Demand Response and Smart Meters

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Introduction

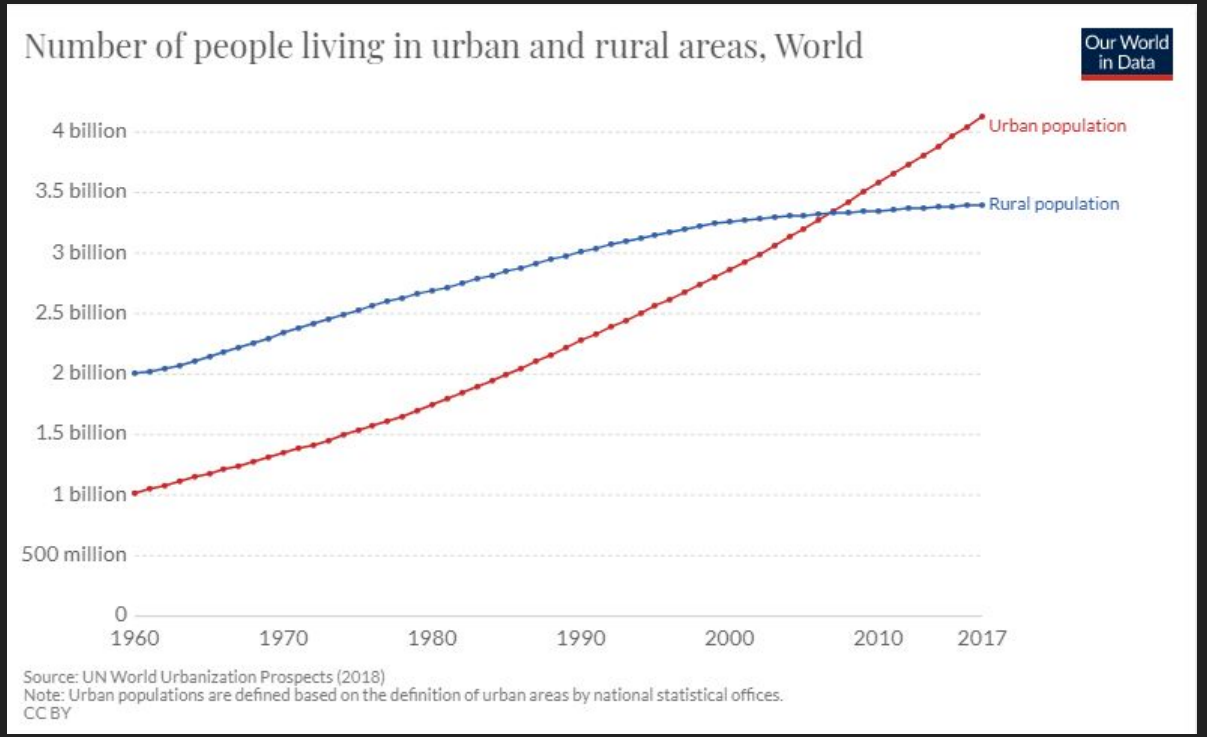
Global Electrification at 88.8%[1], Urbanization at > 50% global Pop[2]

What this means?

+ Dense Power
+ Reliability
+ Peak Load
- Spread

Opportunities

+ Optimization
+ Renewables



Demand Response(DR)

Demand Response: act of providing financial incentives to shift consumer

Why? Cost, Infrastructure, Blackouts[3,4]

