Sub-Metering Devices

Presented by Don Bice

July 10, 2018

IOT ANALYTICS

Agenda

- The Process
- Power Data
- Forecasting
- Recommendations

Our **Process**

The Process

Business Goal
What question can data analytics answer?

Analysis
Analyze, create models and evaluate

Data Collection
Gather, evaluate and prepare data

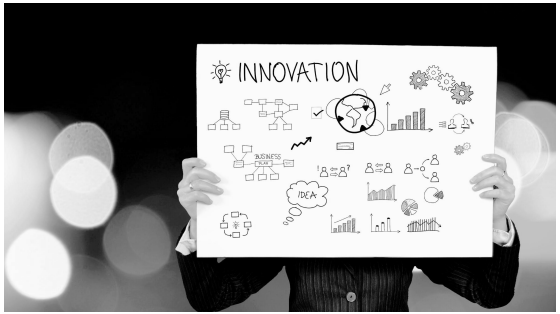
Insights
Recommendations
Monitor/Revise as appropriate

Our Focus

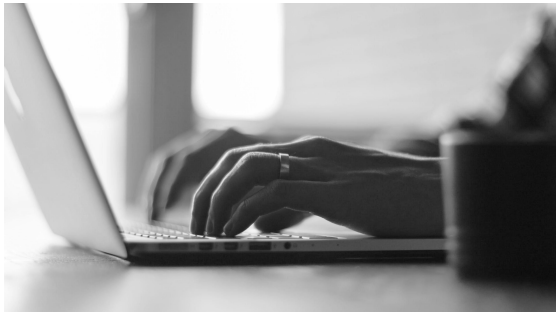
Your Goal: Offer highly efficient smart homes with power usage analytics

Grow your business in the smart home market.

Empower homeowners to understand and control power usage.



Leverage power monitoring & management technology to differentiate your company from other builders.



Residential Electricity Costs in Texas

Electricity bills
Avg monthly bill in Texas is **$128**, which ranks **5th in the U.S** and is 19.63% greater than national avg of $107.

Electricity rates
Rates average **10.98¢/kWh**, which ranks the state **31st in the nation** (national avg 11.88¢/kWh).

Electricity consumption

Residential consumption averages **1,168 kWh/month**, which ranks **5th in the U.S.**
Avg consumption in TX is 29.35% > than national avg of 903 kWh/month (range from 531 to 1,254 kWh/mo).

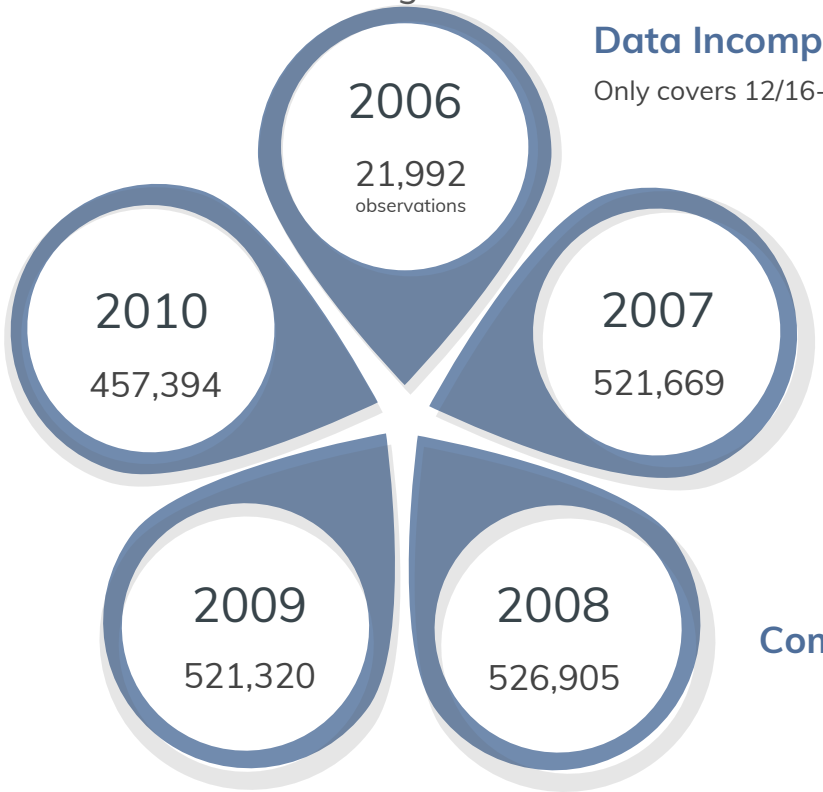
Source: U.S. Energy Information Administration

The **Data**

Power Consumption

Household Power Data In 1 Minute Increments

47 months. 2,075,259 observations. 1.25% missing values.



Data Incomplete

Only covers 12/16-12/31

Complete

Complete

Complete

Forecast

Data incomplete after 11/26 to end of year

Power

Mean and max values in watt-hours of active energy based on 1-minute observations

	Sub-meter 1	Sub-meter 2	Sub-meter 3
	Kitchen: dishwasher, oven, microwave	Laundry room: washer, dryer, refrigerator, light	Water heater and A/C
2007	Mean: 1.2 Max: 78	1.6 78	5.7 20
2008	Mean: 1.1 Max: 80	1.3 76	6.03 31
2009	Mean: 1.1 Max: 82	1.1 77	6.82 31
2010	Mean: 1.1 Max: 88	1.1 80	7.24 31

Insights

Sub-meters could be a big step in offering highly efficient Smart Homes that provide owners with power usage analytics.

