Energy Analytics

Sandia Pattabiraman - IOT Analytics

Power Consumption / Day for 3 Submeters (9th Jan 2008)

❖ Power usage in Kitchen is spiked up around 4.30 - 5.30 PM CT

❖ Power usage in Water Heater & AC is throughout the day. AC usage is not in the night because it's a Winter day

❖ Laundry usage is minimal but has multiple spikes throughout the day
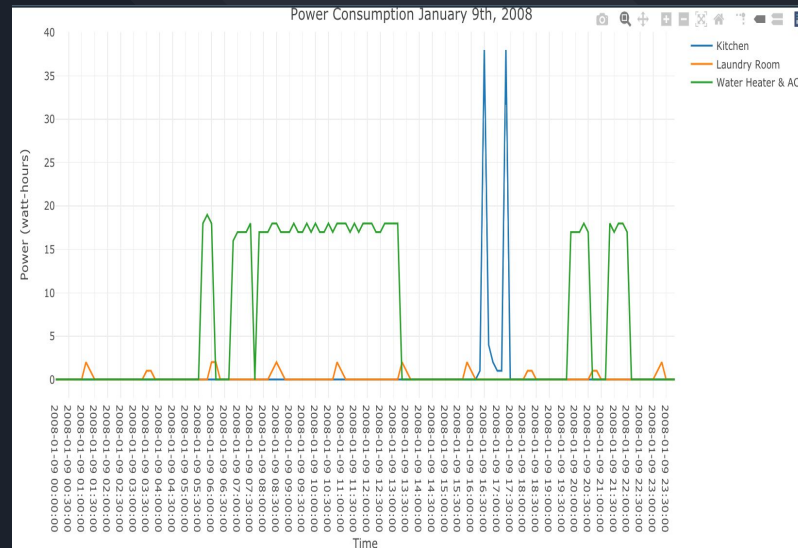
# Power Consumption / Week for 3 Submeters (26th week 2008)

- ❖ Power usage in Kitchen is spiked throughout the day around morning & evening entire week
- ❖ Power usage in Water Heater & AC is throughout the week. Probably because of summer around June
- ❖ Laundry usage is spiked up on certain days in the week (Friday, Saturday & Sunday in this example)

Power Consumption / Week for 3 Submeters (52nd week 2008)


Power Consumption 52nd week, 2009
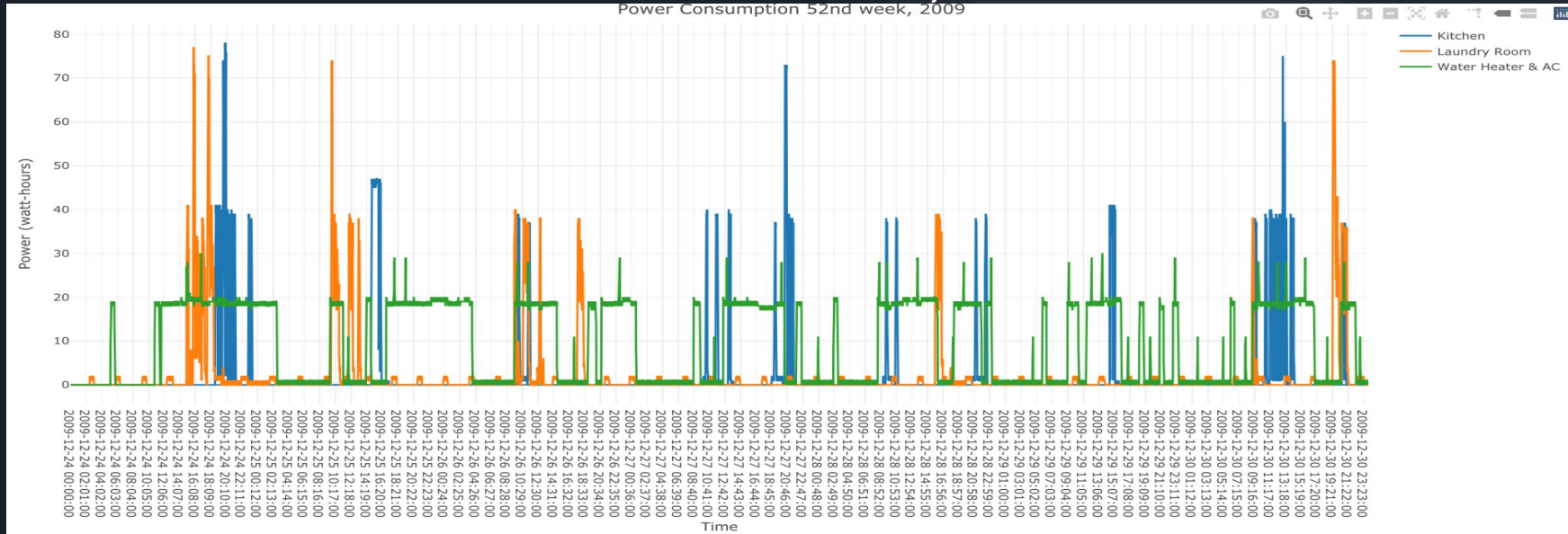
❖ Power usage in Kitchen is spiked maximum around in the evening because Christmas week. 30th December has maximum power consumption around lunch

❖ Power usage in Water Heater & AC is throughout the week in day. Probably because of Winter less usage in the night.

❖ Laundry usage is spiked up on certain days in the week (Max on 24th prior to Christmas day)