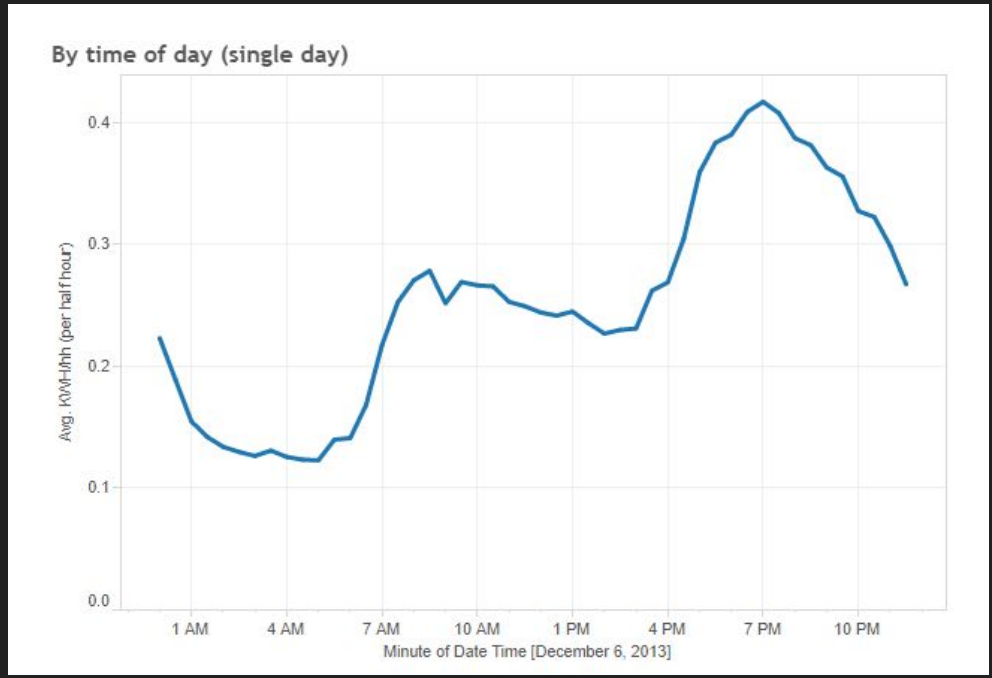
How?

System Balancing

- When do we generate?

Constraint Management

- How do we deliver it?



https://data.london.gov.uk/blog/electricity-consumption-in-a-sample-of-london-households/

UK Power Networks

Extensive research in the U.K.[5]

Data[6] collected between 2012-2014

~5000 houses

- 1k/4k split ToU vs Std

Demographics on “census block”

Tariff level and time in seperate table

KWH/hh (per half hour)	Acorn	Acorn_grouped
0.09	ACORN-A	Affluent
0.16	ACORN-A	Affluent
0.212	ACORN-A	Affluent
0.145	ACORN-A	Affluent
0.104	ACORN-A	Affluent
0.122	ACORN-A	Affluent
0.184	ACORN-A	Affluent
0.171	ACORN-A	Affluent
0.246	ACORN-A	Affluent
0.196	ACORN-A	Affluent
0.229	ACORN-A	Affluent
0.446	ACORN-A	Affluent
0.465	ACORN-A	Affluent
0.305	ACORN-A	Affluent
0.39	ACORN-A	Affluent
0.404	ACORN-A	Affluent

Data table above from, and all data available at:
https://data.london.gov.uk/dataset/smartmeter-energy-use-data-in-london-households

