



IoT Analytics

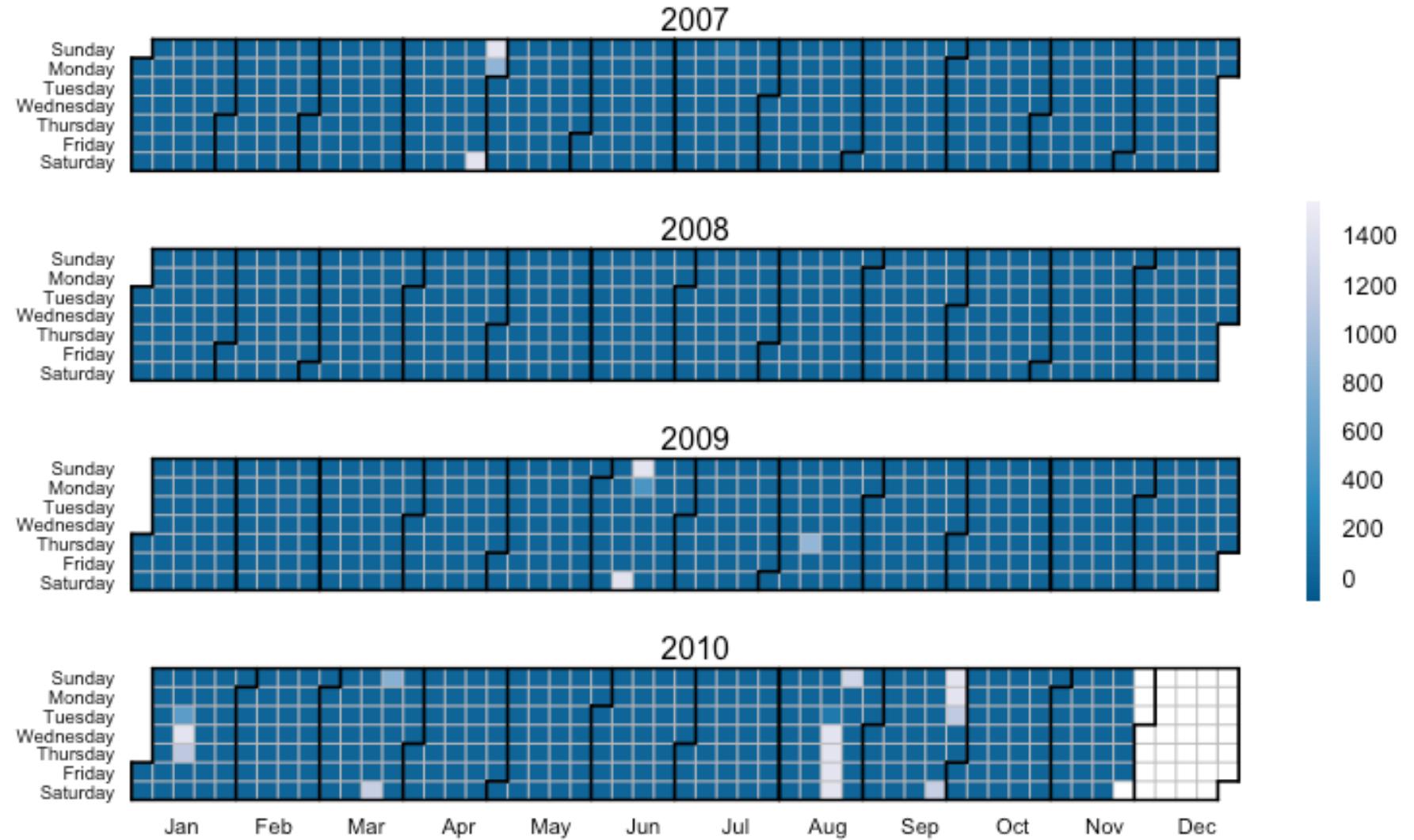
VISUALIZATION AND ANALYSIS OF ENERGY DATA

Vera Rykalina, May 2020

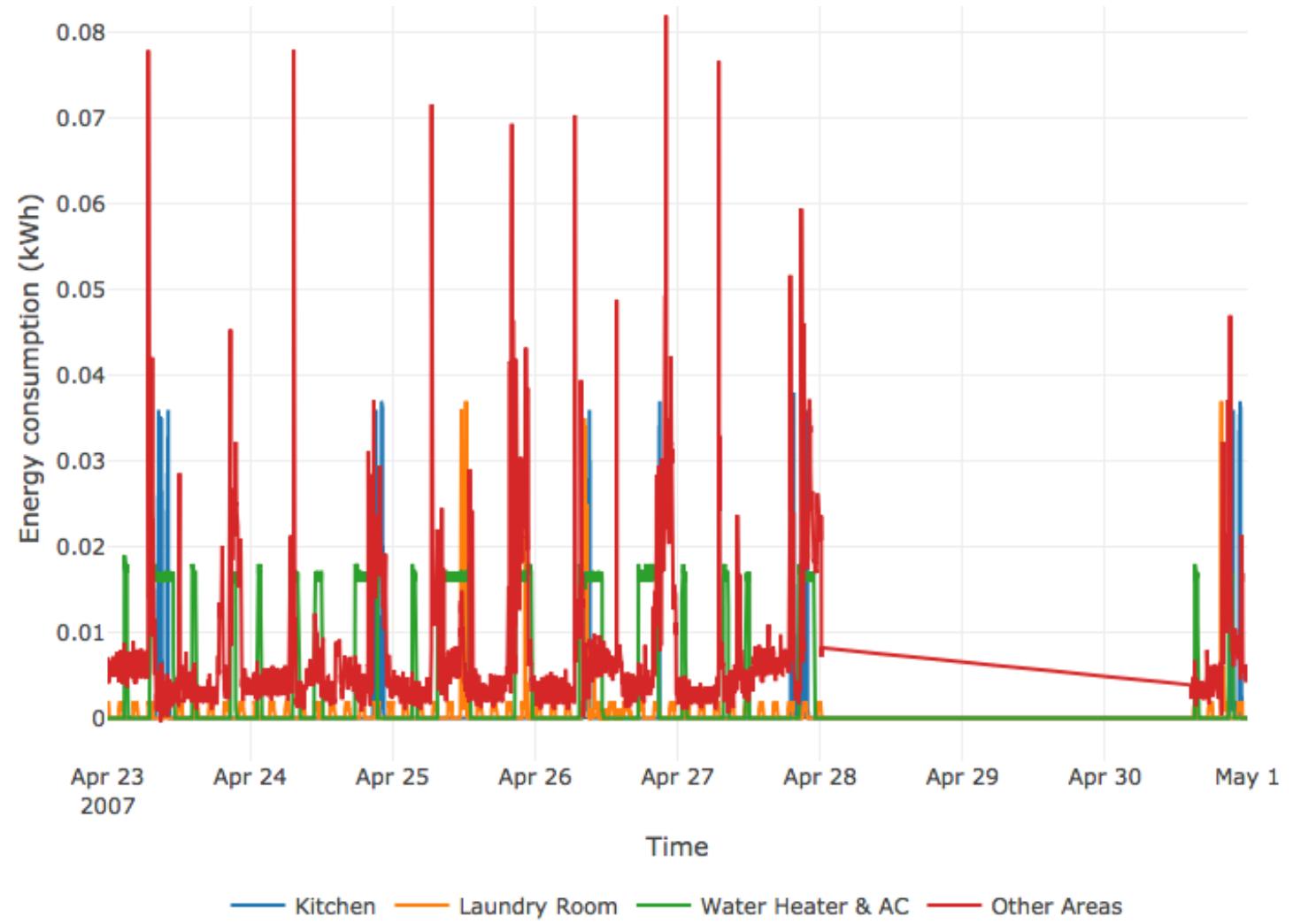
Outline

- Missing values
- Data subsettings
- Finding patterns
- Modeling
- Comparison of models
- Summary
- Recommendations

