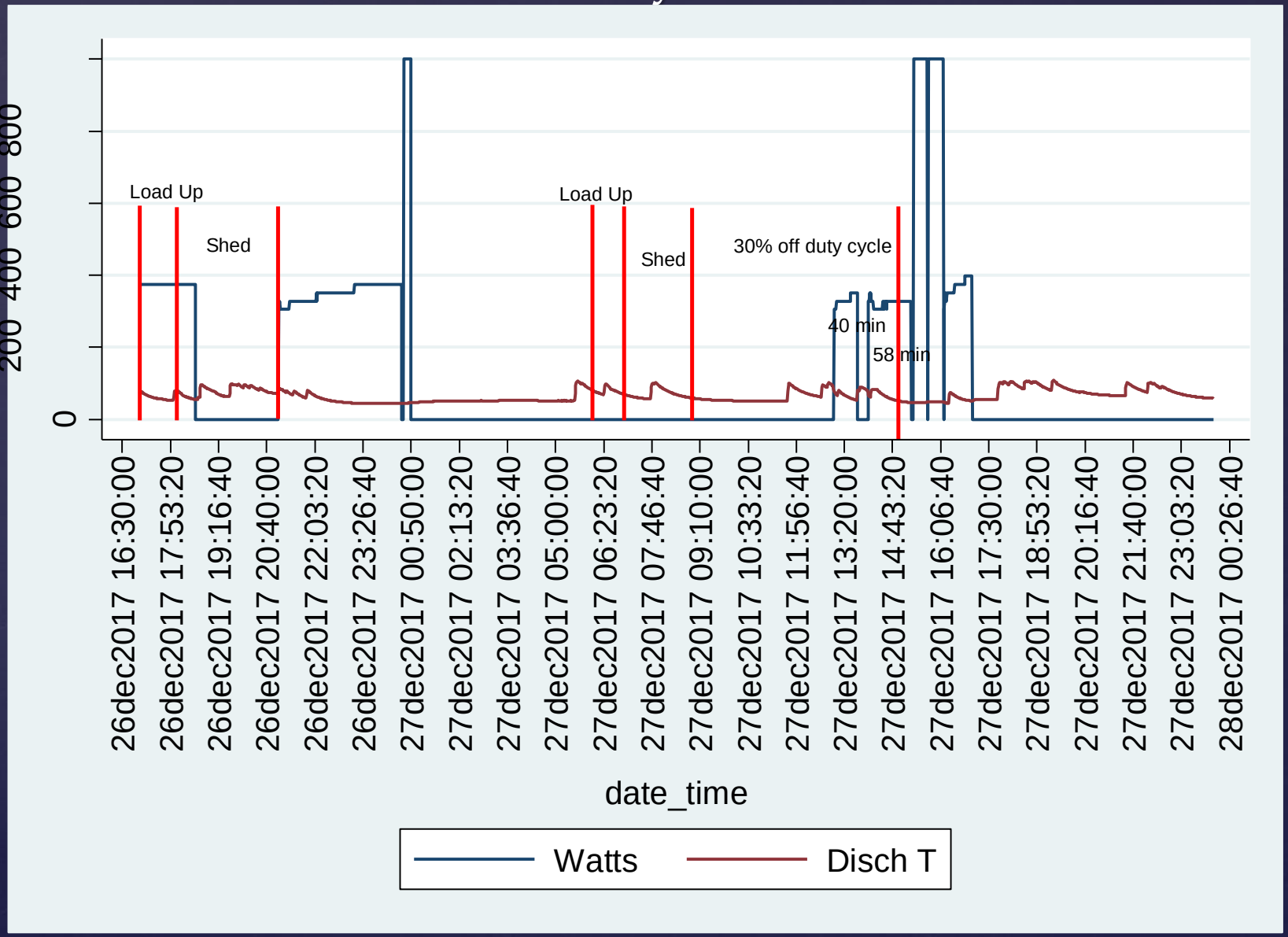
