
Lab Tests to Model Heat Pump Water Heater Controls

ACEEE Hot Water Forum 2018

Session 1B

Verification and Validation of Hot Water System Simulations

March 21

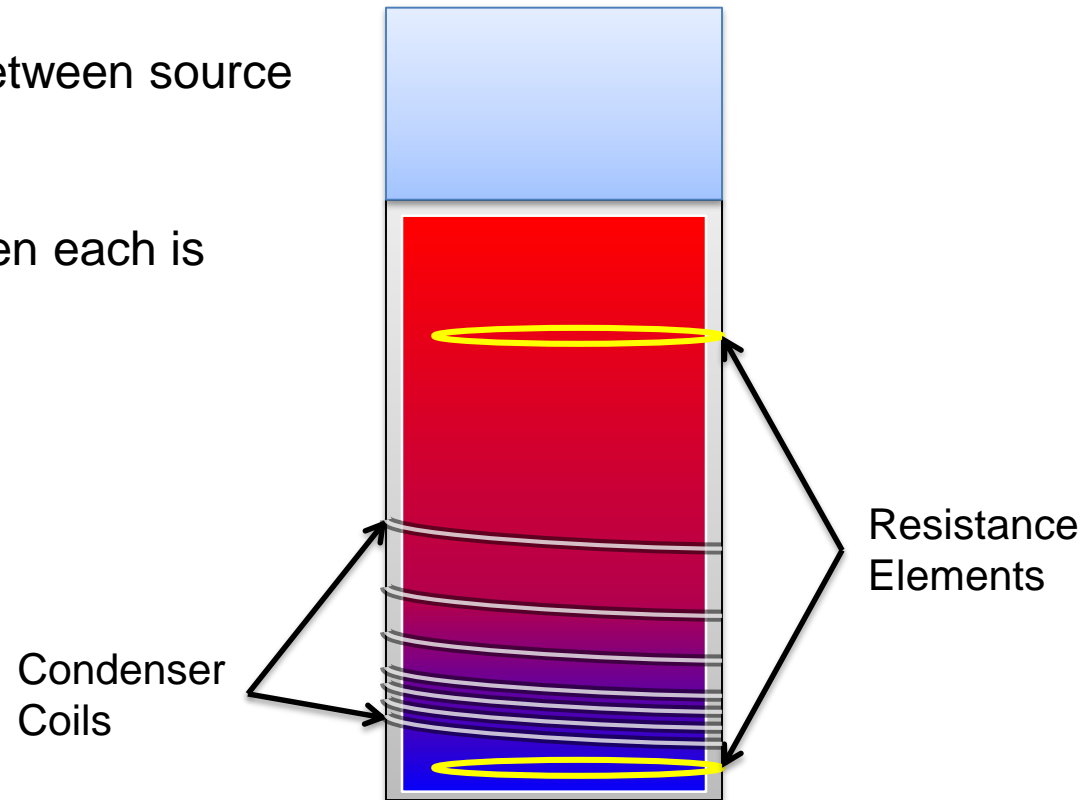


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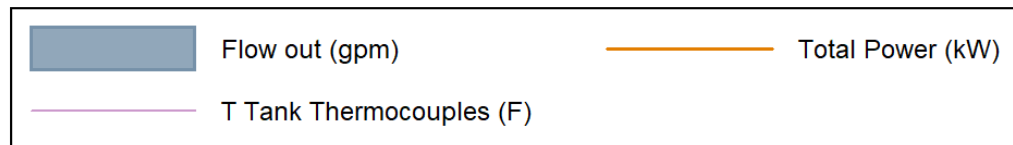