Power Consumption on Weekly basis for 3 years

Power Consumption with weekly frequency 52
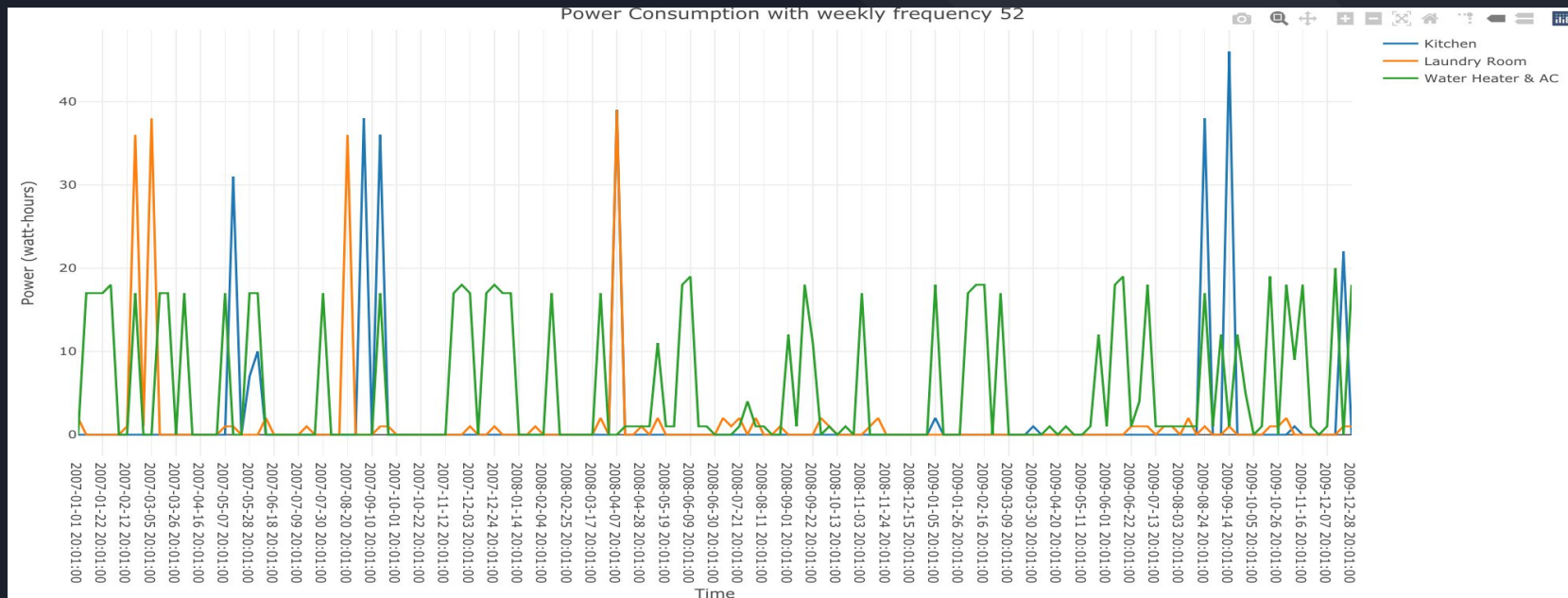
- ❖ There were Power spikes during May-June, Sept-Oct 2007 & Aug-Sept 2009 for Kitchen
- ❖ Power usage in Water Heater & AC is minimum in June - Aug in all the 3 years. Heater usage would be less during the Summer
- ❖ Laundry usage had spiked in Feb-Mar 2007, Aug-Sept 2007 & Mar-Apr 2008 and had low usage in the rest of the years

Power Consumption on daily basis for 3 years

Power Consumption with daily frequency 365
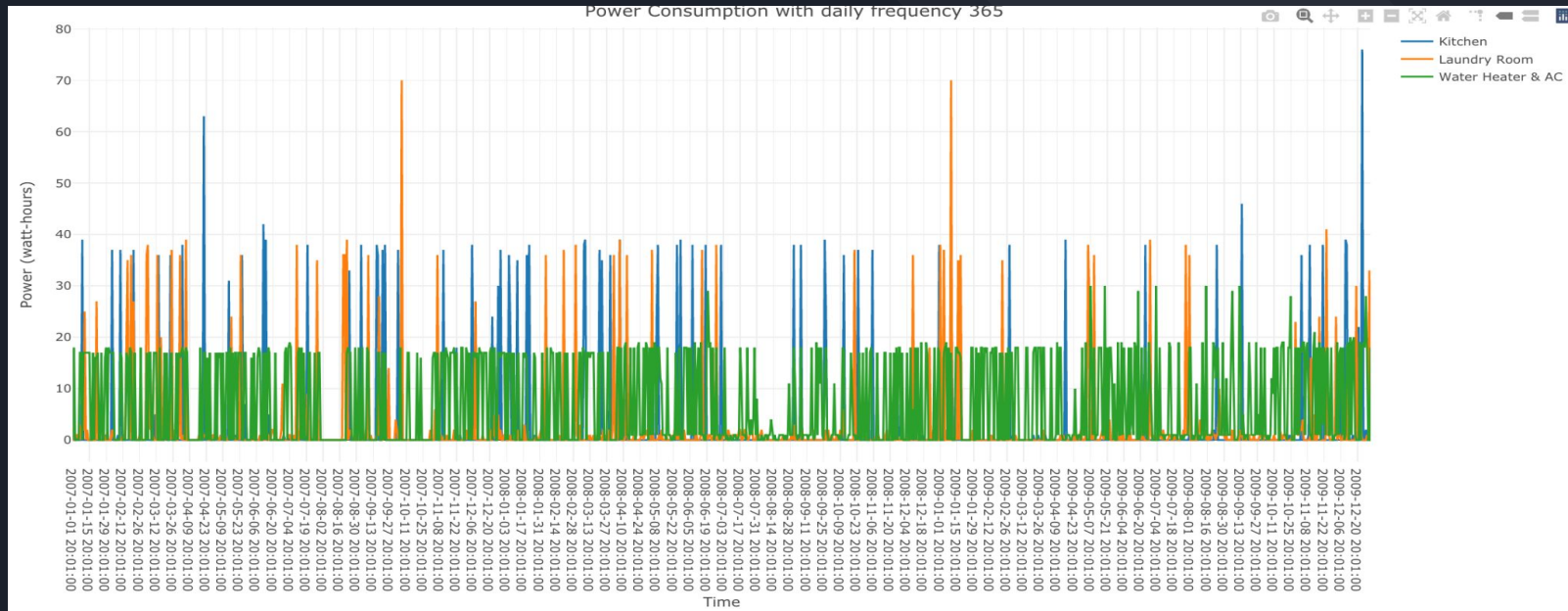
❖ From this we can infer that most dense usage is for Water Heater & AC followed by moderately denser for Kitchen & less dense for Laundry
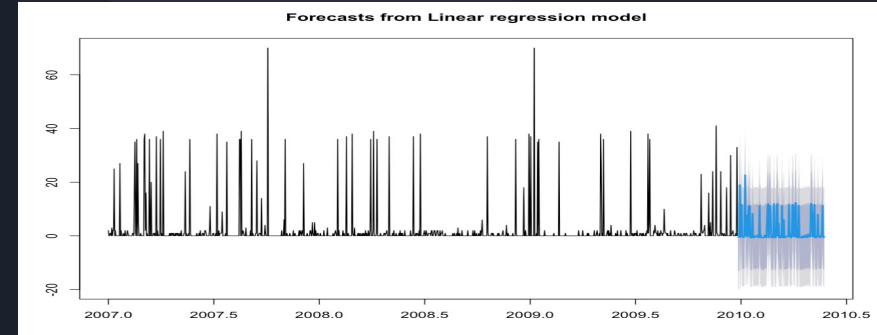
Power Consumption on hourly basis for 3 years
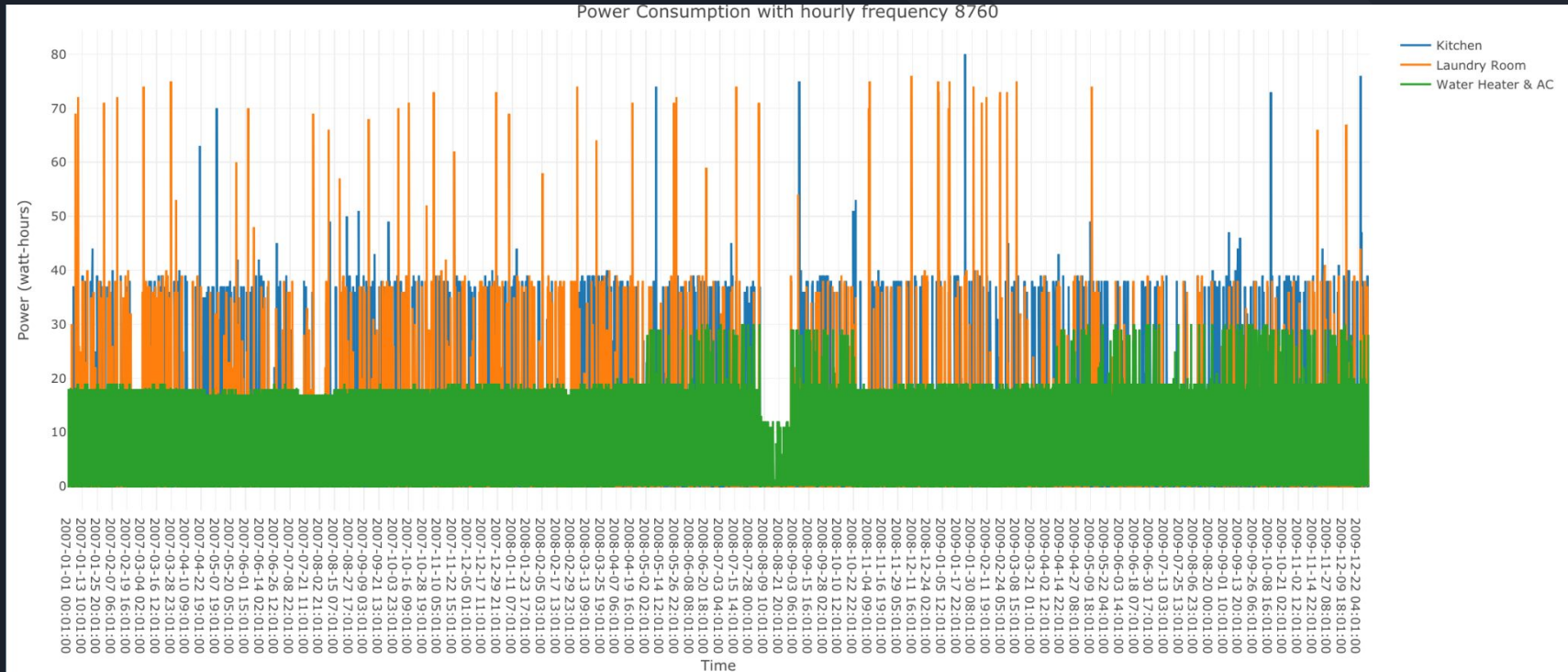
❖ We can conclude similar observations as we did for the daily basis