Understanding Missing Values



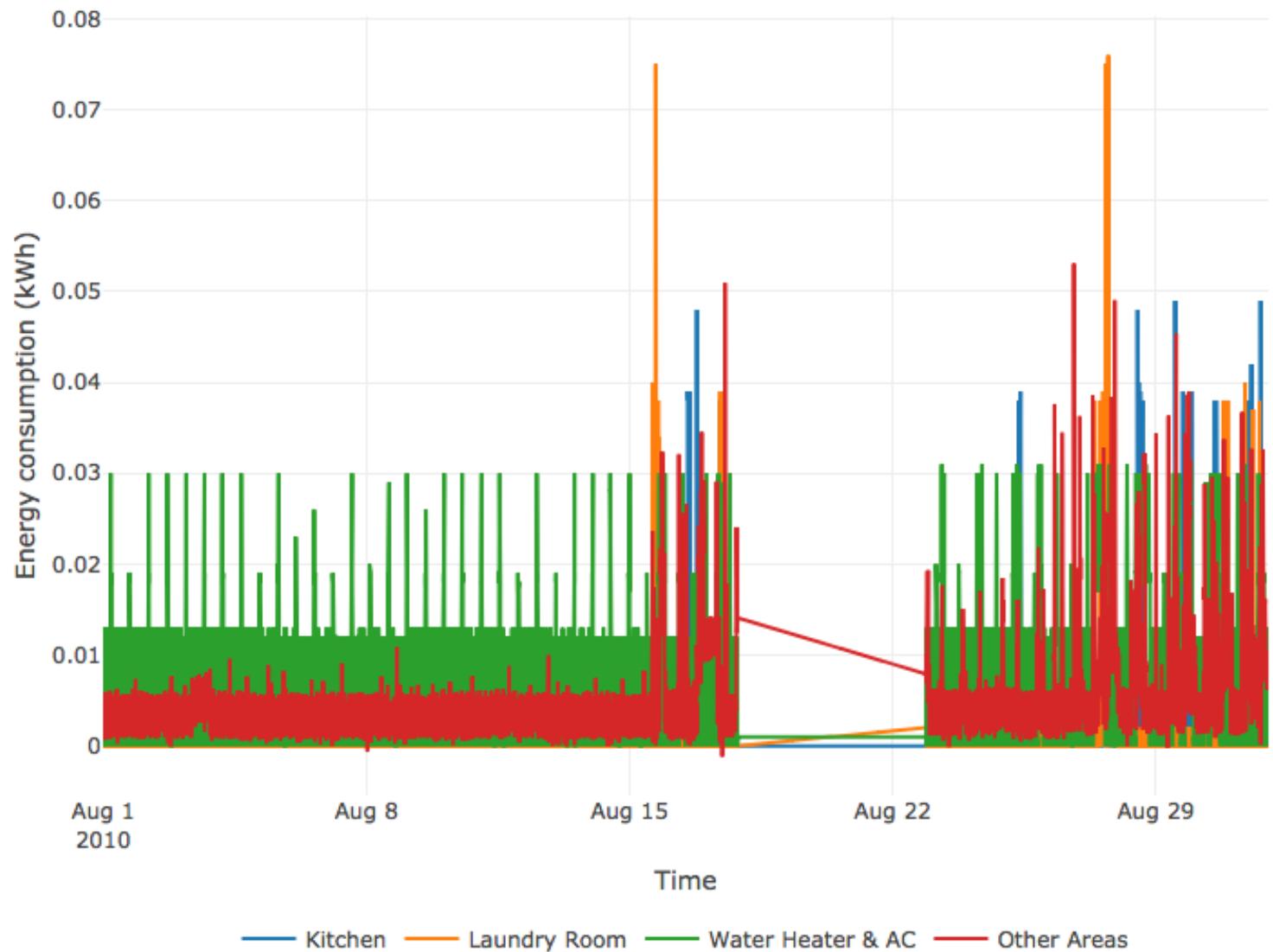
April 23- May 1, 2007



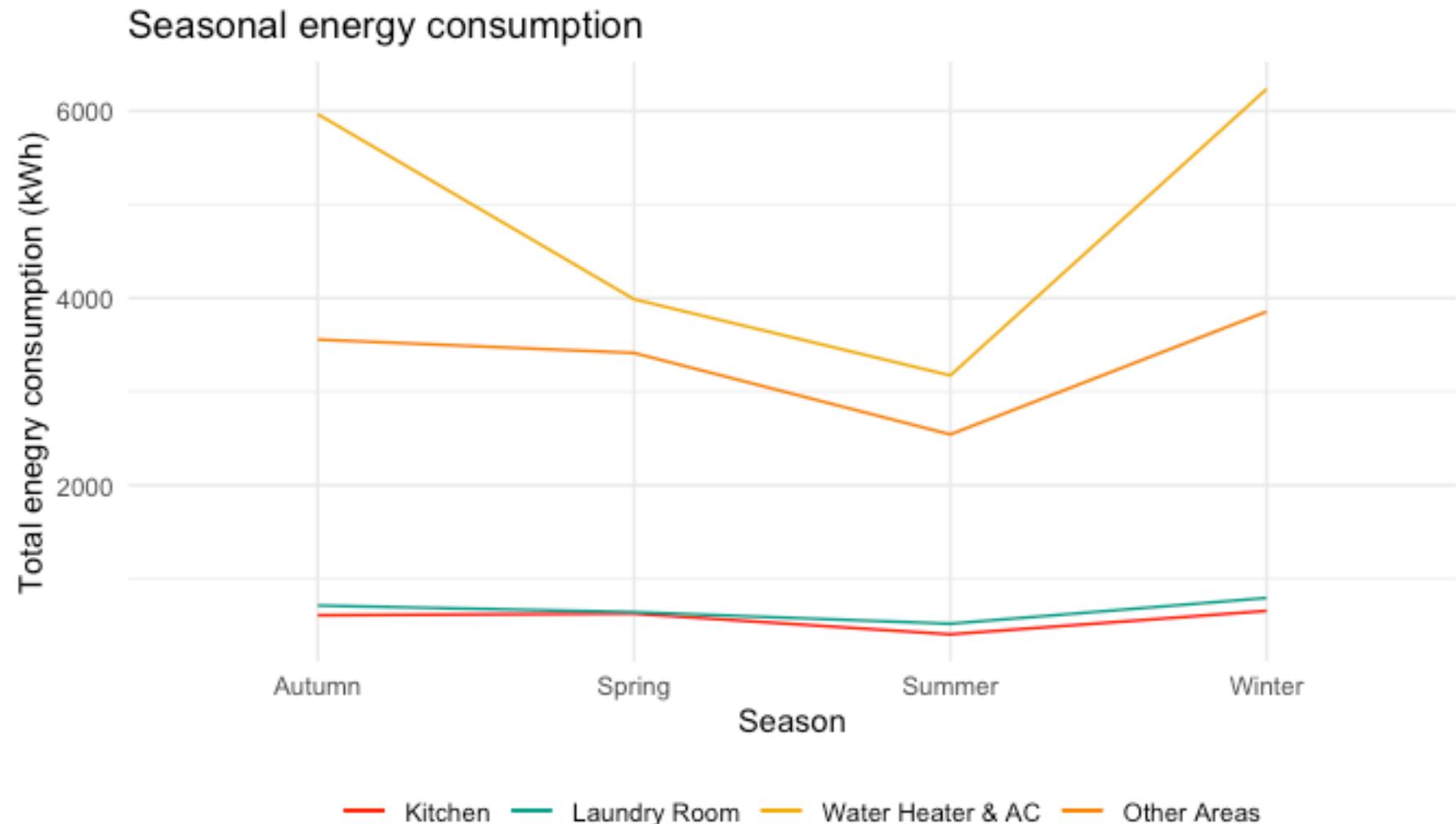
August 13, 2009



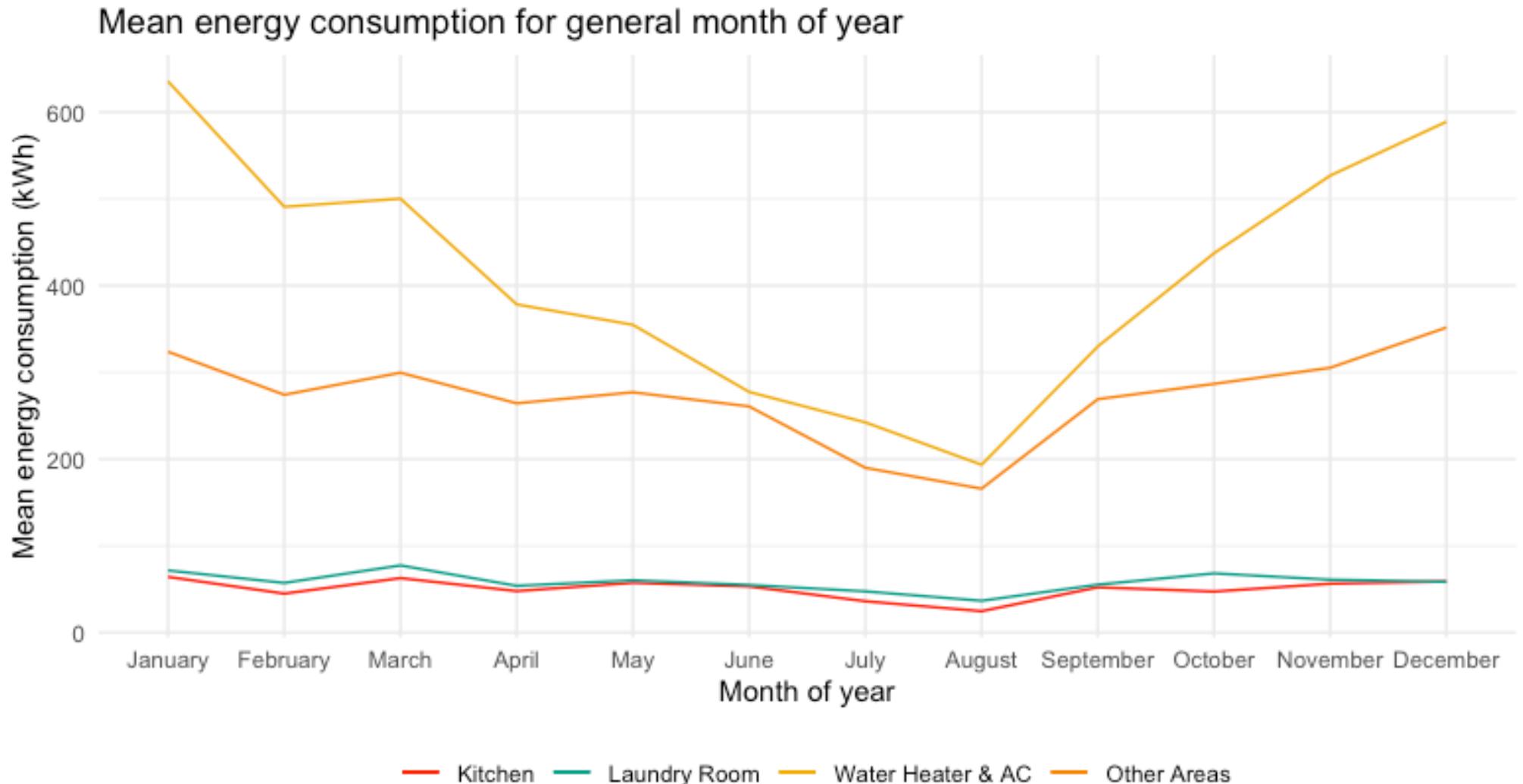
August 2010



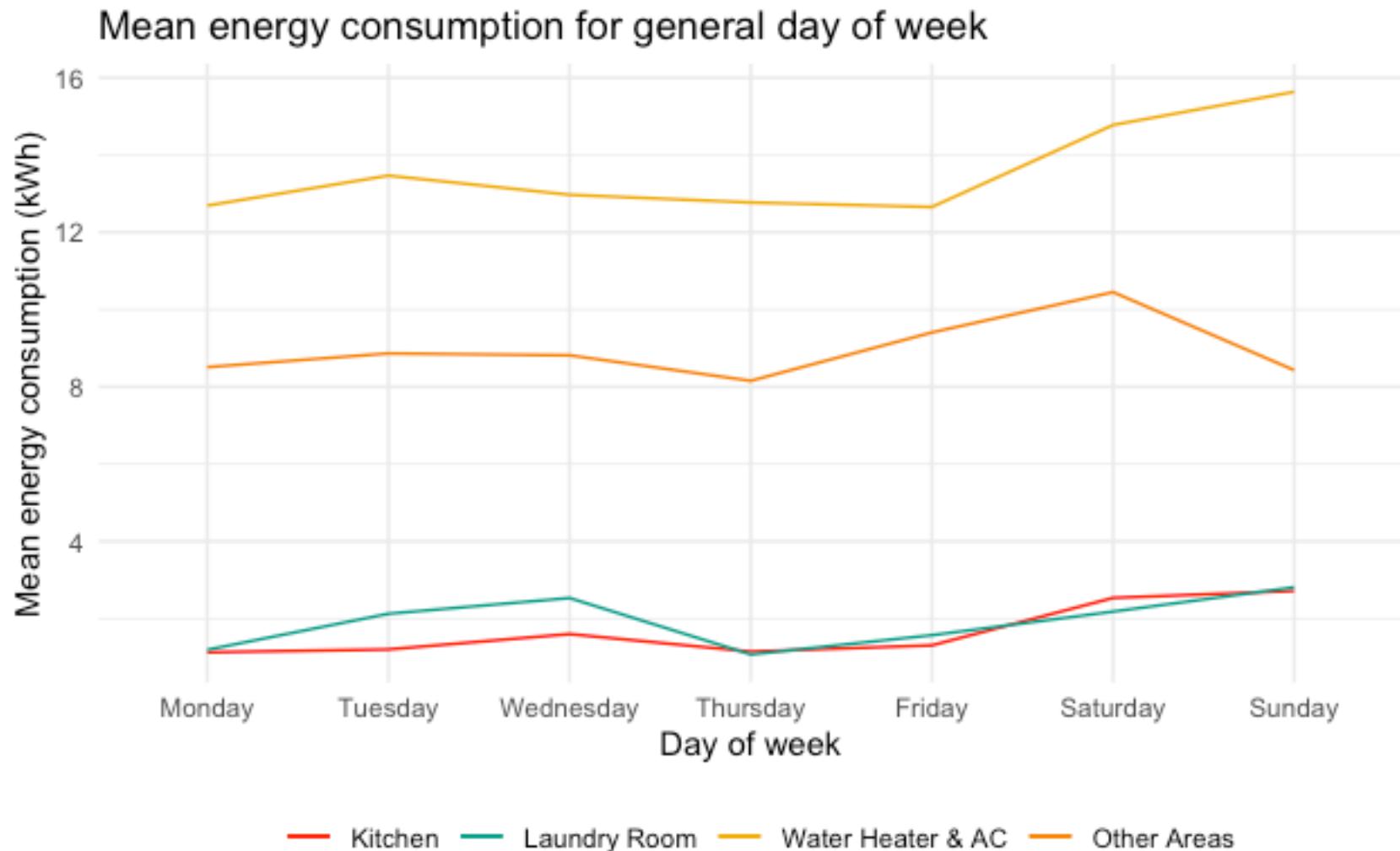
Seasonal pattern (Total enegry)



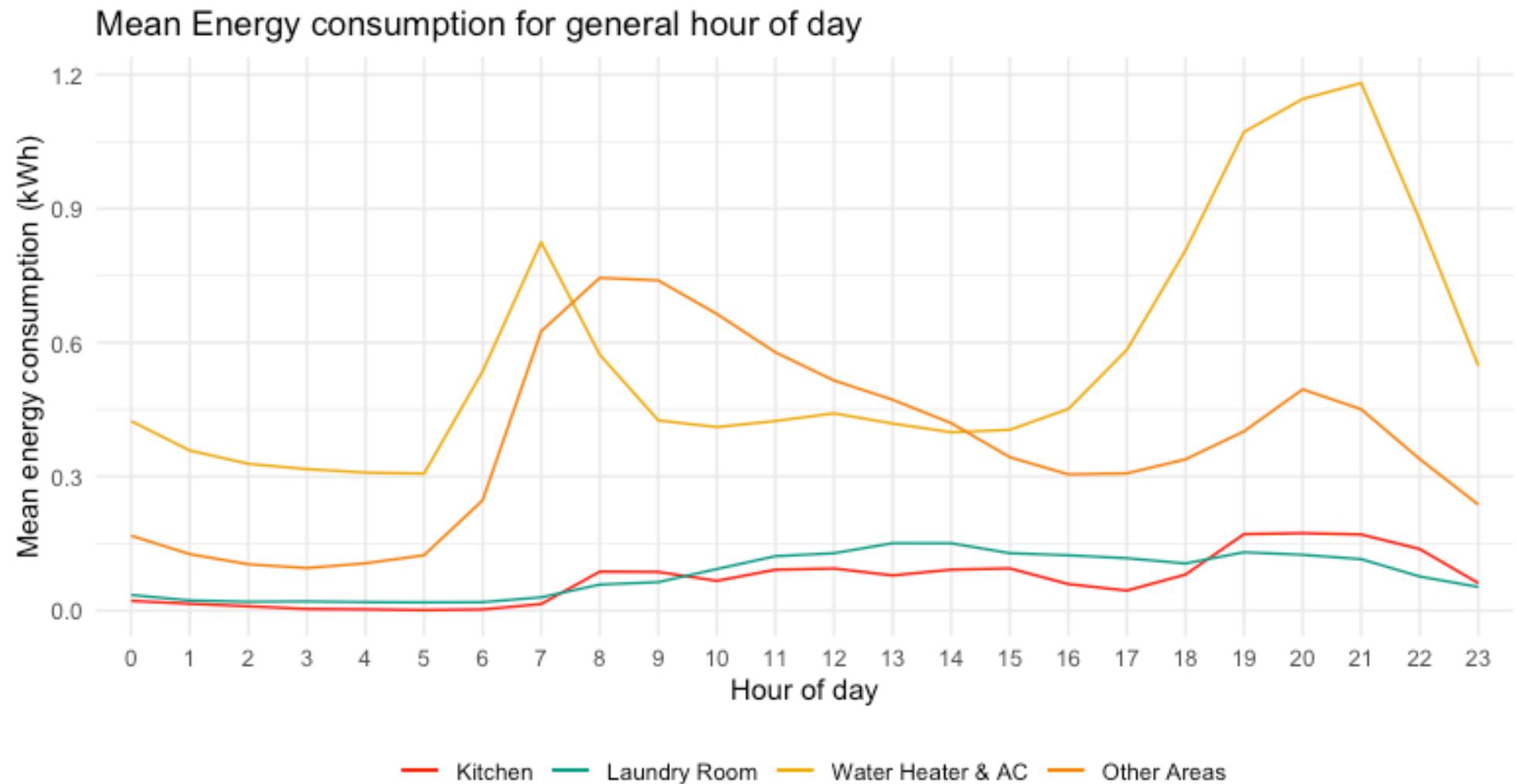
Monthly pattern (Mean energy)



