# A WICKED approach to retail sector energy management

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## Abstract[1]
The UK retail sector is vital to the economy, diverse, and facing a number of challenges. Retailers range from multinational corporations to small independent stores, selling everything from antiques to frozen yoghurt. Stakeholders include landlords, tenants, and owner-occupiers. Across the sector, energy costs and requirements for understanding, displaying, and reporting energy use are increasing. Meanwhile organisations face competing pressures to "go local", support staff development, and keep prices down. Because of this diversity, retail energy management creates a "wicked" problem, where solutions to challenges are contentious and multi-faceted. The Working with Infrastructure Creation of Knowledge and Energy strategy Development (WICKED) project provides energy solutions for different retail market segments. Through cooperative research, WICKED investigates clusters of technical, legal, and organisational challenges faced by retail groups, including those with smart meters and energy managers (the "data rich") and those without (the "data poor"). In partnership with energy suppliers, retailers, landlords, SMEs, and Oxford University, WICKED develops actionable energy and business insights by combining (1) top-down big data analytics, (2) middle-out organisational research, and (3) new bottom-up data. Building on this interdisciplinary evidence base, WICKED co-designs market-ready energy strategies to fit the retail sector's diverse needs. The project uses a segmented socio-technical model to explore challenges faced by six different types of stakeholders in the retail market: data rich and data poor owner-occupiers, landlords, and tenants.

This paper presents data from three different organizations: a European electronics retailer; a multi-national full-service department store; and a budget shopping centre with 91 units. These cases show that one size does not fit all: the data rich and poor will need different energy management solutions. Smart meters will not solve everything: further analysis is necessary to turn numbers into knowledge. Changes to legal infrastructure (e.g., leases) will be needed to assist tenants and landlords in sharing data to enable both groups to monitor, measure, and report energy use. Additionally, how organisational cultures frame employee duties, behaviours, and expectations requires further investigation.

## Introduction
Non-domestic building energy use accounts for approximately 18 % of UK carbon emissions. By 2050, total UK non-domestic floor area is expected to increase by 35 %, while 60 % of existing buildings will still be in use. There is significant potential for energy savings in existing buildings (Ürge-Vorsatz et al. 2012; Levine et al. 2007). Innovative energy saving measures in UK non-domestic buildings could save 18 $MtCO_2$ by 2020 and 86 $MtCO_2$ by 2050, depending upon the rate at which the measures can be deployed.

However, research into opportunities in the non-domestic stock is lagging. Both the recently published Low Carbon In-

1. Authorship for this paper is based on direct contributions to data gathering, analysis, and interpretation of these particular cases. The project overall is a joint effort which includes the work of Principal Investigator Peter Grindrod (Maths) and Co-I Malcolm McCulloch (Engineering). Suggested author order for citing this paper as written is: Janda, Patrick, Granell, Bright, Wallom, & Layberry.

novation Coordination Group's 'Technology Innovation Needs Assessment on Non-Domestic Buildings' (LCICG 2012) and the workshop on 'Energy in the Home and Workplace' highlighted End Use Energy Demand (EUED) in non-domestic buildings as an area of current low research activity (Hannon, Rhodes & Skea 2013). The Scientific Advisory Committee to the UK Research Council's Energy Programme has similarly noted that research into non-domestic buildings accounts for less than 10 % of the EUED portfolio and recommended further funding in this area. To bolster research in this area, in 2014 the UK Engineering and Physical Sciences Research Council funded six new projects on energy management in non-domestic buildings.

This paper discusses the conceptual basis for and initial results of one of these projects. The project is called WICKED, which stands for Working with Infrastructure, Creation of Knowledge, and Energy strategy Development. WICKED is a 2-year (July 1 2014–June 30 2016) interdisciplinary project, designed to learn from real world situations. The WICKED academic research team combines expertise in energy use, maths, computing, engineering, physics, law, and organisational behaviour. It partners with the retail sector, using empirical research and big data analytics to uncover how much information is needed and by whom to help the sector move beyond paying bills towards thinking more carefully about strategic energy management. In exchange for energy and organisational data, the researchers will provide insights to help businesses save money and respond to government initiatives. Project partners include energy suppliers; retail property owners, landlords, and tenants; business support groups; and energy advice companies. It also has project advisory group with representatives from the British Retail Consortium, the Better Buildings Partnership, the Department of Energy and Climate Change, the British Council of Shopping centres, the electric power industry, and academics with experience in sustainable property and retail management.

The paper begins with a discussion of WICKED's approach to the problem of energy management in the retail sector and non-domestic organizations, describing WICKED's novel socio-technical and interdisciplinary approach to the sector. Next, it presents three partner case studies – a European electronics retailer; a multi-national full-service department store; and a budget shopping centre with 91 units – using three different levels of analysis and disciplinary approaches. These cases articulate initial results from the projects' work on (1) big data analytics implementing maths and computing methods; (2) organizational initiatives though a lens of law and organizational studies; and (3) building-level analysis using engineering and meterology. Each of these case studies contains short descriptions of methods, issues, and impacts, and each case study also contains a short section on the organizational context. A final discussion and conclusions section looks across the cases to articulate how WICKED plans to build coherent understandings across these cases and methodologies, and more broadly throughout the sector.

## A WICKED approach

In the UK, the retail sector is the largest commercial property sector and a vital part of the economy. Valued at over £300 billion, it accounts for one in 12 companies and employs one in nine working people. Businesses in the sector are diverse, ranging from multinational corporations to small independent stores. Across this diversity, the sector as a whole faces a number of challenges, including the global economic slowdown and the growing problem of energy management. Energy prices have increased significantly in recent years, as have the number and nature of government requirements for understanding, displaying, and reporting energy consumption (e.g., Energy Performance Certificates and Display Energy Certificates). A number of government policies seek to guide the non-domestic sector toward using less energy, for example: the Carbon Reduction Commitment Energy Efficiency Scheme, the sector wide Climate Change Agreements, the European Union's Emissions Trading Scheme, and the Energy Savings Opportunity Scheme. A successful response to these mandates while maintaining a thriving economy will require ingenious decisions from managers and employees at all organisational levels from strategy and operations through to staffing and everyday routines.

