Understanding Energy Usage for Smart Home Device

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Presentation Outline

Project Overview
Objectives/Goals
Data Management
Description and Location
Background
Data Analysis and Exploration
Issues Discovered
Recommendation

Data Project Overview

Applicability of data analytics for electrical sub-metering and power management.

Data Description Characteristics

- Electric power consumption from 1 household in FRA
  - Estimated 2 million measurements
  - Measurements per date and time
- Timeframe :
  - 2006-2010 (47 months)
- Submeters:
  - Sub1: Main Kitchen Appliances
  - Sub2: Washer/Dryer, Refrigerator
  - Sub3: Water Heater & AC unit
- Power :
  - KiloWatt Hours
  - Global active power (not measured in meters)

- Data Management

- Location of Data :
  - Secured on R MySQL Server
  - Access through R Studio

Objectives/Goals

-Grow business use of sub-meters in housing Market

- Provide homeowners with efficient Smart Homes and increase their understanding and control of their power usage

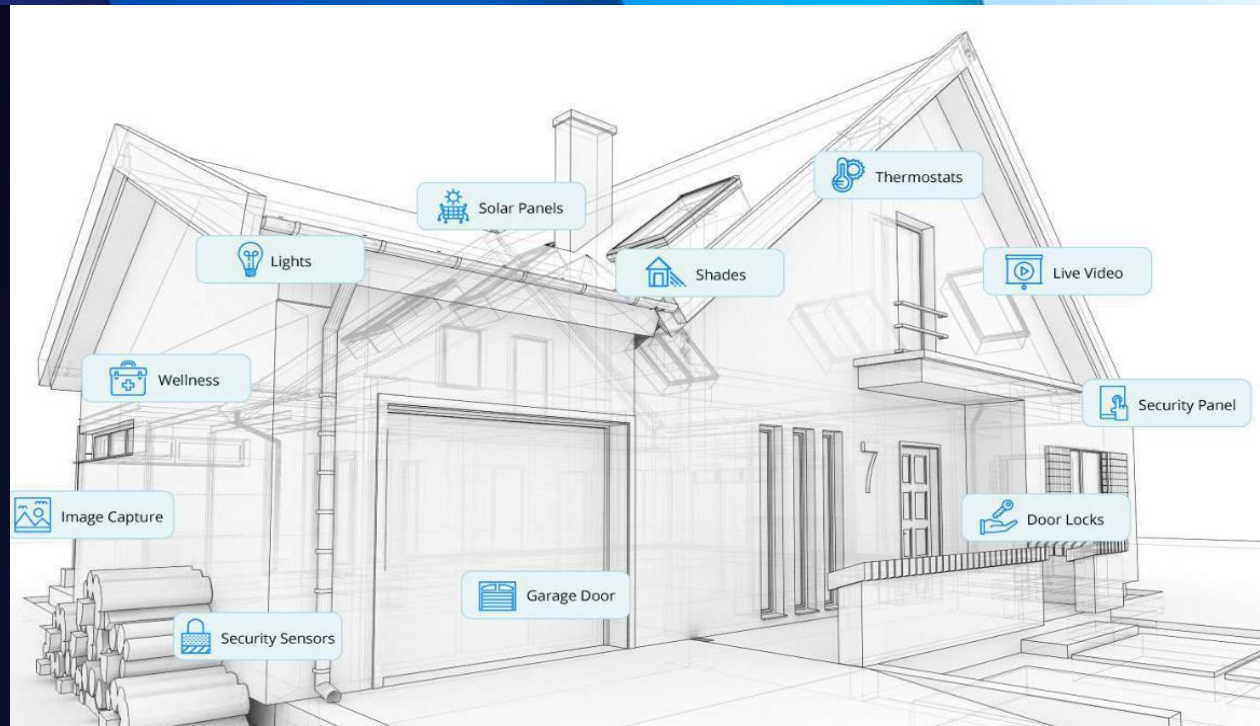
- Utilize data analytics and visualizations to model patterns of energy usage from electrical sub-meters for residential homes

