WORKING with
Infrastructure Creation of Knowledge and Energy **strategy** Development

Quantifying the impact of green leasing on energy use in a retail portfolio: limits to big data analytics

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The problem

- Improving energy efficiency of buildings a key component of meeting the UK's carbon reduction targets
- Commercial sector buildings estimated to be responsible of 10% of UK's greenhouse gas emissions overall

But…

- Retail sector provides ~5.7% of GDP & employs one in nine working people ,
  - Diversity of type, from the small independent to national scale chains
  - Diversity of premises ownership model, owner occupier is the minority with rental the predominant model

‘Green Leases’

- Developed to support collaborative approaches to environmental and energy management in rented commercial property
- Two different routes to the use of green legal instruments:
  - ‘green’ clauses within leases (green leases [GL])
  - ‘green’ Memorandum of Understanding (MoU) alongside standard lease

Measuring impact of GL/MoU

- Two objectives:
  - to give a quantitative overview of the impact of GL/MoU,
  - to understand the limits of a big-data approach using real smart-metering energy data.

Partner description

- Very motivated!

- Full-line food and clothing retailer
- ~800 UK stores & 300 non-UK stores
- UK stores range in size from 183 m^2 - 20,036 m^2.
- Three different store types that roughly categorize what kind of goods each store sells and whether it is located in town or out of town.

Green Lease strategy

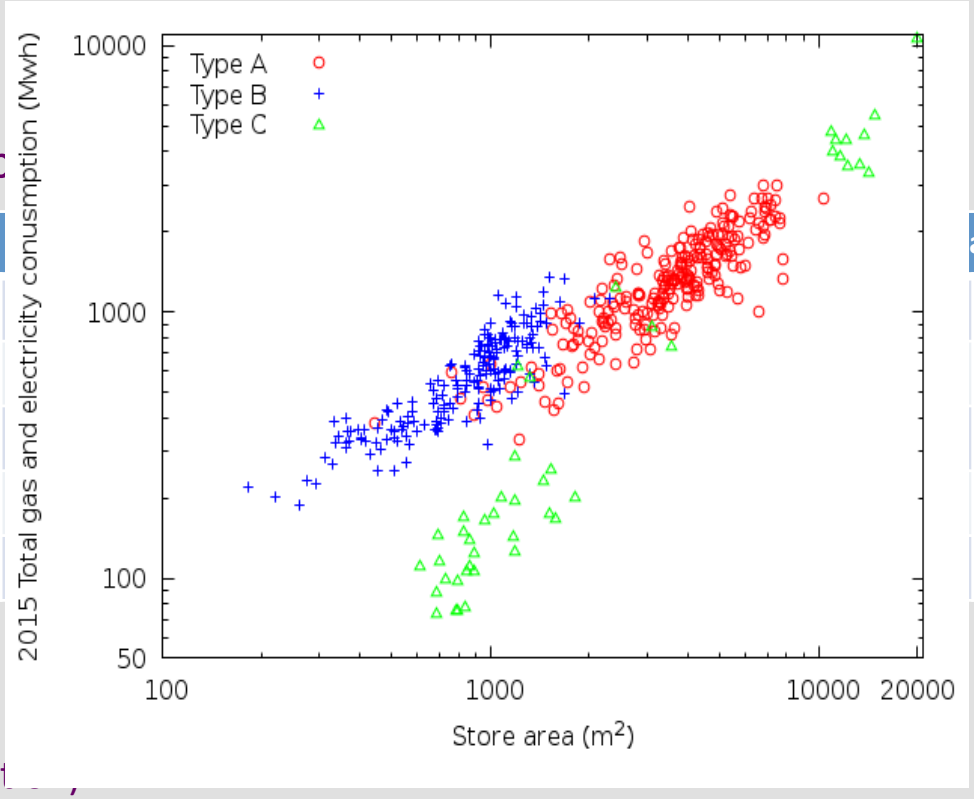
- Started 2013, building on BBP toolkit & templates

- No visibility of individual leases,
- Shared common GL terms from agreed and in use agreements
  - Green lease and MoU
    - To cooperate on commit to sustainability and provide a forum to discuss sustainability
    - Agree to use reasonable endeavours to agree and comply with an environmental management plan
    - Agreement to share utility data
  - MoU only
    - To consider the implementation of specified energy efficiency measures and practices
- **Exact date of signatory of either instrument not available, proxy date of 1/4/13 used**

Data

- Energy consump

	MoU
Type A	33
Type B	13
Type C	5
Total	52



as	
SL	Total
192	223
92	110
38	43
322	376

- Metadata
  - Floor area
  - Postcode (locat

Data preprocessing

- Criteria applied in series as filters
  - Stores with constantly zero gas readings throughout the period,
  - Electricity daily consumption <50 kWh and >50,000 kWh,
  - For both electricity and gas readings, a frequency test is performed over remaining non-negative readings, and those
  - Stores that have values with the exact value repeated more than 2% of the total are manually checked. Periods of times with these exact repeated values are found and removed.
  - Both types of Metadata available

