Change from within? Carbon management in commercial real estate

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Abstract

All firms and organizations pay energy bills, but not all actively "manage" energy. Where energy management does occur, it may be driven by financial concerns or corporate social responsibility, rather than treated as a strategic business opportunity (Cooremans 2011). This paper examines opportunities for developing data-backed software solution to support commercial real estate (CRE) firms in adopting strategic energy-saving opportunities. Previous research has suggested that cross-firm partnerships and portfolio assessment tools are helpful in producing "middle out" change in the CRE sector (Parag & Janda 2014; Janda & Parag 2013). This paper continues in this vein of research, looking at assessment tools for portfolios of existing buildings and the groups who invent and support them. It provides a partial overview of non-domestic data in the US, Europe, China, and India with a particular focus on the UK. It finds that, on average, European governments do not have the data necessary to make critical arguments to the CRE sector. From this, the paper suggests a focus on learning with and from data and initiatives based within the CRE industry itself. The paper highlights the work of emerging for-profit and non-profit groups who work with and for the CRE industry. It provides a snapshot of 10 groups (mostly small and medium enterprises) who provide data analytics software for retrofits, which is a key element in turning numbers into knowledge. A deeper dive into the work of two of these groups who are active in the UK – Pilio and CO2 Estates – shows diversity in the orientation and capabilities of the "software as a service" model. It also suggests that these early stage companies could develop new approaches and tools to solve data problems that have thus far confounded academic researchers, governments, and the European CRE sector. The conclusions discuss policy implications for the future of a CRE market based largely on self-regulated solutions identified by 3rd party algorithms, rather than one driven by government policies.

Introduction

The EU emission reduction targets for 2020 and 2050 place stringent requirements upon member states to transition to a low carbon economy. The built environment presents a cost effective means to undertaking this transition, as it accounts for approximately 40 % of energy consumption in many EU countries (BIS, Lyons & IEEP 2013). There is significant potential for energy savings in existing buildings (Ürge-Vorsatz et al. 2012; Levine et al. 2007). In the UK, energy use in commercial and public buildings 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. 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.

Despite these opportunities, engaging in wide-spread energy retrofits is difficult, particularly in the non-domestic sector. The existing stock is replaced at low levels annually, with retrofit traditionally undertaken at long intervals, and factors other than energy efficiency are usually the primary drivers for such works. Further to this, the non-domestic stock's heterogeneous

physicality, operation and ownership hierarchies add complexity to energy driven retrofit opportunities (Strachan 2013).

Ownership hierarchies present both a challenge and an opportunity for energy retrofits in commercial buildings, where the groups who own, use, manage, maintain, and upgrade a building can all be different entities. In the non-domestic stock, approximately half of the floor area is generally assumed to be owner-occupied; whereas half is tenanted. The tenanted half may be owned by private CRE firms or publicly-traded firms. Any of these ownership types may employ other groups like facilities managers or managing agents to operate and maintain the buildings. They may have holdings that range from a single building to hundreds to 1000s of buildings. "Many" buildings constitute a "portfolio", which may be distributed locally, regionally, nationally, or even globally. Large real estate companies with mixed portfolios of properties are an important part of the global economy, and they represent an equally important opportunity for energy efficiency. If the commercial real estate sector as a whole could be convinced to adopt energy efficiency measures in the way that technical potential studies say they should, we could save a lot of carbon. However, the successful business case for change in standard commercial real estate practice has a number of practical hurdles to overcome.

Consider for example, the role of buildings as investment opportunities. Although the benefits associated with a low carbon built environment are widely accepted, corporate investment in energy efficiency schemes is conversely limited. The publicly listed commercial real estate sector contributes significant value to the EU economy, estimated at €285 billion direct contributions in 2011, with substantial job creation, and wealth generation through investors, insurance companies and pension funds (EPRA 2013). Real estate itself is considered to be a secure investment; energy efficiency's role in this industry is somewhat less certain, particularly at the portfolio level. Ma et al. (2012) provide a review of the state-of-the art in retrofitting the building stock, but their review takes a building-by-building approach, rather than a portfolio approach. Energy performance improvement of a property portfolio is a complex, multi-attribute, decision-making process that requires a structured support mechanism backed by data in order to reduce uncertainties. The barriers to portfolio analysis stem from deficiencies associated with: data availability, a mechanism for deep insight into energy performance data, an efficient decision support mechanism for optimum investment strategy determination and an effective means of feedback post-investment. As Franconi, Bendewald and Anderson (2014) describe, there are challenges associated with evaluating portfolios. For instance, are the needed data available? Can a scaled evaluation be done accurately and cost effectively?