Background: Smart Homes

Homes equipped with lighting, heating, and/or electrical devices that can be controlled remotely

Application of Smart Homes:
- Security and Surveillance System
- Lighting Schedules
- Programmable Thermostat/ Water softener's

Benefits of Smart Homes to Consumers:
- Convenience
- Control
- Savings
- Efficiency



Background: Sub-Meters

Devices that can be used to access, collect, and monitor energy consumption data remotely

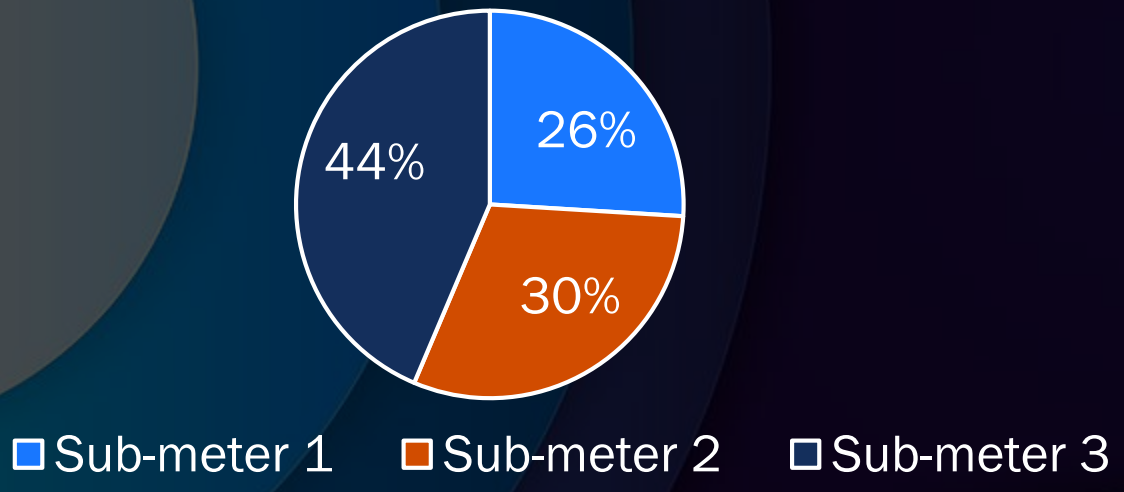
What Can be Learned

- Measure a specific location or energy load
- Categorize of energy from different of sources
- Check consistency of power consumption with billing
- Identify where energy efficiency opportunities exist
- Increase understanding of energy usage

Descriptive Statistics

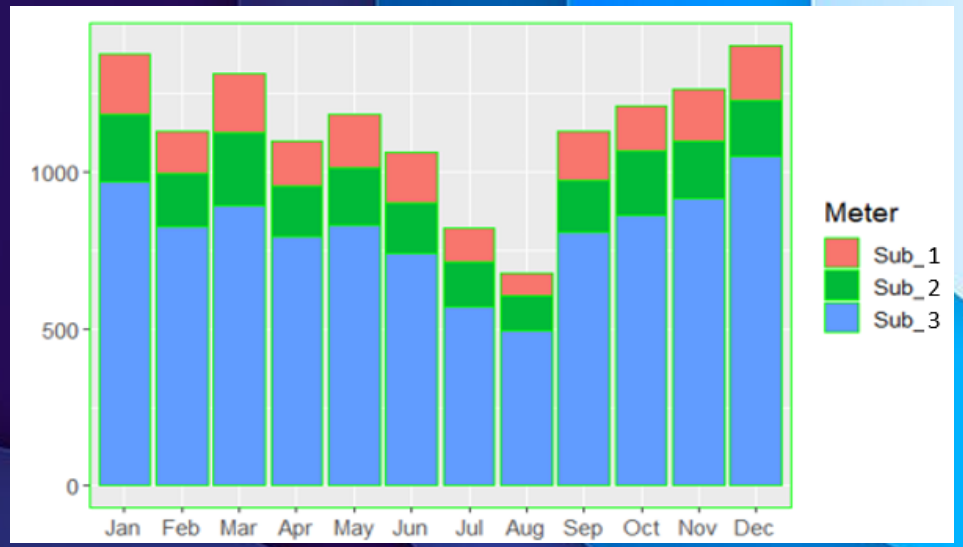
Meter	Min	1st	Median	Mean	3rd	Max
Meter1	0.0	0.0	0.0	1.2	0.0	82.0
Meter2	0.0	0.0	0.0	1.3	1.0	78.0
Meter3	0.0	0.0	1.0	6.2	17.0	31.1