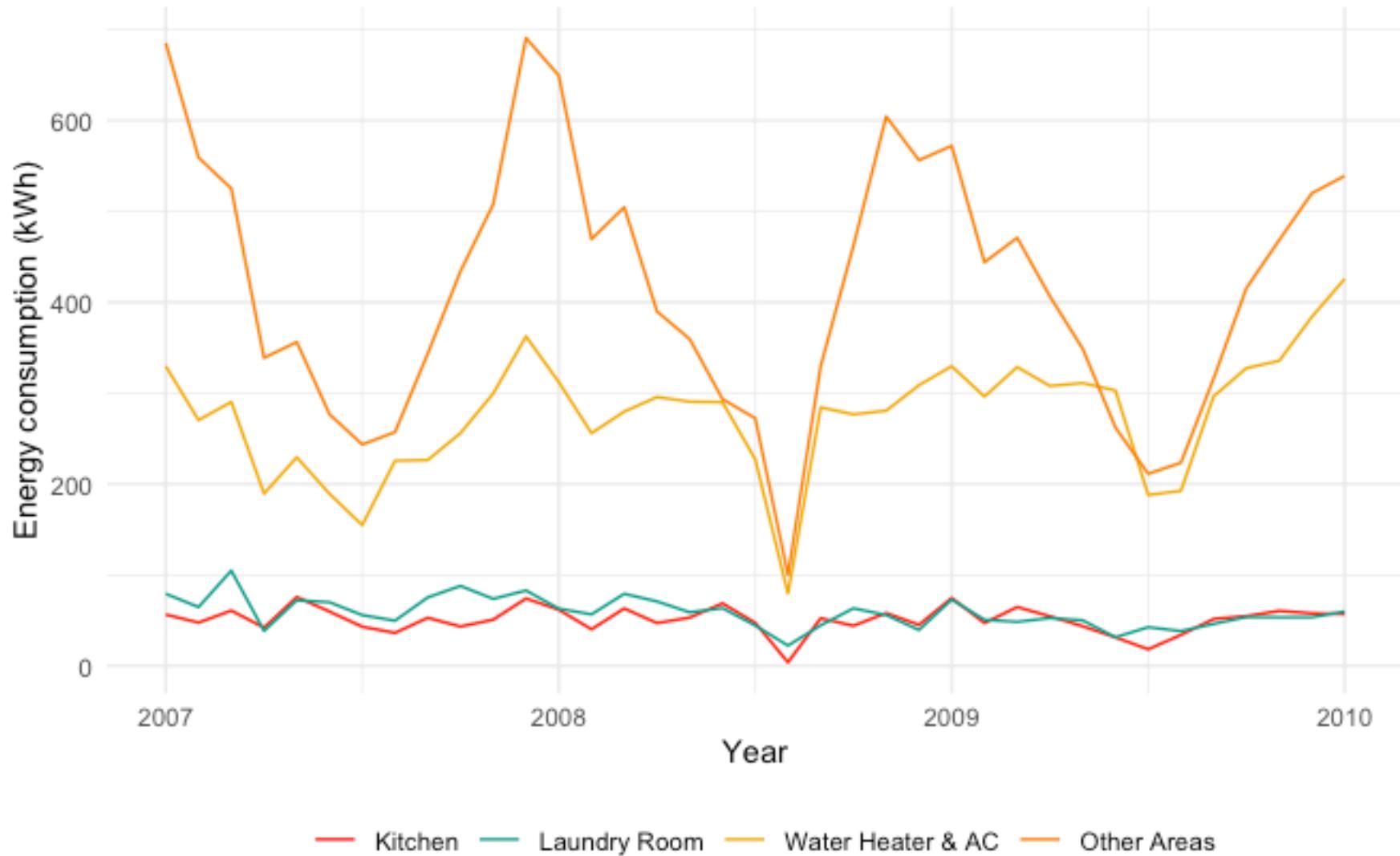
Weekly pattern (Mean energy)



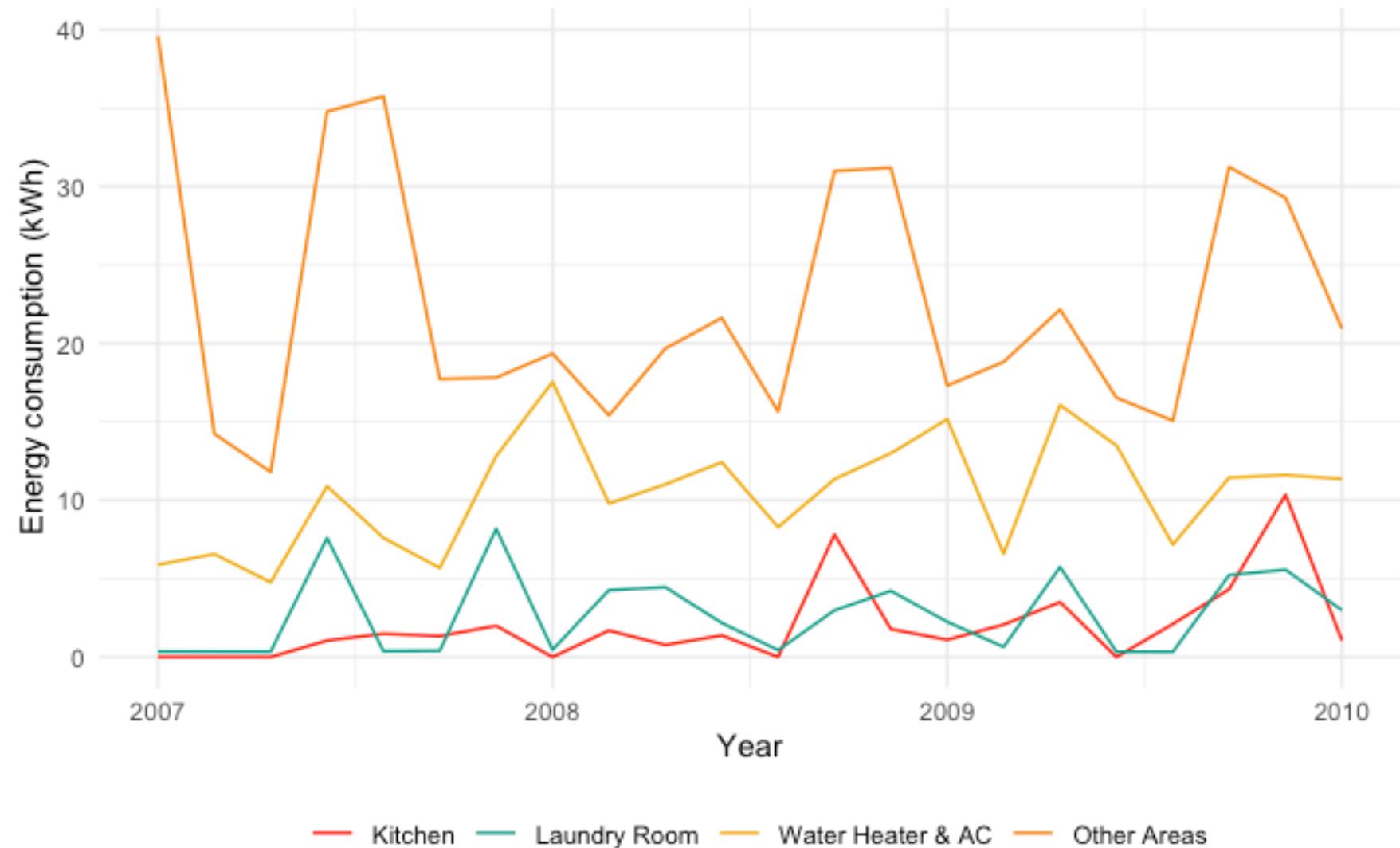
Hourly pattern (Mean energy)



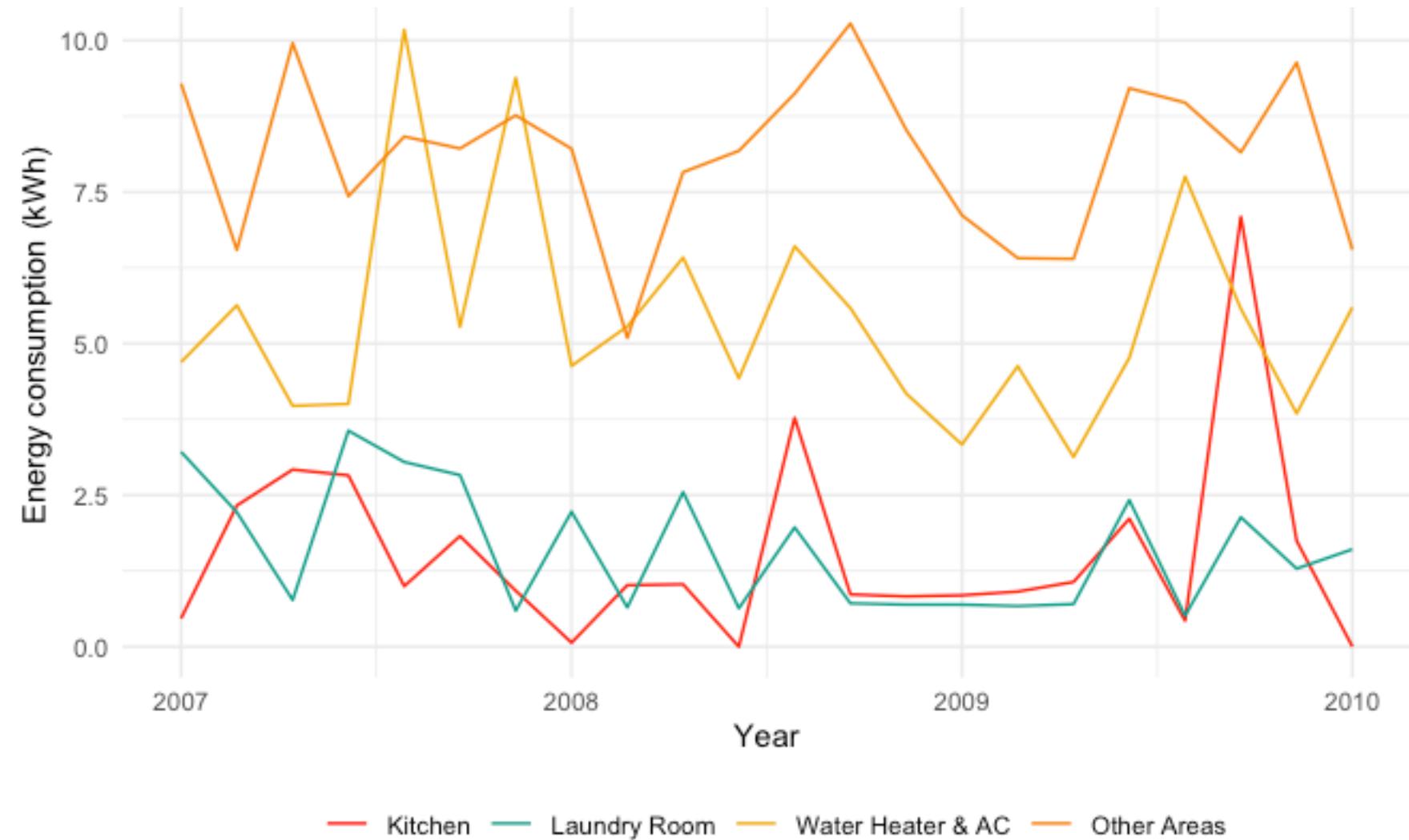
Time Series (Monthly)