Over the past 40 years, the poor uptake of retrofit technologies and management practices has resulted in efficiency and performance "gaps" between how buildings perform in practice and in theory. A lack of information about the distribution, combination, and effects of these variables turns energy management in the non-domestic sector into a "wicked" problem (Rittel & Webber 1973).

### ENERGY MANAGEMENT IN NON-DOMESTIC ORGANIZATIONS

There are many different factors that can influence the uptake of energy efficiency measures and strategies in businesses and other organizations. In this paper, we look at three broad categories of factors that that shape how organizations can pursue their goals: legal, organizational, and technical. We call attention to these factors as different kinds of "infrastructure" that are largely taken for granted in the daily operations of most organizations. Although these parameters can be changed over time, they generally set the frame in which most short term or "normal" activity and decision-making occurs.

#### What is legal infrastructure?

By legal "infrastructure" we refer to the legal parameters that shape how buildings are owned and used. These parameters affect what kinds of changes owners can and cannot make to their premises (e.g., for health and safety reasons, or because of cultural and historical significance) and include energy and building regulations. Of particular interest in this area from an energy management point of view is the "split incentive" problem between tenants and landlords. Half of the total UK stock of 'core' commercial buildings (shops, offices and industrial premises) is occupied by tenants (Dixon 2009). Energy management opportunities in leased properties depend on the physical premises, the varying organizational capacities of both landlord and tenant, and the language of the lease itself. Most leases do not permit tenants to make alterations to the premises nor require landlords to share energy data with tenants. 'Green leasing' encapsulates the idea that a new form of leasing will enable landlords and tenants to work cooperatively to help meet environmental targets. Greener leasing practices can adjust the incentive structures within leases to facilitate upgrade and retrofit initiatives, promote co-operative dialogue between the landlord and tenant, and incorporate environmentally sensitive wording. Green leases are built on 'green' clauses within the lease. Bright and Dixie (2014: 10) defined 'green clauses' as those which are "designed to facilitate the property being used in a resource efficient manner and which … [take] account of energy efficiency and other sustainability goals and measures." Examples of categories include 'Sustainability statement', 'Environmental plan', 'Alterations and Repairs', 'Data-sharing' and 'Environmental improvements'. Although there is no standard definition of greenness, 'light green' clauses are often non-binding provisions that encourage or facilitate cooperation and data and information exchange on environmental matters between landlords and tenants; 'darker green' clauses are more specific, directive and/or binding obligations (e.g., allowing increases in service charges related to environmental upgrades). However, even 'green' leases have been found to vary in the extent to which they allow alterations and data sharing (Bright & Dixie 2014). Moreover, there is "surprisingly little discussion as to how the letting regime does, and can, promote (or hinder) commercial activity" (Bright 2006: 138).

#### What do we know about organizational infrastructure with respect to energy?

Currently, all firms and organizations pay energy bills, but not all actively "manage" energy. Where energy management does occur, it is usually driven by financial concerns or corporate social responsibility, rather than being treated as a strategic business opportunity (Cooremans 2011). The presence or absence of an energy manager is one important indicator of organizational capacity to manage energy; an energy reduction plan is another. A recent Major Energy Users Council (MEUC) survey in the UK (Jones 2013) found that 75 % of respondents said they have at least one staff member responsible for energy, but the rest have not allocated staff time to manage energy concerns. 62 % of respondents had a clearly defined energy reduction strategy for their business, but the remainder did not. These results indicate gaps in organizational capacity to manage energy, even amongst self-defined major energy users. Staffing is an acute problem for many SMEs and other organizations without an energy manager, who may not have either the necessary information or the staff capacity to pay attention to improving energy usage profiles.

#### Technical infrastructure: How do meters matter?

Although energy metering is the key to building energy management programs, it is often (1) not done and (2) not done well. A Carbon Trust study found there are approximately 2.7 million manually-read meters in UK SMEs, which are read only quarterly or annually (Carbon Trust 2007). Many businesses do no monitoring at all, paying bills being their only exposure to energy use and cost. Some businesses manage to take manual meter readings and some have real time meters (usually at the 30 minute level) installed at the fiscal (billing) meter level – but normally only for electricity. These ½ hour electricity meters are expensive and only mandated for the larger businesses such as those within the Carbon Reduction Commitment. Data that are automatically collected from the meter may not be easy to get back from the supplier in near real time, or may only be returned as a daily file; online software can be cumbersome and not attuned to the user. The smart meter roll out programme for domestic and non-domestic buildings in the UK attempts to overcome some of these problems. There are plans to replace and upgrade 53 million electricity and gas meters by 2020 (Carbon Trust 2007). There are still, however, questions about how the smart meters will roll-out, and to whom; also whether users will have easy access to their data.

A data gap has opened between the groups that have better meters and energy management infrastructure and those that do not. This gap will persist at least until the smart meter rollout has been completed, and possibly beyond. Smart meters tend to be targeted at the main fiscal electricity meter for the premises, and are often thought to help the utility (e.g., with billing and possible real-time pricing in the future) more than the user. A metering regime targeted towards users (instead of utilities) might take a more detailed and diverse approach: measuring energy use at the meter, sub-meter and appliance level, for gas, electricity, water and oil.

WICKED uses a segmented socio-technical approach to work with and learn from different configurations of physical, legal and organizational infrastructure in the non-domestic sector; co-create knowledge through interdisciplinary and multi-level academic research; and develop energy strategies tailored to different market segments based on new actionable insights drawn from the intersection of theory and practice.

### A SEGMENTED SOCIO-TECHNICAL APPROACH

WICKED introduces a segmented socio-technical approach to work with and learn from different configurations of building energy data and ownership in the existing UK non-domestic stock (Janda et al. 2013). This segmentation model (see Table 1) uses the concepts of "data rich" and "data poor" to identify and map energy-related infrastructure, as well as barriers to and opportunities for change.