Percentage of Power Consumption 2007-2010 (Kwh)



Subm. 1 & 2 had the highest max values
Subm. 3 had the highest power consumption

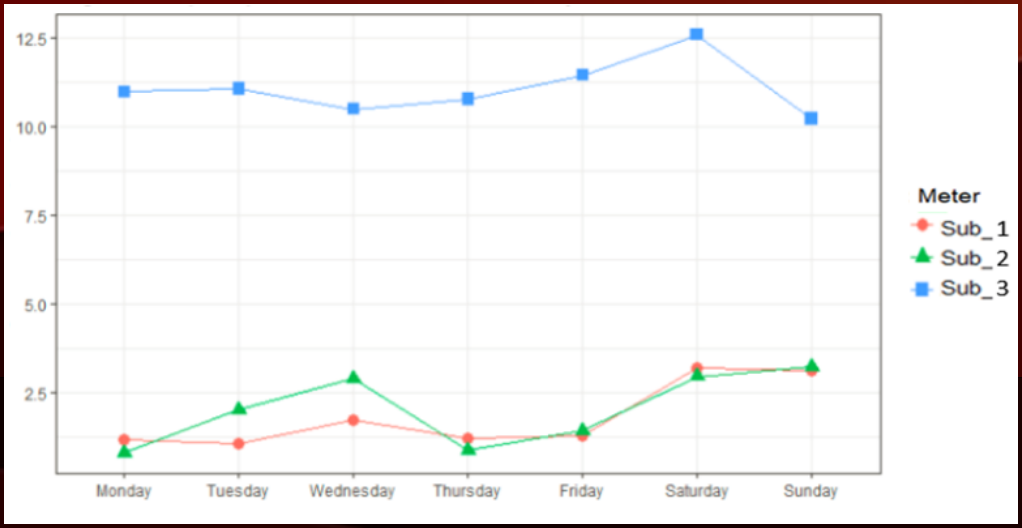
Power Consumption (POC) (kwh) among Sub-Meters by Year and Month



During yrs, POC rose for Subm. 3 / drop for Subm. 1 & 2
Overall POC drops from Q1 to Q2 /rise from Q3 to Q4