Results, ToU vs Std

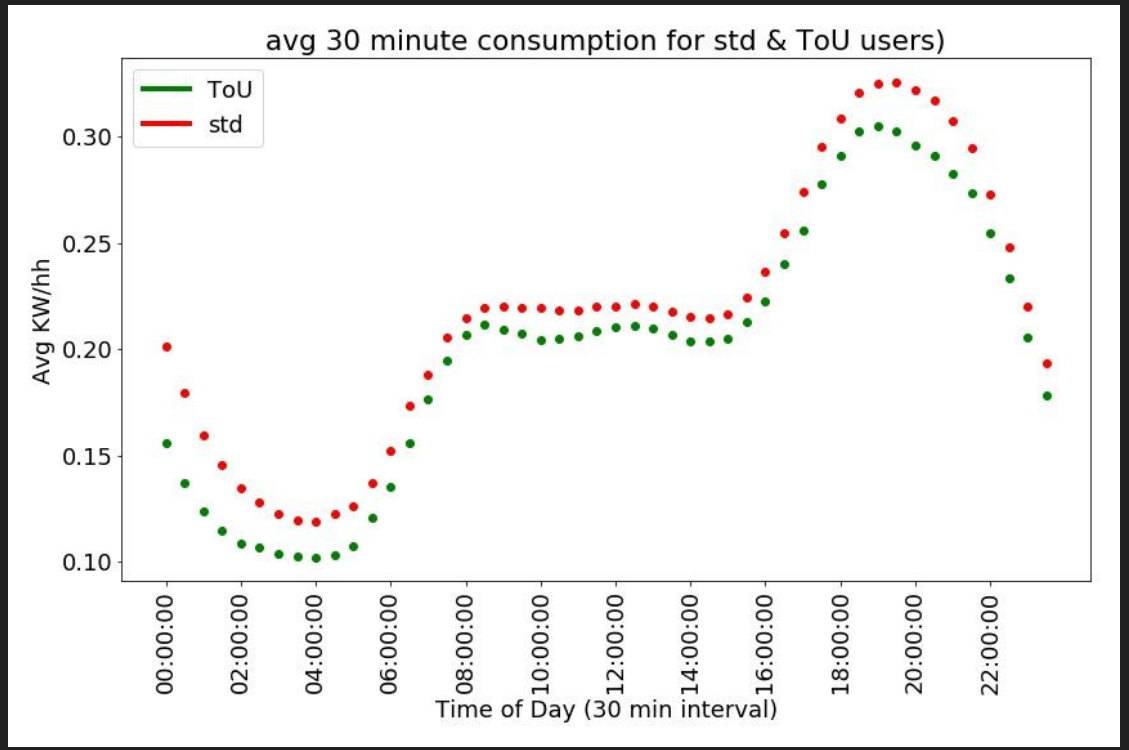
All intervals significant!

Avg annual savings per house:

<u>308kWh* £0.1176/kWh</u>[6]

= £36.672 ~ $48.25

- Greatest savings at 00:00
  - 0.455 kWh
- Reduce peak (18:00,20:00) Load by 5.5-8.1%



Results,SINDy (Sparse Identification of Nonlinear Dynamics)

Can we come up with an equation to model demand?

This is $0.004c_{t-4}+0.04c_{t-3}+0.003c_{t-2}$

$+0.57c_{t-1}+0.018c_{t-2}^{2}+0.005c_{t-1}^{2}+0.007c_{t-1}^{3}$

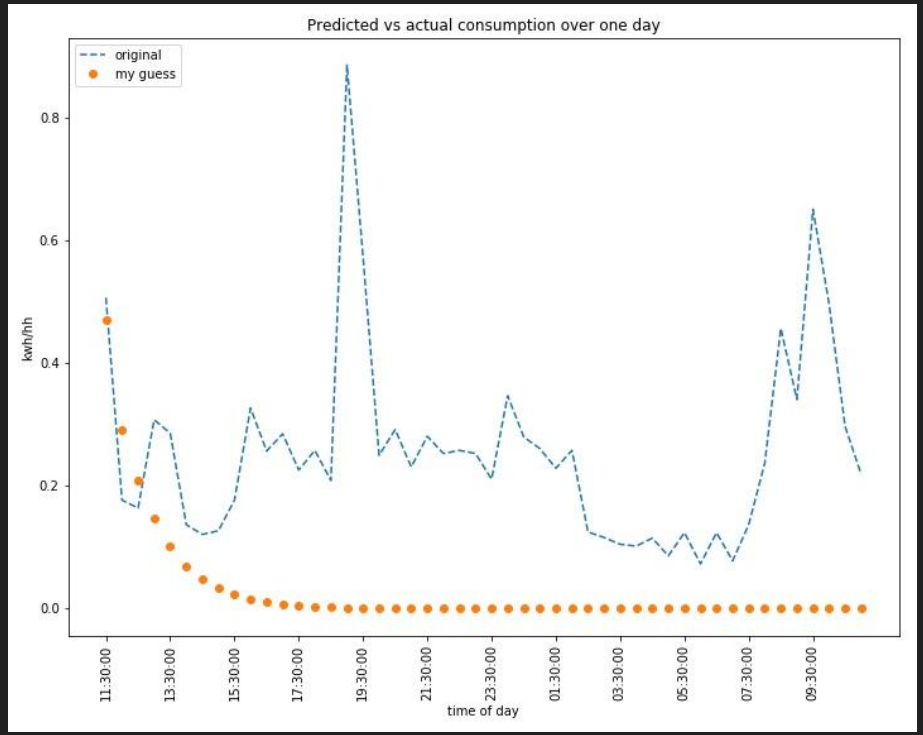
c=consumption

Can this be improved?