The question remains: who can gather the necessary data about energy opportunities and present options to CRE decision-makers in an effective way? How much data needs to be gathered? Should it be gathered by governments, CRE firms themselves, 3rd party businesses, intermediaries, tenants, or all of the above?

This paper provides results of a knowledge exchange partnership between an academic researcher and a start-up company called CO2 Estates. CO2 Estates provides web-based energy efficiency risk management and retrofit decision-support to many large CRE investment firms in the UK, including British Land, M&G, and Henderson. It examines opportunities for developing a data backed software solution to support large property owners in taking much greater advantage of profitable energy-saving opportunities. Previous research has suggested that cross-firm partnerships and portfolio assessment tools are helpful in producing middle out change in the building sector (Parag & Janda 2014; Janda & Parag 2013). This paper continues in this vein of research, looking more deeply at assessment tools for portfolios of existing buildings and the groups who invent and support them. It provides a partial overview on the state (such as it is) of available data in the non-domestic sector in the US and Europe, with a particular focus on the UK. It finds that, on average, European governments do not have the data necessary to make critical arguments to the CRE sector. From this, the paper suggests a focus on learning with and from data and initiatives based within the CRE industry itself. The paper highlights the work of emerging for-profit and non-profit groups who work with and for the CRE industry. It provides a snapshot of 10 groups (mostly small and medium enterprises) who provide data analytics software for retrofits, which is a key element in turning numbers into knowledge. A deeper dive into the work of two of these groups who are active in the UK – Pilio and CO2 Estates – shows diversity in the orientation and capabilities of the "software as a service" model. It also suggests that these early stage companies could develop new approaches and tools to solve data problems that have thus far confounded academic researchers, governments, and the European CRE sector. The conclusions discuss policy implications for the future of a CRE market based largely on self-regulated solutions identified by 3rd party algorithms, rather than one driven by government policies.

Uncertain State of Non-Domestic Data Quality

Suggesting a data-backed solution for wide-spread CRE retrofits presupposes two things: first, that the underlying data for such solutions are available, and second, that we have the analytical capability to build on this data to reliably generate new knowledge. This section considers the first of these two challenges, focusing on data availability in the US, the UK (as a proxy for Europe[1]), and within the real estate industry itself. The following section will consider the second challenge: the availability of analytical tools and expertise.

NON-DOMESTIC ENERGY DATA: A COMPARATIVE SNAPSHOT OF THE US AND UK

Schnapp and Lausten (2013) studied building data quality and robustness across four different regions – US, Europe, China, and India – for the Global Building Performance Network. They found that in general, the data quality of the non-domestic stock lagged behind that of the domestic stock in most regions. Looking just at the non-domestic stock (see Figure 1), the European evidence base lags behind the US in every area except for fuel mix and new building energy use.

In the US, commercial building data has been periodically and regularly gathered by a large-scale survey administered by

