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Regional UK Electricity Cost Modelling Concept, Framework, and Results

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Motivation and Questions

- **The oversimplification of electricity prices by the business is a missed opportunity to evaluate more accurately energy efficiency projects and investments**
- Is it possible to describe the half-hourly prices of electricity across UK regions via a mathematical model?
- How does electricity price change with the time?
- What is its intraday volatility and seasonal trend?
- How is it going to evolve in the future?
- Which regions are the most expensive?
- How can this information be used to assess with a greater level of detail the energy costs of running supermarkets?

The Electricity Commodity

- The electricity commodity is traded in the wholesale market
- Producers, suppliers, traders and consumers trade electricity in two different markets: *forward market (90%)* and *exchange market (10%)*
- Bilateral contracts in the forward market are secret
- The electricity commodity accounts for 50% of the final bill
- The rest of the bill is composed of
  - Network costs
  - Balancing charges
  - Environmental and social obligations
  - Supplier margins

Component Features

- Non-commodity bill components have special features

- HH. These components change every half-hour of the year. It includes all other temporal variations.
- Intraday. These components change within the day but not every half-hour. They have different values for a number of defined periods inside a day.
- Day type. These components have different values for weekdays and weekend days.
- Seasons. These components have different values for different months or group of months of the year.
- Annual. These components are constant during the entire year. Even if not shown in the table, all the components change from one year to another.
- Voltage level. These components depend on the connection voltage level of the building or facility.
- DNO area. These components are different for the 14 DNO areas of the UK.
- UK. The components are the same for the entire country

Electricity Components

Component	Parameter	Seasonality level	Settlement freq.	Spatial variation	Main Stakeholder
Energy	Market Index Price (MIP)	HH	HH	UK	Wholesale market
Tloss	Transmission Loss Multiplier (TLM)	HH	HH	UK	Elexon
Dloss	Line Loss Factor (LLF)	Intraday, Seasons and Day type	Annual	DNO areas + Voltage Level	DNOs
DUoS Commodity	Red / Amber / Green tariffs	Intraday and Day type	Annual	DNO areas + Voltage Level	DNOs
DUoS Capacity	Daily tariff per capacity unit	Annual	Annual	DNO areas + Voltage Level	DNOs
DUoS Admin.	Daily tariff	Annual	Annual	DNO areas + Voltage Level	DNOs
AAHEDC	AAHEDC Tariff	Annual	Annual	UK	NG and SSE
TNUoS	Triad tariff	Triad periods	Annual	DNO Areas	NG
BSUoS	BSUoS price	HH	HH	UK	NG
RO	RO buy-out price and obligation level	Annual	Annual	UK	Government and Ofgem
FiT	Tariff	Annual	Annual	UK	Government and Ofgem
CCL	Tariff	Annual	Annual	UK	Government and Ofgem
CM	Tariff	Intraday and Seasons	Annual	UK	Government, NG and Ofgem
CfD	Tariff	Annual	Annual	UK	Government and Ofgem

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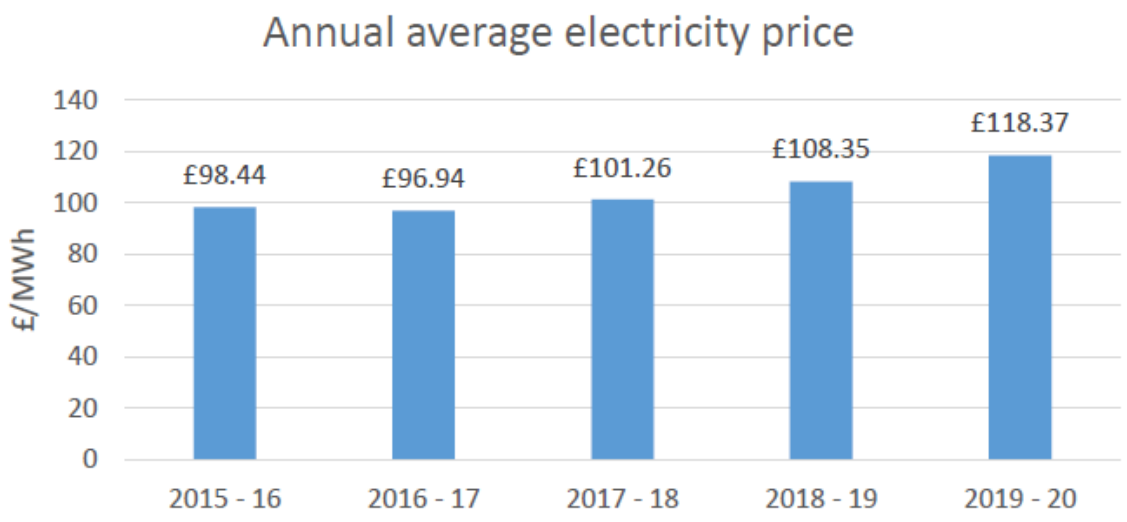
Electricity Bill Projections