Forecasts from Daily frequency

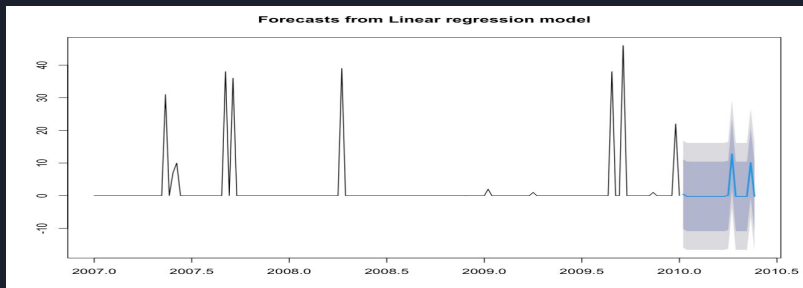Forecasts from Linear regression model

Forecasts from Linear regression model
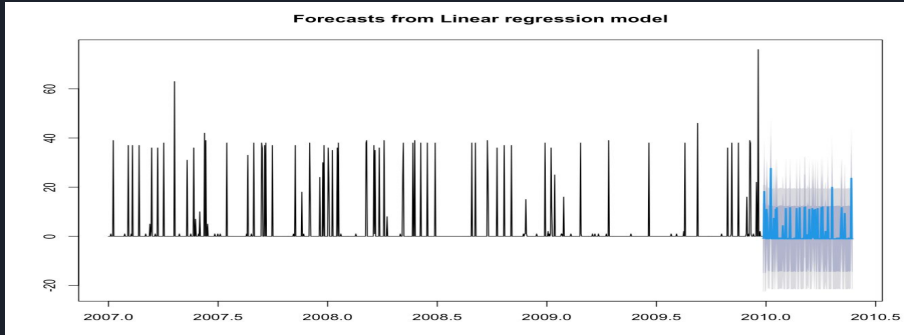
❖ We can say that the average forecasts here is 18 Watt-Hours from the chart for Kitchen for 2010

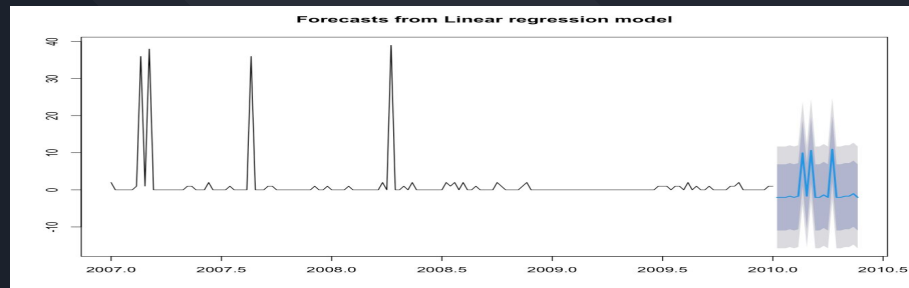❖ We can say that the average forecasts here is 10 Watt-Hours from the chart for Laundry for 2010
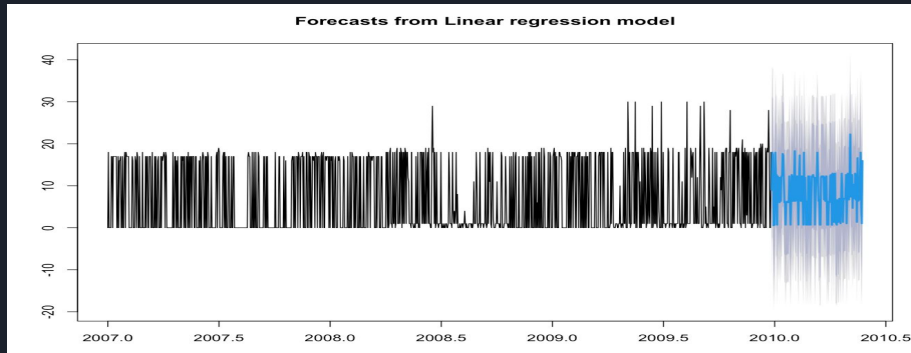
Forecasts from Linear regression model