Data Analysis and Exploration

Highest POC was among the month of January

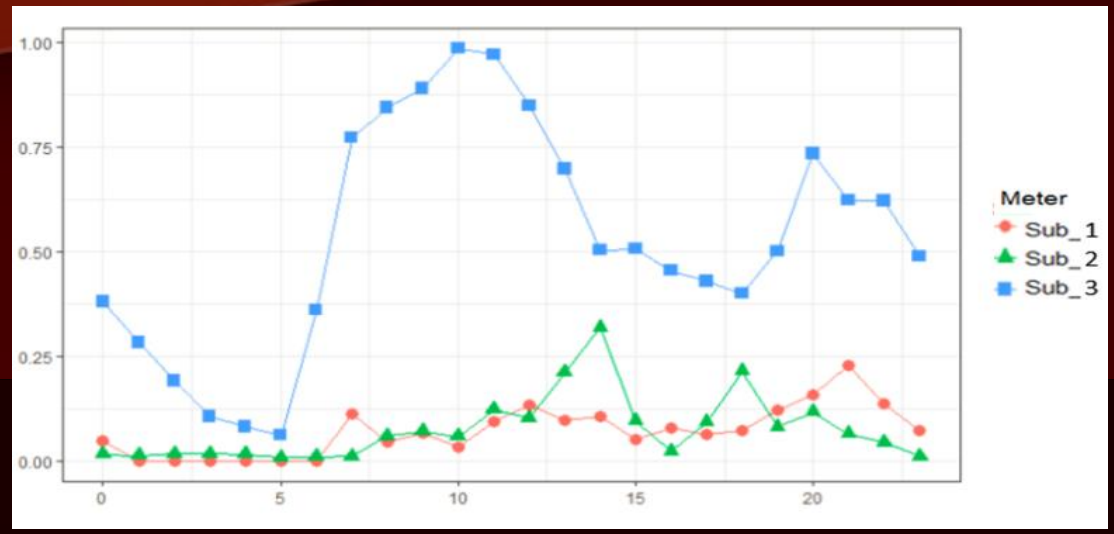


Avg. POC (kwh) by Weekday

-During the years, Saturday followed by Sunday had the highest avg. POC (over 10.0 kwh)

-POC increased gradually from Wednesday to Saturday for Subm.3

-Variation in POC between Subm.1 & Subm.2 between Mon. to Wed.



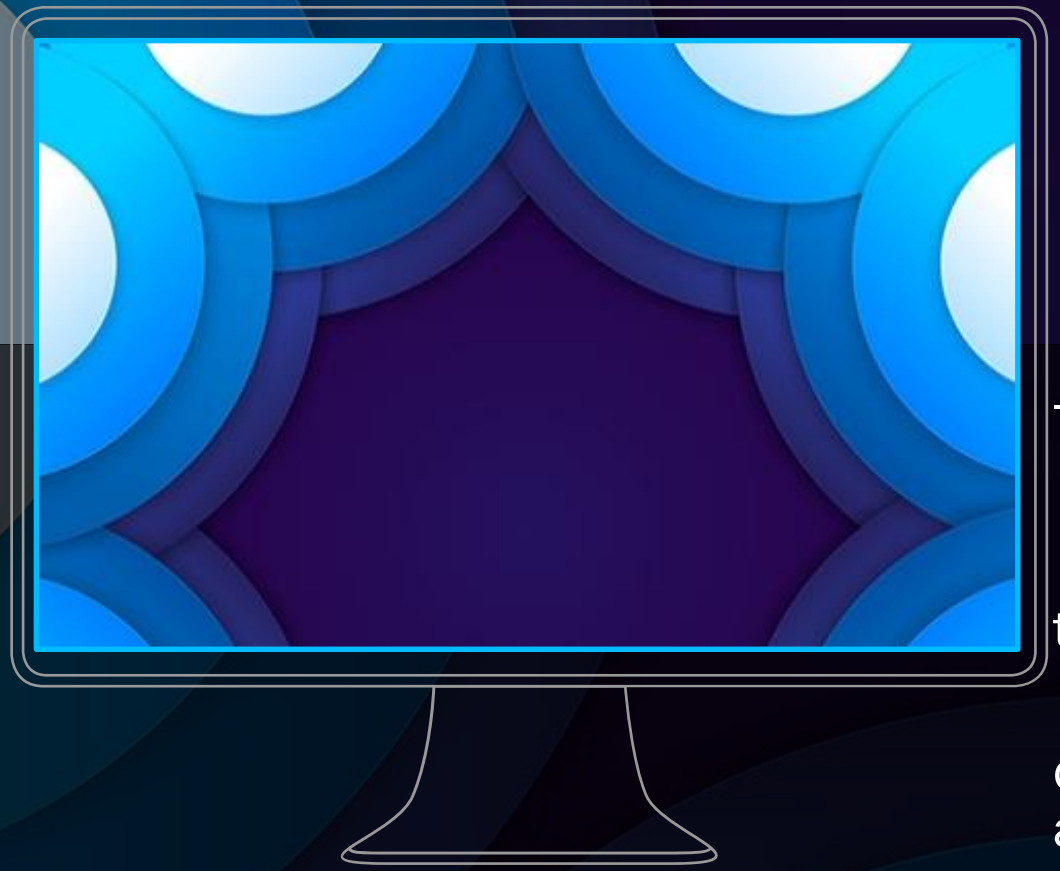
Avg. POC (kwh) by Hours

-Subm.1 Gradual increase from 3:00pm. Peak observed around 8:00-8:30 pm

-Subm.2 Dormant activity in the am. Peaks observed around 2:00pm and 6:30pm

-Subm.3 Significant POC at 5:00am. Usage high from 7:00am-10:00am

Issues Discovered



Management

-Missing Data Values

- 1.25% of data missing
- Determine if missing due to submeter or human error
- Data is recorded in a different time zone than analysis