1. The UK is one of 6 countries selected by Schnapp and Lausten (2013, p. 47) to calculate the European average.

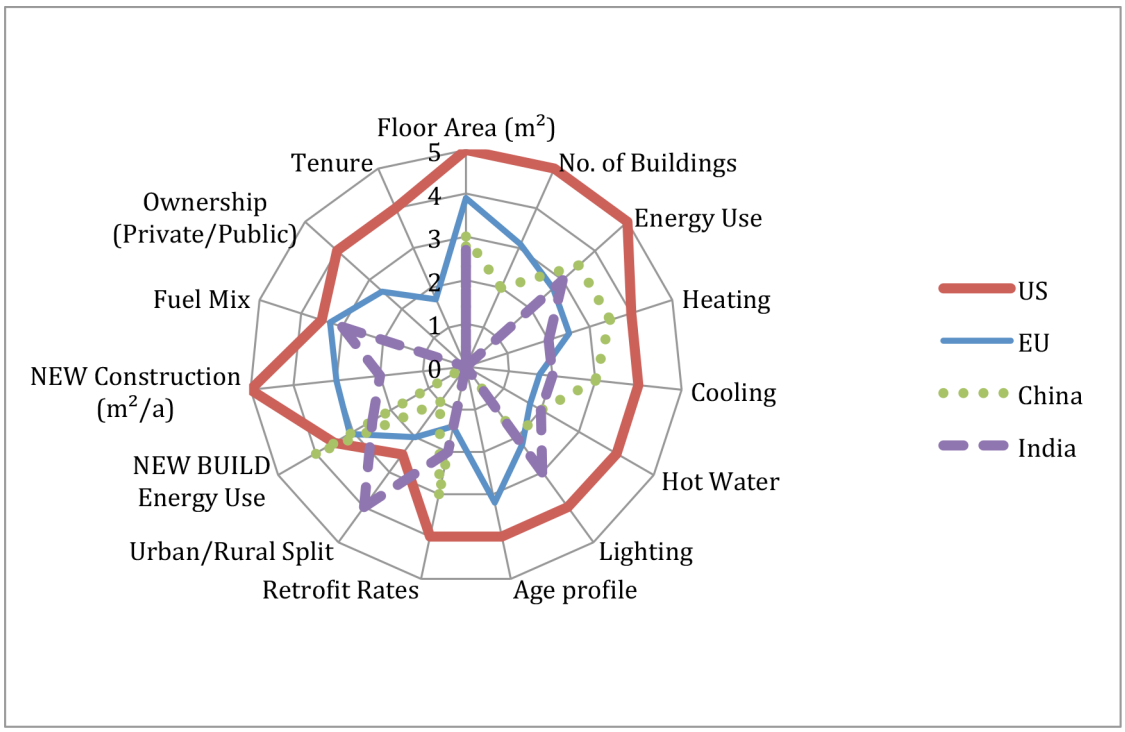

Figure 1. Commercial and Public Data Quality of 4 GBPN Regions (source: Schnapp & Laustsen, 2013 p. 22).

the US Energy Information Administration. The first Commercial Building Energy Consumption Survey (CBECS) was conducted in 1979; the tenth CBECS (the most recent survey) was fielded in April 2013 (EIA 2015). This data set lays the foundation for benchmarking, forecasting, modelling, and policy formulation in the US. It also serves as the basis for the US Environmental Protection Agency's "Energy Star" rating tool in the non-domestic sector. Despite its widespread use, the CBECS data are not perfect, and neither is its survey process. The 2007 CBECS data was withheld due to survey design issues, and the 2011 survey was briefly postponed due to federal funding cuts, so by early 2013 the latest available data hailed from 2003. Despite these glitches, according to Schnapp and Lausten (2013), "the US has the strongest set of building energy data among the GBPN priority regions".

In contrast, in the UK very little information is publicly available about energy characteristics of the UK non-domestic stock, and government statistics in 2015 rely still heavily on a small data set collected in the 1990s (Nicholls 2014). There are several national initiatives underway to build understanding in this area and update the nearly two-decade long data gap. DECC has commissioned a study of energy use and abatement opportunities across the entire non-domestic stock, which will gather new information primarily via a large-scale telephone survey (Nicholls 2014). The Westminster Sustainable Business Forum recently coordinated an MP-led inquiry into the uptake of energy efficiency in non-domestic buildings. This inquiry is largely based on a desk study and expert opinion (WSBF & Carbon Connect 2013).