❖ We can say that the average forecasts here is 20 Watt-Hours from the chart for Water Heater & AC for 2010

Forecasts from Weekly frequency

Forecasts from Linear regression model

- ❖ We can say that the average forecasts here is 2 Watt-Hours from the chart for Kitchen for 2010

Forecasts from Linear regression model

- ❖ We can say that the average forecasts here is 5 Watt-Hours from the chart for Laundry for 2010

Forecasts from Linear regression model

- ❖ We can say that the average forecasts here is 20 Watt-Hours from the chart for Water Heater & AC for 2010

Forecasts from Daily frequency with high CI - 95% (Non negative predictions)

❖ We can say that the average forecasts here is 2 Watt-Hours from the chart for Kitchen for 2010

❖ We can say that the average forecasts here is 5 Watt-Hours from the chart for Laundry for 2010

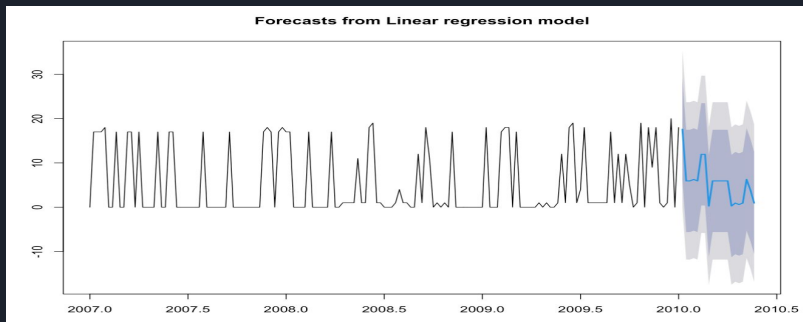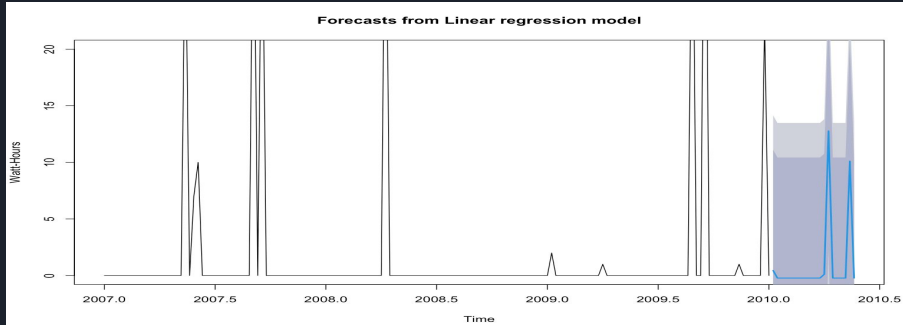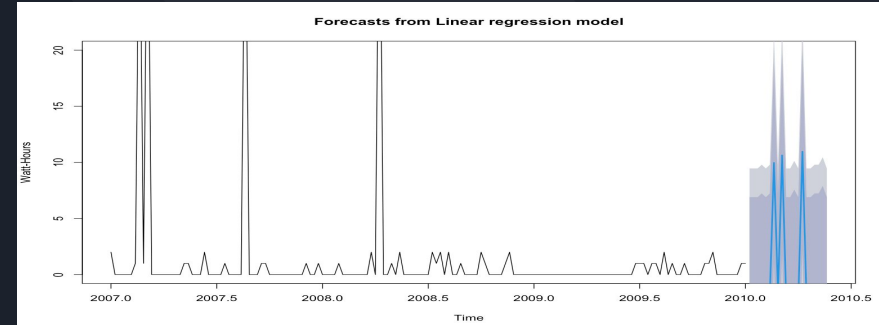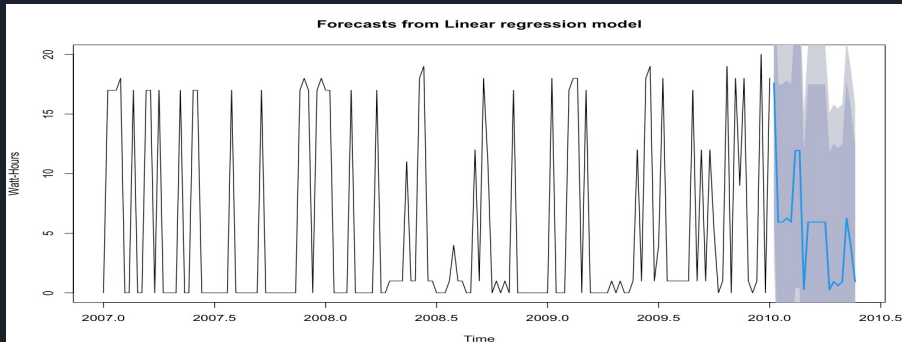❖ We can say that the average forecasts here is 5 Watt-Hours from the chart for Water Heater & AC for 2010

Comparing R-squared & RMSE for the 3 Models

Daily

- ❖ Kitchen - R2 0.3365 & RMSE 9.021 on 724 degrees of freedom
- ❖ Laundry - R2 0.3029 and RMSE 8.086 on 724 degrees of freedom
- ❖ Water Heater & AC - R2 0.3495 and RMSE 8.423 on 724 degrees of freedom