Security

-Data Governance access and security concerns

-Convenience of R MySQL

-Interoperability with Tableau

-Long Run times

Recommendations

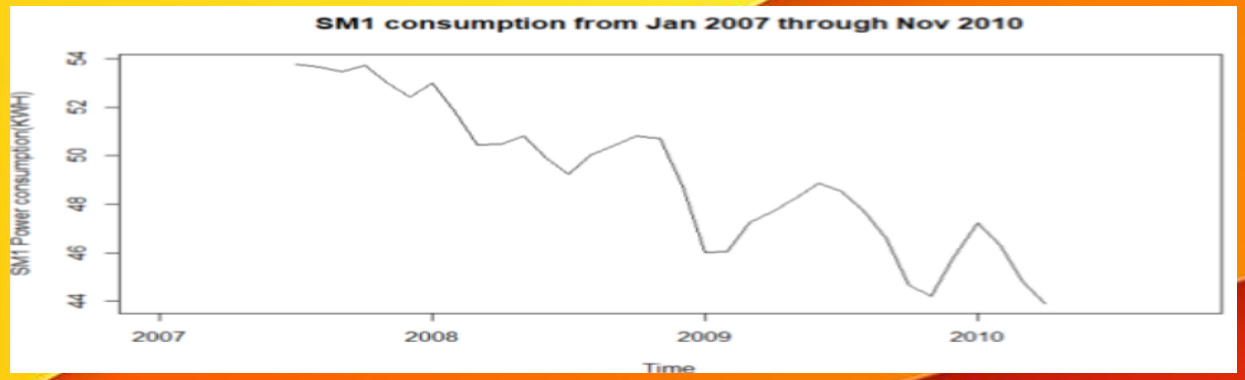
- Separate meter 3 into two groups (Water Heater & AC)
- Create meters for other electronic or appliances of interests
- Check insulation of house during winter and summer for heat lost and accumulation
- Check Water Heater &AC settings throughout
- Record measurements for all units of time
- Invest in system that improves real-time surveillance of energy used.

