

Demand Response and Smart Meters

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Introduction

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

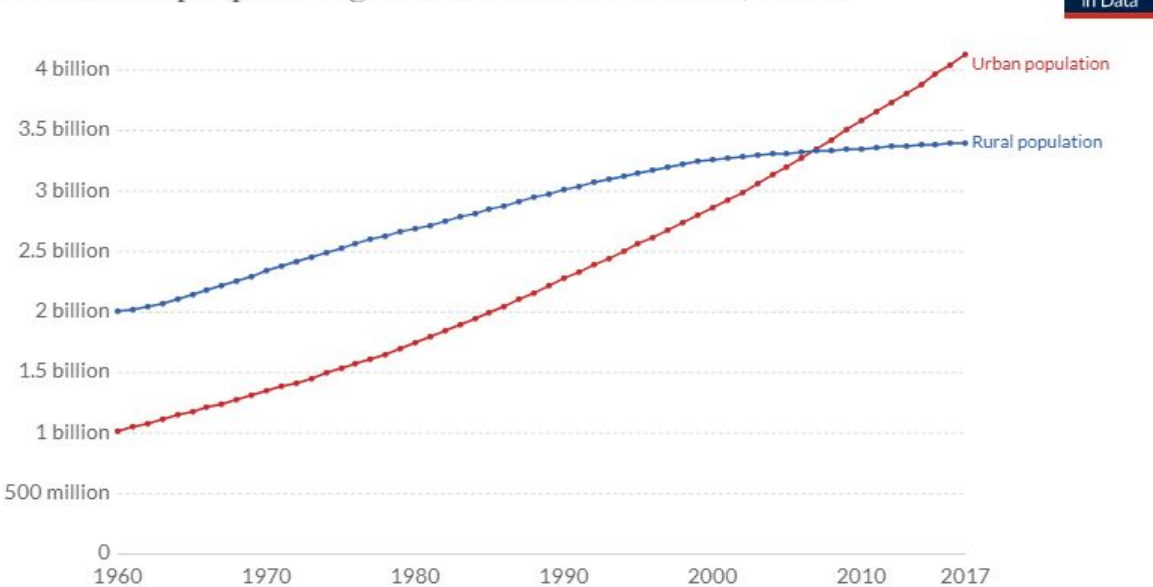
What this means?

- + Dense Power
- + Reliability
- + Peak Load
- Spread

Opportunities

- + Optimization
- + Renewables

Number of people living in urban and rural areas, World



Source: UN World Urbanization Prospects (2018)

Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

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Demand Response(DR)

Demand Response: act of providing financial incentives to shift consumer

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

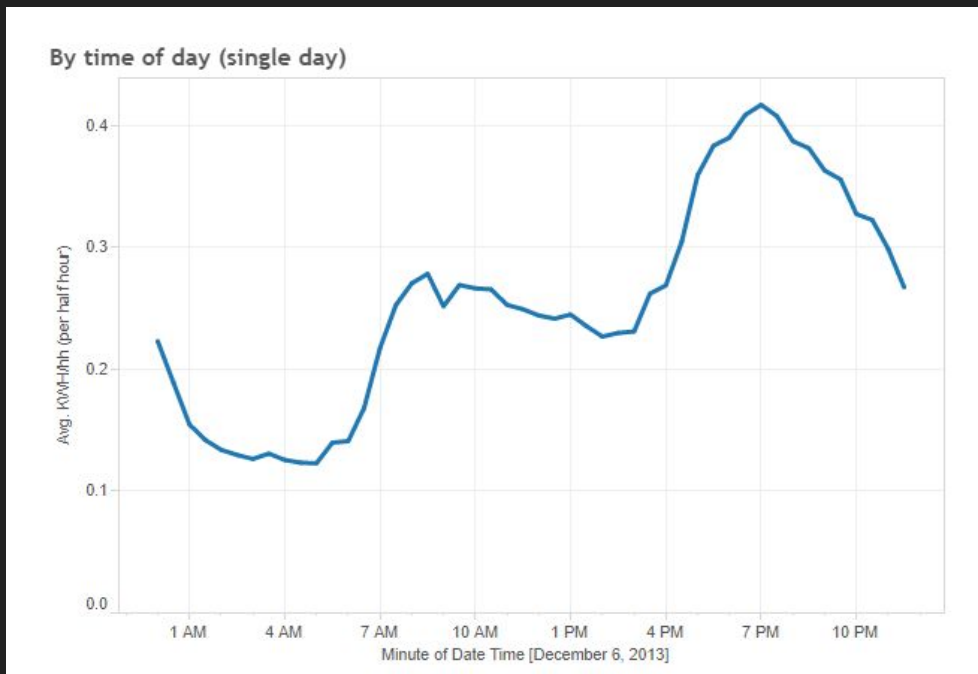
How?