Component	2015-16	2016-17	2017-18	2018-19	2019-20
Energy	51.8%	45.5%	37.7%	34.9%	31.7%
Losses[1]	2.9%	2.7%	2.2%	2.1%	1.9%
DUoS[2]	12.3%	13.6%	12.8%	13.6%	12.9%
TNUoS	5.6%	6.6%	7.1%	8.0%	8.4%
BSUoS	2.5%	2.7%	2.5%	2.3%	2.1%
RO	13.1%	16.1%	19.2%	18.7%	18.2%
FiT	4.8%	5.1%	5.6%	5.7%	6.0%
CCL	5.6%	5.8%	5.6%	5.4%	7.2%
CM	0.02%	0.1%	2.9%	2.7%	2.5%
CfD	0.1%	0.5%	3.2%	5.7%	8.2%
Other[3]	1.3%	1.3%	1.2%	0.9%	0.9%



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UK Regional Cost Modelling

- **<u>Model Objective</u>:** Quantify half-hourly regional electricity prices by deconstructing each tariff component
- Composed of
  - *Month type [Jan, Dec]*
  - *Day type [WD, WE]*
  - *DNO area [10, 23]*
  - *Year [2015-16, 2019-20]*
  - *Connection [LV, LV Sub, HV]*
- Value to the business
  - Rank UK regions in terms of electricity costs
  - Positively steer energy programmes Graphite, UKGG, Smart Hub, etc.

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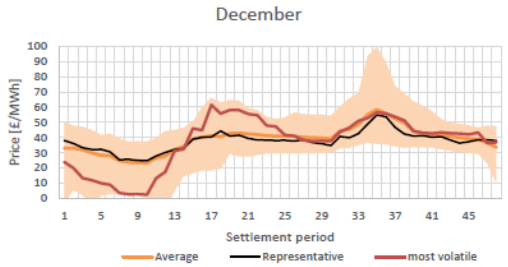
Component Modelling

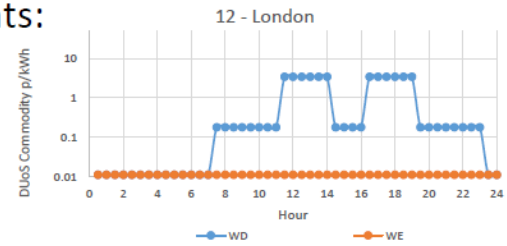
HH settled components:

- *Commodity*
- *BSUoS*
- *TLM*



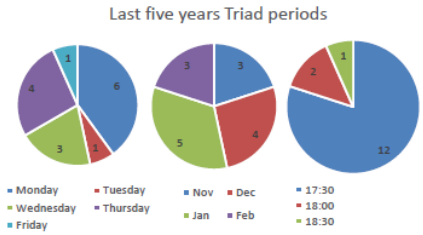
Deterministic components:

- *DUoS commodity*
- *LLF*
- *CM*



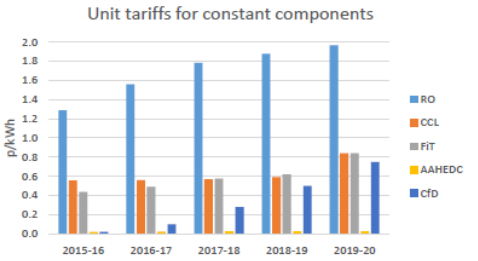
Non-kWh based components:

- *DUoS capacity*
- *DUoS admin (negl.)*
- *TNUoS*



Constant components:

- *RO, CCL, FiT, AAHEDC*
- *CfD*



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Example Results

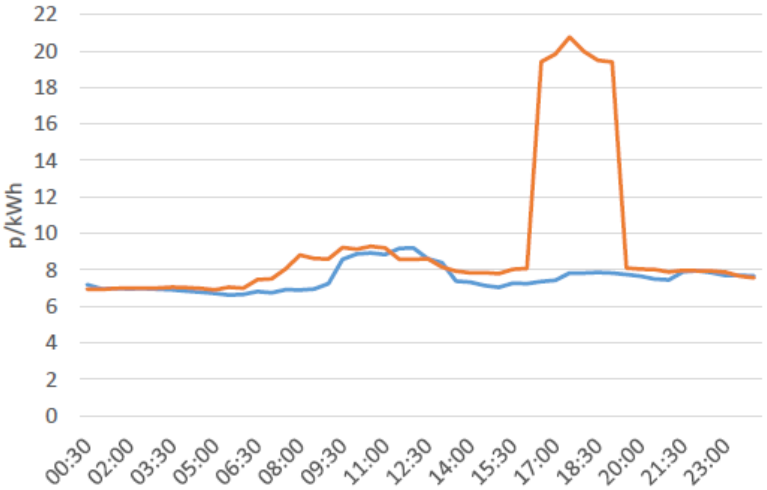
WE WD

June

2016-17

Low Voltage

South East



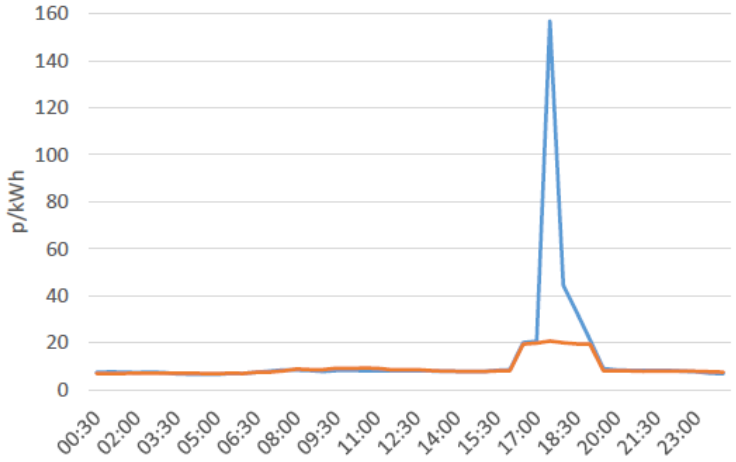
Weekday

January June

2016-17

Low Voltage

South East



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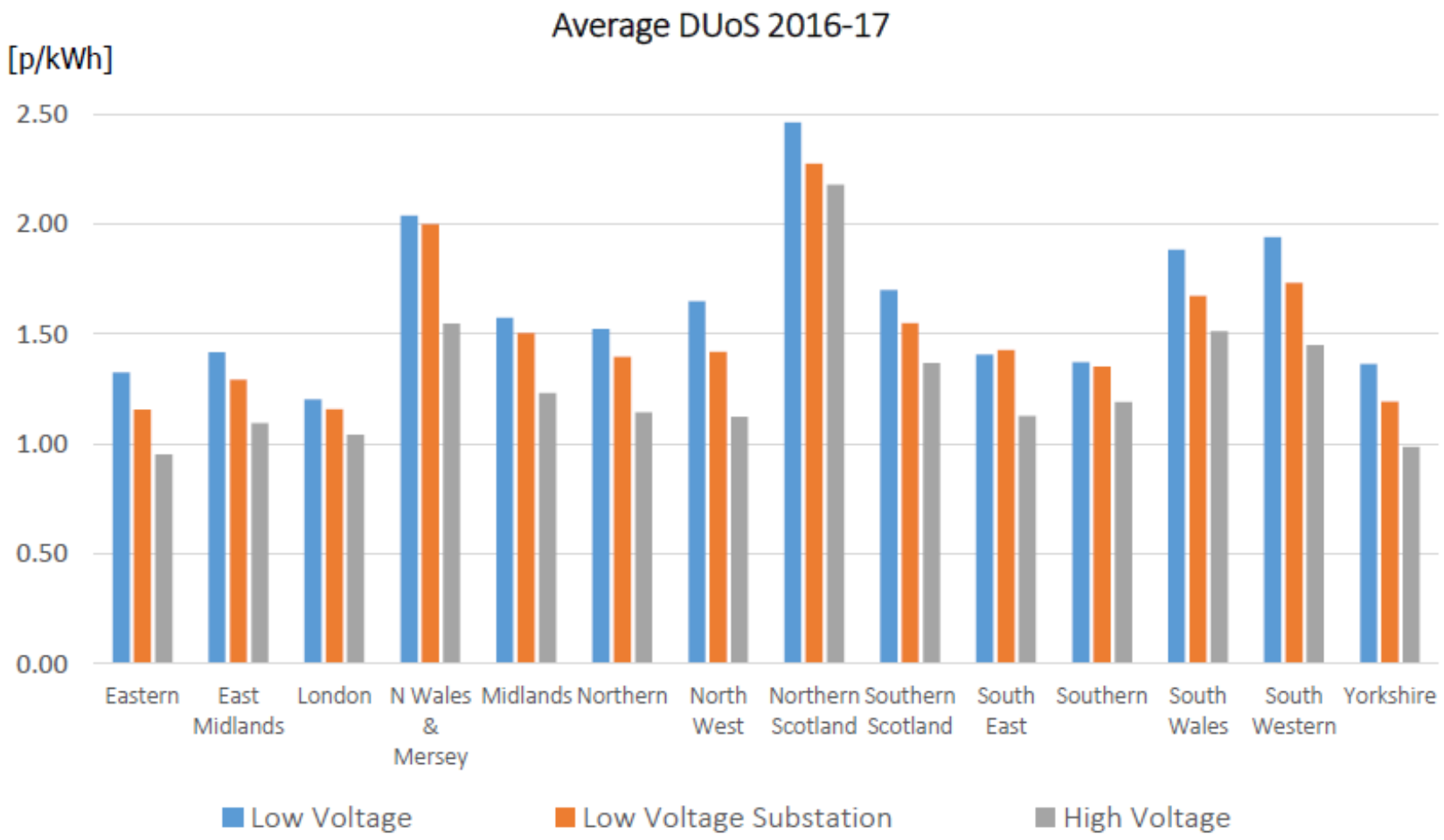
Results - DUoS Capacity and Commodity



Results TNUoS

	HH Demand Tariff (£/kW)	HH Demand Tariff (p/kWh)
London	51.87	40.35
Southern	50.08	38.95
South East	49.20	38.27
South Western	48.58	37.79
Eastern	46.54	36.20
Midlands	45.74	35.58
East Midlands	44.72	34.79
Northern	42.93	33.39
North West	42.83	33.31
N Wales & Mersey	42.68	33.20
Yorkshire	42.49	33.05
South Wales	42.31	32.91
Northern Scotland	40.97	31.87
Southern Scotland	40.24	31.30