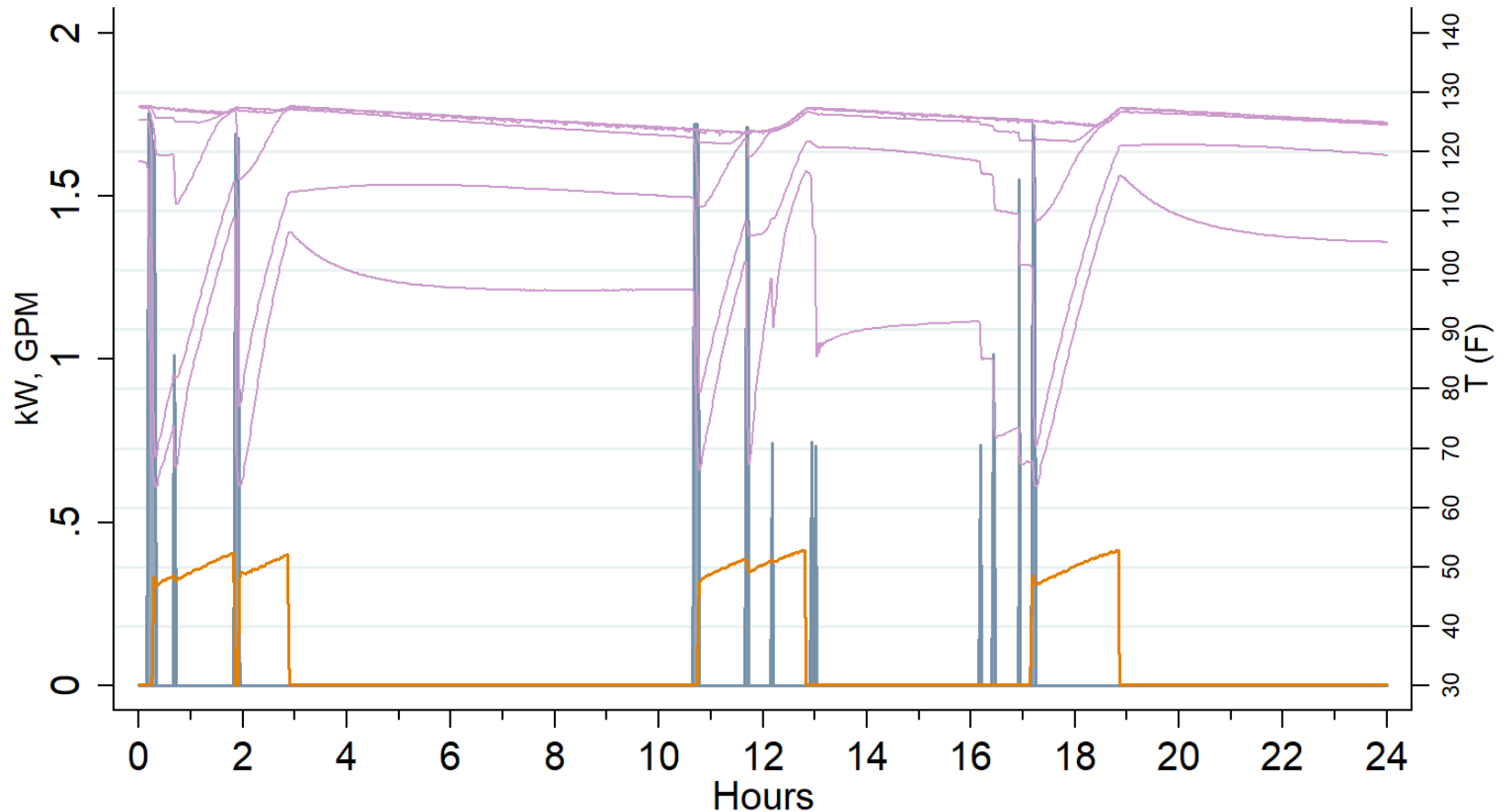
Problem Statement

- Hybrid heat pump water heaters contain two heat sources
 - Compressor
 - Resistance Elements
- Efficiency differs drastically between source
 - Compressor COP ≈ 3
 - Resistance Elements COP = 1
- Simulations need to know when each is active