Despite these recent efforts, UK research into opportunities in the non-domestic stock is lagging. Both the recently published Low Carbon Innovation Coordination Group Technology Innovation Needs Assessment on Non-Domestic Buildings (LCICG 2012) and the workshop on 'Energy in the Home and Workplace' (Hannon, Rhodes & Skea 2013) highlighted End Use Energy Demand (EUED) in non-domestic buildings as an area of current low research activity. The RCUKEP Scientific Advisory Committee has noted that research into non-domestic buildings accounts for less than 10 % of the EUED portfolio and recommended further funding in this area.

The lack of publicly available data and research suggest that both governments and academics in the UK are struggling to formulate a decent picture of the non-domestic stock. The next section looks at the data available from with industry itself.

NON-DOMESTIC DATA FROM WITHIN CRE FIRMS

In general, large CRE firms have reasonable access to data about their own building portfolios. A recent survey of 392 global corporate real estate leaders[2] found that these firms have lots of data (precisely what kind is not defined) and are working to upgrade their internal analytical capabilities (Forrester Research Inc 2014). One of the UK's largest landlords, British Land, recently published an article describing how they added automated meter reading to their retail properties in 2013 (Webster 2014). Large CRE firms have also been working cooperatively to orchestrate change across the industry, through mechanisms like the Better Buildings Partnership (BBP). The UK BBP represents a collaboration between 17 leading UK commercial property companies (BBP 2013a). It has developed a number of toolkits to help standardize practices across the industry, including guidance on green management, green leases, sustainability benchmarking, better metering, landlord energy ratings,

2. The survey included real estate executives across 11 countries and 10 industries. Interviews were also conducted with 10 senior corporate real estate executives across five countries to gather qualitative perspectives.

and sustainable retrofits (BBP 2013a, 2013b). Standardization of data and techniques is helpful because these companies often share clients (who expect some measure of continuity across landlords) and may buy and sell buildings between themselves as well as with other, smaller firms.

Although there are data "out there", the proliferation of BBP toolkits suggest that the use of data in practice may still be somewhat of a mystery. The Forrester Research Inc (2014) study suggests there is a need to move from "data-informed" decision making (where a firm uses data only when it supports opinions or decisions) to "data-centric" decision making (where a firm uses data to shape all opinions and decisions). Currently, "data-informed" firms represent 67 % of the market, and 28 % of the market is "data-centric". Forrester Research's findings, however, may not adequately reflect perspectives from the smaller end of the commercial market. The Carbon Trust (2007) found there are approximately 2.7 million manually-read meters in UK small and medium enterprises, which are read only quarterly or annually. These organizations are "data poor" and present different energy management challenges than "data rich" organizations do (Janda, Bottrill & Layberry 2014). Although there are plans to replace and upgrade 53 million electricity and gas meters by 2020, an energy data gap between the rich and the poor will persist until then.[3]

The above information suggests that some larger CRE industry actors are better placed to "self regulate" their energy efficiency uptake than either (1) government or (2) smaller firms. If this is the case, are they currently capable of making these decisions "in-house", or do they need other forms of assistance to upscale energy retrofits across their portfolios?

Models and Players for Upscaling Retrofits

The previous section suggested that the level of non-domestic energy data availability differs between countries and firms. This section considers the ways in the presence/absence of data of different kinds shapes opportunities to use this information to generate change in the market. Where governments see a "barrier", consulting firms may see an opportunity.

The market and commercial potential of energy efficiency software targeted at CRE is significant as it spans across a number of high growth sectors. In the US alone:

- More than $279 billion could be invested across the residential, commercial, and institutional market segments. This investment could yield more than $1 trillion of energy savings over 10 years, equivalent to savings of approximately 30 % of the annual electricity spend in the United States (Rockefeller & Deutsche Bank 2012, p. 3).
- The retrofit market will exceed $100 bn by 2017 (Eckard & Bloom 2014).
- The energy services market is projected to grow from $6 billion in 2013 to $11–$15 bn by 2020 (Stuart et al. 2014).
- The energy software market will exceed $5.5 bn by 2020 (Machinchick & Wheelock 2011).

Given these business opportunities, we are particularly interested in the development of analytical tools, processes and expertise for upscaling retrofits. This section focuses on the role of software as a service[4], focusing on the intermediary groups and emerging businesses actively engaged in their development.