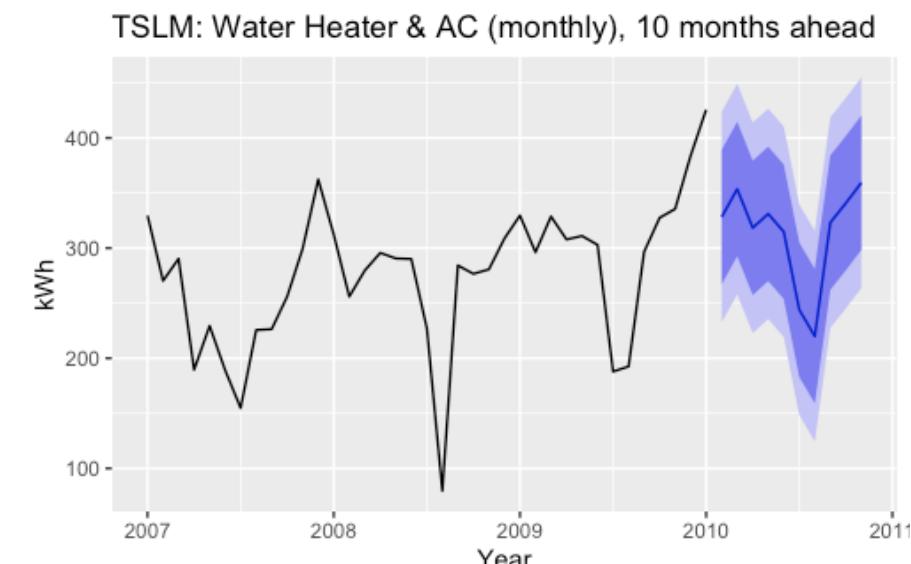
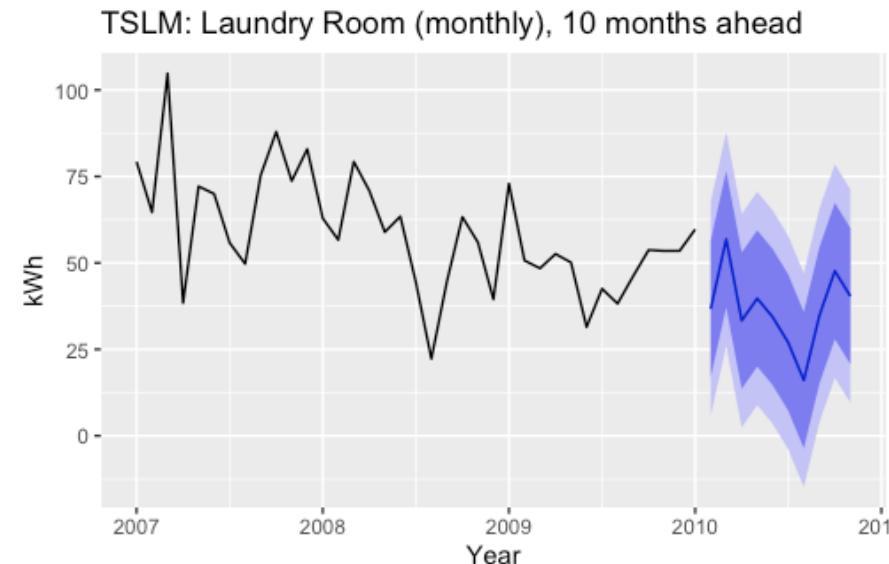
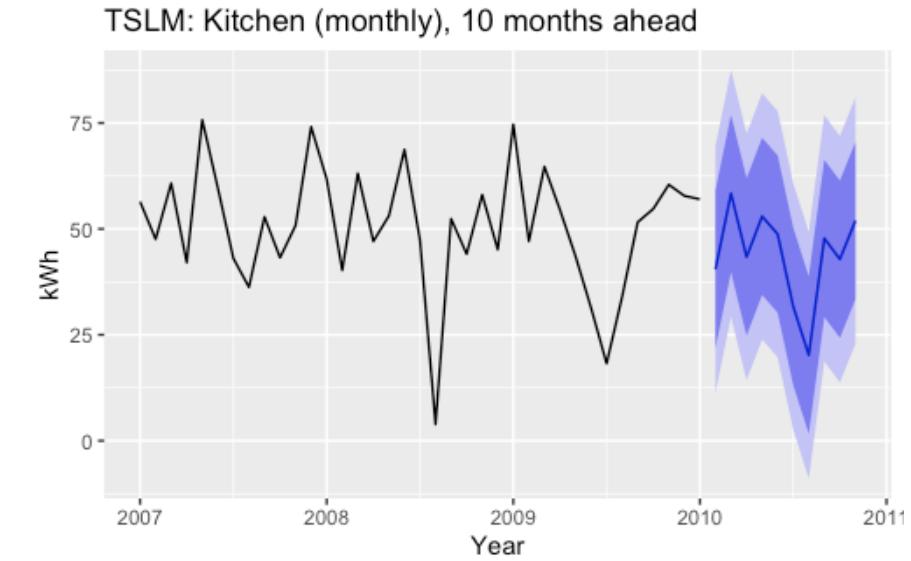
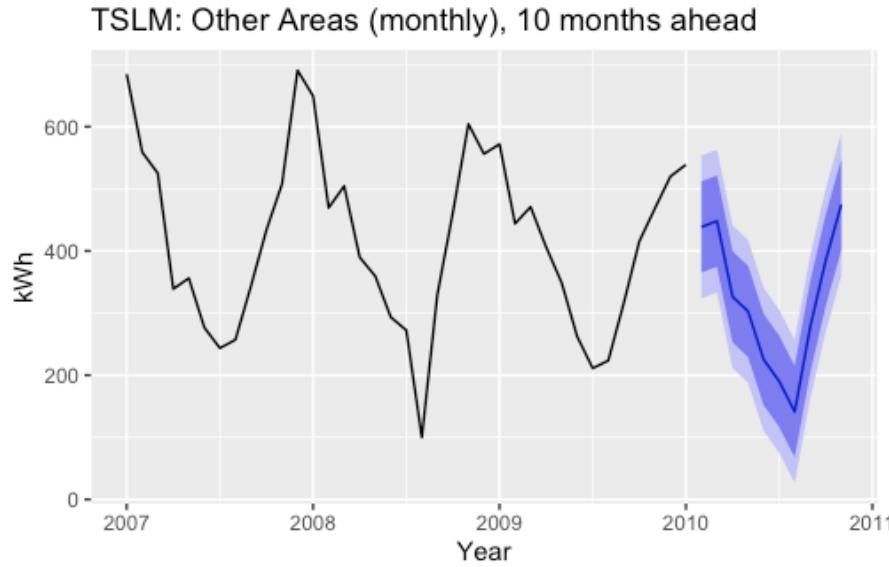
Time Series (Weekly in Winter)



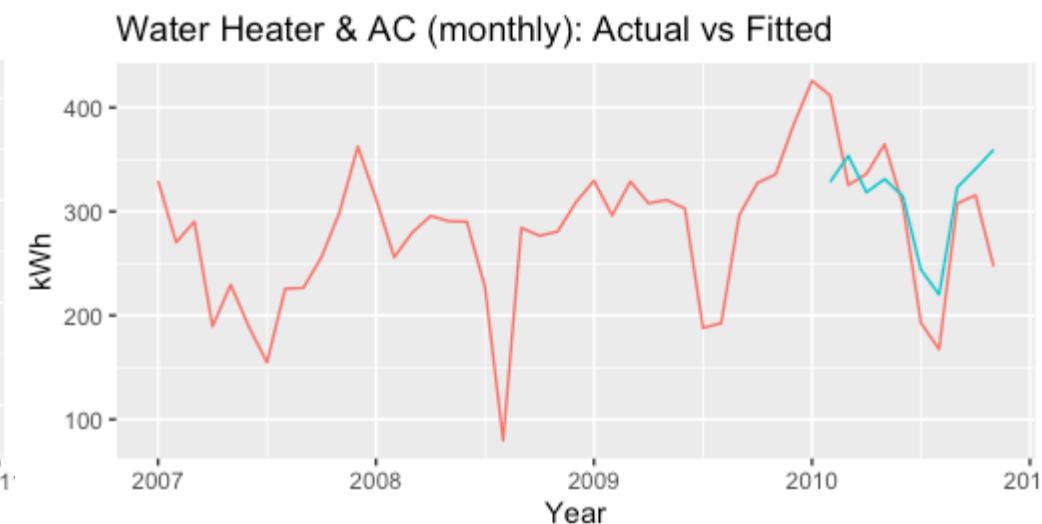
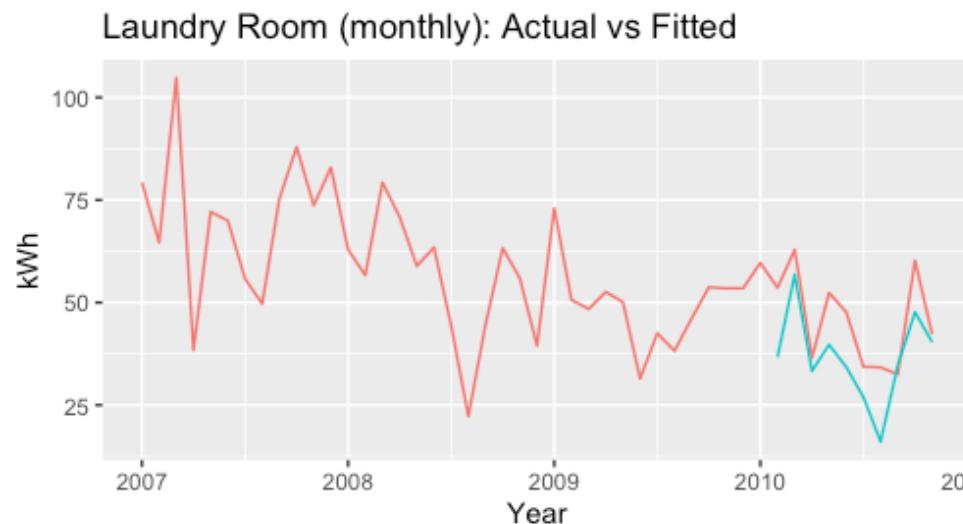
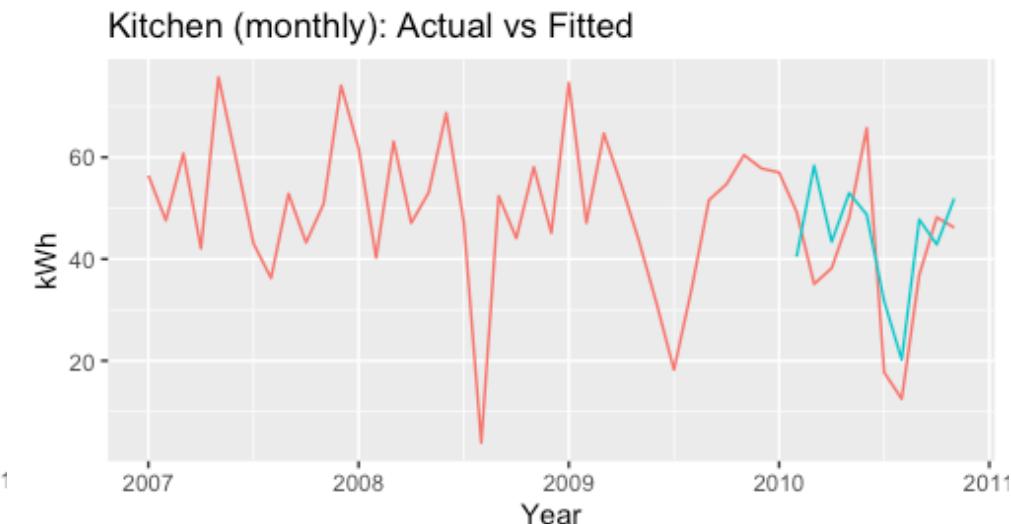
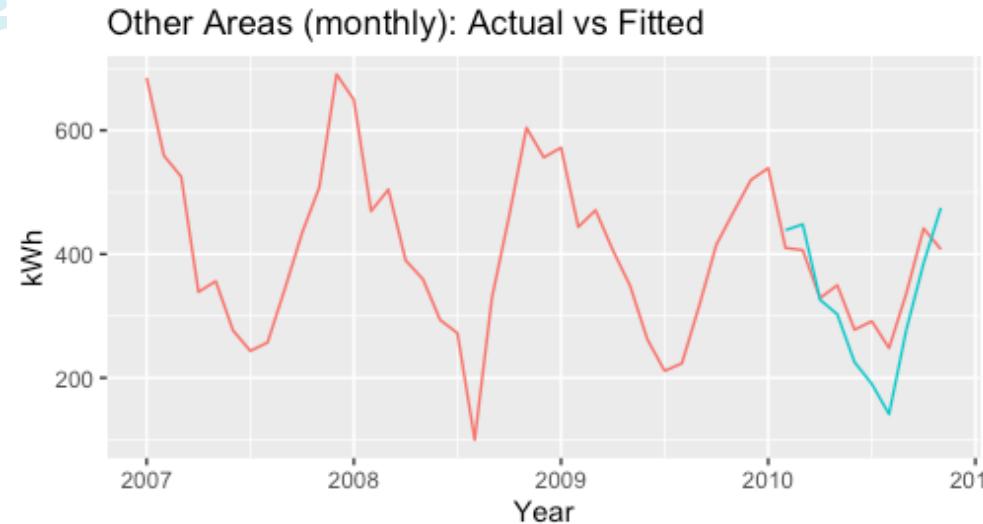
Time Series (Weekly in Summer)



Forecasting (Time Series Linear Model)