Weekly

- ❖ Kitchen - R2 0.422 & RMSE 7.054 on 104 degrees of freedom
- ❖ Laundry - R2 0.3245 and RMSE 5.911 on 104 degrees of freedom
- ❖ Water Heater & AC - R2 0.3243 and RMSE 7.648 on 104 degrees of freedom
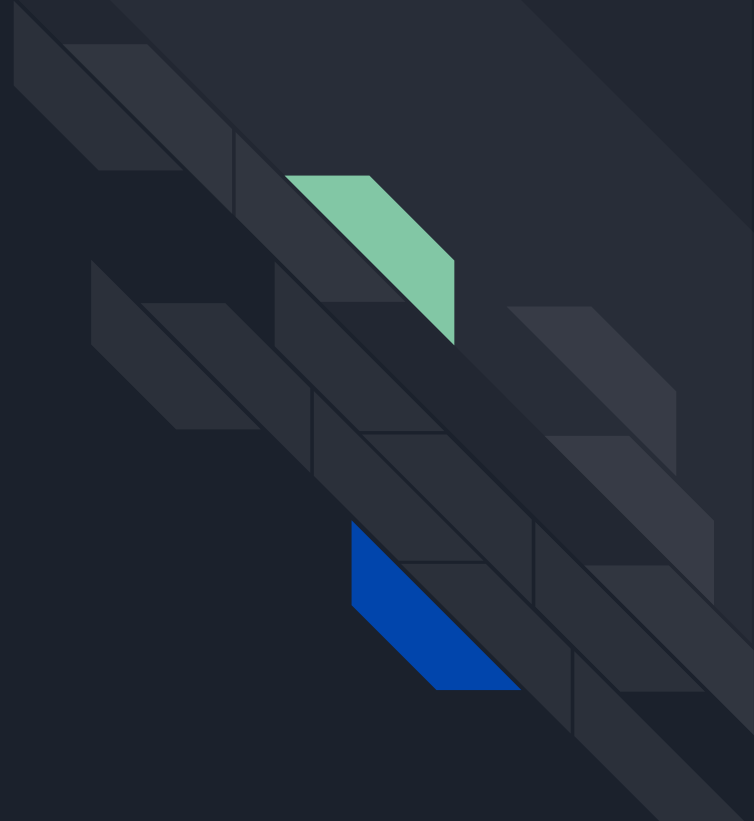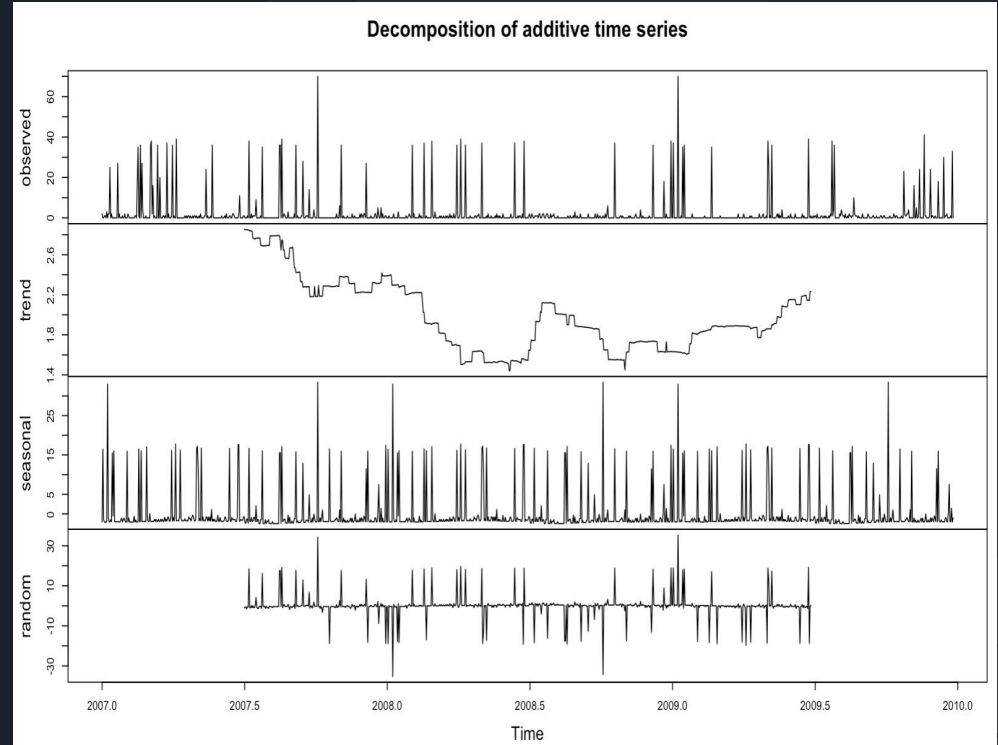
Decomposed from Daily frequency - Kitchen

❖ If you see the trend the power usage decreased from 2007-08 & then again started increased little by 2009

❖ Kitchen usage is widespread throughout the year


Decomposition of additive time series
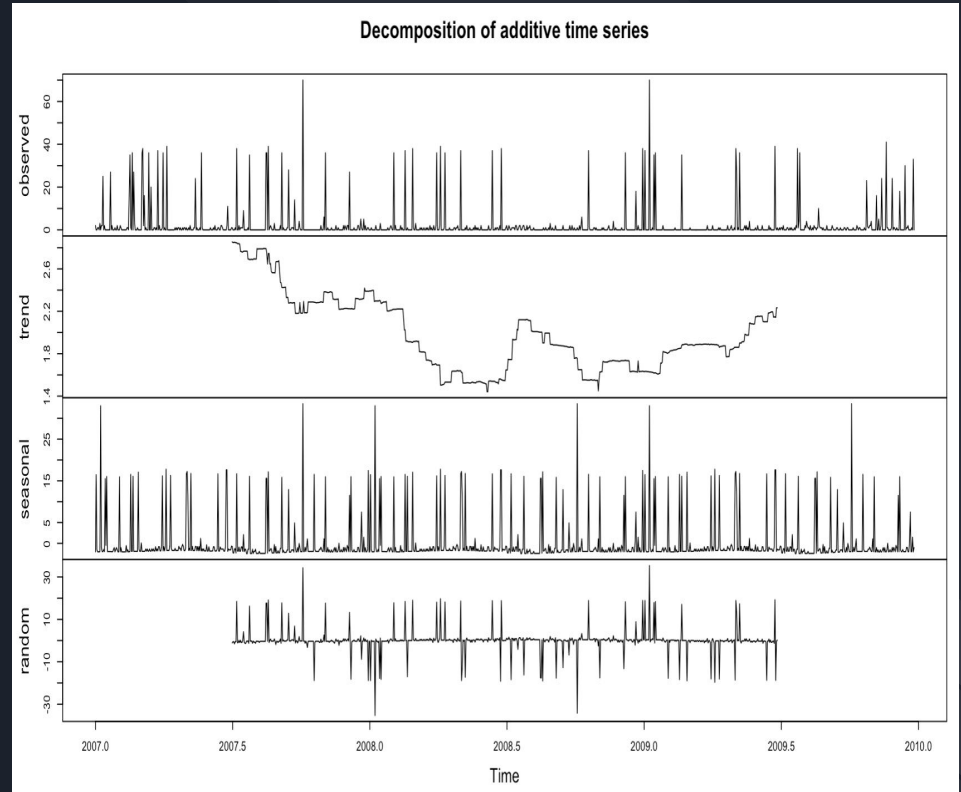
Decomposed from Daily frequency - Laundry

❖ If you see the trend the power usage decreased from 2007-08 & then again started increased little by 2009

❖ Laundry usage is widespread throughout the year

Decomposed from Daily frequency - Water Heater & AC

- ❖ If you see the trend the power usage increased from 2007-08 & then again started increased much further by 2009