The section begins with a short description of financial models to note that these are also in flux, evolving, and in need of new market actors. Then it turns to a description of "information models" used by 10 different companies, engaged in various ways in providing analytical services to non-domestic building owners and managers.

FINANCIAL MODELS AND PLAYERS

Rockefeller & Deutsche Bank (2012) looked at the development of financial models that could assist in upscaling retrofit activity. These include energy services agreements (ESAs), property assessed clean energy (PACE) and on-bill finance (OBF). This report also includes a small section about the existing market participants who use these models. Rockefeller & Deutsche Bank (2012) see the existing participants in the retrofit market as composed of four categories of competitors: energy service companies (ESCOs); original equipment manufacturers (OEMs), and two types of emerging integrated investors/developers, focusing on ESAs and PACE respectively. These authors see two difficulties with ESCOs expanding into CRE market: (1) ESCOs are tied to OEMs and (2) work mainly in MUSH (Municipal, University, School, Hospital) sectors and with the government. The authors also see limited advancement for OEMs, given that much of the existing building market for OEMs is created by old equipment reaching the end of its useful life, when owners are forced to upgrade. OEMs therefore face challenges when trying to pitch equipment upgrades to building owners. Rockefeller & Deutsche Bank (2012) believe that ESAs are the retrofit finance structure that allows the commercial and institutional market to most efficiently evolve and scale on its own, enhanced by, but not requiring, external influences such as legislation and subsidy. They also note that "emerging intermediaries are needed to provoke action" (Rockefeller & Deutsche Bank 2012, p. 43). Their focus is more on the financial side, but we agree that additional players are needed to provide services to an evolving market.

INFORMATION MODELS AND PLAYERS

What we call "information models" are more dependent on physical information than financial information, and take an engineering approach rather than an economic one. As part of a Rocky Mountain Institute project on assessing retrofit portfolios in the US, Franconi, Bendewald and Anderson (2014) considered the emergence of new software analysis tools designed to make portfolio-scale energy assessments easier by providing a no- or low-touch approach for opportunity assessment. These

3. For readers interested in learning more about the data rich and data poor, particularly in the retail sector, another paper in the 2015 eceee Summer Study proceedings (Janda et al. 2015) presents initial findings from a project focused on the presence, absence, and use of data in this sector (Janda et al. 2014).

4. Software as a Service (SaaS) is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network, typically the Internet. http://searchcloudcomputing.techtarget.com/definition/Software-as-a-Service

authors used six different tools on the same data set to learn more about the tools' approaches and limitations: Energy Star Portfolio Manager, FirstView, LEAN, simuwatt, Retroficiency, and FirstFuel. They found that different tools were good for different problems. In particular, the utility of low-touch methods depend on several considerations, including: 1) the uniformity of the characteristics of the buildings within the analysis group, 2) the similarity of the buildings in the analysis group to a standard building, and 3) the building information available for each site in the group. In other words, actuarial approaches work better with building portfolios that are fairly uniform, match expected characteristics, and have a lot of data.

Unlike Franconi, Bendewald and Anderson (2014), our paper does not compare the tools and their capabilities in use. Instead, we provide a snapshot of a larger number of actors (10) who provide proprietary services in this area. For all but 2 of these actors – CO2 Estates and Pilio, who are partners in this and previous research – we use information available through the public lens of their websites. We recognize that perusing a company's website is not a good proxy for evaluating the tools themselves. This method does, however, signify whether the companies place value on producing publicly available information, such as a detailed description of the company and its services. Like Franconi, Bendewald and Anderson (2014), our list is not exhaustive, and it does not indicate endorsement.

Our paper uses two lenses to see the firms in this area. The first is the newly-launched "Investor Confidence Project" (ICP), which aims to have global reach but is thus far most developed in the US. The second is a list of market actors culled from the author's experience in this area which spans both the US and Europe. Together, these lenses create roughly three subsets of firms, as shown in Table 1. These are: US-focused firms involved in the ICP as certified providers (5 companies); US-focused firms involved in the ICP as allies (ICP allies are supporters of the ICP's agenda but not certified to create "Investor Ready Energy Efficiency projects") (2 companies); and firms working in the UK/Europe (3 companies). The reader is reminded that this research is exploratory, there is no way of knowing what the total population of firms is operating in this area, and therefore we do not claim our research is representative.