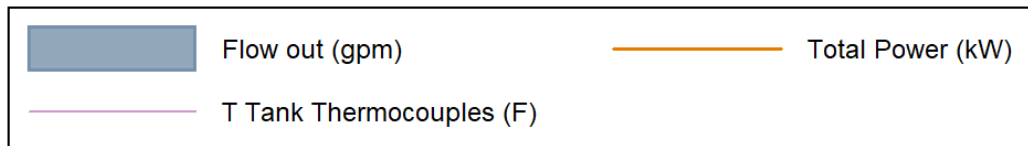
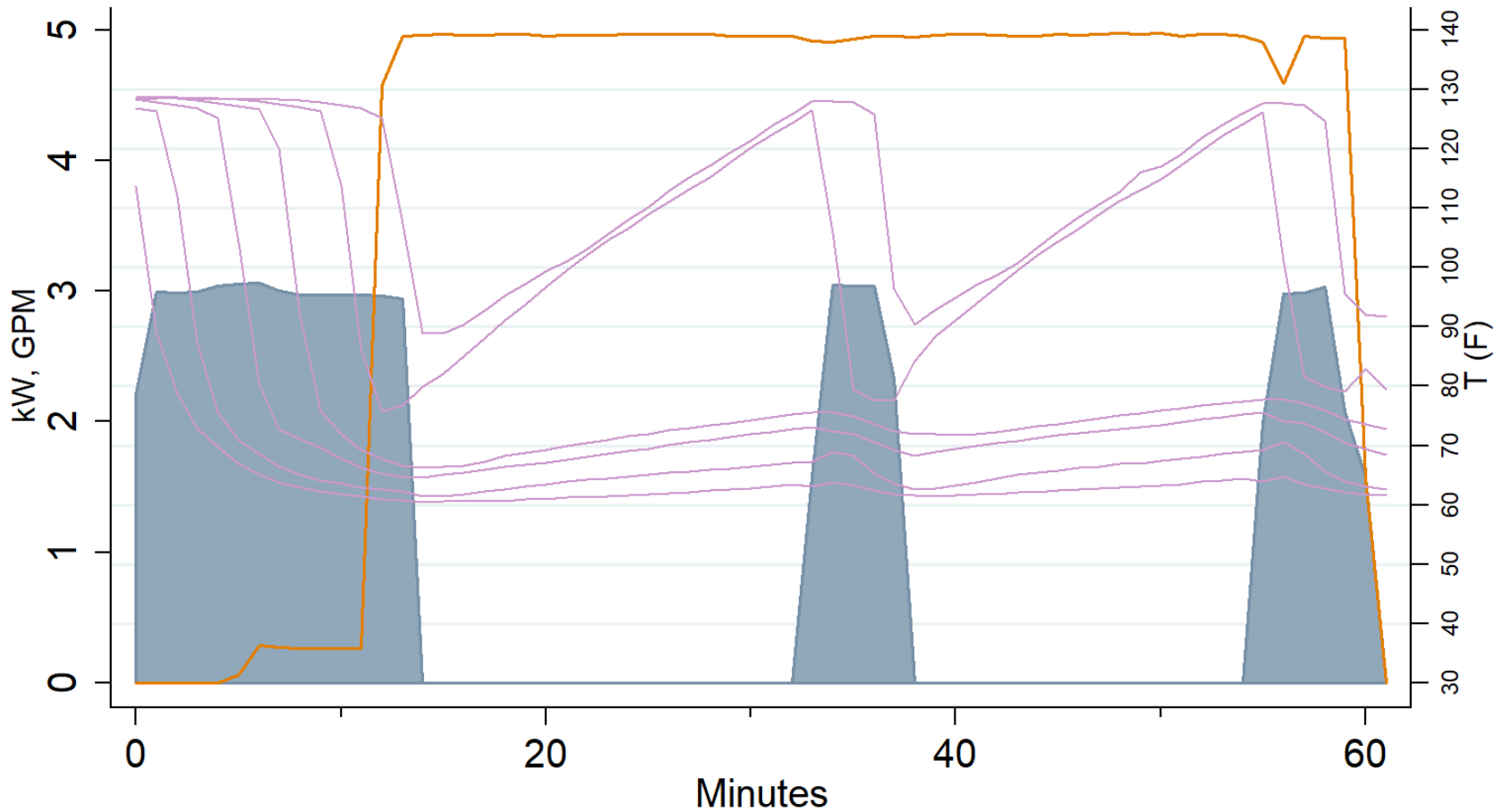
Starting Point 1: UEF Draw Pattern