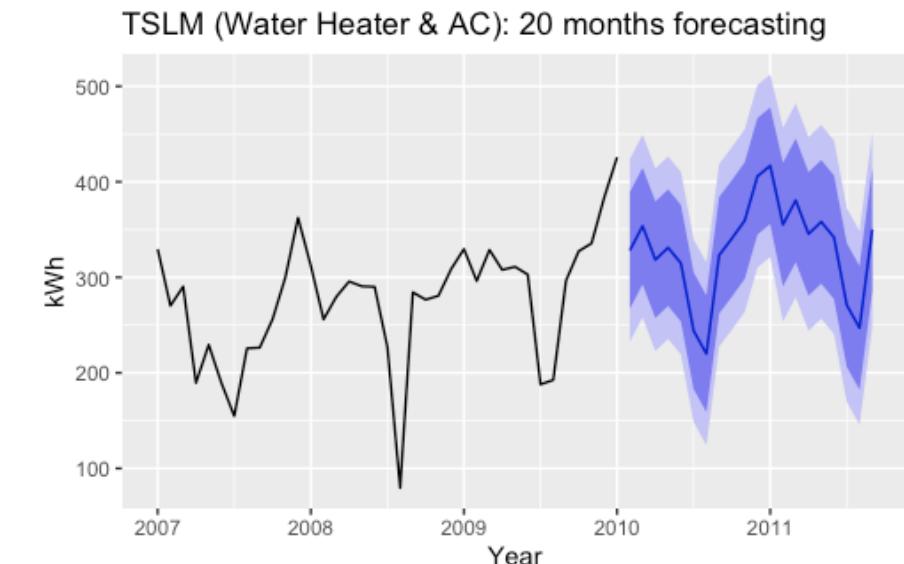
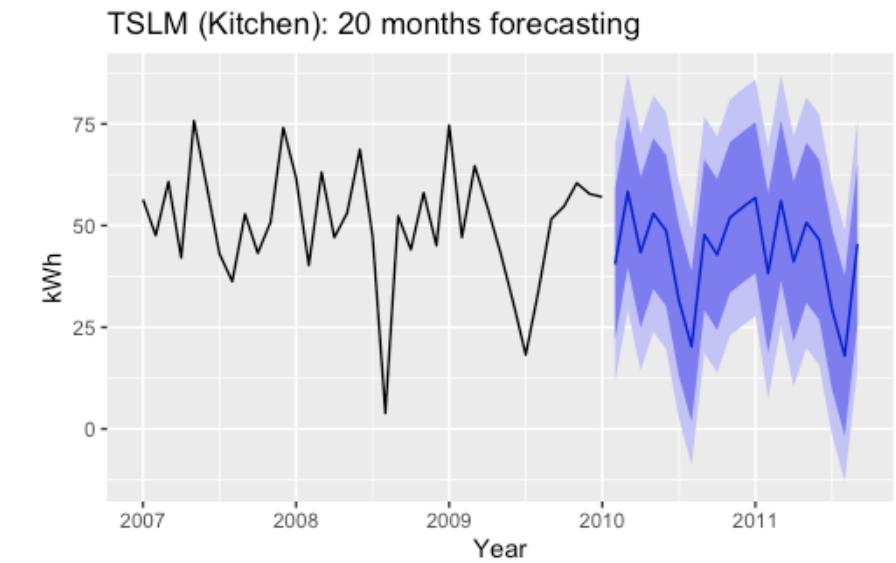
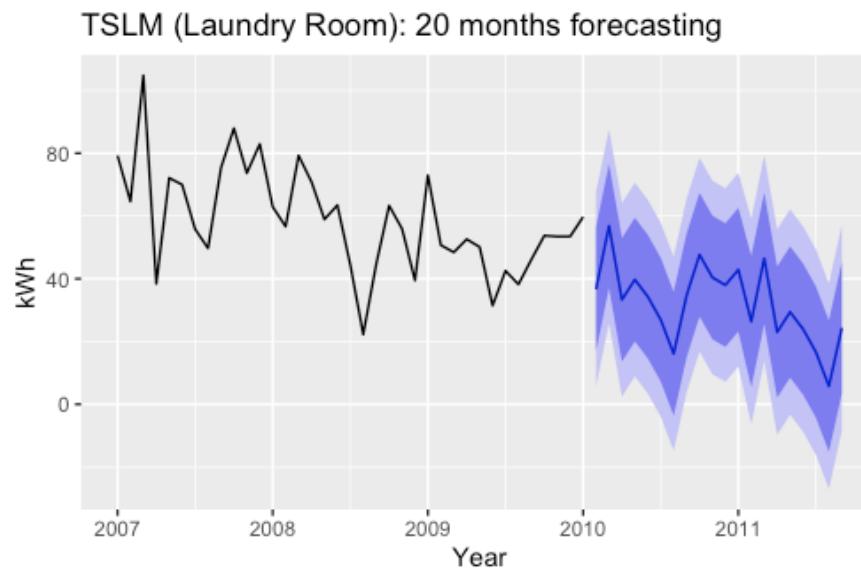
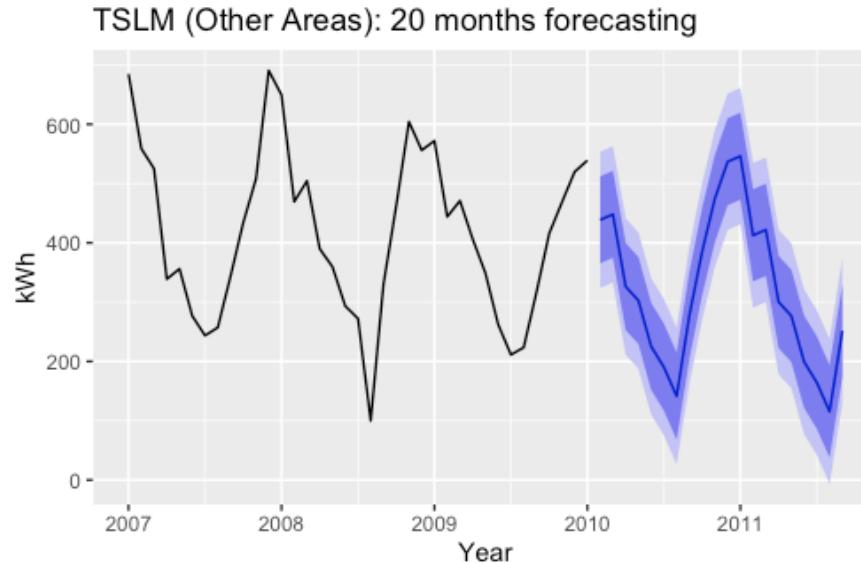
Actual vs Fitted (Time Series Linear Model)



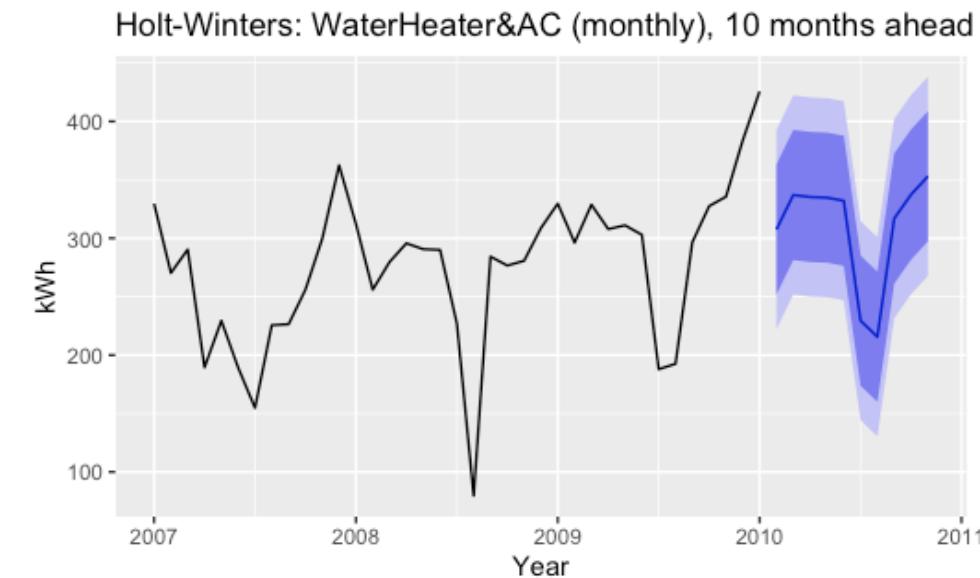
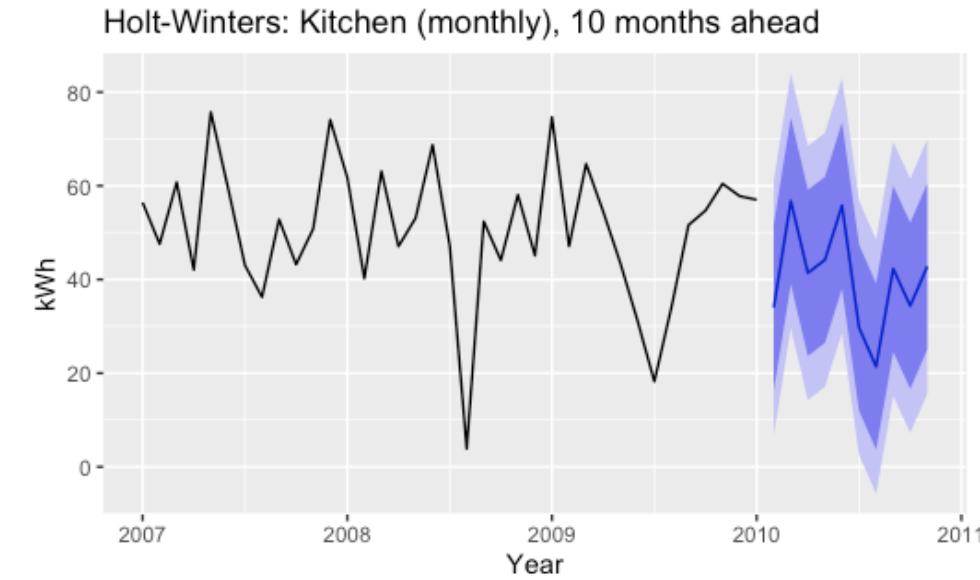
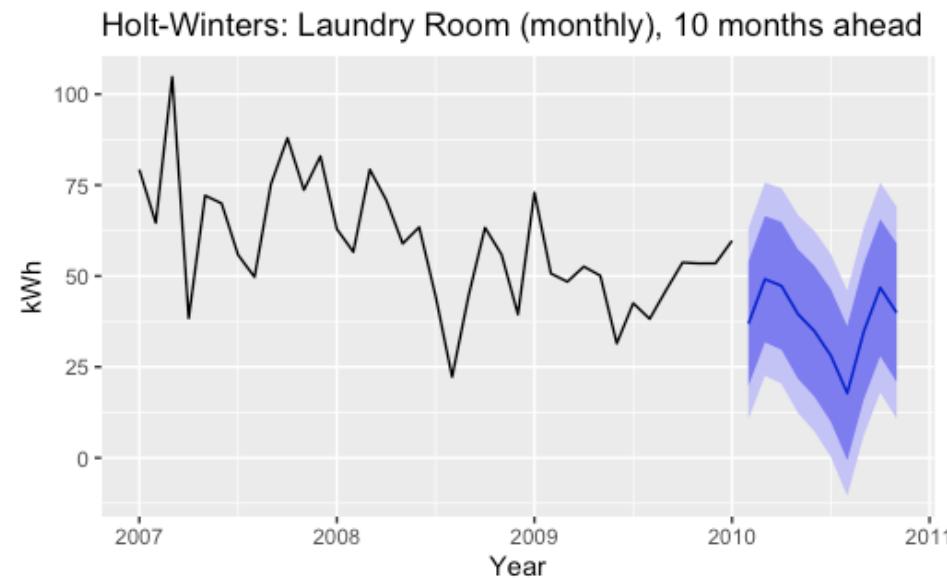
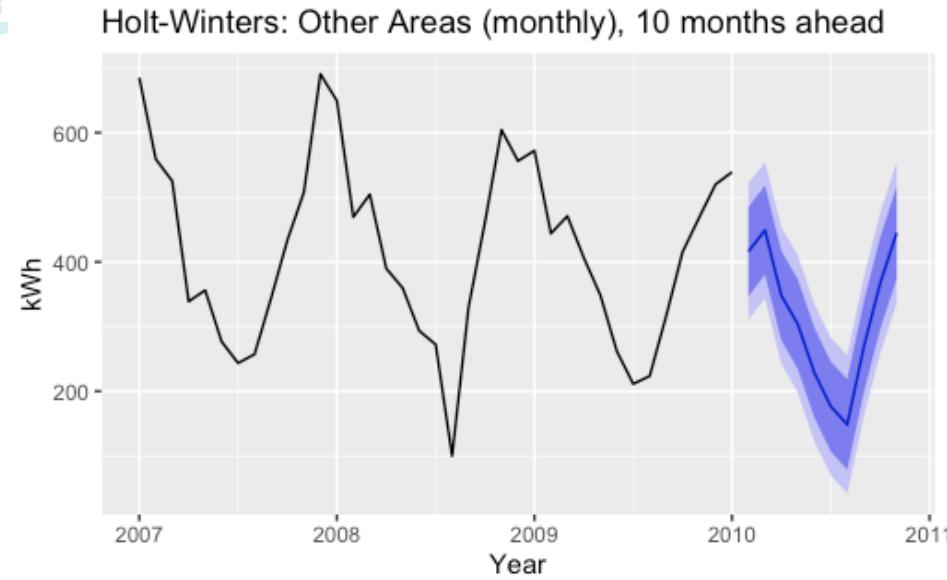
Actual TSLM