Investor Confidence Project – US

The "investor confidence project" (ICP) suggests that widespread energy retrofitting will require more reliable and transparent networks of information shared between CRE investors, energy analysts, and retrofit companies (EDF ICP 2015a, 2015c). ICP is a new energy efficiency credentialing system for developers, software providers, and quality assurance providers supported by the Environmental Defense Fund, a US environmental non-profit. From this perspective, the CRE system doesn't need new players (as the financial model of changes suggests) as much as it needs replicable data and a standardized method of accounting for the benefits of energy efficiency. ICP intends to "brings order to the world of energy engineering methods that have been too long a confusing menu of technically valid approaches and idiosyncratic techniques" (EDF ICP 2015c).

One of the ways in which ICP brings order to chaos is by anointing software providers whose systems follow ICP's protocols. As part of the launch of their software credentialing practice, EDF recently announced six software vendors whose products are "guaranteed" to make life easier (EDF ICP 2015d) – at least in the US. These vendors are: Performance Systems Development, Noesis Energy, Sustainable Real Estate Solutions, E-Capital Development, Encentiv Energy, and HELiOS Building Efficiency. A brief description of each certified vendor is below and some key attributes of their systems are also included in Table 1. In addition, this initiative also names approximately 160 companies as members of the "ICP Ally Network" (EDF ICP 2015b). Two of these allied companies, Retroficiency and FirstFuel, are also included in Table 1.

- Performance Systems Development is a 14 year old company from Ithaca, New York whose core mission is to "help achieve peak performance across America's building stock" (Performance Systems Development 2015). It hosts two software packages, one which is devoted to residential buildings (both single and multi-family) and the other called Compass which is ICP-certified.
- Noesis defines itself as "a commercial lending marketplace for building owners to finance energy-related building improvements, including both energy efficiency and distributed generation (e.g. solar) projects" (Noesis Energy 2015). It is US-based (headquartered in Austin, TX), and clients of its "proprietary project valuation technology" (we assume this means "software") include local and national real estate owners, as well as over 150 US commercial energy equipment and services companies. It is an "early stage" start-up with less than 40 employees; its date of inception is not listed on its website.
- Sustainable Real Estate Solutions (SRS) delivers Sustainable Real Estate Manager® a cloud-based, software-as-a-service energy finance and technical underwriting platform enabling program administrators, building owners, contractors, capital providers, and insurers to underwrite energy efficiency and renewable energy projects that yield compelling investment returns. SRS is based in Connecticut, and "pioneered" its platform in 2008 (SRS 2015). Although SRS does not explicitly mention a geographic focus on its website, its testimonials are from New York, Connecticut, and Los Angeles.
- E-Capital development designs, develops, and operates "online platforms that automate sustainable energy project origination, insurance, and financing" (E-Cap 2015). Their website names only two people and contains little additional information about their origin, locational focus, or product offering. A "contact us" page lists a location in New York and one in Florida.
- Encentive Energy is located in Pittsburgh and was founded in 2009. It has a team of 13 people listed on its website. Its software package allows them to "provide data and insights as well as scalability" and to "manage, process and analyze large volumes of building energy data … to create energy efficiency revenue through local, regional, and federal incentives and provide financing". In addition, the company offers technical support such as benchmarking, site inspections and facility audits (Encentive 2015).