Medium draw pattern on a 50 gallon tank



Starting Point 2: 1st Hour Test

Same 50 gallon tank

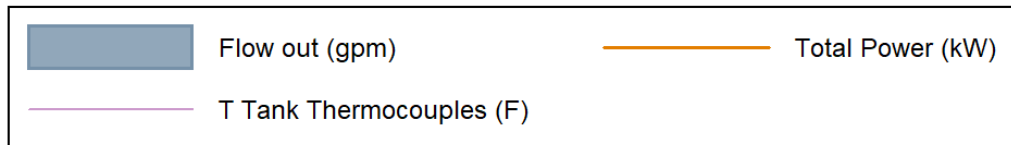
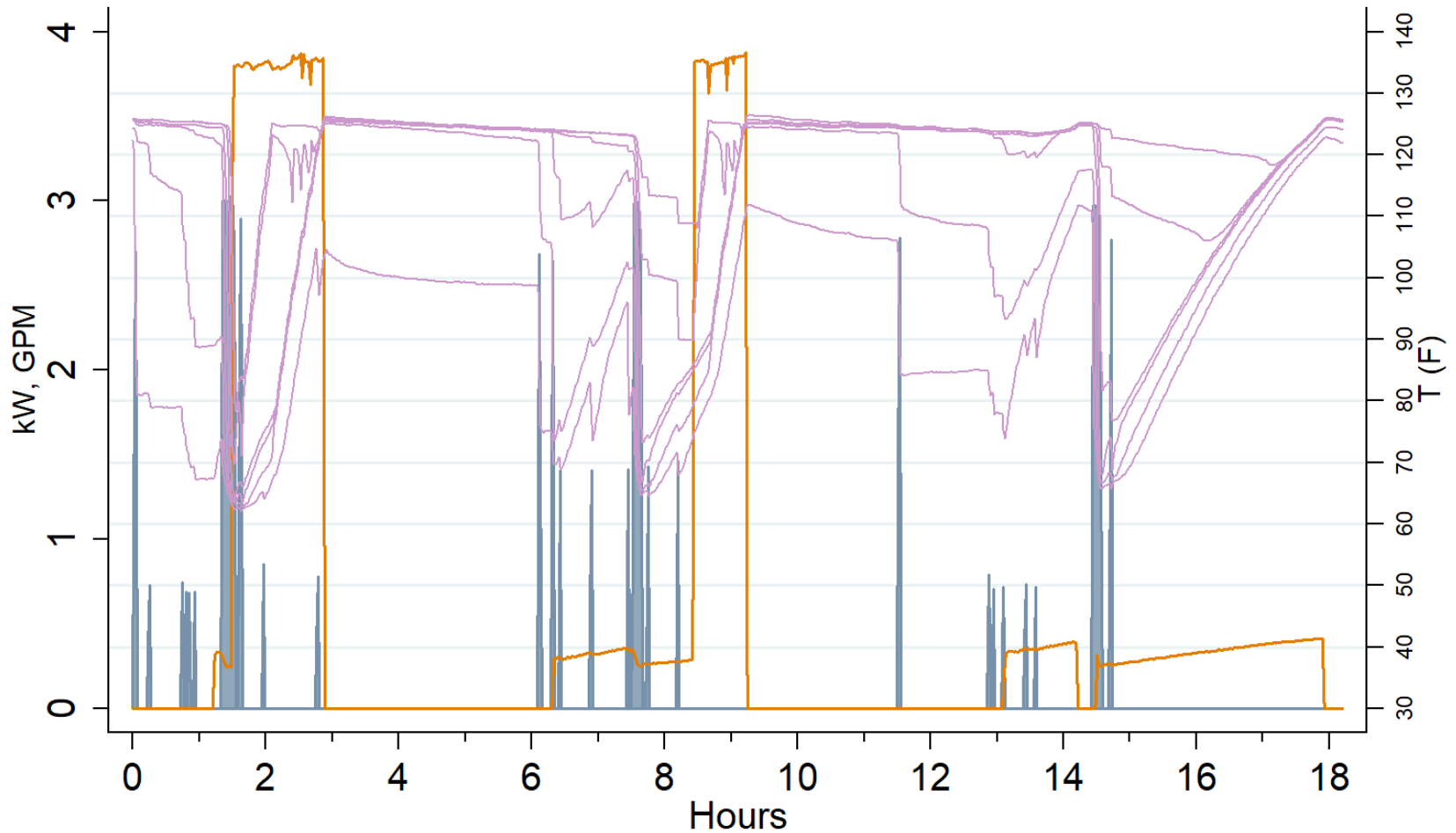