- ❖ Water heater /AC usage is much denser throughout the year
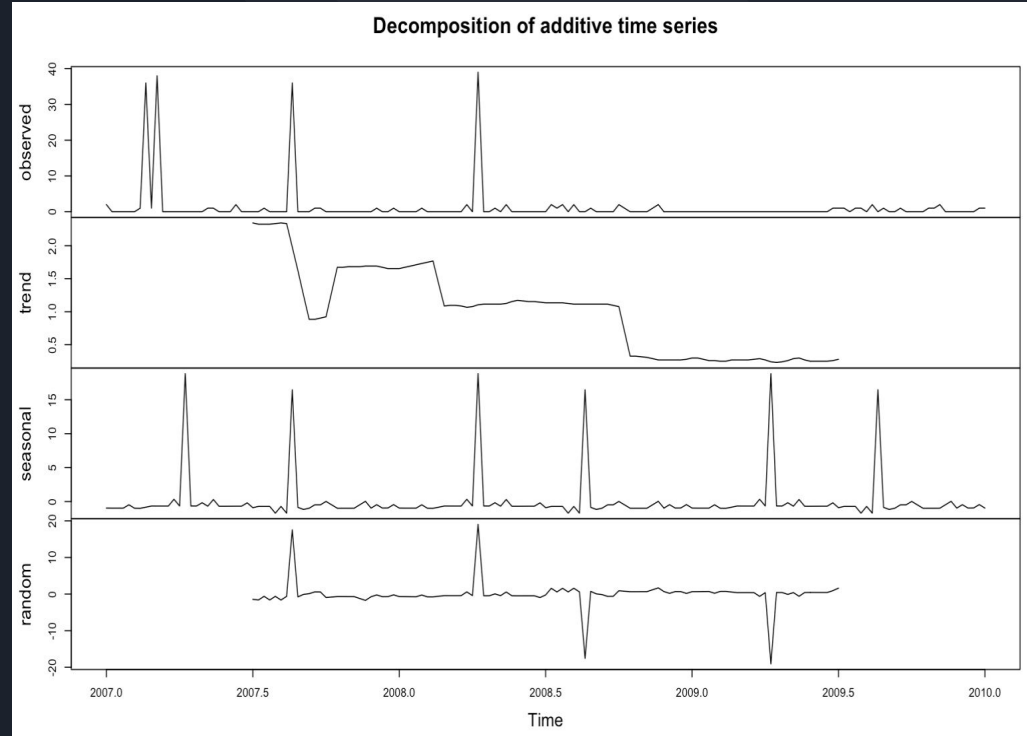

Decomposition of additive time series
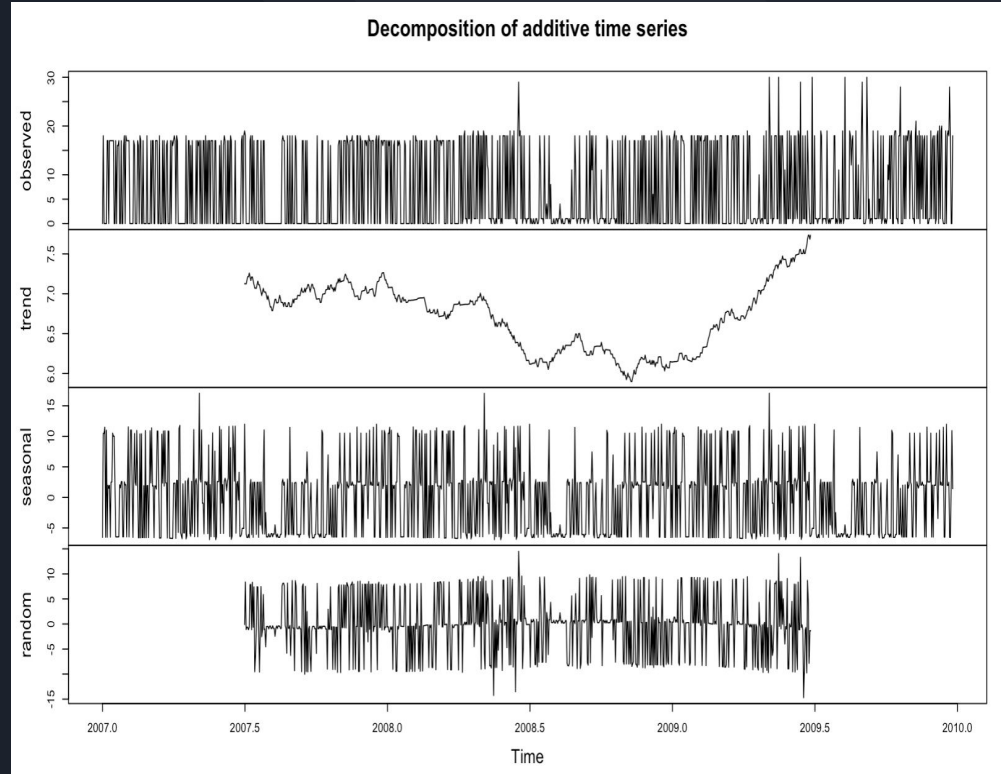
Decomposed from Weekly frequency - Kitchen
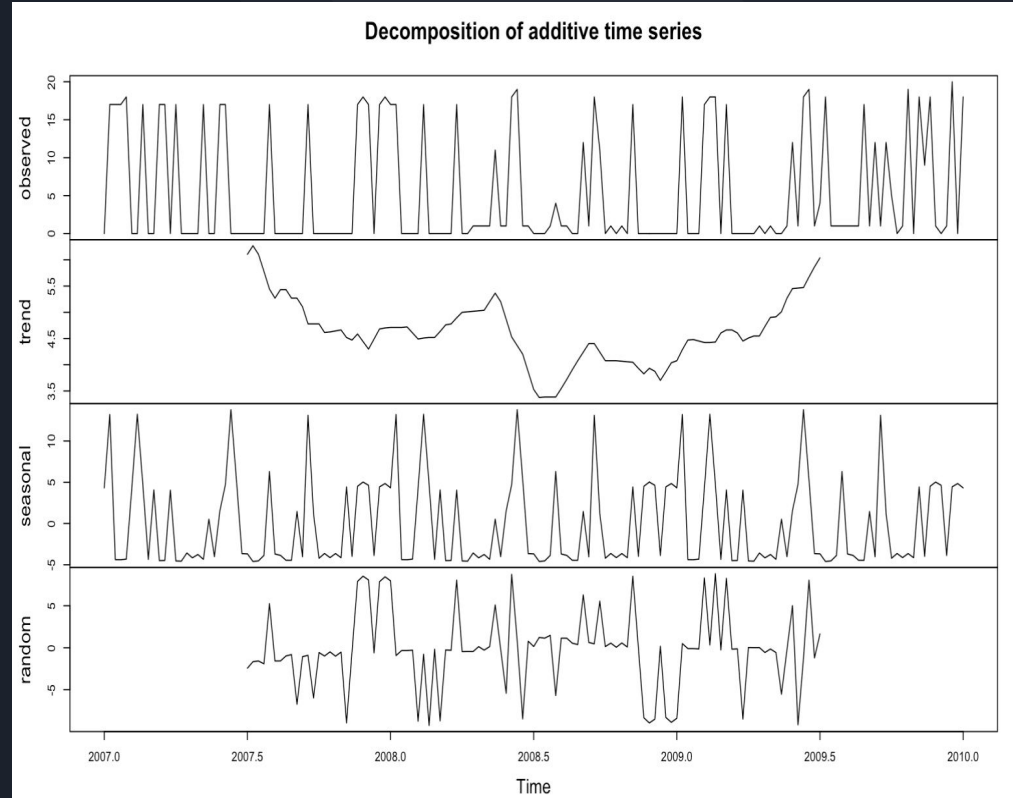
❖ We could see similar trends as we saw for Daily frequency
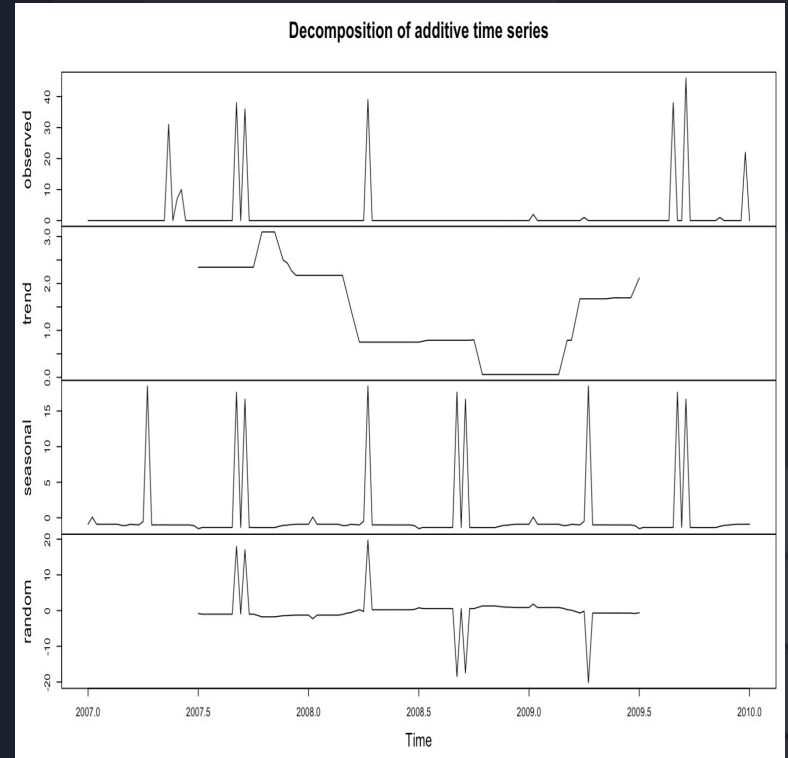
Decomposed from Daily frequency - Laundry