- HELiOS Exchange was founded in 2012 with a mission to "use information technology to create the needed investor confidence to catalyze energy efficiency financing" (Helios Building Efficiency 2015). The company is located in California, but its founder has European work and educational experience. It includes a number of different trademarked software variants which cover aspects of building energy performance assessment, energy audit evaluation, rapid building energy modeling, energy retrofit simulation, energy efficiency risk analysis, and measurement & verification. Notably, its retrofit simulation tool is "based on a standardized building energy model that has been in use in Europe for evaluating building codes and energy performance for over 10 years".
- Retroficiency started up in 2009 and launched in 2011. It is a "market leading energy efficiency identification and qualification platform that enables energy service companies (ESCOs), facility management firms, large commercial property owners and related professionals to systematically evaluate thousands of commercial building energy efficiency measures in minutes. Retroficiency delivers a complete solution addressing the needs of building engineers, facility managers, and financial decision makers." It is based in Boston, Massachusetts, has analyzed more than 2 billion square feet of space as of April 2014, and has a staff of at least 15 (5 members of the leadership team + open positions for 9 more staff members) (Retroficiency 2015). Although it is not an ICP-certified provider, it is named as an ICP US ally (EDF ICP 2015b).

Most of the ICP companies are small start-ups, with a clear focus on the US market. However, information on when the companies started and how many staff members they have are difficult to glean from their websites. HELiOS has some European connections, which suggests that of these companies, it might be the most likely to consider expanding into European markets.

EUROPE

This brings us to the question of whose products do what and for whom, particularly in Europe. Software has to be based on some kind of data, and as the GBPN study revealed, confidence about data availability for benchmarking is lower in Europe than in the US. The US-based investor confidence project has a European branch, but this branch is in the process of developing its protocols and has not yet listed any certified software providers. It has, however, recently received a €1.92 million grant from the European Commission to:

- Develop ICP's project protocols for the European market;
- Work with financial institutions to embed them into their financing process; and
- Organize National Steering Groups in five countries: (Austria, Bulgaria, Germany, Portugal and the U.K.) to take the protocols to markets in those countries (Bartholomy 2015).

In addition, there are approximately 40 listed ICP-Europe Network Allies (ICP Europe 2015). Absent the certified software provider frame, we have generated a list of 3 players based on the authors' knowledge of the field. This list is not exhaustive and is biased towards UK companies, given that this is main activity base for the authors.

- FirstFuel Software was founded in 2010, and describes itself as a "building energy analytics company that helps utilities and government agencies deliver scalable energy efficiency across their commercial building portfolios." The company's software, Building Impact, uses metered data and data analytics to target energy efficiency opportunities. FirstFuel is a US based business, but has recently started working with E.ON in the UK to deliver energy efficiency solutions to British SMEs (FirstFuel 2014). It is listed as part of the ICP US ally network (EDF ICP 2015b).
- CO2 Estates Ltd is a start-up that has developed and commercialised a cloud based application for CRE investors to manage, report and improve energy efficiency within their property portfolios. It started in 2012, and has a staff of 10 employees (CO2 Estates 2015). Over the past 18 months, the business has made significant traction in the UK CRE market, securing contracts with Europe's largest Real Estate Investment Trusts (REITs) and publicly listed Real Estate Investors, as well as securing a partnership with Deloitte Real Estate. CO2 Estates has assessed, modelled, and simulated for retrofit, through their Carbon Estates platform, over 4.3 Mm^2 of CRE to date. It is listed on the ICP-Europe Ally Network (ICP Europe 2015).
- Unlike most of the other companies on this list, Pilio (2013) is oriented toward small and medium enterprises, including those that lack automatically-read electricity and gas meters. Pilio provides energy management advice and weather-adjusted analysis to help turn data into useful information, whether this is gathered manually or automatically. Pilio has worked in with some unusual clients, including the Church of England and a network of theatres and performing arts venues. It has also done some pilot tests in California. Pilio started at the household-level in 2006 and developed a tool called sMeasure for SMEs in 2008. The sMeasure service is tailored to client's specific energy management needs through online energy analytics software, expert energy efficiency guidance and staff engagement training. Pilio operates with a skeleton staff of 3, with additional help drawn from a pool of consultants.

Understanding these companies, their tools, and their services from publicly available information is quite a challenge. It suggests that the level of publicly available information about these evolving market actors could evolve further, and it supports the ICP premise that greater levels of legibility, translation, and transparency could serve to make the market more intelligible.