Grouping of appliances in the power consumption data set is likely not the best way to sub-meter a home.

Explore options beyond sub-metering. Consumers want a seamless experience in their homes, and innovative connected home products are using the power of Internet of Things (IoT) to make that a reality.

Additional data to include overall energy consumption (global active power) representing energy consumed in the household not measured in sub-meterings 1, 2, and 3 could yield valuable information.

Reducing granularity of the data (ie. aggregating minute data into hourly/daily) provides additional insights into usage.

Power Consumption Analytics

Reducing granularity of the data (ie. aggregating minute data into hourly/daily/monthly) provides additional insights into usage.

Visualizations provide a more intuitive means of uncovering and interpreting patterns and trends.

Forecasting allows the consumer to make proactive choices to reduce energy usage.

Understanding how power is used in the household and when spikes occur can result in significant cost savings for the homeowner.

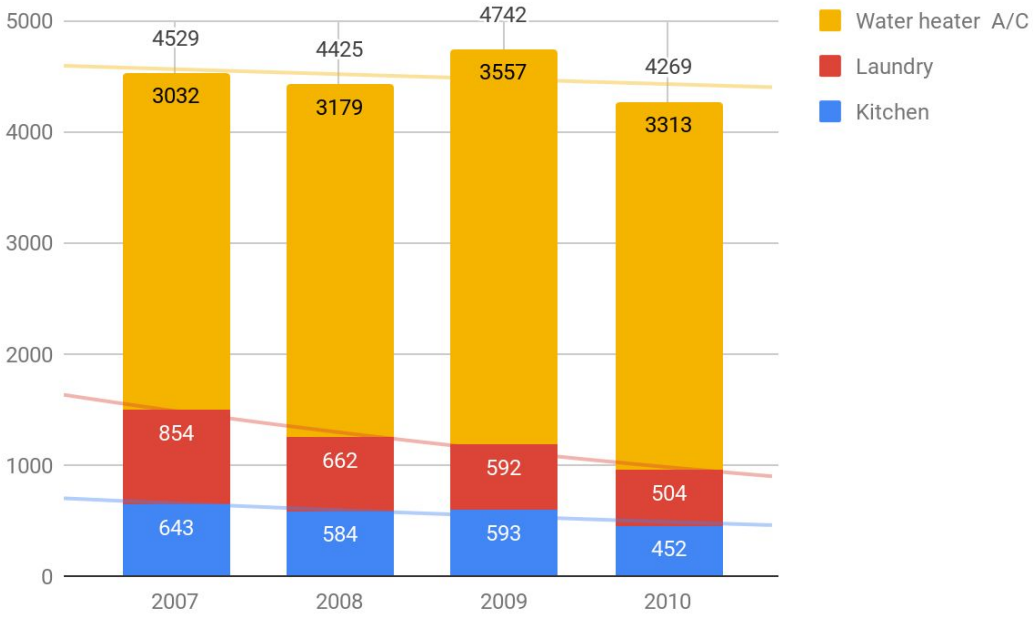
Power Consumption

Annual kilowatt-hours (kWh) of active energy

	Sub-meter 1	Sub-meter 2	Sub-meter 3	Total
	Kitchen: dishwasher, oven, microwave	Laundry room: washer, dryer, refrigerator, light	Water heater and A/C	
2007	643	854	3032	4529
2008	584	662	3179	4425
2009	593	592	3557	4742
2010 *(thru 11/25)	452	504	3313	4269