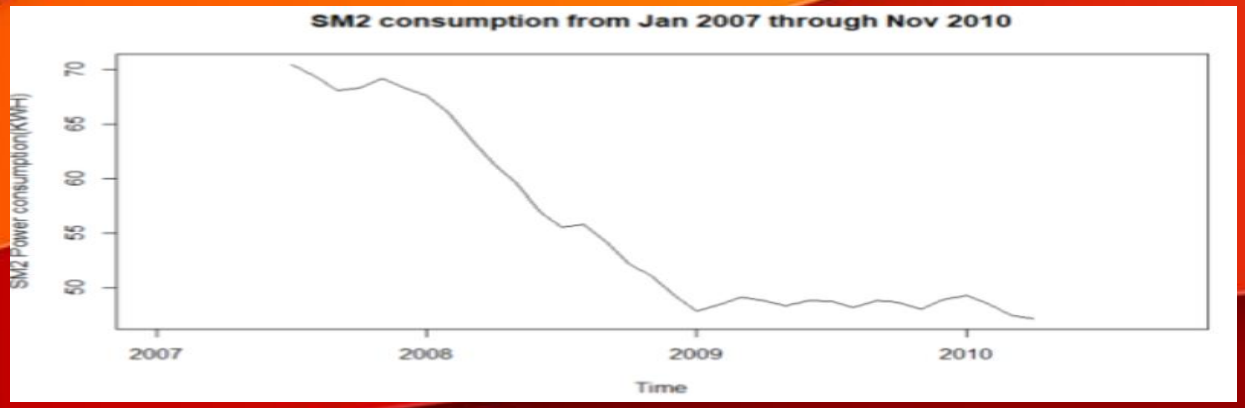
What to Research

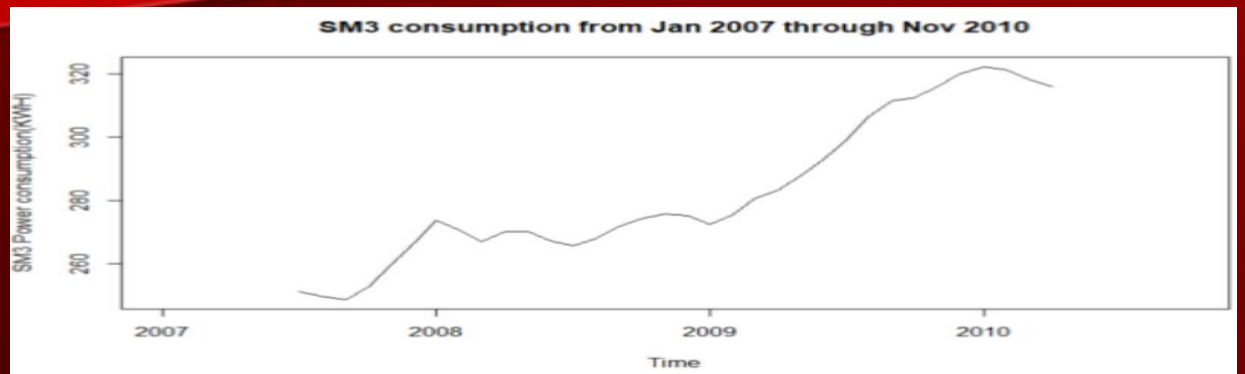
- Variation in power consumption among different regions
- Understand characteristics of household owners
- Who are the competitors within the industry
- How can analytics be used to improve power consumption management

Forecast Prediction

Submeter Trends







- Observed differences in submeters from 2007-2010

- Overall SM1 and SM2 decrease over time

-SM3 gradually increases over time

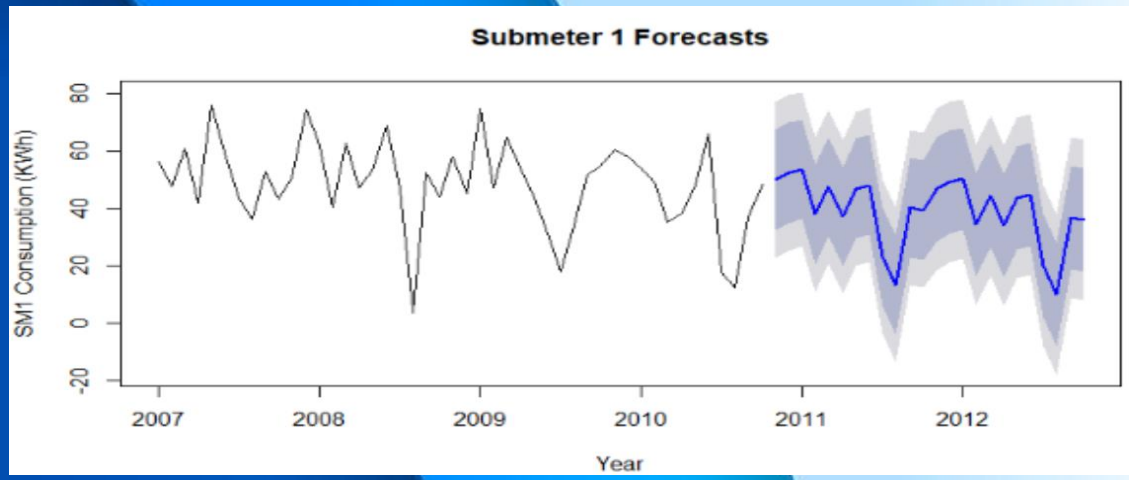
Utilize data analytics and visualizations to model patterns of energy usage from electrical sub-meters for residential homes