Actual TSLM

Future forecasting (Time Series Linear Model)

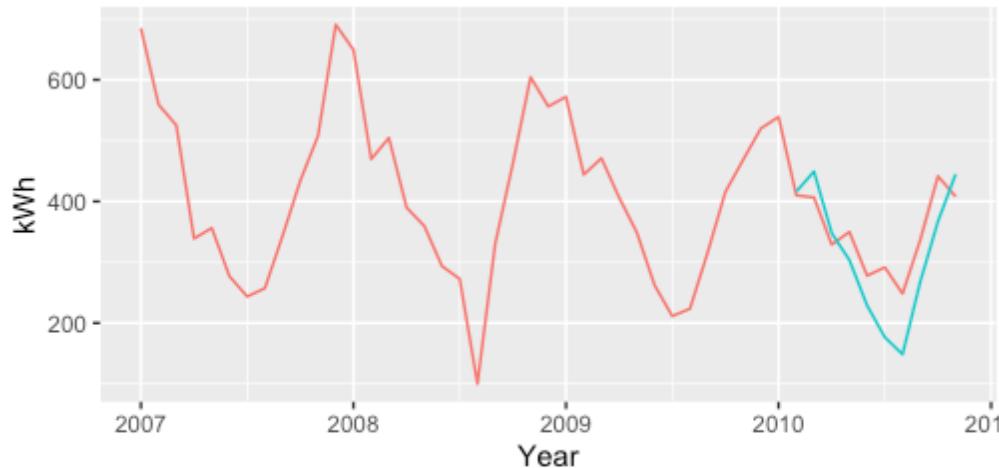


Forecasting (Holt-Winters)

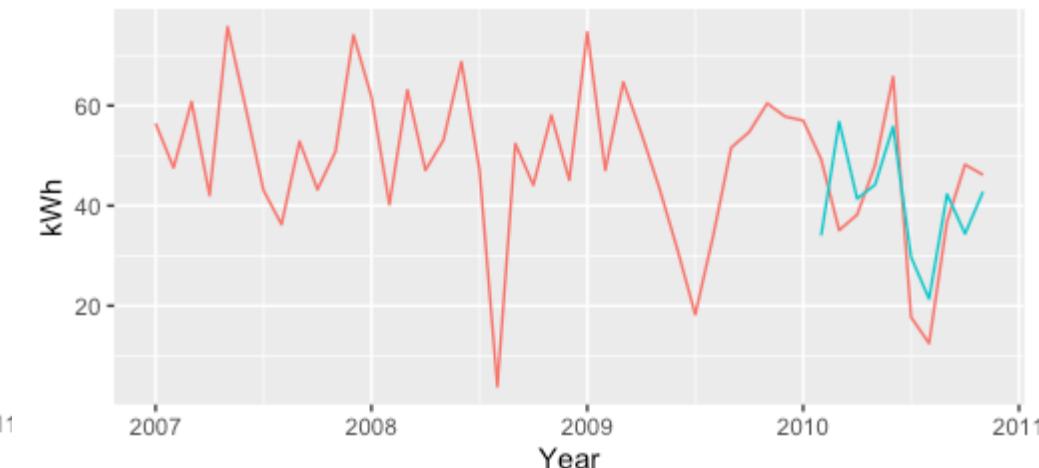


Actual vs Fitted (Holt-Winters)

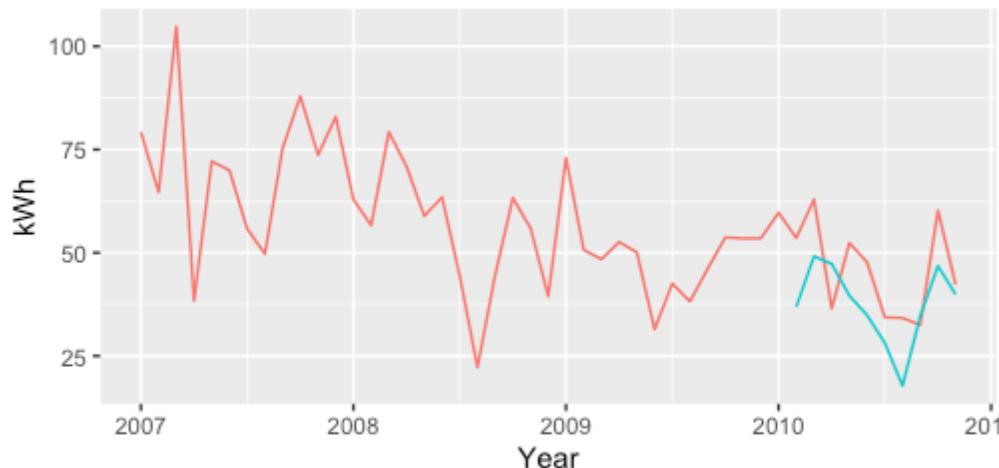
Other Areas (monthly): Actual vs Fitted



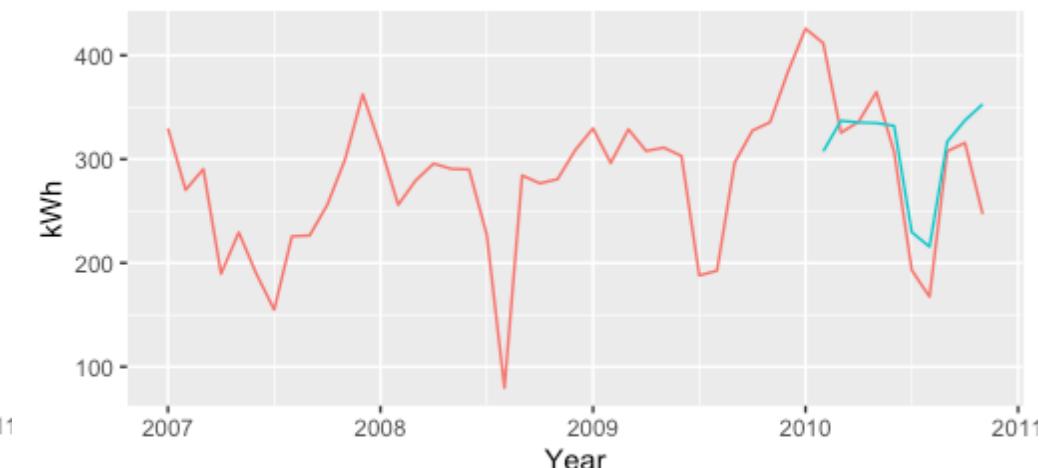
Kitchen (monthly): Actual vs Fitted



Laundry Room (monthly): Actual vs Fitted



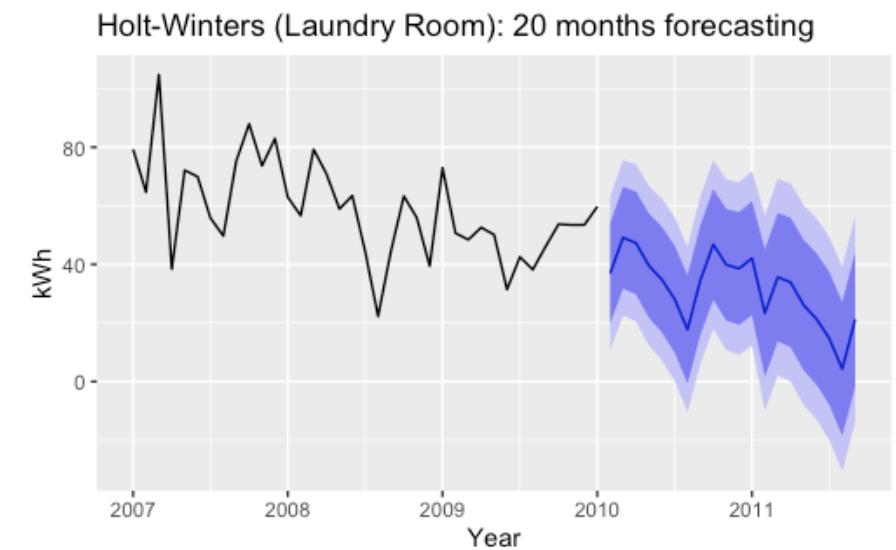
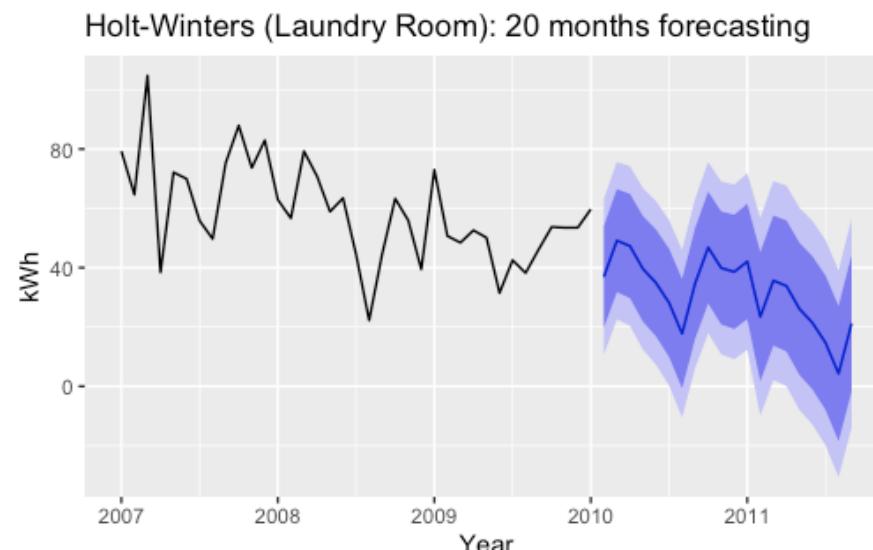
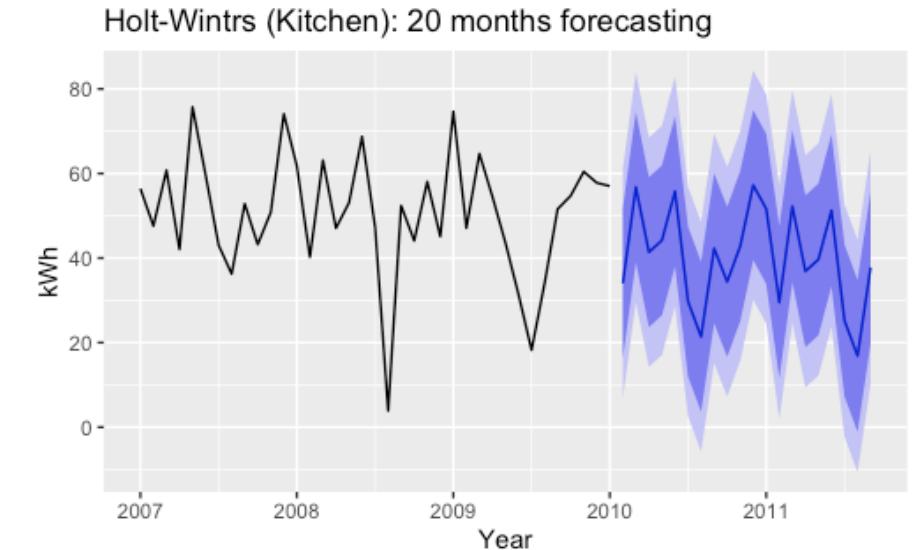
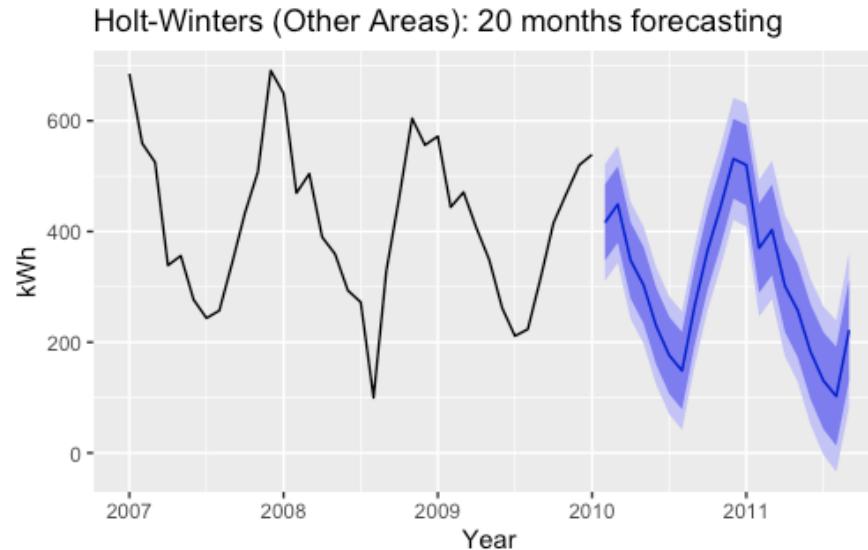
Water Heater & AC (monthly): Actual vs Fitted