	Electricity			Gas		
	MoU	SL	Total	MoU	SL	Total
Type A	32	202	234	29	180	209
Type B	11	152	163	5	72	77
Total	43	354	397	34	252	286

Analysis

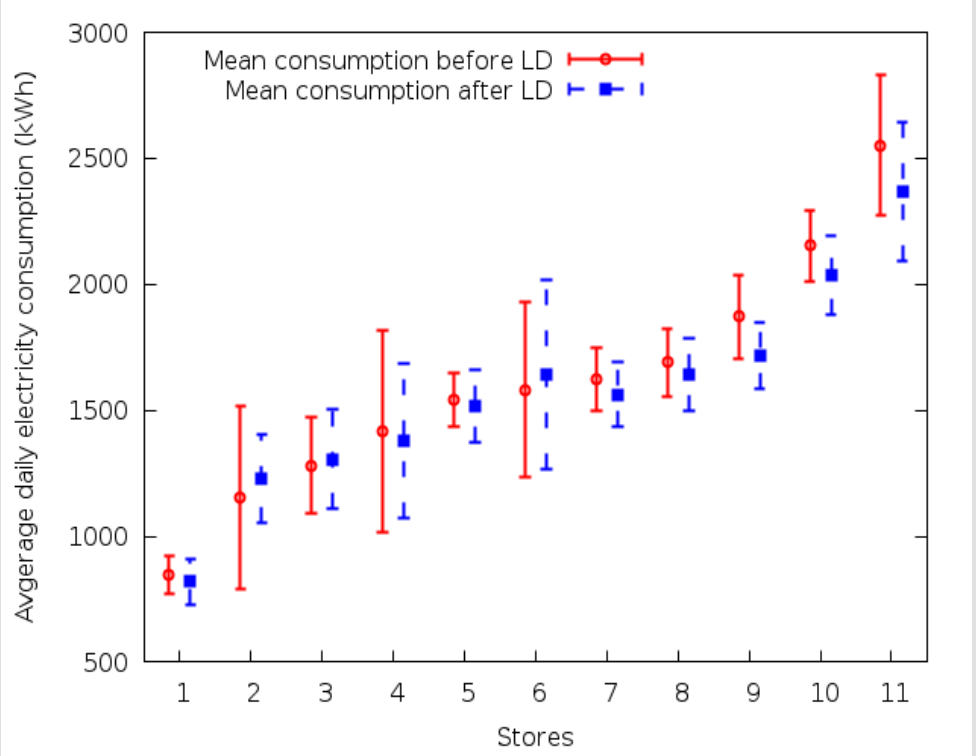
- Based on two different comparisons of the electricity and gas consumption
  - Three groups of stores:
    - GL stores,
    - MoU stores,
    - SL stores.
  - Two different aspects of energy consumption considered:
    - Time series: Comparing electricity and gas consumption two years before and after the adoption of MoU. This comparison is limited by the need for reasonably consistent time series data over a 4-year period between 2011 and 2015.
    - Portfolio Comparison: Measured consumption of MoU and GL stores is compared to SL stores for 2015, intending to show whether any changes found were transitional only or if there is a longer-term benefit possibly visible in GL- or MoU- stores.

Time Series: Self Comparison

- 72.4% of stores have μ_{CAL} smaller than μ_{CBL}
- But…
  - not statistically significant

Type-B stores with MoU

* Mon-Sat



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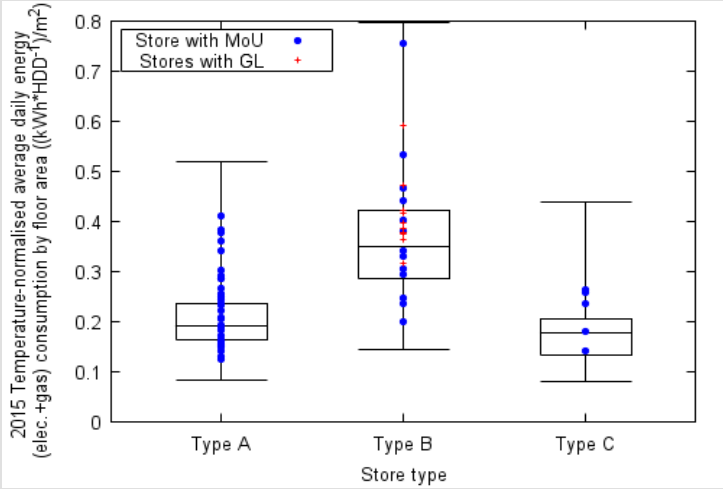
Time Series: Comparison between MoU and SL stores

	Electricity				Gas			
	% of Stores with a reduction in consumption		Stats. Ratio (Mean Δ_μ, Std Deviation in Δ_μ)		% of Stores with a reduction in consumption		Stats. Ratio (Mean Δ_μ, Std Deviation in Δ_μ)	
	MoU	SL	MoU	SL	MoU	SL	MoU	SL
Type A	78.1	81.7	(-6.5, 9.2)	(-6.5, 6.5)	62.1	60.0	(6.0, 65.6)	(-4.1, 37.0)
Type B	72.7	72.4	(-2.0, 4.5)	(-4.1, 7.2)	100.0	54.2	(-17.7,13.7)	(130.9, 599.7)

Comparing CBL and CAL showing the percentage of stores that decrease consumption after the lease date ($\mu_{CAL}<\mu_{CBL}$) including the mean and standard deviation.