We define "data rich" as a Platonic ideal archetype: an organization that is able to gather, analyze, and use energy data to manage its premises in perfect harmony with its core strategy and central concerns. The reality is somewhat messier and inexact. Real organizations fitting this category will have lots of data – generally achieved through automatic meter reading (AMR) – and an energy manager of some description. In contrast, a "data poor" organization is one without access to real-time data and lacking the in-house analytical capacity to measure, map, and understand energy issues.

This typology is a heuristic model designed to help define and categorize research assumptions about the nature and distribution of firms and organizations with respect to energy issues. The horizontal categories recognize that there are three kinds of ownership types in the market: owner-occupiers, landlords, and tenants, each of which is subject to a different kind of legal infrastructure. The categories on the right split these three ownership types into data rich and data poor categories, resulting in a typology of six different firm types.

## Learning from Three Levels of Analysis

WICKED is designed to develop actionable energy and business insights through interdisciplinary research by combining (1) top-down big data analytics, (2) middle-out organisational research, and (3) new bottom-up data collection. This section provides insights from initial explorations in each of these three dimensions with three different partners: a European electron-

**Table 1. Socio-technical segmentation of the UK non-domestic stock.**

| **Segmentation of the UK Non-Domestic Market** | | **Data Rich** (e.g., an organization with AMR and an energy manager) | **Data Poor** (e.g., an organization with legacy meters and no energy analysis) |
| --- | --- | --- | --- |
| Owner Occupied | | A | D |
| Leased Space | Landlord | B | E |
| | Tenant | C | F |

*Janda, Bottrill and Layberry (2014) used this approach to focus on the "data poor" tenants and owner-occupiers (Types D & F). The current research aims to "fill in" the table further by concentrating on "data rich" tenants (Type C) and "data poor" landlords (Type E). It also goes beyond the survey methods used in Janda, Bottrill and Layberry (2014) to incorporate three different levels of analysis, additional disciplinary methods and perspectives. This broader approach enables us to learn both within disciplinary approaches and across them.*

ics retailer; a multi-national full-service department store; and a budget shopping centre with 91 units. These three cases show different ways in which the field of energy management is developing, and also articulates the challenges faced by these different groups.[2] This tripartite analysis is followed by a discussion section that links these three different levels of analysis, seeking synergies between them.

### TOP-DOWN ANALYTICS: A CASE STUDY USING "BIG DATA"

Much has been written about the potential benefits of big data analysis to understand various kinds of problems. Theoretically, it is possible to learn a lot by using the right tools to filter, organize, and assess energy data from large building portfolios. However, little is known about the kinds of analytical tools (or 3rd party companies) that energy managers actually employ to understand their data sets, whether these tools/companies use the best algorithms for the tasks, whether quality of the data gathered is uniform, or if the data gathered contain all the variables necessary to turn numbers into knowledge. In WICKED, a number of our retail partners have large energy data sets accruing across their portfolios. This anonymized case study focuses on one such retail partner (Retailer 1), which is a European electronics company with a work force of 40,000 employees in 3,000 stores spanning 11 countries. It shows how big data analytics can assist in classifying data, offering new insights to energy managers.

#### Context: big data analytics

Behavioural classification is one of the possible analyses that can be performed with the presence of big data sets of electricity readings. Detecting groups of customers that present similar patterns of energy consumption can be helpful for many purposes such as detecting failures and discovering fraudulent usage (Nikovski et al. 2013) or applying focused marketing (Van de Grift, Marquis & Dougherty 2014).

Our purpose is to find groups of premises from the same company/sector that present different electricity consumption patterns. We will use this division to perform a posterior investigation (secondary analysis) of the existence of physical features of the shops (e.g. size, geographical location), the presence of large energy-intensive appliances such as heat pumps or air-conditioning, or any other technical aspects that explain differences in electricity profiles. The remainder of the variance should highlight opportunities to examine possible technical malfunctions, differences in store management/staff behaviours, or possible dissimilarities in customer use (e.g., stores with more customers may use more energy at tills, open and close doors more frequently etc.).

Clustering techniques provide an unsupervised classification (automatic segmentation) of customer behaviour based only on electricity readings. Many previous studies have employed clustering analysis to electricity load profiles (see Chicco, Napoli and Piglione 2006; Chicco 2012 for literature reviews comparing techniques and evaluation measures).

#### Case study 1: cluster analysis of electricity data

This case study focuses on data provided by a European electronics retailer (Retailer 1). This data set corresponds to electricity readings from a set of 663 shops in the company's UK portfolio, which are a definable subset of the company's total holdings. Retailer 1 rents these shops from a variety of landlords, and they range from 500 to 1,500 sqft. These data reflect readings at thirty minute intervals from April 2013 to October 2014, representing a data set with about 17 million electricity readings, as well as some meta-data associated with these readings (e.g., a retailer's classification of building type, postcode, and etc.). The data are held online, accessible via a website hosted by a 3rd party energy data analytics company.

In our clustering analysis, we performed the following steps. First, we computed a representative daily electricity load profile that describes the typical daily behaviour of consumption for each shop by aggregating and averaging all the 30-minute electricity readings during days when the shop is open (48 values per day per shop). In this study we selected from Monday to Saturday as we have perceived that the usage pattern changes during Sundays. Secondly, a clustering algorithm was applied to the set of daily profiles, obtaining the groups of profiles as an output. The algorithm we employed is the Dirichlet process mixture model (DPMM), which is a Bayesian non-parametric

2. Due to anonymity requirements, only one of our partner organizations is named in the text. The need for anonymity limits our ability to cite our sources fully. Through pending collaborative disclosure agreements, we hope to be able to name additional partners in future work.

algorithm that uses Dirichlet-multinomial distributions to model the data (Granell, Axon & Wallom 2015). The main advantage of this algorithm is that the resulting number of clusters is not an input parameter given by the user, which happens with most other clustering methods previously used to cluster electricity profiles (e.g. k-means, fuzzy k-means, hierarchical clustering algorithms, self-organising maps [Chicco 2012]). Finally, the obtained clusters are analysed and common features of the shops in each cluster are investigated.