Power Consumption

Annual kilowatt-hours (kWh) of active energy

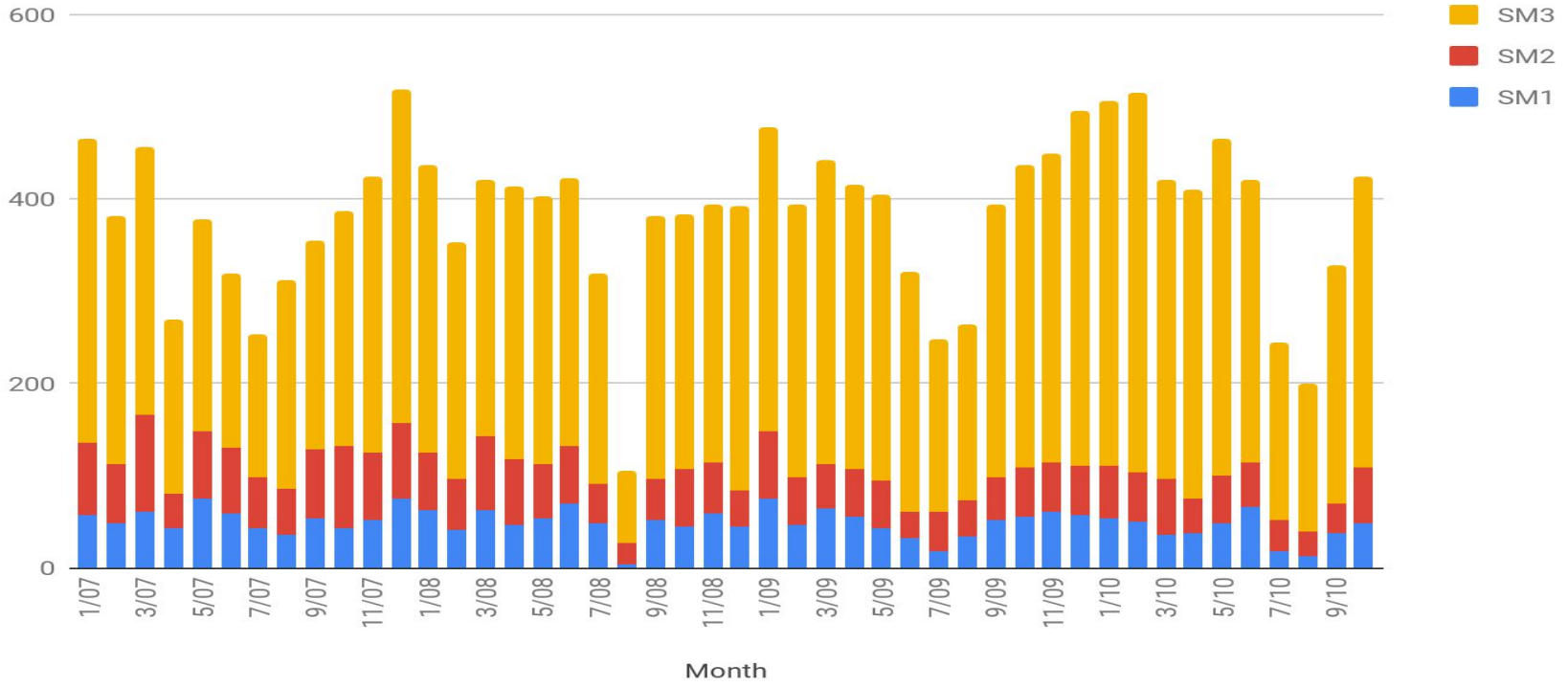


Insights

1. Sub-meter 3 water heater & A/C ranges 65 to 78% of total.
2. Sub-meter 3 trending upward over time.
3. Kitchen & Laundry sub-meters show yearly declines.
4. Can further subset data to look at other time intervals.