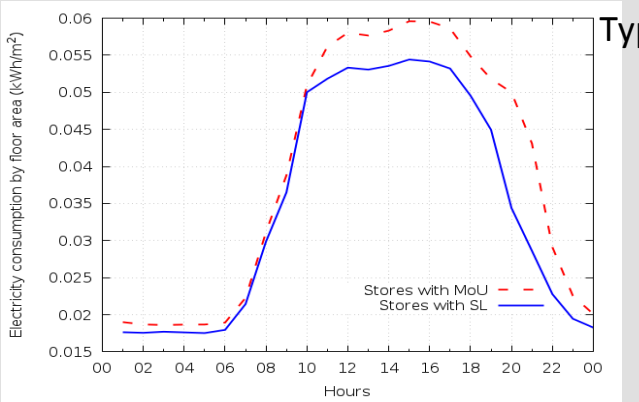
Portfolio comparison: Energy consumption among stores for 2015

	Electricity				Gas			
	MoU	GL	SL	Total	MoU	GL	SL	Total
Type A	33	-	208	242	28	-	180	208
Type B	13	11	172	196	8	9	82	99
Type C	5	-	42	47	5	-	33	38
Total	51	11	422	485	41	9	295	345

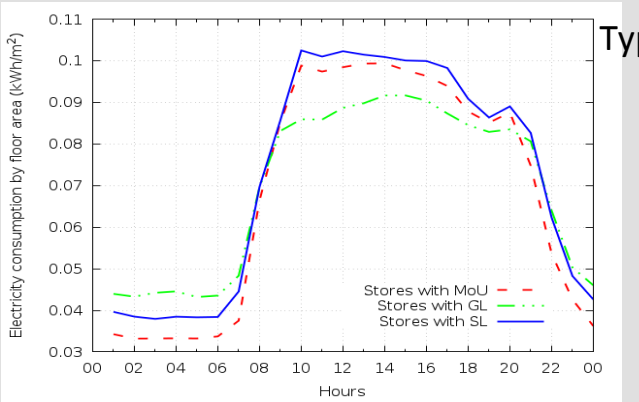


Aggregated temperature-normalised energy consumption by floor area of all the stores separated by store type and exact values of the stores with MoU/GL

Type-A



Type-B



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Results…

- MoU stores, **on average, do decrease** their **consumption** in the period afterwards.
- But… **% reduction** MoU stores **approx equal** to SL stores with similar levels of variability

- Have to remove the advantages from portfolio wide energy efficiency measures, i.e. gains that would have happened anyway.

- For temperature-normalised gas consumption,
- For Type A stores, # decreasing approx equal for all classes of store
- For Type B stores, # MoU stores > # SL stores that decrease their consumption (though the decrease is small on average)

- 2015 energy consumption of stores, average of both MoU and SL stores are similar
- Type A - The consumption of the MoU stores is slightly higher than SL stores.
- Type B - MoU/GL stores have smaller electricity consumption that Type B SL stores

- For aggregated energy consumption, differences between stores with and without MoU are not significant.

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We know there are limitations…

- Lack of availability of real metadata;
  - **specific details about** content of **individual legal agreements** describing landlord tenant relationships and obligations,
  - the **dates of entry** and extent to which legal agreements were therefore relevant to day to day energy practices,
  - **date of entry doesn't equal** energy saving process **implementation date**
  - **property use**, including exact utilisation of different areas of ground space with different energy density and environmental conditions,
  - **physical building information** such as year of construction, materials, structure, orientation, environment,
  - S**ub metering** information that may be more easily linked directly to drivers of energy usage and different energy efficiency measures taken
- Lack of internal information sharing within partner

  Energy information and necessary metadata may be available but…

  only accessible under standard conditions by different parts of the company and requiring non-trivial resources to access and analyse

- Making it available for analytics in any meaningful manner will require an internal change in its format, storage and access

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Conclusions

- Early analytic study **does not prove that GL/MoUs lead to quantifiable statistically significant impacts**,
  - Causality of decrease in consumption in specific classes cannot be fully established
  - Changes in consumption may be a reflection of retailers energy management policies
- Does not mean that these instruments do not have an effect
  - some clauses are designed to achieve specific objects, for example, sharing data may help achieve compliance requirements,
  - the effects can be slow and the analysed periods are quite short. It would, for example, be more useful to repeat the analysis over longer time periods before and after establishment of the clauses such as five or ten years.
  - compare stores that are more similar above and beyond just their type (A, B or C). This can include detailed internal differences, building differences and effectiveness of local regime/management inputs.
- 'Green Leases' are tools to help to induce social, behavioural and physical change in consumption.
- Changes should be translated into tangible energy reductions or peak shifts but which may be only directly discernible among smaller groups of stores where there are both external and internal similarities for comparison.

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THANK YOU

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