Controls Information

- Base Tests Provide
 - 4 instances of heat pump activation
 - 1 instance of resistance element activation
 - Need More Information – A New Test
 - High Demand / Large Draws elicit resistance element usage
 - 18 hours, 130 gallons
 - 3 draw clusters: 51, 43, 36 gallons
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More Information: 18hr High Demand

Same 50 gallon tank



High Demand Lab Test Findings

■ General

- ❑ Observations of more test patterns lead to better predictive capability
- ❑ At least 3 distinct tests can be conducted in an 18 hour period
 - 3 clusters spaced to allow full recovery between each

■ Specific – for particular tank test shown

- ❑ 4 compressor activations observed
 - ❑ 2 element activations observed
 - ❑ We more than doubled our knowledge of the controls!
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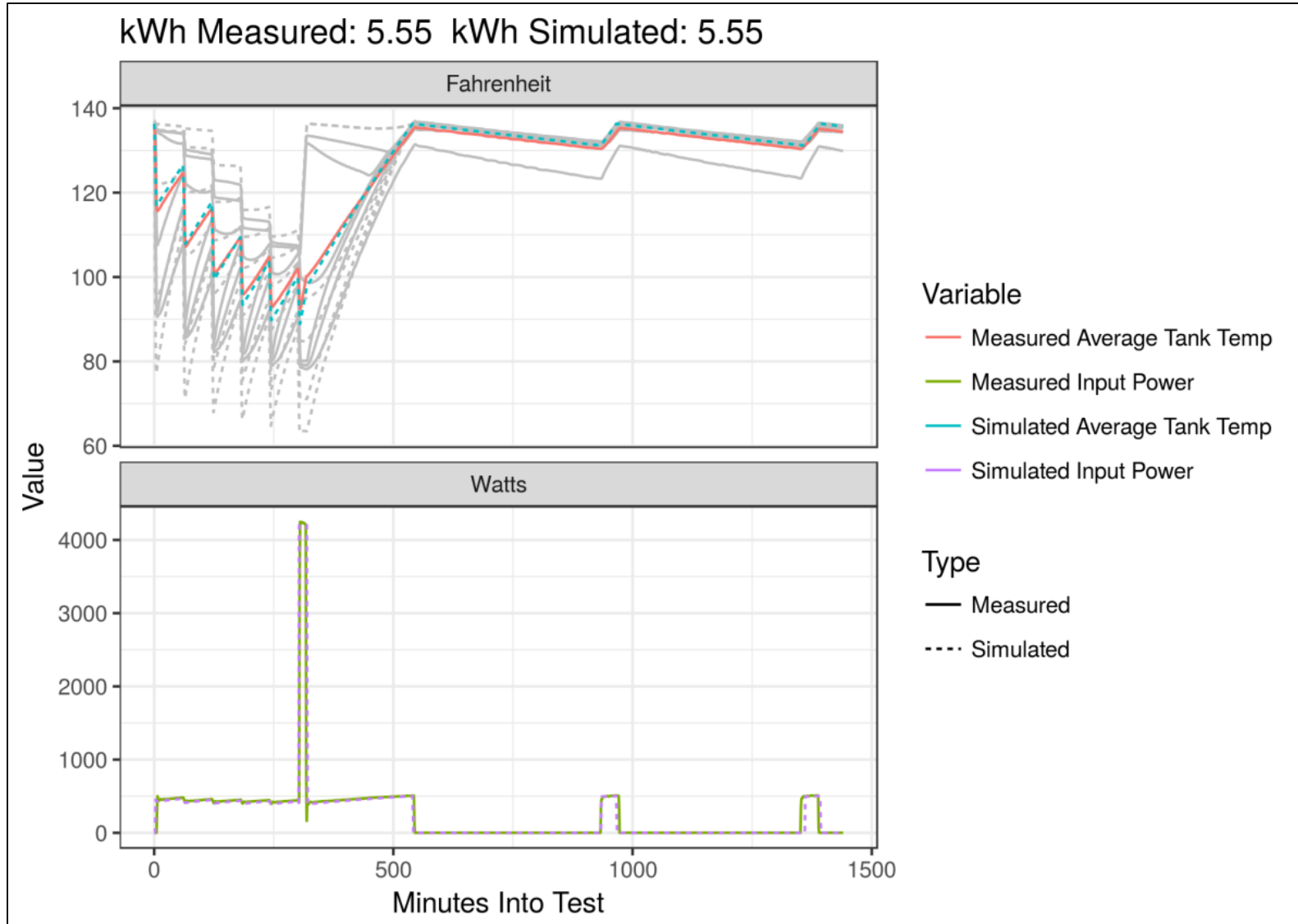
Defining “Good” Calibration

What makes a calibration good?