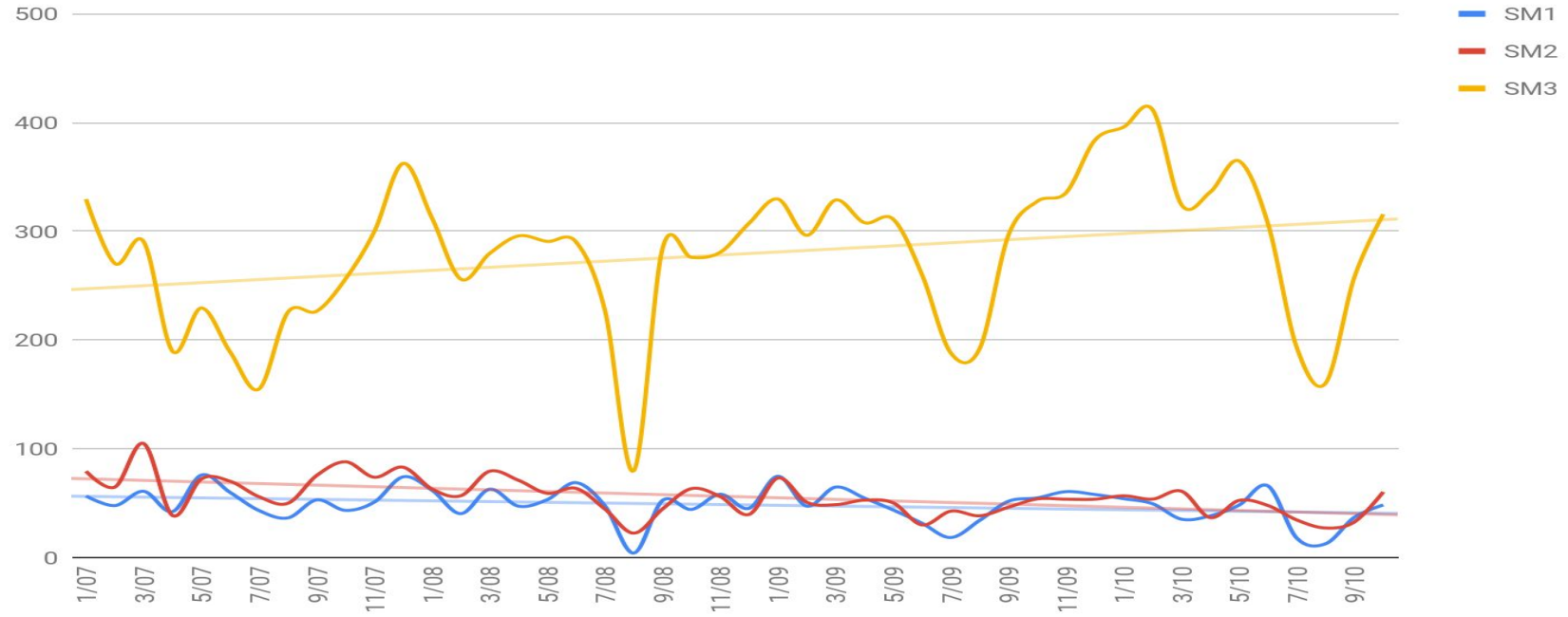
Power Consumption

Average Monthly kWh



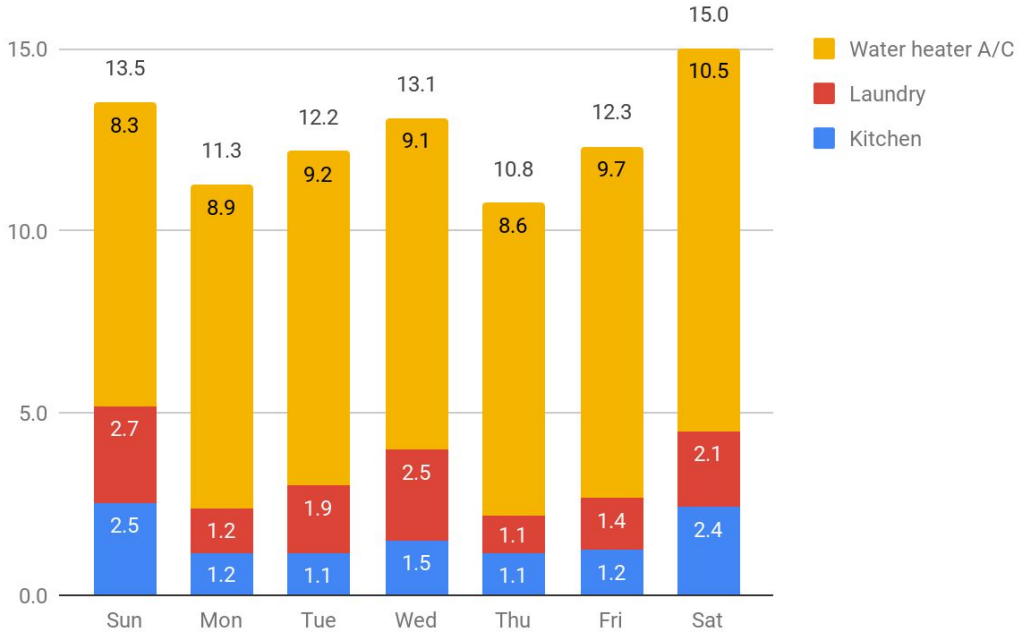
Power Consumption

Avg Monthly kWh reveals seasonality and longer-term trends



Power Consumption

Average kWh by Weekday 2007-2010

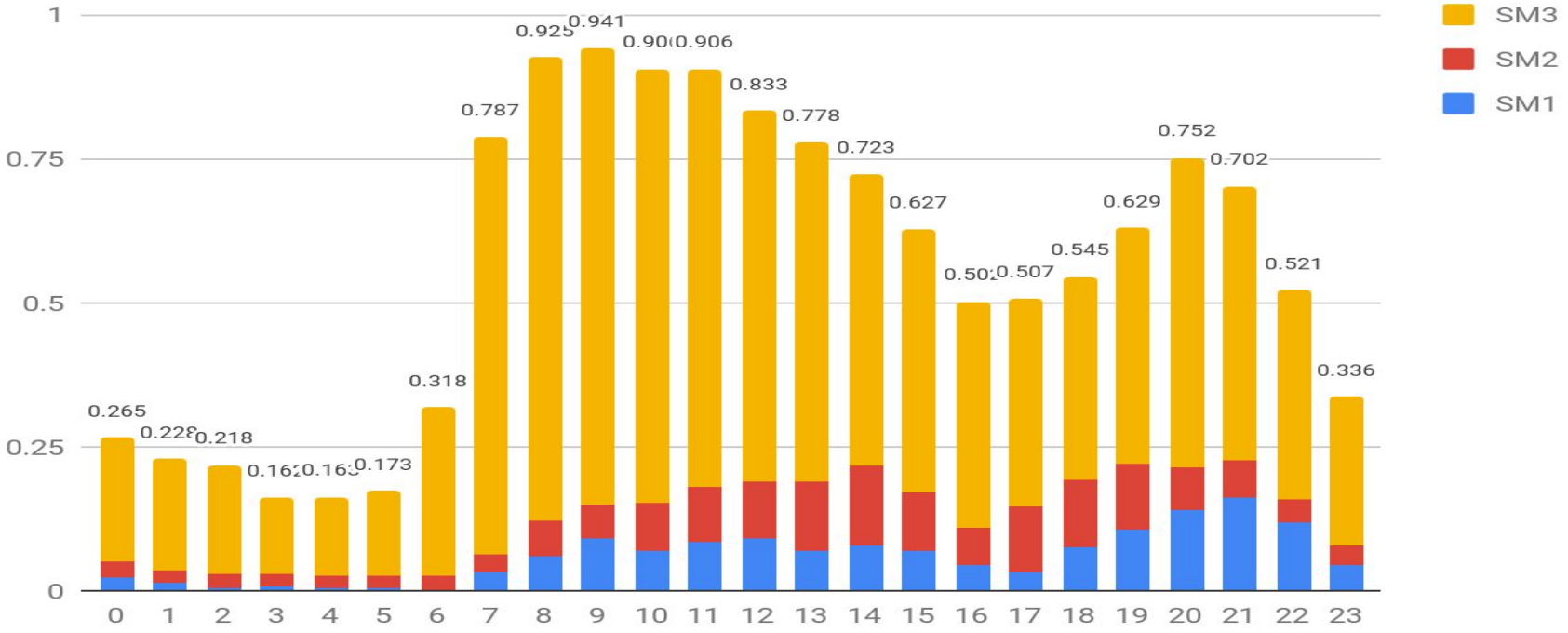


Insights

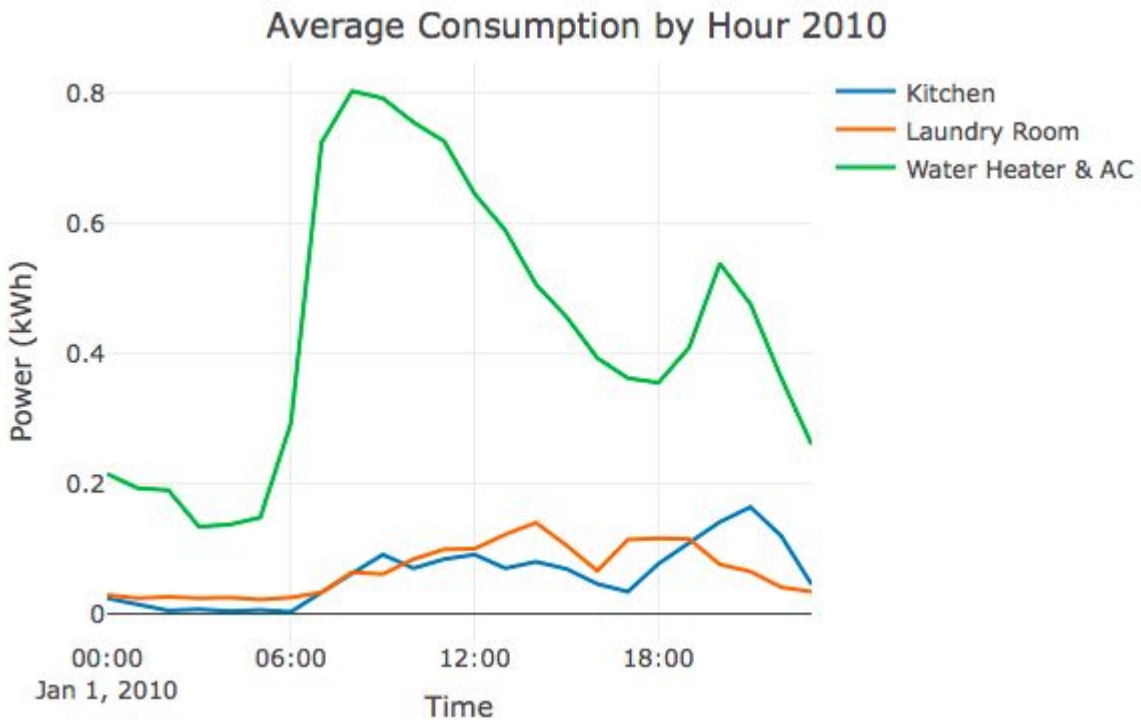