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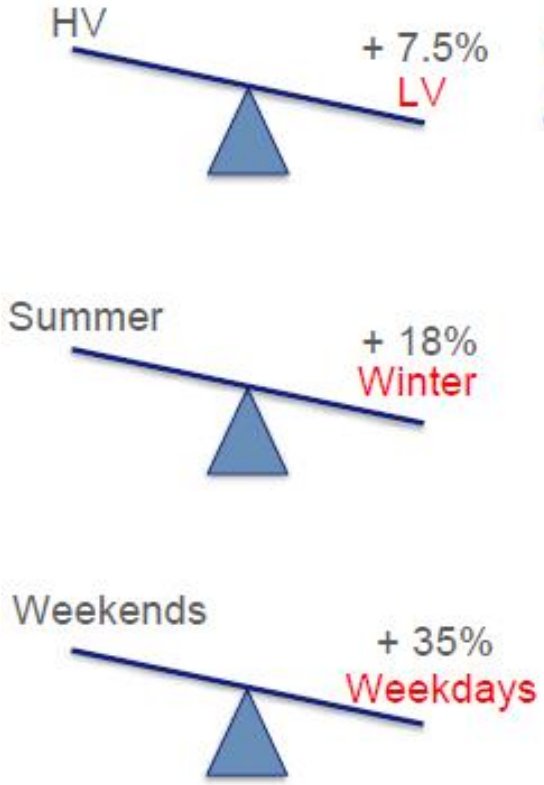
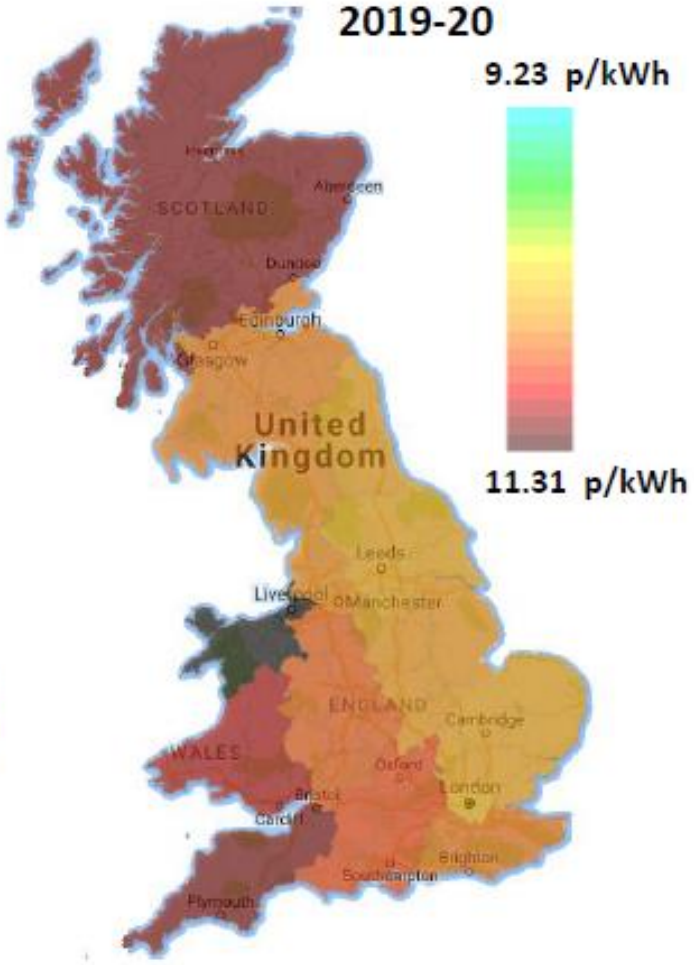
Results – Average Electricity Price





Strengths & Limitations

- Ability to capture HH prices for multiple regions is insightful
- Model was validated against the budget tool (98%) accurate
- Listing of SSL sites per energy cost becomes feasible
- Quantifying the cost of services or business operations becomes possible, albeit sub-metering required
- The model provides accurate results and it is very flexible
- This flexibility increases the complexity of using the model
- It only predicts prices up to 2019-20
- It must be actively and frequently updated

Findings

- Properties connected to LV should offer a better financial return on investment for energy saving projects
- The difference between the highest and the lowest electricity prices will increase in the future, increasing the benefit of load shifting and flexibility
- Maximum import capacity tariffs in London and Northern Scotland are high so special attention must be paid to the contracted capacity in these regions
- The regions of Northern Scotland and North Wales & Merseyside are the most expensive to run a business and therefore the most attractive to invest in energy saving measures

Conclusions and Further Work

- Capacity to understand cost dynamics is possible
- Assumptions used to convert charges to HH influences the
- Data can be very valuable to enhance energy investments
- Sources and market intelligence is key
- Additional resources needed to constantly update the tool
- All the results were validated with the budget tool but not with actual bills. Validating the results with proper bills could increase the accuracy of the model
- Tool could be enhanced to forecast costs by using uncertainty

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Feedback