The electricity data set contains retailer-specific meta-data used to classify shops into one of nine different categories (e.g. shopping centre, high street, arterial route shop). In our analysis, we included only the top five of the retailer's categories (containing 652 buildings).[3] We employed the DPMM algorithm to independently cluster daily electricity load profiles for shops in each of the top five categories: high-street shops, shopping centres, retail parks, arterial route stores, and regional stores. Due to space limitations, we present the results of only one category in this paper: 75 arterial route stores.

Figure 1 shows an example of the centroids (average of all the profiles of a cluster) for the four clusters obtained when clustering arterial route shops. There are 38 shops in cluster 1; 13 shops in cluster 2; 17 in cluster 3; and seven in cluster 4. The shape of all the centroids is similar, but there are differences considering the quantity of energy consumed. When the shops are closed, the centroids of cluster 1, 3 and 4 present low levels (less than 1 kWh), whereas cluster 2's centroid consumes around 2 kWh. At opening times, there is also a divergence of consumption values: cluster 3 and cluster 1 present respectively the highest and lowest value for this period of time. The same clustering analysis has been performed on the other shop categories. The next step is to obtain more information about the shops to understand the likely reasons for these different profiles. This analysis can be carried out by looking for correlations between the shops' features and their cluster membership and separation. Additional research over different features from the electricity readings and more clustering algorithms can also be investigated.

In addition to clustering analysis, other data mining techniques can be also applied to analyse different aspects of the available energy data. For example, we have performed linear regression analysis to investigate the correlation between the energy consumed and temperature (eg, Kennedy et al. 2013). Another aspect that we are interested in is adaptive rolling forecasts to predict the time and amplitude of the consumption peaks at consumer level. We are also working to obtain new data sets from other retail partners.

From this process, we can also make some observations about the current and possible roles of using electricity data to create actionable insights. First, the electricity data for this particular retailer does not have a lot of "meta" data attached to it. Anyone looking for energy management opportunities in the existing data sets will have to cross-reference with a different database to tell each store's size, number of employees, or other factors that might influence consumption patterns. This process would be cumbersome and could introduce additional errors. Second, the pre-processing of the data showed that there were a number

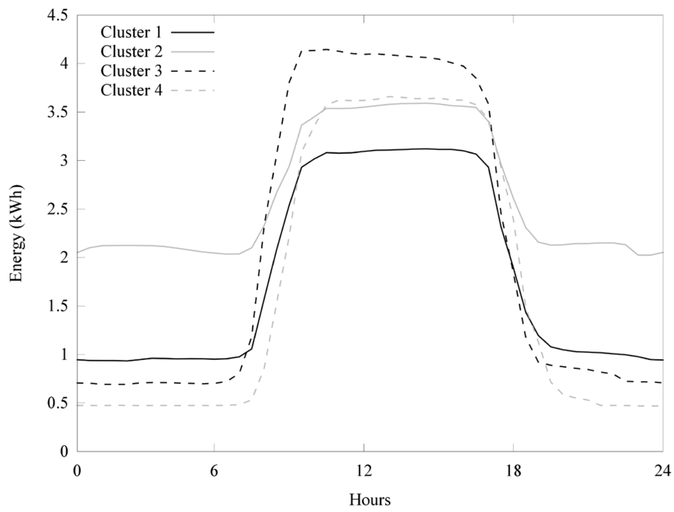


*Figure 1. Cluster analysis of electricity data from 75 arterial route shops.*

of empty files and false readings contained in the data set. This process in our analysis showed that 0.8 per cent of the meters were "off" (returned readings with values less than or equal to zero); 2.8 % of the meters were "stuck" (identified by repeated time stamps); and 3 % of the meters were communicating only intermittently (identified by a lower number of readings than expected). Across the data set, there were 20 meters (3.1 % of the total) which failed one or more of these tests. Other flaws in the data set may also exist, but are difficult to filter out without gaining a better idea of the expected performance and consumption norms. This process of looking for anomalies can be automated, but it is unclear to what extent either the retailer or the 3rd party manager is actively engaged in fine-tuning the analysis to assist with granular assessment of the meters themselves. For example, are intermittent meter readings indicative of meters that are about to get stuck or fail? This kind of close attention over time to fine details and fluctuations may or may not be part of the data package purchased from a 3rd party provider. Third, when purchasing data analysis from a 3rd party and possibly switching between different providers, a retailer may lose (or gain) data continuity and functionality in ways that are not immediately obvious. Consider, for example, the likelihood that different data companies use different filters to clean, sort, and understand their data. These differences are unlikely to be transparent to the retailer, as they would be embedded within the service provided. Which technical and organizational factors are included or discarded from the analysis will inevitably affect the results. As the idiom "the devil is in the details" suggests, there is more to big data analytics than algorithms.

### MIDDLE-OUT ORGANIZATIONAL ANALYSIS: A CASE STUDY IN CONTEXT

This section moves from a quantitative focus on electricity data to a more qualitative exploration of the organizational aspects of the retail sector in Britain. It begins with a description of the current context of sustainability programmes and green leases in the UK retail sector. Then it focuses on a case study of one retail company's notable efforts to break new ground in the area of green leases.

3. The remaining four retailer categories contained only 11 buildings in total, representing 1.6 % of the retailer's portfolio. The low distribution of buildings within the remaining categories did not justify further analysis using clustering methods.