1. Energy usage overall and by sub-meter varies by day of week.
2.
3.
4.

Power Consumption

Average kWh by Hour 2010



Sub-meters Uncover Daily Routine



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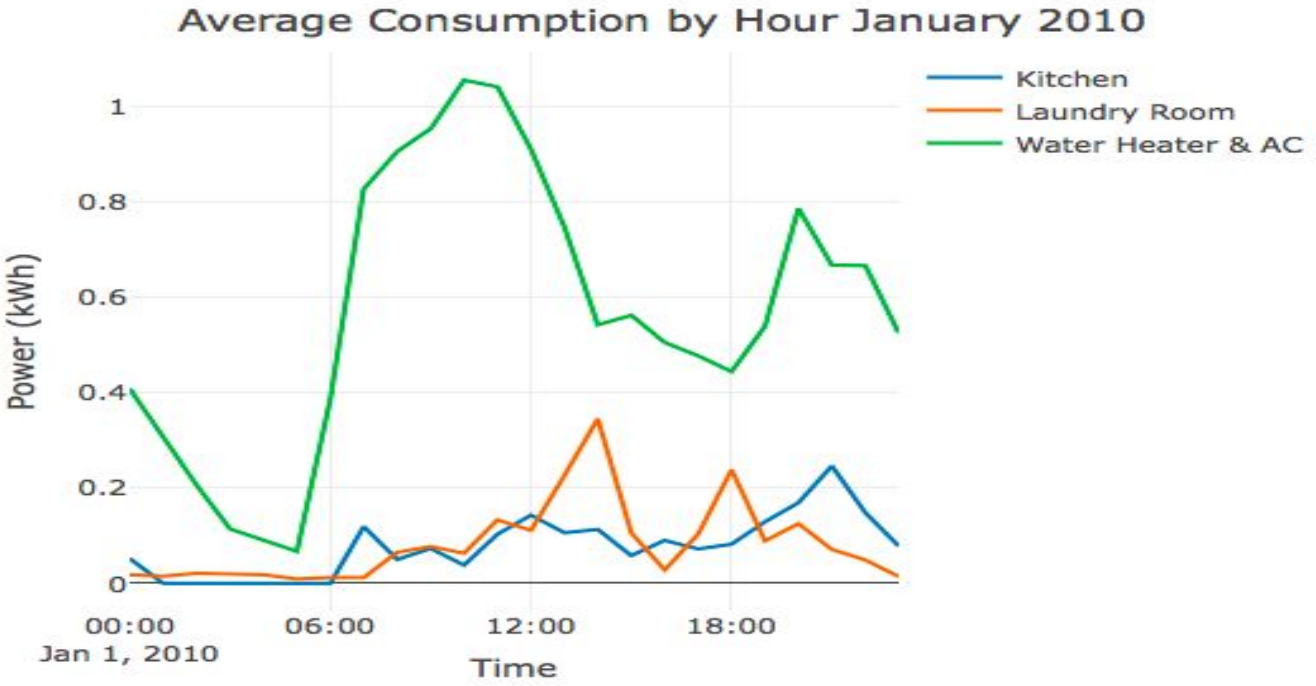
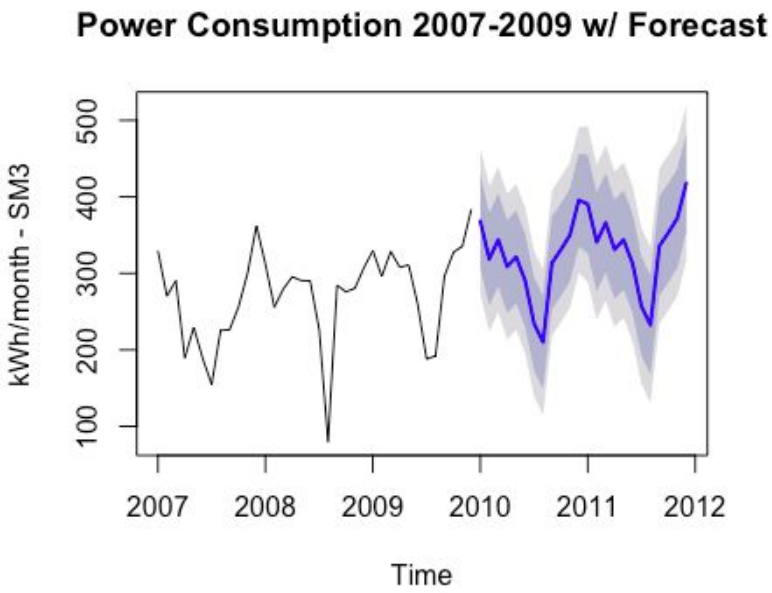
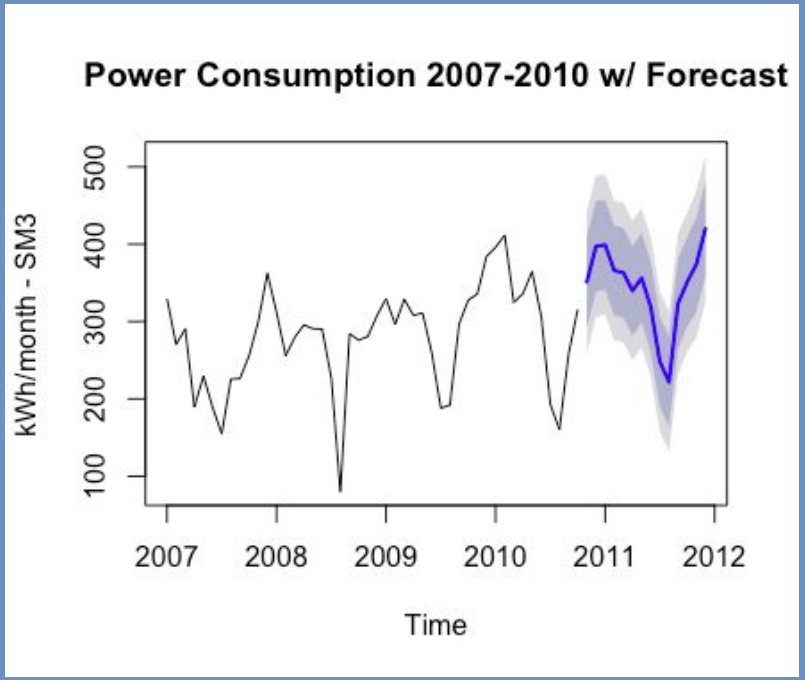