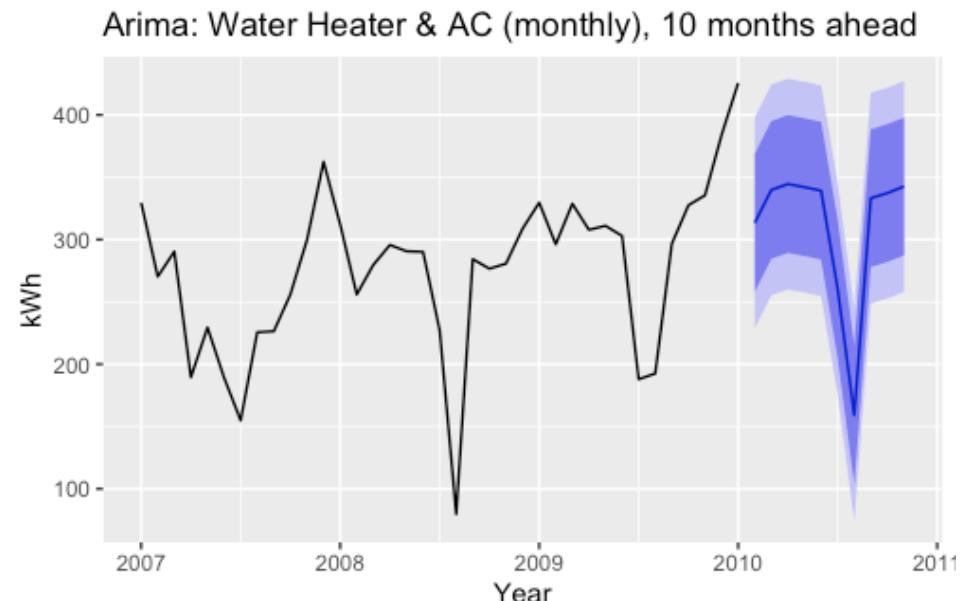
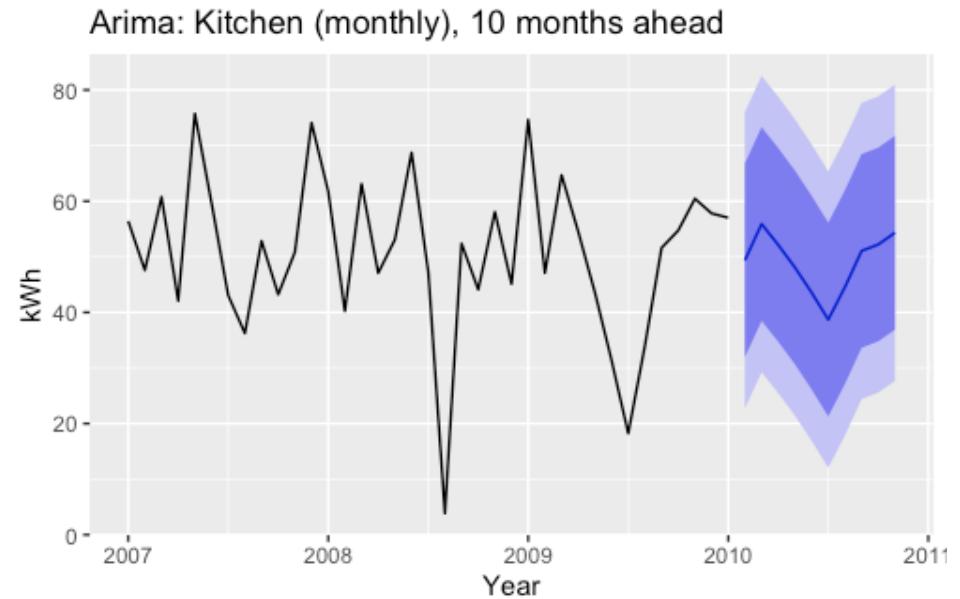
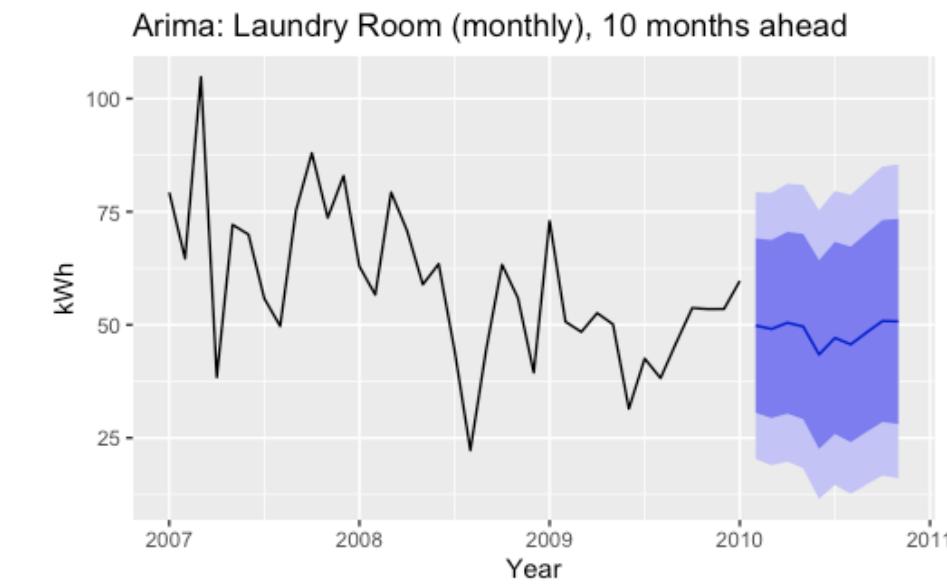
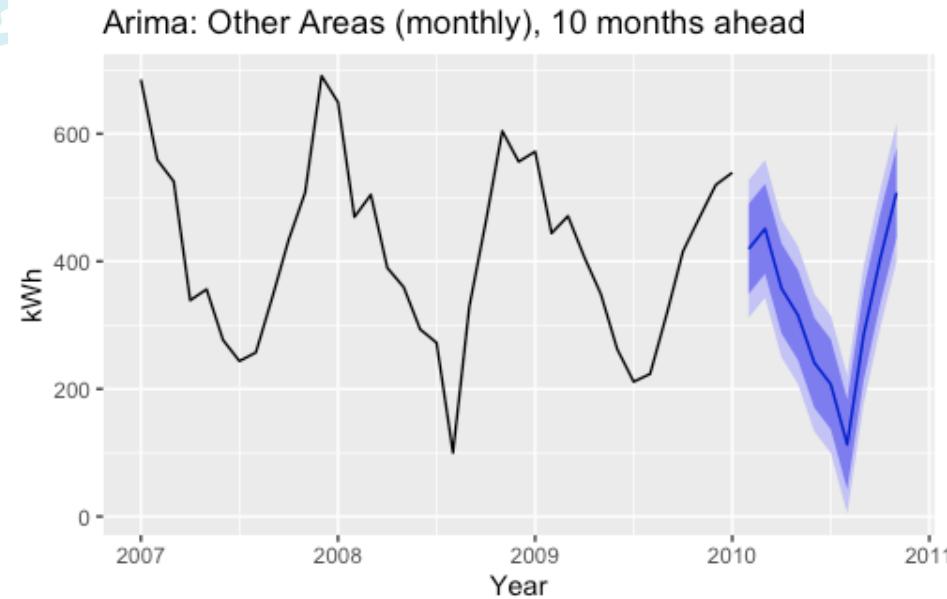
Actual Holt-Winters

Actual Holt-Winters

Future forecasting (Holt-Winters)



Forecasting (Arima)

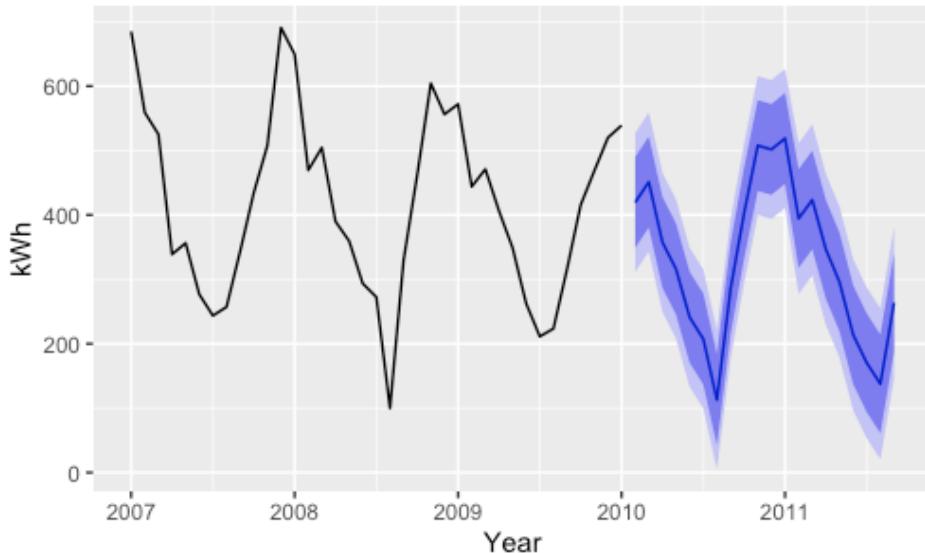


Actual vs Fitted (Arima)

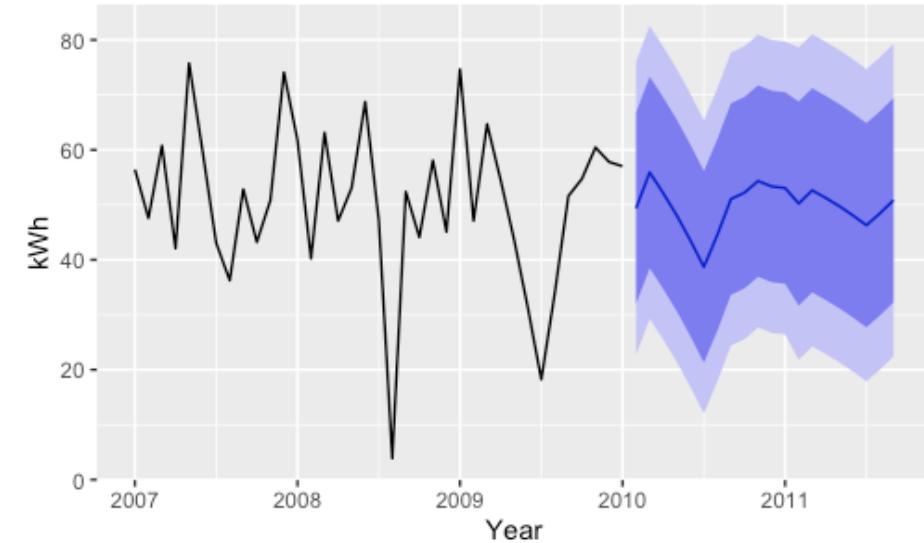


Furure forecasting (Arima)

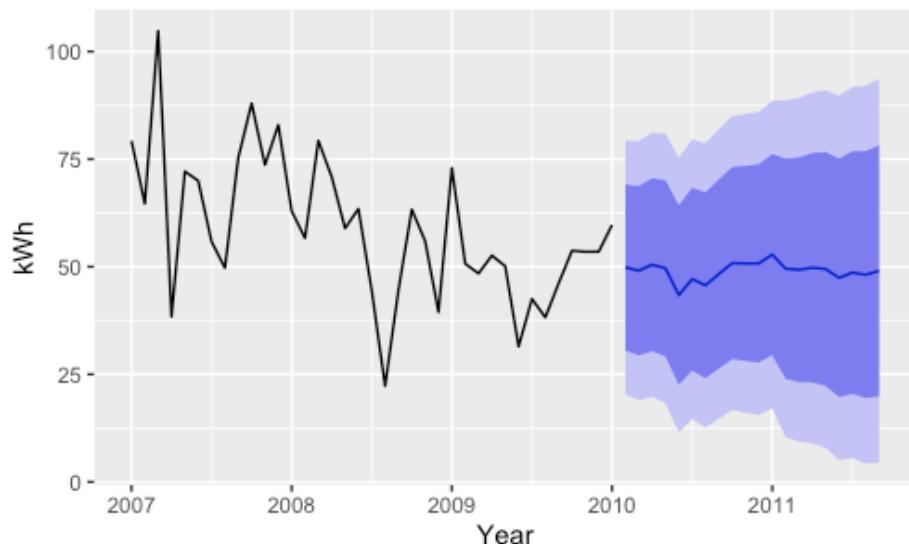
Arima (Other Areas): 20 months forecasting