**Context: sustainability programmes and green leases in the retail sector**

The UK retail sector contains a number of large organisations that have well-known and highly publicized sustainability programmes. For example Sainsbury, Tesco, Morrison, and Marks & Spencer all have sustainability plans that incorporate carbon reductions (Sainsbury 2015; Morrison 2015; Tesco 2015; M&S 2014a). These initiatives are supported by the British Retail Consortium (BRC), which is the leading trade organization for the retail industry (BRC 2015a). Its members include approximately 200 retailers and food service companies, including a number of multi-national firms headquartered outside the UK (e.g., McDonalds, Ikea, and Starbucks). It also partners with trade associations (e.g., the British Council of Shopping Centres) and other groups providing services to retailers (e.g., banks, landlords, distribution companies, accountants, etc.). Independently and in partnership with the UK Department of Energy and Climate Change, the BRC has produced a number of initiatives to assist with and learn from its members' efforts, resulting in reports about increasing resource efficiency (BRC 2014), workshops (BRC/DECC 2014), and policy guidance (BRC 2015b).

Despite these initiatives by leading companies and trade organizations, retailers as a whole may not be "buying"[4] the sustainability agenda fully, particularly with respect to green leases. A recent study by the College of Estate Management, in collaboration with the British Council of Shopping Centres, interviewed and surveyed retailers based in UK shopping centres in relation to sustainable asset management generally, and attitudes to green leases specifically (Whitson & Crawford 2013). In relation to sustainable asset management, the study found that retailers are concerned that the cost of green improvements may be passed on through the service charge. With respect to green leases, the results suggest that retailers are concerned about the fairness of green lease obligations, who has responsibility for implementing them, and the impact on rent levels. The results also suggest that agents are advising against signing green clauses within leases. Additionally, poor communication and lack of trust between landlords and tenants hinders cooperation.

The study also suggests that the introduction of green leases has been more successful in the office sector than in shopping centres and highlights several reasons for this. First, shopping centre landlords' control over the supply of utilities is limited to the common parts, whereas in offices it tends to extend to the whole building. Second, shopping centre landlords' control of operations more generally is also limited to the common parts. Third, the large numbers of different retailers in shopping centres compared to companies in offices make building management committee negotiations more difficult. Fourth, local shop managers tend to have less relevant training and authority compared to office managers. Fifth, few real estate professionals sit on advisory boards for retailers. Sixth, retailer areas with open shop fronts create an inherent conflict in relation to environmental control of the common parts.

Despite this high level analysis that suggests the UK retail market lags behind the UK office market in green lease adoption and implementation, there is another story that is emerging. The case study below identifies progress in one organisation's development of green leases in the UK retail sector, as well as opportunities for green leases to support effective energy (and broader environmental) management practices.

**Case Study 2: Green leases & M&S**

Marks & Spencer (M&S) is a large, longstanding (founded in 1884) food and clothing retailer, with approximately 800 stores throughout the UK and another 300 stores in 40 overseas locations, including Europe, Asia, and the Middle-East. M&S owns and occupies a number of stores, and it also operates as a powerful tenant in buildings owned by others. Within the general picture of the UK retail market, M&S is an outlier in many ways. It is, for example, one of the few companies that has overcome what Restorick (2011) calls "the marzipan layer" of middle management, which lies between the corporate sustainability "icing" and the bright young enthusiastic (often temporary) employee "cake." Restorick sees the marzipan layer as an inert level of managers focused on "facing the everyday challenges of business life." These managers view sustainability as "an irritating irrelevance far removed from daily targets and routines", which can prove to be an impediment to reaching them. Staffing is an important issue, particularly as it relates to energy management. This topic will be explored in more detail in the third case study in this paper. This section focuses specifically on M&S's public commitment to green leases across its portfolio of stores ("green lease programme").

We describe below M&S's experience to date in developing green Memoranda of Understanding (MoUs) and green leases. The case study explores the drivers behind the green lease programme, its content, process and progress, and the impact of the programme. It draws on two phone interviews with and email responses from key M&S staff (including the Head of Property Plan A, two Plan A Project Managers and an M&S Property Lawyer with knowledge of and responsibility for the green lease programme), as well as public documents and internal M&S documents (e.g., a database documenting the status of green MoUs and green leases across M&S stores).

*Background – Plan A and the green lease programme*

In January 2007 M&S launched its original "Plan A", followed by a revised "Plan A 2020" in 2014, setting out 100 commitments to help M&S become "the world's most sustainable retailer" (M&S 2014a). Since 2007, M&S has garnered more than 190 awards for its sustainability initiatives and performance (M&S 2014b: 40).

In March 2013, during the run-up to Plan A 2020, M&S announced its new "green lease policy", which included the introduction of green clauses in new leases and green clauses through MoUs for existing stores (DECC 2013). Plans for green MoUs for 70 existing stores were developed in collaboration with the London Better Buildings Partnership (BBP) and its members, including British Land, Canary Wharf Group, Hammerson, Hermes Real Estate, Henderson Global Investors (renamed TIAA Henderson Real Estate in April 2014), Land Securities, LaSalle Investment Management, Legal & General Property and PRUPIM (renamed M&G Real Estate in June 2013) (BBP 2013b).

4. Use of "buying" here is based on the title of the quoted study. It is meant to cover a range of issues with reluctance to adopt a sustainability agenda, including ethics, scientific concerns, and/or financial limitations.

Building on this announcement and the introduction of MoUs for existing stores, Plan A 2020 introduced a new specific commitment to include:

> … environmental leasehold clauses covering energy, water and waste in all new relevant UK leases. For existing stores, we will promote co-operation with existing landlords and evaluate the results of that co-operation before implementing agreements for existing stores more widely in the future. (M&S 2014b, p. 29)

*Drivers*

In relation to environmental and energy management generally, the M&S story suggests that strong leadership and concern about climate change are important drivers for ambitious plans and effective practices. The origins of Plan A go back to Al Gore's film "An Inconvenient Truth", which is said to have inspired Stuart Rose (then Chief Executive of M&S) and his staff to develop the first Plan A (Vernon 2007). Our interviews with M&S staff suggested that Plan A is considered intrinsic to M&S's wider strategy and an important part of its brand, with a network of staff members willing to monitor and implement best environmental practices (Grayson 2011).