Linear **Regression**


Power Consumption 2007-2009 w/ Forecast
kWh/month - SM3
100
200
300
400
500
2007
2008
2009
2010
2011
2012
Time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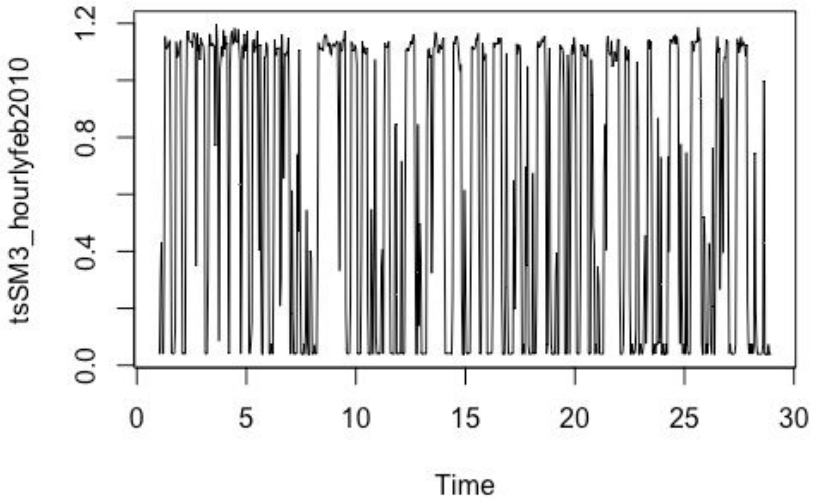
Time