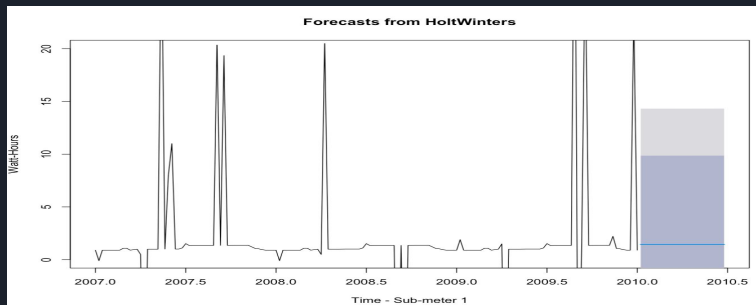❖ We could see similar trends as we saw for Daily frequency

Decomposition of additive time series

Decomposed from Weekly frequency - Water Heater & AC

❖ We could see similar trends as we saw for Daily frequency

Decomposition of additive time series

Holt Winters Forecasts from Daily frequency

Forecasts from HoltWinters (Sub-meter 1)

Forecasts from HoltWinters (Sub-meter 2)

❖ We can say that the average forecasts here is 2 Watt-Hours from the chart for Kitchen for 2010

❖ We can say that the average forecasts here is 2.5 Watt-Hours from the chart for Laundry for 2010

Forecasts from HoltWinters (Sub-meter 3)

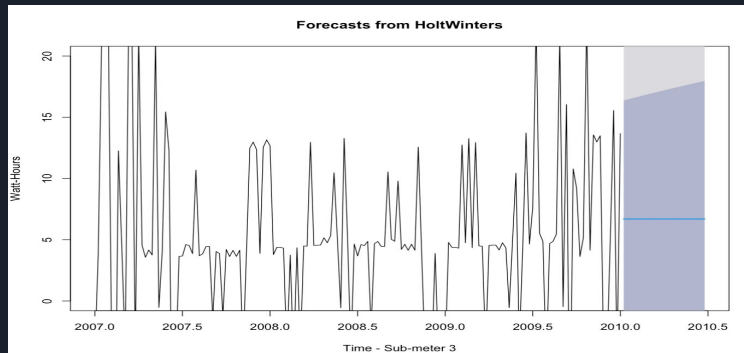❖ We can say that the average forecasts here is 8 Watt-Hours from the chart for Water Heater & AC for 2010

Holt Winters Forecasts from Weekly frequency

❖ We can say that the average forecasts here is 3 Watt-Hours from the chart for Kitchen for 2010

❖ We can say that the average forecasts here is 2.5 Watt-Hours from the chart for Laundry for 2010

❖ We can say that the average forecasts here is 8.4 Watt-Hours from the chart for Water Heater & AC for 2010

Holt Winters Forecasts from Weekly frequency - CI 30%

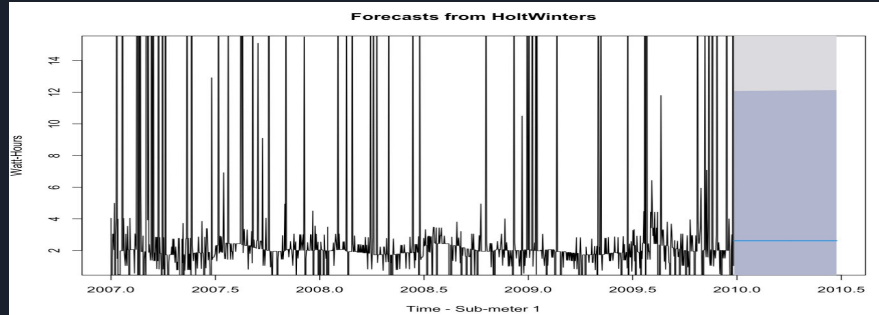❖ We can say that the average forecasts here is 2 Watt-Hours from the chart for Kitchen for 2010