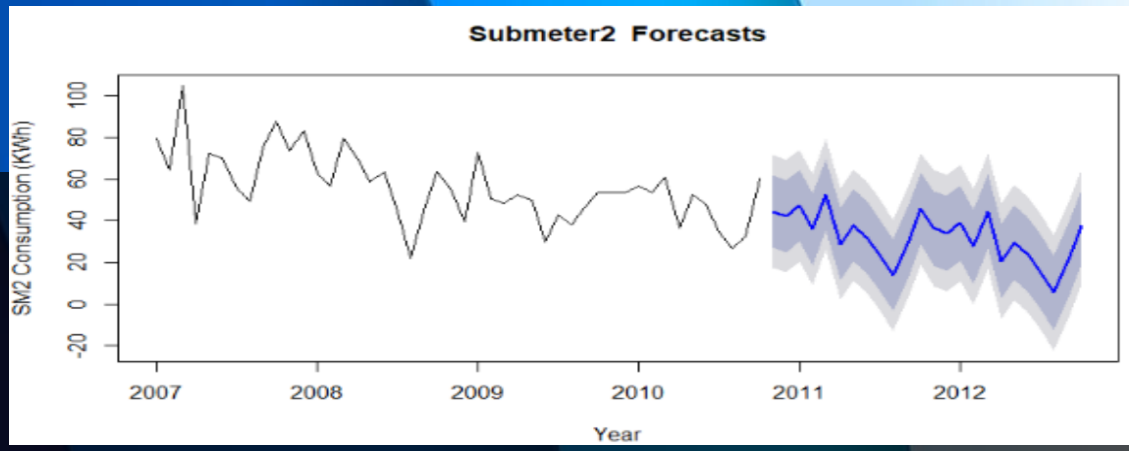
Forecast

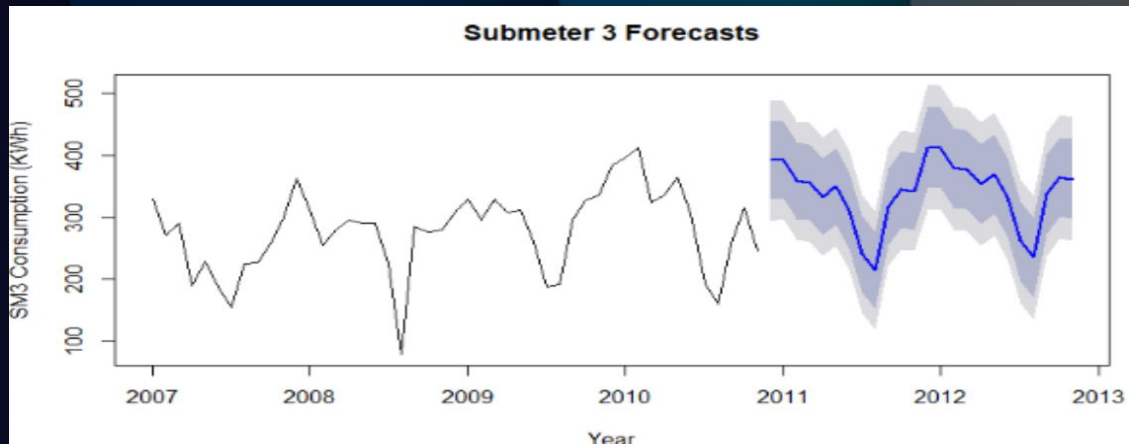
-Forecast of total power consumption of SM1, SM2 and SM3 over the next two years are consistent with trends

-SM1 and SM2 will gradually decrease whereas SM3 will increase

-The blue line represents forecast for 2011-2012
-95% prediction interval is represented by light gray area
-80% prediction interval is represented by dark gray area







Conclusion

- Submeters are in important and give homeowners better understanding for power consumption

- Homeowners using submeters will be able to control and gauge how much energy is being utilized throughout the day and peak hours
- Homebuilders should market submeters and explain to homeowners the benefits of submeter control