Energy for Sustainability 2015
Sustainable Cities: Designing for People and the Planet
Coimbra, 14-15 May, 2015

A WICKED APPROACH TO ENERGY STRATEGIES IN RETAIL ORGANISATIONS

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Keywords: non-domestic, retail, energy use, interdisciplinary research, energy strategy

Abstract *The UK retail sector is vital to the economy, diverse, and facing a number of challenges. 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 organisations, including those with smart meters and energy managers (the "data rich") and those without (the "data poor"). This paper presents data from 3 different organisations: 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.*

1. INTRODUCTION

Non-domestic energy use in buildings accounts for approximately 18% of UK carbon emissions. By 2050, 60% of existing non-domestic buildings will still be in use. There is significant potential for energy savings in existing buildings [1, 2]. Innovative energy saving measures in UK non-domestic buildings could save 18 MtCO2 by 2020 and 86 MtCO2 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 Innovation Coordination Group's 'Technology Innovation Needs Assessment on Non-Domestic Buildings' [3] 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 [4]. 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 initial results of one of these projects, called Working with Infrastructure, Creation of Knowledge, and Energy strategy Development (WICKED). WICKED is a 2-year (July 1 2014-June 30 2016) interdisciplinary project, designed to learn from real world situations. 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 discusses WICKED's approach to the problem of energy management in retail organisations, describing WICKED's novel socio-technical and interdisciplinary approach to the sector. 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.

2. A WICKED APPROACH

The retail sector is a vital part of the UK 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. 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 [5].

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 [6]. 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.

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

WICKED 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

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 organisations 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 organisations 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.

Janda, Bottrill and Layberry [7] 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 Jandaet al [7] 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.

3. 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 electronics 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.[i] This tripartite analysis is followed by a discussion section that links these three different levels of analysis, seeking synergies between them.

3.1. Top-down analytics: a case study using "big 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. Retailer 1 rents these shops from a variety of landlords, and they range from 500 to 1,500 sq ft. 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.

We performed a cluster analysis of these data using the following steps. First, we computed a representative daily load profile that describes the typical daily behaviour of consumption for each shop by aggregating and averaging all the readings during days when the shop is open (48 values per day per shop). 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 algorithm that uses Dirichlet-mutinomial distributions to model the data [8]. 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 9 different categories (e.g. shopping centre, high street, arterial route shop). The same

[i] Due to anonymity requirements, only one partner organization 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.

clustering analysis has been performed the other shop categories. Due to space limitations, we present the results of only one category in this paper: 75 arterial route shops.

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 one; 13 shops in cluster two; 17 in cluster three; and 7 in cluster four. 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 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.

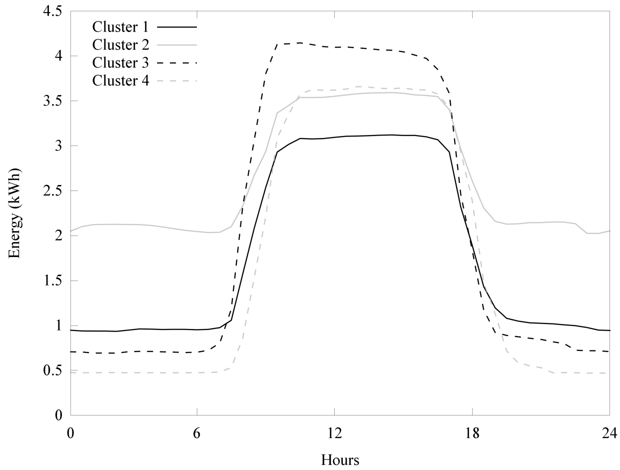

Figure 1. Cluster analysis of electricity data from 75 shops

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, 9]. Other aspects 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 of empty files and false readings contained in the data set. This process in our analysis showed that 0.8 percent 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.

3.2. Middle-out organisational analysis: green leases in a multi-national retailer

This section moves from a quantitative focus on electricity data to a more qualitative exploration of a large retail company's notable efforts to break new ground in the area of green leases. Marks & Spencer (M&S) is a large and well-known food & 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. In 2007 M&S launched its flagship environmental strategy "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" [10, 11]. This section focuses specifically on M&S's public commitment to green leases across its portfolio of stores.

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 [12]. 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 [13, p.

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).

We describe below M&S’s experience to date in developing green Memoranda of Understanding (MoUs) and green leases. 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).

The M&S story suggests that strong leadership and concern about climate change are important drivers for the environmental plans that fed into this leasing policy [14]. The leasing policy emerged from a convergance of drivers: that leases should not undermine Plan A; a desire to control the lease drafting process to create more standardisation across the M&S portfolio; an opportunity to save costs through enabling building improvements; and the promotion of green leases by the UK Better Buildings Partnership (BBP). The BBP is a collaboration of the UK’s leading commercial property owners who are working to develop solutions to improve the sustainability of existing commercial building stock and achieve substantial CO_2 savings [15].

There is a key distinction between M&S policy on MoUs and on green leases, which reflects the important role of the UK BBP. Working together, M&S and UK BBP launched an initiative to introduce green MoUs for 70 M&S stores already under lease with BBP landlords [16]. This ‘buy in’ from BBP landlords has meant that the scope of the M&S MoU clauses (broadly based on the BBP green lease toolkit [17]) is broader and more ambitious than the green clauses being used in new M&S leases. Green MoUs with UK BBP landlords have now been introduced for 65 existing stores.

By contrast, for new leases M&S has to negotiate with a much greater diversity of landlords. M&S has developed a standard set of green clauses, informed by the BBP “Green lease toolkit” [17]. 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. Between January 2013 and December 2014 M&S entered around 80 new leases. Early indications are that most of these, other than lease renewals, include green clauses. The long lead time for completing some leases means M&S’s green lease programme will take some time to filter through to all new signed leases. M&S’s experience suggests that the “light green” clauses based on the BBP toolkit have proved largely uncontroversial in negotiations, possibly because of the role of BBP in influencing standard industry practice and also M&S’s position in the market, where its brand and size add value to landlords’ premises. A further study of the impact of green leases and MOUs is underway.

3.3. 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 [18]. 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.

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

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 3500 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: 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 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."

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 two visits to SC 1 show. 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 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 this visit, WICKED researchers learned that SC 1 has 3 distribution rooms on site 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. CM 1 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 trialled 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.

4. 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; organisational 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, organisations, 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 [19]. 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 [20], 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 organisations 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 to be fixed or replaced) for their data to play a useful role. 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 energy 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 accurate and 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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