Against this background, M&S staff told us that M&S's approach to negotiating leases for their stores was initially influenced by a desire not to conflict with either the ideology of Plan A or specific provisions within it. This approach resulted in striking out certain clauses perceived to be in conflict (e.g. in relation to lighting of shop windows). Building on this initial approach to lease negotiations, three key drivers converged to create a more proactive and positive approach to green clauses. These drivers influenced M&S's green lease policy announcement in 2013, and its subsequent Plan A commitment in 2014. First, M&S prefers to be in control of the lease negotiation process and propose its own green clauses rather than respond to those proposed by landlords, thus creating more standardisation across the M&S portfolio. Second, M&S desires the opportunity to save costs through enabling building improvements. Third, M&S is working in tandem with the development and promotion of green leases by the London BBP.

*Content, process and progress of green lease programme*

Reflecting this increasingly proactive and positive approach and following M&S's green lease policy announcement in 2013, M&S developed a set of standard green clauses (referred to as "sustainability clauses") to introduce into legal arrangements with landlords. Whilst the clauses are broadly based on the BBP "Green lease toolkit" [BBP 2013a], their content and the process for introducing them differ in existing stores (with leases in place) and new stores.

For existing stores, M&S worked with the BBP and their landlord members, together launching an initiative to introduce green MoUs for 70 M&S stores already under lease with BBP landlords (BBP 2013b). This initiative built on the BBP's development of model green clauses and a mutual desire by M&S and the BBP to promote green MoUs and green leases. For M&S, this supported their Plan A goals and provided a methodology that this group of landlords had already bought into. This 'buy in' has meant that the scope of the MoU clauses (broadly based on the BBP green lease toolkit [BBP 2013a]) is broader and more ambitious than the green clauses being used in new leases. Green MoUs with BBP landlords have now been successfully introduced for 65 out of the 70 existing stores which were initially targeted.

By contrast, for new leases M&S has to negotiate with a greater diversity of landlords. M&S has developed a standard set of green clauses, informed by the BBP "Green lease toolkit". These include a general commitment to carry out lease obligations with a view to promoting environmental best practice, but specific obligations (e.g. for data-sharing and the development of an Energy Management Plan) are limited to the common parts. Some landlords now ask M&S to provide the first draft of new leases (instead of following industry practice where landlords typically supply initial drafts) which enables M&S to use the template sustainability clauses as well as other standard M&S clauses. Between January 2013 and December 2014 M&S has entered around 80 new leases. Early indications are that most of these, other than lease renewals, include green clauses. M&S's property lawyer explained that the long lead time for some leases means M&S's green lease programme will take some time to filter through to all new signed leases.

Commenting on the negotiation process, M&S staff reported that green clauses proposed through MoUs or new leases have generally been accepted by landlords. Prior to the 2013 development of the standard MoU and green lease clauses, "darker green" clauses (with specific directives or binding obligations) were resisted by landlords. More recently, the "lighter green" clauses (often non-binding) based on the BBP toolkit have proved uncontroversial. This was attributed both to the role of BBP in influencing standard industry practice through its green lease toolkit, and to M&S's position in the market, where its brand and size add value to landlords' premises. This may, therefore, not necessarily reflect the experience of other retailers and negotiations between retailers and landlords in the sector. M&S staff suggested that external lawyers tend to strike out unfamiliar clauses, including green clauses, particularly if there is pressure to conclude a deal within a limited time frame.

*Impact*

M&S plans to carry out an evaluation of the impact of its green MoUs and green leases over the next year or so, reflected in Plan A 2020 in a commitment to evaluate the "results of … co-operation" with landlords (M&S 2014b: 29). Given the recent introduction of M&S's green lease programme, M&S staff commented that it was difficult to say whether green clauses had made a difference yet. They highlighted the fact that M&S has a sophisticated energy management system regardless of its leases, and that other developments, in particular minimum energy efficiency standards (MEES), are seen by both M&S and landlords as potential drivers for increased cooperation. With various exclusions and subject to Parliamentary approval, MEES legislation will make buildings with EPC ratings less than an E unlettable as of April 2018 (DECC 2015).

On the other hand, it seems that MoUs and green leases have had some influence on staff practices in relation to energy management, in providing a framework for meaningful co-operation with landlords. They also have the potential to enable particular practices such as data sharing and the development of an energy management plan, and they provide a legal incentive to ensure EPC (Energy Performance Certificate) ratings are not adversely affected.

In particular, in relation to the MoUs, the existence of green clauses has provided a framework and incentive for M&S's Plan A Project Manager to engage with landlords, meeting with them to discuss priorities for co-operation "under the guise of green leases" (Jan 12, 2015 interview with Plan A Project Manager). Whilst MEES have been raised by both M&S's Plan A Project Manager and landlords as strong incentives for cooperation, M&S's Plan A Project Manager suggested that the green lease programme had provided a reason to set up meetings with landlords in the first place, thereby kickstarting stronger engagement.

In relation to data-sharing, whilst the M&S team had not yet been asked for regular data by many of the landlords, it was recognised that the existence of data-sharing clauses has required M&S to respond to any requests for such data. Similarly, M&S staff commented that provisions requiring reasonable endeavours to agree an Energy Management Plan provided M&S a vehicle for requiring such a plan, if desired. In relation to EPCs, M&S staff commented that clauses seeking to prohibit adverse effects on EPC ratings (e.g., negatively affecting the rated efficiency of an asset through fit-out, repairs or refurbishments) were becoming standard and more important with the forthcoming advent of MEES.

These observations and early experiences, it is suggested, highlight potential opportunities for green leases to influence effective energy (and environmental) management in the retail sector. More work will be needed to evaluate both qualitative and quantitative effects of green clauses, and how they relate to other drivers.

### A VIEW FROM THE BOTTOM-UP: A BUDGET SHOPPING CENTRE

Case 1 and Case 2 provided a portfolio view of "data rich" properties which are geographically diverse and organizationally coherent. These cases used quantitative and qualitative data—in the form of electricity data and green lease clauses—as a lens to provide different snapshots of the energy strategy landscape for two different retailers.