System Balancing

- When do we generate?

Constraint Management

- How do we deliver it?



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 separate 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

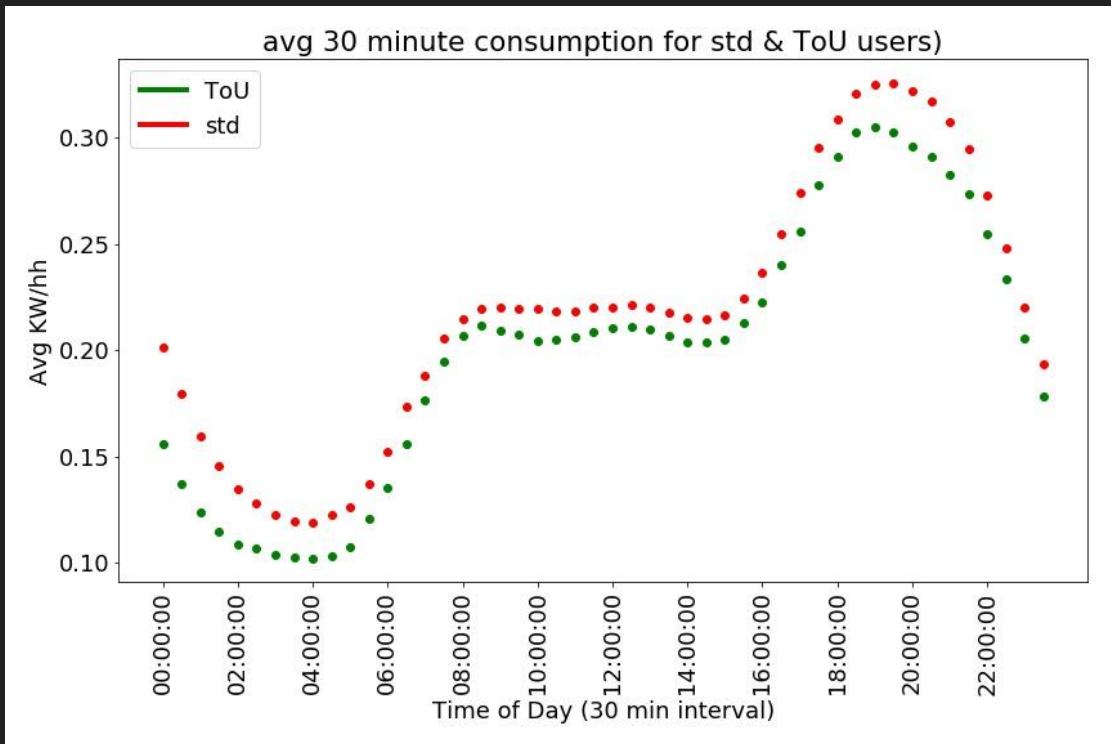
All intervals significant!

Avg annual savings
per house:

308kWh* £0.1176/kWh^[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?