Decomposition **Analysis**

Decomposing Time Series Data

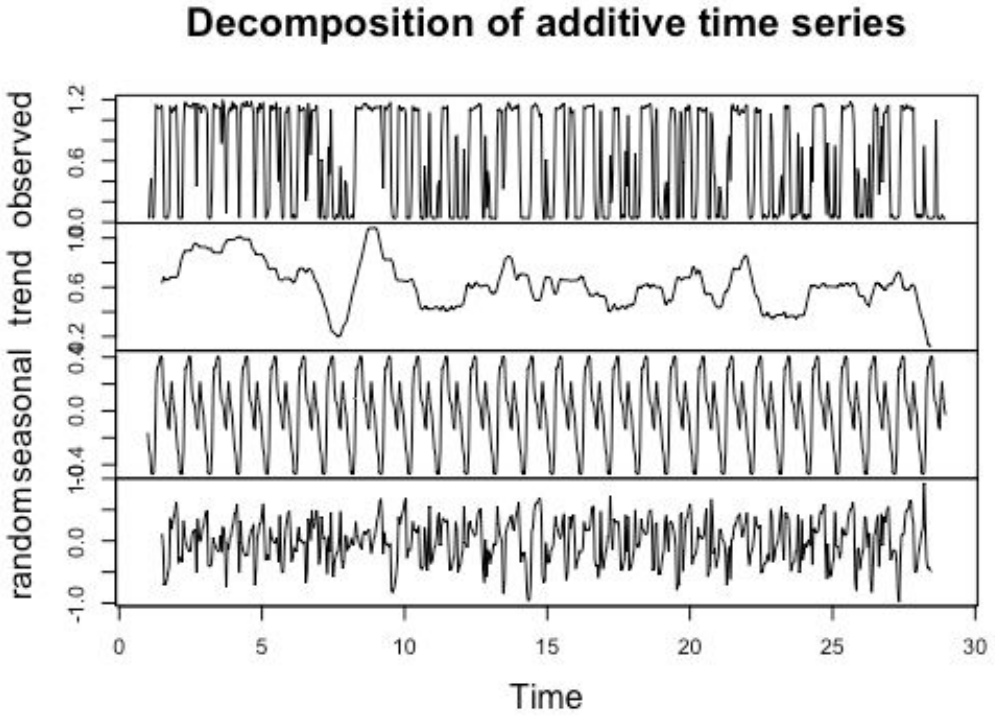
Can we use analytics to uncover underlying components and improve forecasts?



Total hourly usage (kWh) over each day of February 2010.

Decomposing Time Series Data

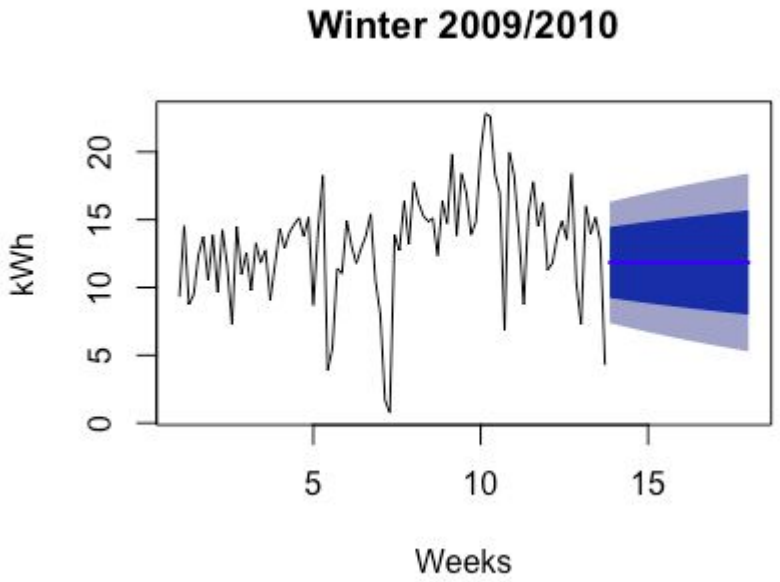
Components-- trend, seasonal and random.

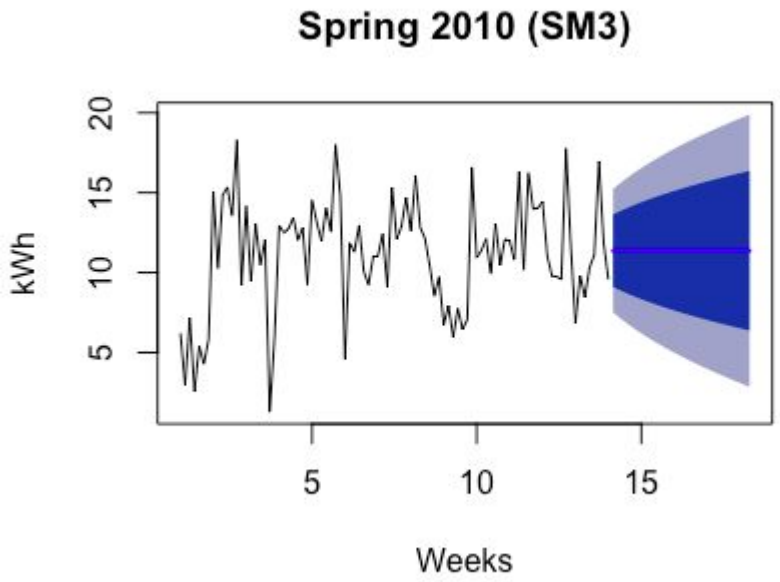


Seasonal **Forecasts**

Forecasting by Season 2010

Sub-meter 3 (actual) for 90-day season with Holt-Winters 30-day forecasts with confidence levels 50 and 75%.