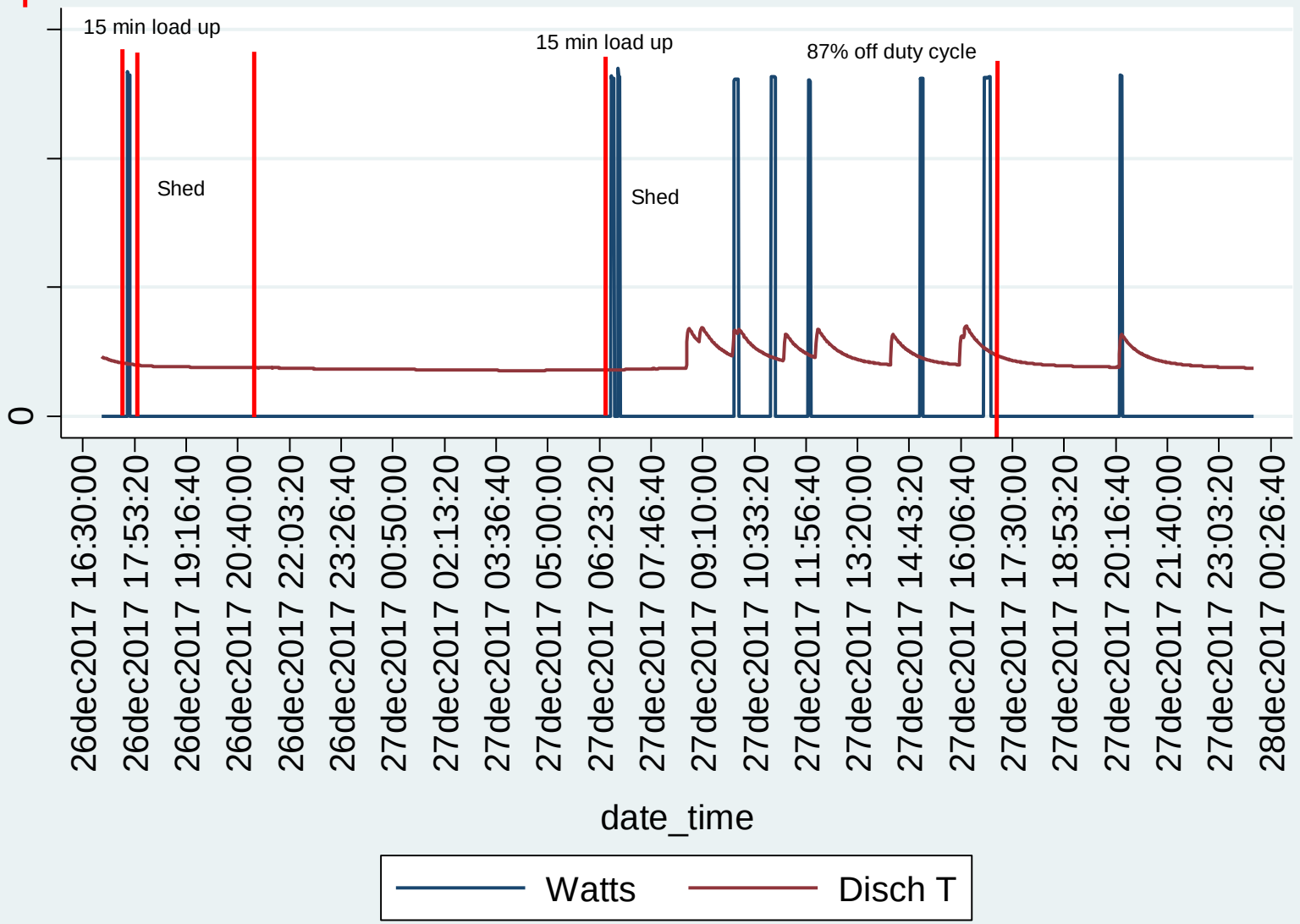
# Resistance Tank