Case 3 considers a retail situation that contrasts with Cases 1 and 2. Case 3 is geographically contiguous but organizationally diverse. It concerns a medium-sized (> 200,000 sqft) budget shopping centre (SC 1) that hosts 91 retail units. This case study focuses on the nested and intertwined problems of energy management as a specific form of property management. SC 1 is run by a small team led by a centre manager (CM 1) operating on behalf of a property management company (PM 1), which serves as an interface between the landlord (REIT A), up to 91 different shopping centre tenants, the public, and the city council. Case 3 explores the very real reasons why energy management is difficult to implement in a multi-tenanted space with multiple stakeholders and varying business objectives (Axon et al. 2012). It draws on two in-person interviews with the shopping centre manager (CM 1), a guided tour of the facilities and meters, and public documents about SC 1, PM 1, and REIT A.

#### Technical, Organisational and Legal Context

The shopping centre (SC 1) opened in 1965 and contains 91 units, of which 87 are currently rented. Tenants include pound shops, a budget supermarket, bank branches, hair dressers, a gym, electronics stores, charity shops, insurance brokers, convenience stores, cafes, restaurants, a jewelry store, a bookstore, etc. Some of the retailers represent national or international chains, others are independently owned.

The CM 1's job is to run the centre. This responsibility includes ensuring security, cleanliness, functionality, attractiveness (e.g., arranging for holiday decorations), and paying the bills for these services (including energy services for the common areas). The shopping centre is manned 24 hours a day, 7 days a week, so some lights and machinery are on even when the centre is closed. The centre manager has a small team assisting him, which include an operations manager and a security manager. There is no "energy manager" per se. The manager feels stretched thin between his responsibilities, which include managing both SC 1 and a smaller cluster of stores (SC 2) within 2 miles of SC 1, both of which are owned by REIT A and managed by PM 1. The centre manager has worked in retail management for over 15 years; managing SC 1 & 2 is a new position which he began in August 2014.

CM 1 works for a large national property management company (PM 1) with a commercial property portfolio of over 3,500 properties. PM 1's retail portfolio includes 70 shopping centres and 130 retail parks, which it manages mainly for real estate investment trusts (REITs). PM 1's website indicates that it has a dedicated sustainability team to assist its clients in providing industry best practices, meeting legislative requirements, and other client-driven environmental management goals. PM 1 has been providing property management services for approximately 30 years, has about 500 employees, and is starting to expand its offerings in Europe.

The landlord for this particular shopping centre (REIT A) "owns" about 30 shopping centres in total, and this centre is one of the largest in their portfolio. REIT A is a relatively recent company. It built its portfolio during the economic downturn in 2008–10 by buying shopping centres from other companies at a favorable price. REIT A specializes in food and value retail, and is one of the top three owner/managers of shopping centres in the UK. REIT A does not own this centre outright: it has a long-term (125 year) leasehold from the city council.

Tenant spaces are individually metered, and the lease requires them to pay for their own utility use as well as a service charge for the joint use of the common areas. Historically, landlords have had no right to insist who tenants use as an energy provider; all they can do is require tenants to pay for utilities. In the centre manager's experience, high street/national brands will go for longer leases (between 10 and 25 years), with reviews typically every 5 years. Smaller/regional retailers will go for shorter lease terms (3–5 years); independents seek terms that are as short as possible with break clauses. In contrast to M&S's interest in leases, shown in Case 2 above, the centre manager feels that leases have very little impact on energy or anything else. As he put it, "they sit in a drawer until there is a problem or a rainy day."

#### Case Study 3: energy management issues and opportunities in a shopping centre

SC 1 is a challenging place for obtaining real-time energy data to support detailed energy management. This difficulty leads to some issues about how to engage with energy management across SC 1, as we discuss below.

*Meters and data availability*

On the first visit to SC 1, the centre manager told WICKED researchers that there is 30 minute data from SC 1's common areas and that the retail units all have individual half hourly metering. However, he also said that 95 % of meters are "old-fashioned" which means they are manually read. SC 1 also has a BMS (Building Management System) through which lighting, heating, ventilation, and air conditioning and mall power circuits are controlled.

A second visit was arranged to see the meters and gain a better sense of SC 1's physical and operational context. On the second visit, WICKED researchers learned that SC 1 has 3 distribution rooms on site and which house 17 different meters. These meters are on a mixture of monthly and quarterly billing cycles, read manually every few weeks for billing purposes. Only one half hour electricity meter has been installed, which measures the "main landlord supply". Researchers observed cases of well-organized bills from electricity and gas companies and learned the total energy bill for the common areas costs about £50,000 per year. The main gas meter is located in a sealed box on the SC 1 roof. It did not have a pulsed output, so it is unlikely to be a "smart" meter delivering near real-time information. The three distribution rooms include wires, breaker switches and some meters. A circuit diagram in one of the rooms looked like it might date back to SC 1's original 1965 design. Originally, SC 1 contained 4 separate buildings in an open, streetscape design. It has since undergone two major refurbishment programmes, the last in the mid 80's, which included enclosing and covering the centre. These infrastructure changes over time explain the meters of different vintages and capabilities. This infrastructure stands in marked contrast to a newer shopping centre (SC 3). SC 3 (another WICKED partner site not discussed in detail here) opened to the public in 2013, and the design of the electrical system reflects a more rational approach. Each shop in the newer shopping centre has its own distribution box, and all are clearly marked.

From our observations, we conclude that quarterly and monthly utility bills contain the only readily available information for energy management at SC 1. Given the absence of either AMR data on-site or a dedicated energy manager, SC 1 qualifies as a "data poor" site according to WICKED's typology. Hence, it is a candidate for enhanced data collection methods to enrich and widen its existing knowledge base.

*Management and engagement*

The centre manager believes that energy management is a "big issue" but there is also a lot of "lip service" paid to it. Differentiating between what is real and important and what is "greenwash" can be difficult to do, particularly without the ability to measure the effects of technical or behavioural changes with any level of precision based on quarterly bills alone.