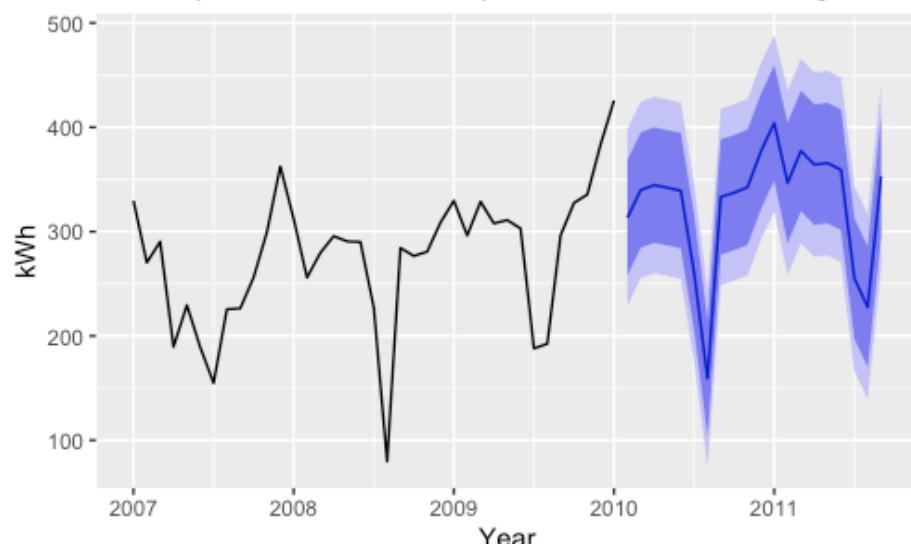
Arima (Kitchen): 20 months forecasting



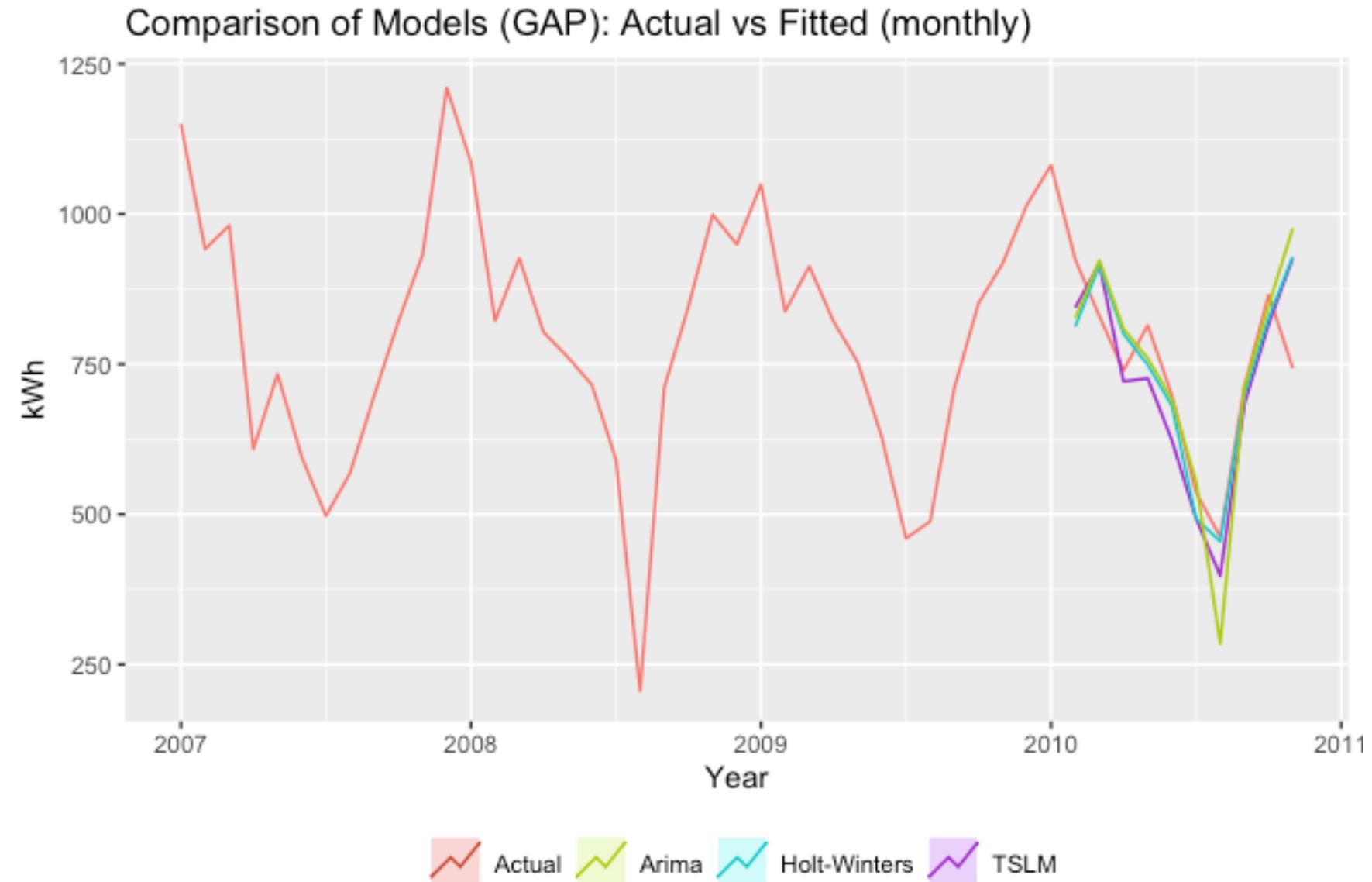
Arima (Laundry Room): 20 months forecasting



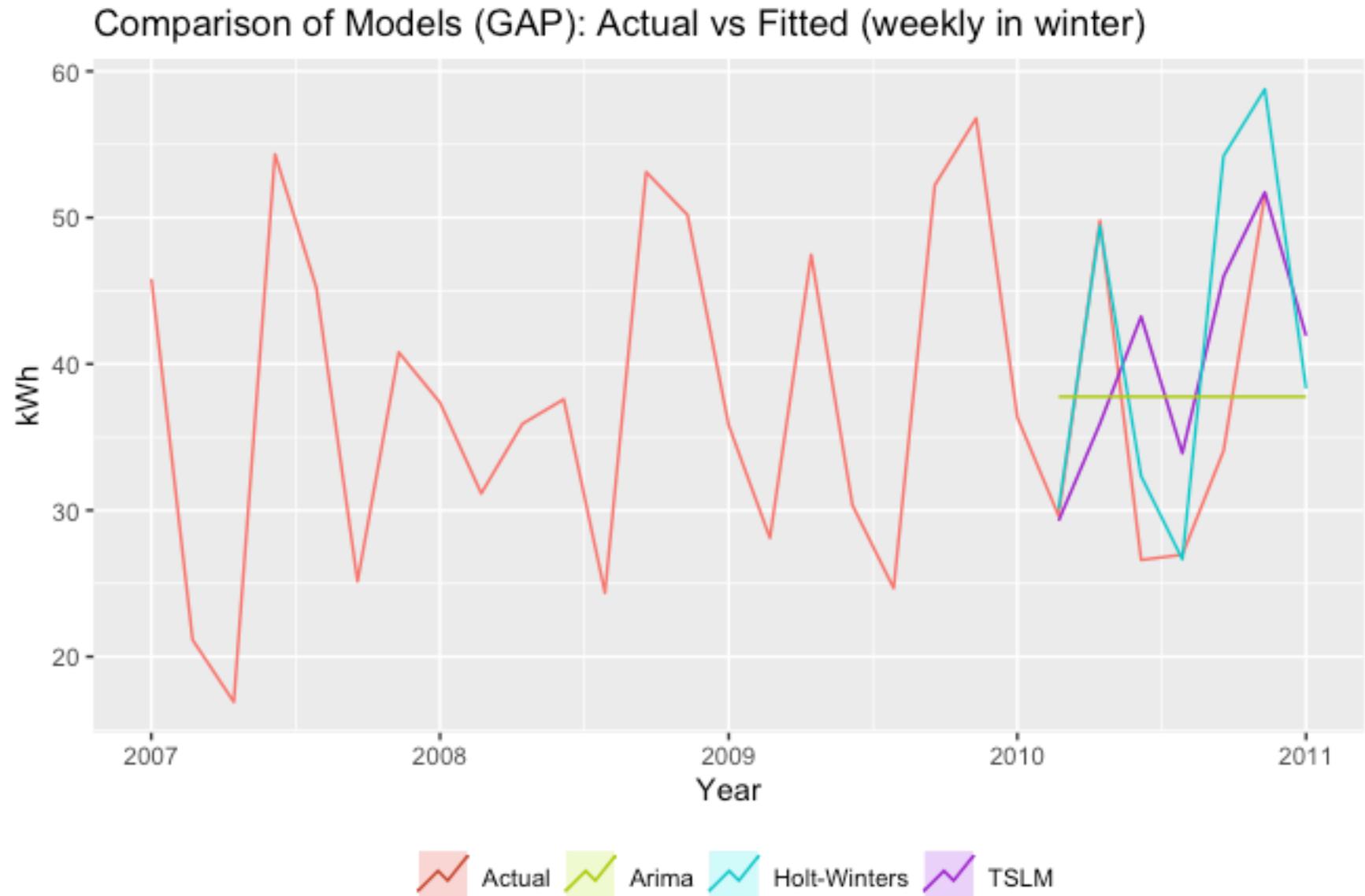
Arima (Water Heater & AC): 20 months forecasting



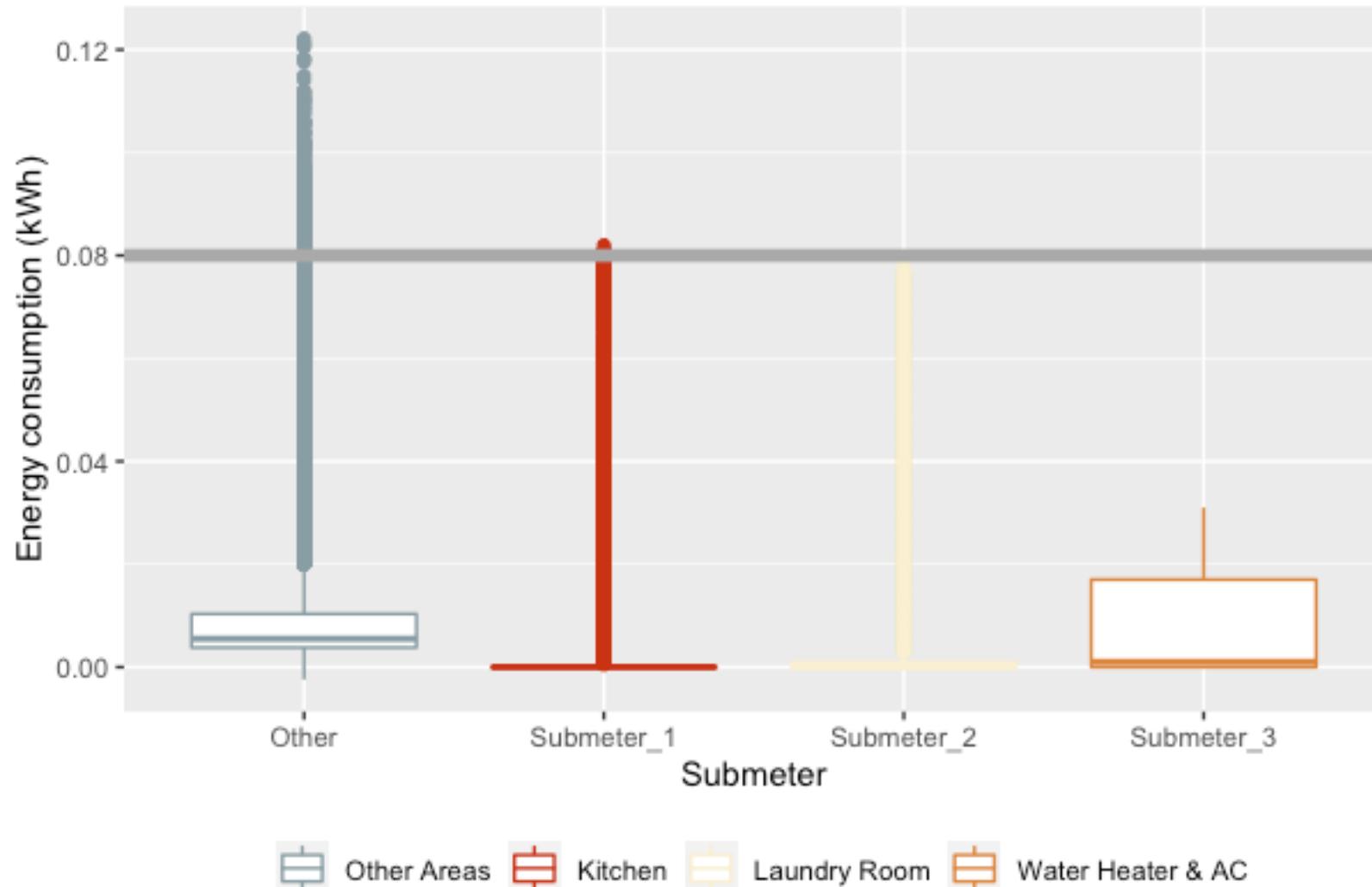
Comparison of Models



Comparison of Models



Alarm System



Summary

- Submetered energy consumption data provided enough granularity to reveal patterns in family behaviour and appliance performance
- Off-peak energy consumption was identified allowing for taking advantage of overall energy savings
- Identified patterns of energy consumption made it possible to forecast future usage

Recommendations

- Kitchen submeter to be complemented with gas consumption for unambiguous data collection
- Reduction in consumption can be determined by monitoring monthly data before and after installation of submeters
- Alarm system to flag potential appliance degradation or unusual energy consumption

Next Steps

- Detailed data subsetting and comparison:
seasons/years (monthly, weekly, hourly)