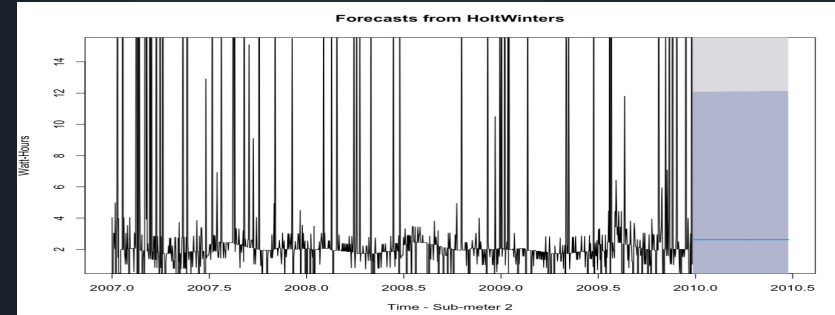❖ We can say that the average forecasts here is 2.5 Watt-Hours from the chart for Laundry for 2010

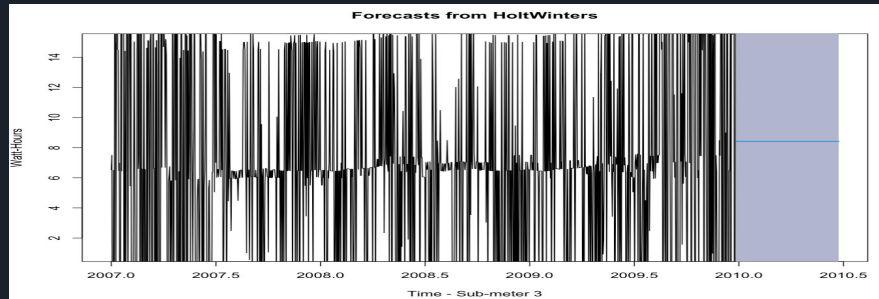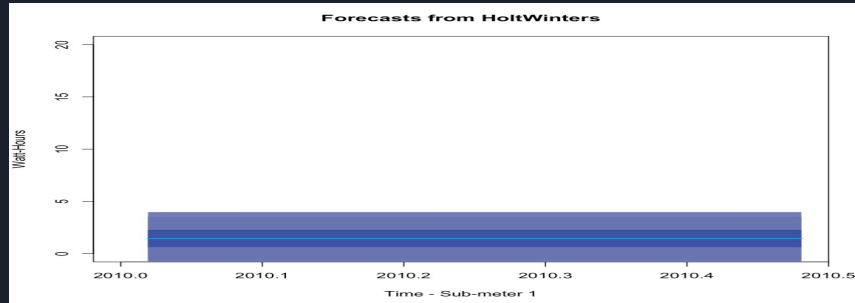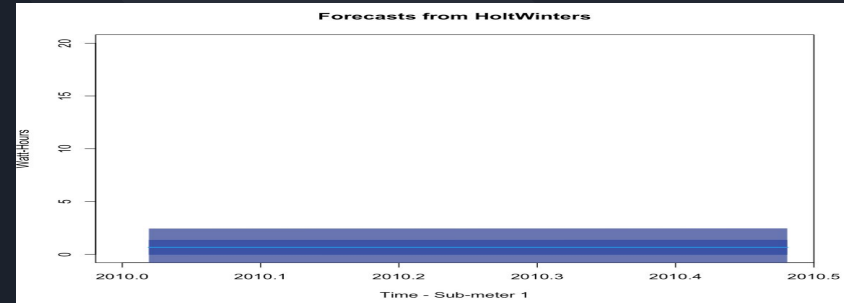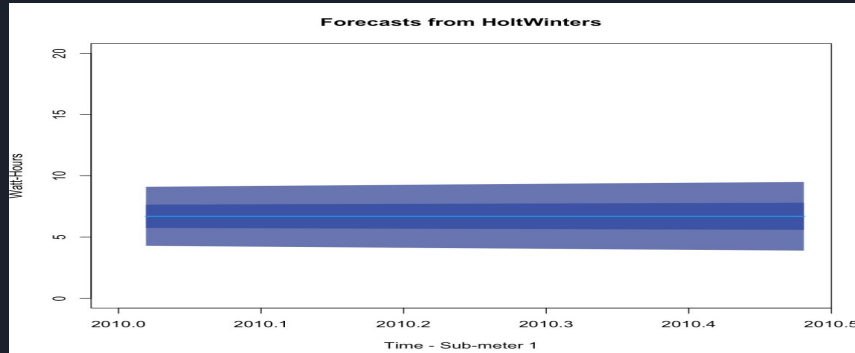❖ We can say that the average forecasts here is 8 Watt-Hours from the chart for Water Heater & AC for 2010

Useful predictions

❖ We can say that the average usage for Kitchen is around 3 Watt hours
❖ We can say that the average usage for Laundry is around 2.5 Watt hours
❖ We can say that the average usage for Water Heater & AC is around 3 Watt hours

Suggestions

❖ Getting both Heater & AC metrics would be useful in generating more granular metrics

Can Sub-Metering be useful to HomeOwners?

Some key insights:

- ❖ Understanding the trends. From the given data we can say that the overall power consumption for Kitchen & Laundry has gone down whereas the power consumption for Water heater & AC has gone up.
- ❖ Understanding the forecast. Knowing the average power consumption can help utilize the power better. From the data given we can say that the average for Kitchen & Laundry is around 2.5 Watt-Hours and for Water Heater & AC is 8 Watt-Hours

Recommendations

❖ Laundry usage is not spread out but has extreme spikes during specific days like Weekends as we see in the daily frequency data. It would be recommended to use Laundry on non peak days to reduce the overall power usage.

❖ The overall power usage for Kitchen & Laundry has gone down since 2007 which would mean an increase in electricity bill is potentially caused by high Water Heater & AC usage. It would be recommended for HomeOwners to consider cutting down on their Water Heater & AC usage if they are looking for to reduce their electricity costs.

❖ It would be best for HomeOwners to consider seasonal spikes in power usage like we saw clusters of spikes around the Christmas day.

❖ The power spikes almost always happens in Kitchen during specific hours in a day. Homeowners can be prudent in usage of it & can try to reduce the overall power usage if they consider using it in non peak hours.

❖ Please check the forecasts of each of the submeter usage which can help in planning for future to the Homeowners.

Lessons learnt

❖ Submetering in one of most effective way to understand the power usage at a more granular level.

❖ Further drill down of Thermostat as Heater & AC manifestation can help to understand seasonal implications of the power usage much better.

❖ Drilling down the visualization from weekly frequency to daily frequency can give better insights at each level of analysis.

❖ Forecasting Power usage with low confidence intervals can give precise predictions but maybe off the boundaries sometimes.

Thank You