In CM 1's opinion, retailers generally are not interested in engaging with things outside their core business, including energy management. This coincides with the "marzipan layer" management problem noted in Case 2. The centre manager has no control over retail staff, although the centre is supposed to hold 'Retailer's Association' meetings quarterly for shop managers to discuss any 'centre management' issues. In practice such meetings are poorly attended unless encouraged by retailer's head office. For at least five years prior to the centre manager's appointment in 2014, SC 1 has not held any Retailer's Association meetings. In October 2014, the centre manager held meetings but only total of seven retailers attended (8 % of the total SC 1 population). This result supports Whitson and Crawford (2013)'s results suggesting that landlord and tenant communication is difficult to achieve.

CM 1 sees real-time energy monitoring as a possible area in which he can engage with the retail staff in a positive way. He does not have access to the retailer's data, and he has inferred that their metering infrastructure may be a mixture of old and new. CM 1 is keen to work with WICKED to understand SC 1's energy consumption in greater detail and learn which meters are most significant to SC 1 and its retailers.

WICKED researchers are developing an inexpensive range of electricity and gas monitors based on smart phones. By combining current clamps and other peripherals with the phones, WICKED researchers can use the phones' built-in communications to convey data collected to the web for display and further analysis. Depending on the peripheral used, these meters can measure, display, and collect information over time for other variables besides energy (e.g., temperature, light levels, or humidity). They can also be used at different points within a building, thus providing flexible sub-metering for energy or other building characteristics that a typical smart meter does not. By enabling users to choose what they want to measure and where, they also provide opportunities for engagement that a typical smart meter does not. Prototypes of these smart-er monitors have already been trialed in several business and research settings. WICKED will further test their ability to assist the centre manager in deciphering his system and engaging retailers in SC 1 at the same time. He plans to use the smart-er monitor concept as an incentive to attract attention to (and hopefully greater participation in) a future Retailer's Association meeting.

## Discussion & Conclusions

This paper presented and discussed initial findings from the first 6 months of a 2-year research project on energy management in the UK retail sector. We presented the conceptual basis for the project and gave examples from each of the major levels of analysis represented in the project. These included cases studies of top-down data analytics based in applied maths and computing; organizational analysis rooted in social and legal studies; and bottom-up building analysis drawing upon engineering and meterology. These cases show that one size does not fit all: the data rich and poor will need different energy management solutions. Smart meters will not solve everything: further analysis is necessary to turn numbers into knowledge. Changes to legal infrastructure (e.g., leases) will be needed to assist tenants and landlords in sharing data to enable both groups to monitor, measure, and report energy use. Additionally, how organisational cultures frame employee duties, behaviours, and expectations requires further investigation.

The project results to date show that there is still a lot of room for improvement in the retail sector within the realms of data, organizations, and buildings. This is most obvious in Case 3, where the technical infrastructure of a budget shopping centre does not provide detailed access to real-time energy information for its manager. This is a fairly common problem in the retail sector, as evidenced by British Land – the UK's largest listed owner and manager of retail space – posting a case study about adding AMR to its retail properties as recently as 2013–14 (Webster 2014). Moreover, CM 1 has many other responsibilities, so day-to-day energy management can only claim a small part of his attention in his job as currently structured. Energy management is not a top priority in the retail sector (Whitson & Crawford 2013), and moving this item up the organizational agenda is a difficult task. Even in Case 2, which concerns one of the UK's top sustainable retailers, it will be many years before the green lease roll-out announced in 2013 has reached the whole, relevant estate. Changing the legal context takes time and effort, even for M&S. Case 1 also shows us not just that similar stores are different, but also that the available data could be better contextualized, cleaned, and possibly used to pinpoint meters that are faulty. As energy data acquisition and use becomes more commonplace, meter maintenance and data quality control will need to be added to the ongoing processes of "standard practice" for all commercial organizations if they wish to use their information to best effect.

Across the levels of analysis in WICKED, there are two "solutions" that look like they will be helpful in resolving some of the issues across the retail sector, particularly in terms of energy accounting and accountability. One is standardization of data identifiers and variables, and the second is development of flexible smart-er monitors to assist with new meter locations, participant education and engagement. Our initial explorations suggest that some protocols regarding energy data availability and meter functionality may be useful. More work is needed to understand how energy managers in "data rich" firms actually use the data that they have, and whether additional meta-data may be needed. "Data poor" firms will need to access additional data. Through WICKED, they have the option of interactively testing their existing systems to determine which points in the physical system are not yet metered or monitored, and as such could benefit from additional information.

More broadly, these initial results confirm that interdisciplinary problem-solving is important, particularly in the real world. From the perspective of each disciplinary approach in the project, there are some problems that are visible and interesting, others that are obdurate to the tools used by that discipline. An example is the indication of broken or malfunctioning meters in Case 1. From a data analytics perspective, data should be clean and regular, so faulty information streams should be discarded to ensure that "the system" is represented in a functional form. From an energy and management perspective, however, these malfunctioning meters represent 20 very real buildings that require some kind of physical intervention (e.g., meters need fixing or replacement) for their data to play a useful role in energy management. The question of how often meters (whether smart or not) fail, who knows when or if they do, and how they should be fixed is a problem that presents an additional opportunity (or challenge) to energy managers on the ground. Better data and analytics can illuminate this challenge, but engineering (stuff) and organizational effort (staff) are required to fix it.

In its future work, WICKED will continue to collect case studies and examine them from different analytical angles. It will continue to look across companies (e.g., work with different owner-occupiers, landlords, and tenants) and within them for generalizable energy management opportunities. In doing so, it will help to measure the impacts of energy strategies implemented by retailers during the course of the project. Some of these strategies may be pre-existing like M&S's green lease policy (which incorporates energy but is not limited to it), others may be based on new knowledge generated by the project. For example, further behavioural classifications may reveal actionable insights in Case 1; a closer legal analysis of green lease clauses may be paired with quantitative analysis in Case 2; and new, smart-er monitoring technologies may allow stakeholders in Case 3 access to more detailed measurements than they have had to date. Building on this evidence base, WICKED will co-design new energy strategies and recommendations to fit the retail sector's diverse needs.

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