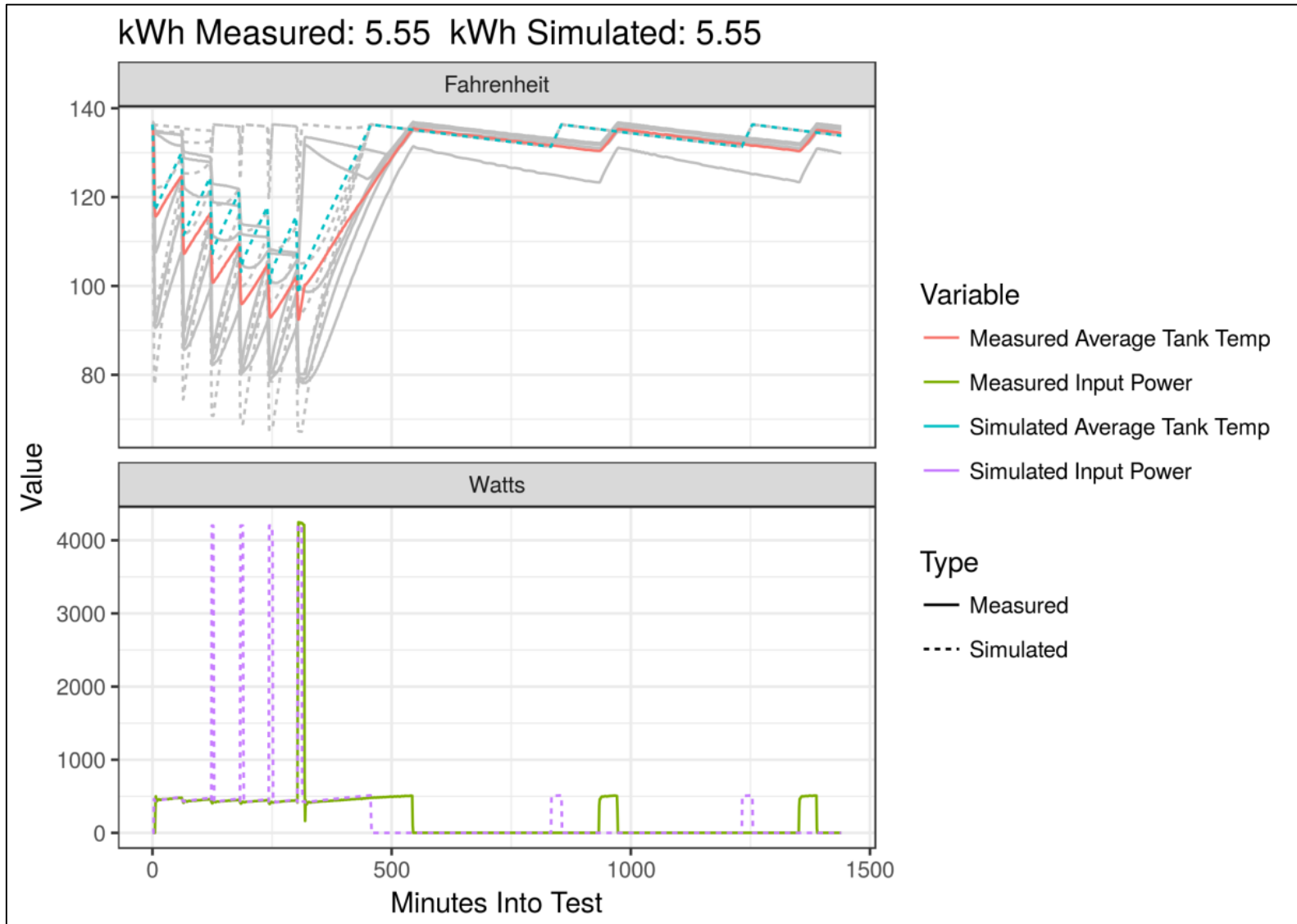
– or –

Not all calibrations are equal

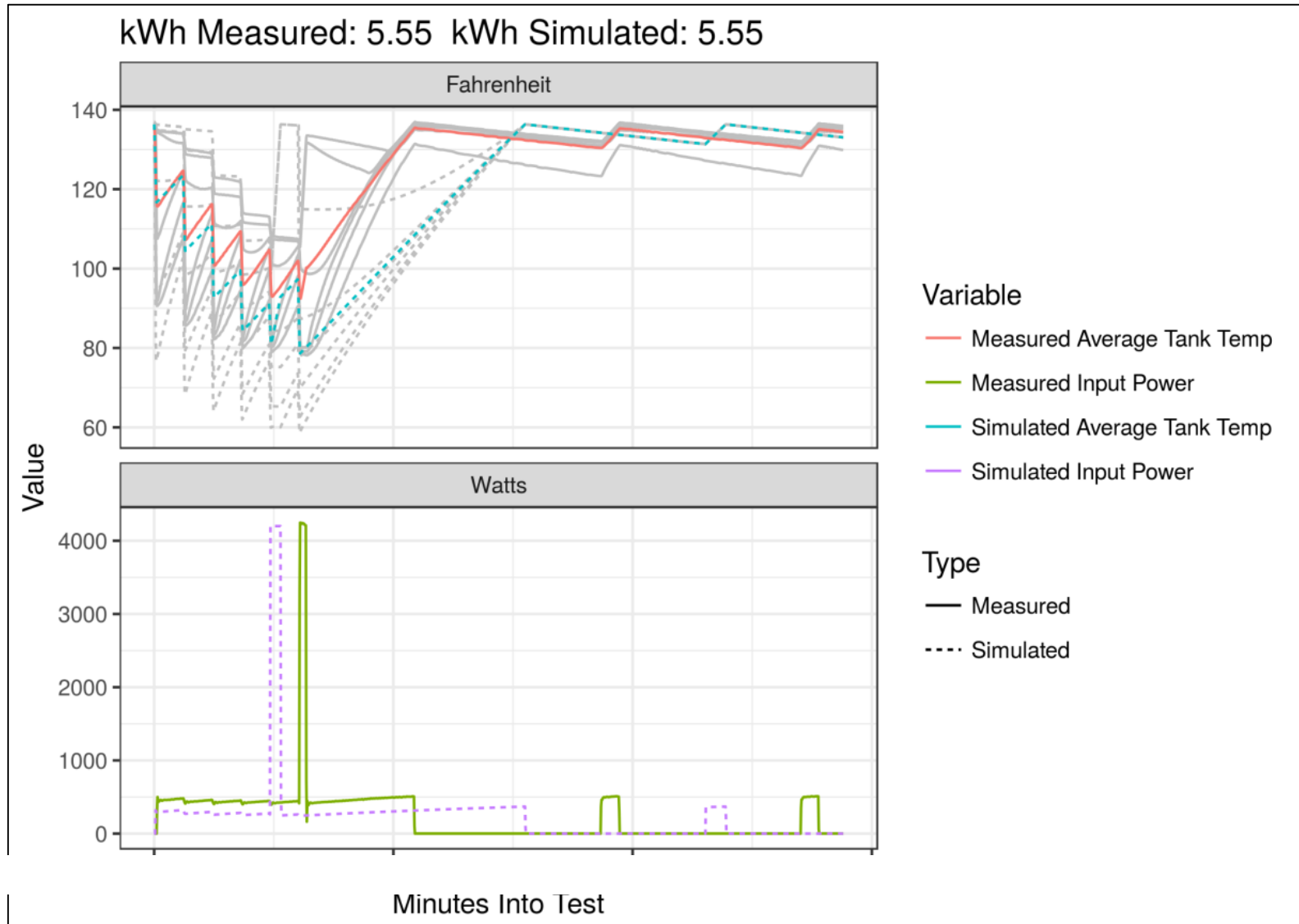
Model Well-Calibrated to Lab Test



Erroneous Calibration



Another Erroneous Calibration



Q & A

- Thanks!
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