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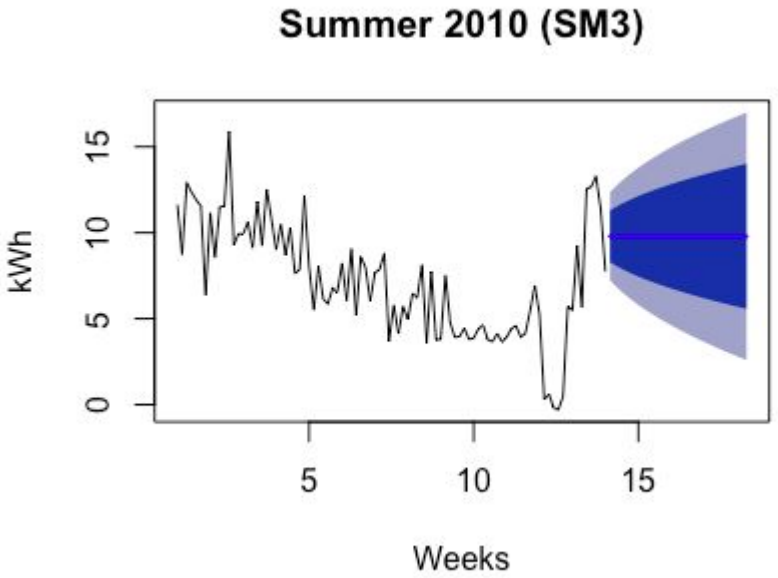
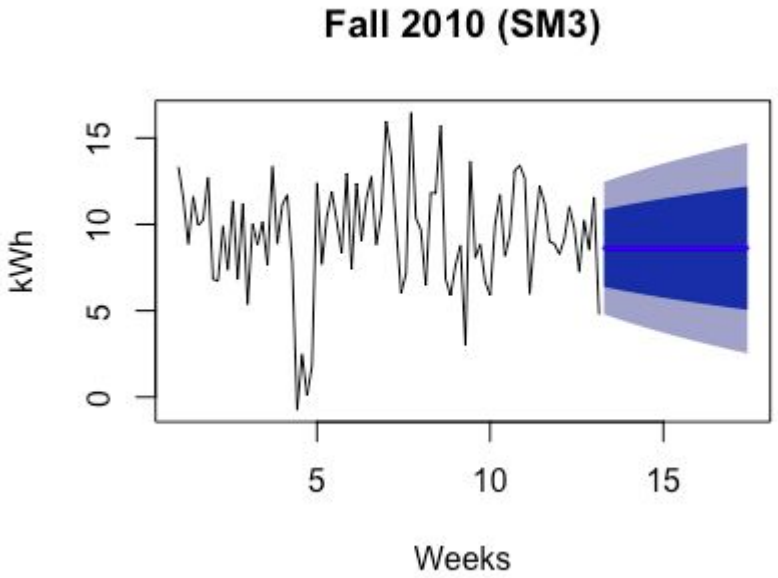




Insights & **Recommendations**

Residential Electricity Costs in Texas

The Opportunity to Save

Electricity bills
Avg monthly bill in Texas is **$128**, which ranks **5th in the U.S** and is 19.63% greater than national avg of $107.

Electricity rates
Rates average **10.98¢/kWh**, which ranks the state **31st in the nation** (national avg 11.88¢/kWh).

Electricity consumption

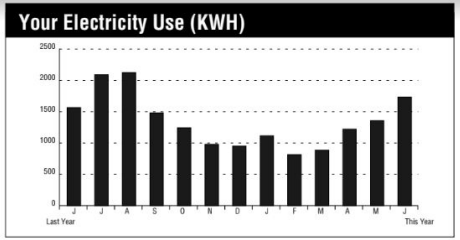
Residential consumption averages **1,168 kWh/month**, which ranks **5th in the U.S.**
Avg consumption in TX is 29.35% > than national avg of 903 kWh/month (range from 531 to 1,254 kWh/mo).

The target homebuyer will be well above these averages.

Source: U.S. Energy Information Administration

Residential Electricity Costs in Texas

2/2.5 1150 sf townhouse in Austin



Current Month

Days of service	31
kWh Used	1733
Avg. kWh per day	55.9
Avg. cost per day	$6.50

13 month avg. consumption: 1351.38

ELECTRIC SERVICE

Meter # 3148[illegible]

Read Date	**05/22/2018**	**06/22/2018**	**Consumption**
Read	23391	25124	1733
	Reading Difference		1733
	Total Consumption in KWH		1733

COA - Electric Residential

Customer Charge	$10.00
Tier 1 first 500 kWh at $0.02801 per kWh	$14.01
Tier 2 next 500 kWh at $0.05832 per kWh	$29.16
Tier 3 next 500 kWh at $0.07814 per kWh	$39.07
Tier 4 next 233 kWh at $0.09314 per kWh	$21.70
Regulatory Charges 1,733 kWh at $0.01362 per kWh	$23.60
Community Benefit Charges	$9.72
Power Supply Adjustment 1,733 kWh at $0.03007 per kWh, Summer	$52.11
Residential Sales Tax	
Taxable Amount	$199.37
City Sales Tax 1%	$1.99
TOTAL CURRENT CHARGES	**$201.36**

Residential Electricity Costs in Texas

Most homes waste 20% of metered power

Electricity bills average **$128**.
Electricity rates average **10.98¢/kWh**.
Electricity consumption average **1,168 kWh/month**.

Assuming target homebuyer is 2X average consumption or 2336 kWh/month:
20% savings annually on electric power is $616/year or $6160 over 10 years.

Reducing usage overall and during peak hours reduces energy costs.

Lower usage and rates may make installing smart submeters uneconomic for the consumer.

Source: U.S. Energy Information Administration

Insights & Recommendations

Sub-meters could be a big step in offering highly efficient Smart Homes that provide owners with power usage analytics.

Grouping of appliances in the power consumption data set is likely not the best way to sub-meter a home.

Dataset is not representative of seasonality or consumption of Texas household that is target buyer of the homebuilder.

Additional data to include overall energy consumption (global active power) representing energy consumed in the household not measured in sub_meterings 1, 2, and 3 could yield valuable information.

Reducing granularity of the data provides additional insights into usage.

Beyond financial costs, many homebuyers have personal incentives to reduce energy consumption.

Explore options beyond sub-metering. Consumers want a seamless experience in their homes, and innovative connected home products are using the power of IoT to make that a reality.

IOT Analytics