- Hopefully

How?

- More data,
- Demographics
- Larger library



Thanks, Questions? & References!

[1] Access to electricity (% of population) (2019). Retrieved November 22, 2019, from World Bank. https://data.worldbank.org/indicator/eg.elc.accs.zs. CC 4.0 License.

[2] Department of Economic and Social Affairs. (2019). World urbanization prospects : the 2018 revision. New York: United Nations.

[3] Qdr, Q. J. U. D. E. (2006). Benefits of demand response in electricity markets and recommendations for achieving them. *US Dept. Energy, Washington, DC, USA, Tech. Rep*.

[4]https://www.drax.com/energy-policy/britains-blackout/

[5] Jenkins, N., Long, C., & Wu, J. (2015). An overview of the smart grid in Great Britain. *Engineering*, *1*(4), 413-421.

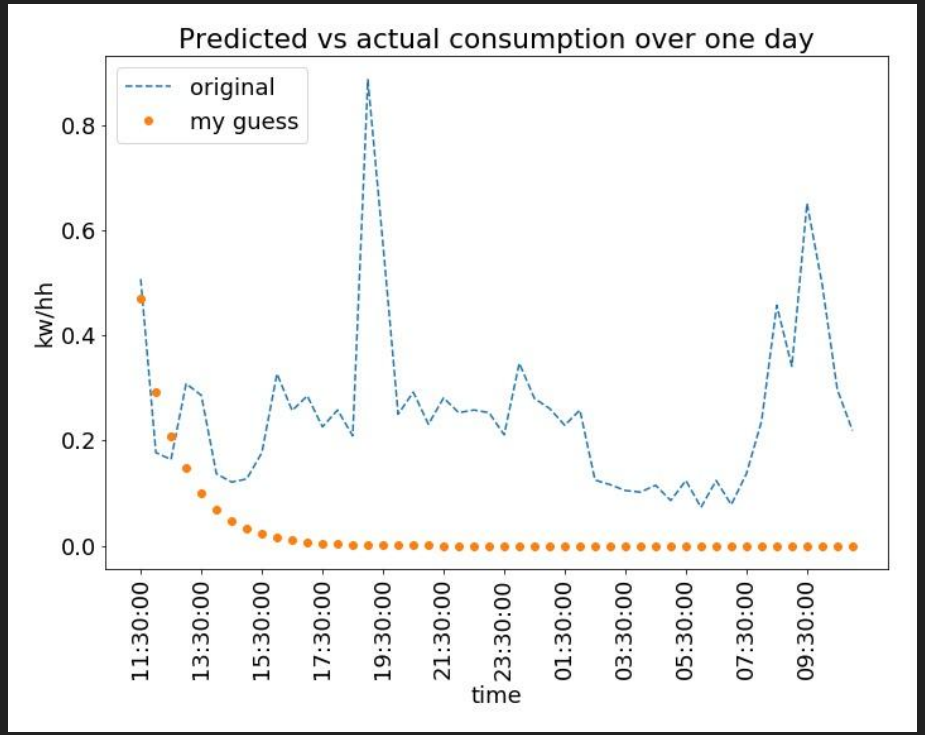
[6] Schofield, J. R., Carmichael, R., Tindemans, S., Bilton, M., Woolf, M., & Strbac, G. (2015). Low Carbon London project: Data from the dynamic time-of-use electricity pricing trial, 2013. *[data collection]. UK Data Service*.

[7] Schofield, J. (2015). Dynamic time-of-use electricity pricing for residential demand response: Design and analysis of the Low Carbon London smart-metering trial.

Appendix

Lamba = 0.0001

Started at 11:30



Appendix

Lamba = 0.0001

Started at 00:00