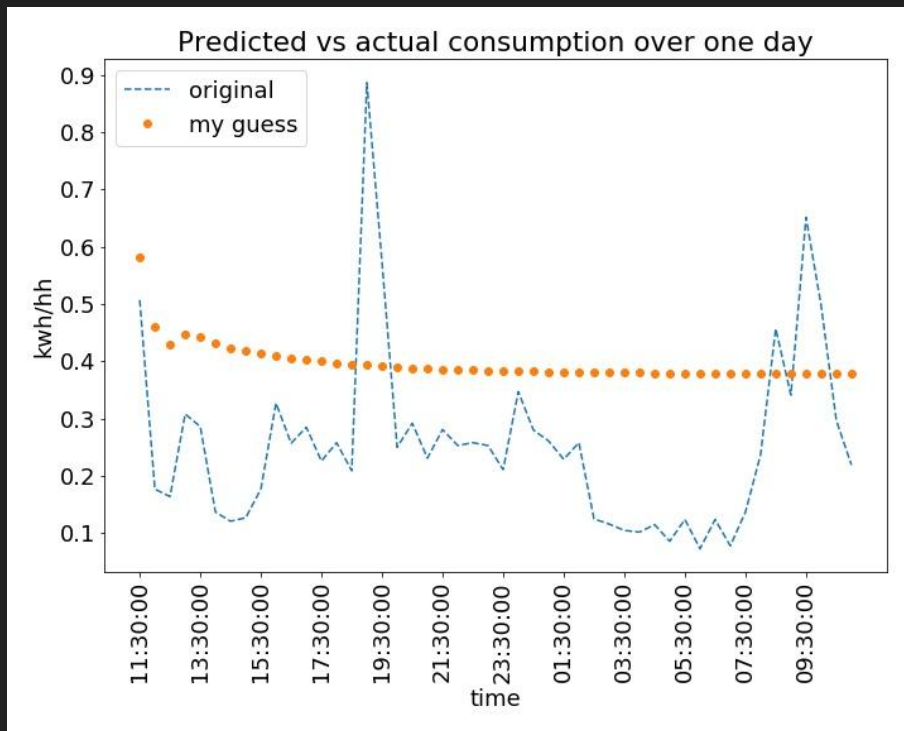
This is $0.004c_{t-4} + 0.04c_{t-3} + 0.003c_{t-2}$
 $+ 0.57c_{t-1} + 0.018c_{t-2}^2 + 0.005c_{t-1}^2 + 0.007c_{t-1}^3$
c=consumption

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/>

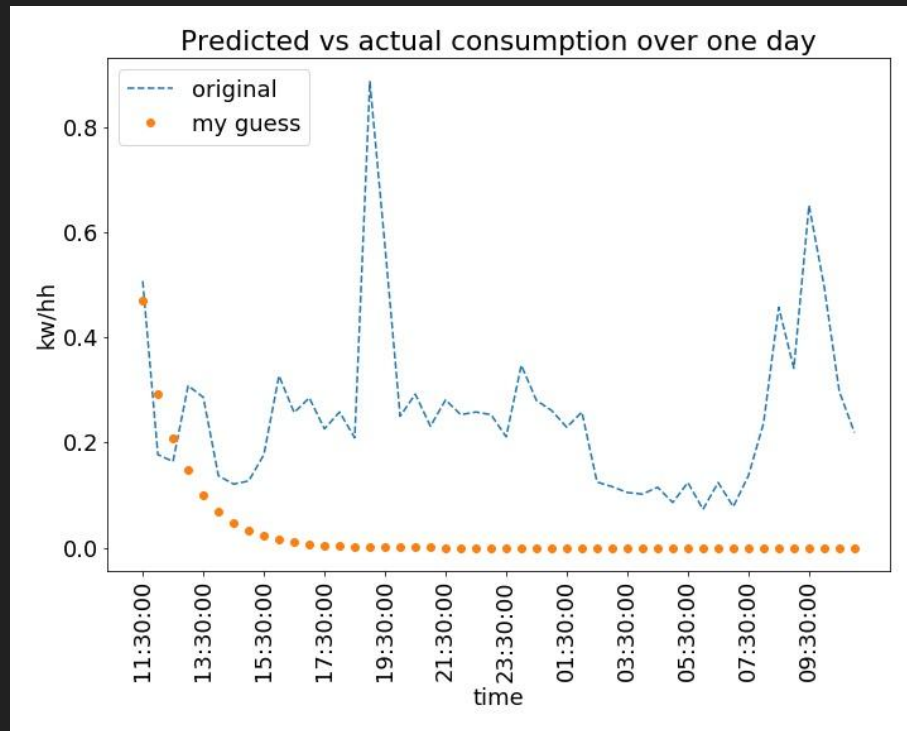
[5] Jenkins, N., Long, C., & Wu, J. (2015). An overview of the smart grid in Great Britain. *Engineering*, 1(4), 413-421.

[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.*

Appendix

Lamba = 0.0001

Started at 11:30



Appendix

Lamba = 0.0001

Started at 00:00