The above investigation of these companies and their websites shows – not surprisingly – that software-as-an-energy-service commercial activities are correlated with the general quality and availability of energy and building data. That is, there is greater activity in the US than in Europe, as evidenced both by the Investor Confidence Project itself and its participants. Within the ICP, most of the companies included in this study are no more than 5 years old, and many have a very small number of full time employees. In Europe, most of the firms are data management applications, visualising energy data and supporting organisation of energy data for compliance report-

Table 1. Snapshot of 10 Retrofit Data Analytics Firms.

Company	Founding year	#staff	Market focus	ICP association	Software	Physical Audits	Physical Building Data	Operational Data	ROI Retrofit Simulation	Portfolio-wide solution
Performance Systems Development	1998	?	US	Provider	Compass	No	Yes	Yes	Yes	Yes
Noesis	?	<40	US	Provider	Yes	?	?	?	?	?
Sustainable Real Estate Solutions	2008	?	US	Provider	Sustainable Real Estate Manager	?	Yes	Yes	Yes	Yes
E-Capital Development	?	?	US	Provider	Yes	?	?	?	?	?
Encentiv Energy	2009	<20	US	Provider	Encentivizer	Yes	Yes	Yes	Yes	Yes
HELIOS Building Efficiency	?	?	US	Provider	HELIOS Property Manager	?	Yes	Yes	Yes	Yes
Retroficiency	2009	15+	US	ICP-US Ally	Yes	Yes	Yes	Yes	Yes	Yes
FirstFuel	2010	15+	US/UK	ICP-US Ally	Building Impact	No	Yes	Yes	Yes	Yes
CO2 Estates	2009	10	UK	ICP-Europe Ally	Carbon Estates	Yes	Yes	Yes	Yes	Yes
Pilio	2008	3	UK/US	No	SMEasure	Yes	Yes	Yes	No	No

ing. Except for CO2 Estates, none of the European firms concentrate on portfolio analysis for CRE or generate retrofit recommendations validated by physical building data collection. Except for Pilio and FirstFuel, most of the firms focus on large clients rather than small ones. And currently, none of them provide integrated links to the financial models currently in use by the CRE industry. Despite the plethora of players, there are still functions that the burgeoning market for software data analytics has not yet captured.

Diverse Approaches and New Tools

The previous section provided a snapshot of the software-as-a-service offerings in the US and UK. This section focuses on the offerings and objectives of two of these data analytics companies – Pilio and CO2 Estates, introduced briefly above – which show some of the different ways these companies are working to make changes in their clients' energy use and understanding.

PILIO PROMOTES CITIZEN SCIENCE WITH SMES

What if energy users had the ability to constructively contribute to better buildings and better energy use? Moezzi and Janda (2014) used notions of citizen participation and citizen science to provide an initial framework for considering what a citizen science agenda look like in the built environment. Pilio provides one example of how this kind of agenda could evolve.

Currently, most smart meters for electricity provide most of their intelligence to the utility rather than to the user. Third party companies like Opower help feed this utility intelligence back to the user, but the data and algorithms that turn raw numbers into information are not accessible to the user. Moreover, the "customer" in such business models is the utility, not the energy consumer. On the other end of the spectrum, many hand held devices, home electricity monitors, and building management systems provide information to the user only. These tools often cannot provide a context in which to situate the data, and the data gathered is either "lost" after the owner reviews it or saved in a computer file with little or no onward analysis. Academics and researchers who are interested in understanding the larger systems of consumption have had a very hard time getting access to detailed consumption data that could be used to increase their own knowledge as well as those of policy makers and energy users.

Pilio (2013) aims to bridge this particular information gap. As described above, Pilio is oriented toward small and medium enterprises lacking electricity and gas meters that can be read remotely and automatically. Pilio realized that some of their customers have data but don't know how to use it. It also asks its customers to contribute their information to Pilio's data set. By contributing their own data, these customers agree to be a part of an evolving dataset that can identify clusters of buildings by owner as well as by type or size. This will help research-

ers to understand how different types of owners manage their properties, while helping owners understand their buildings better, and in a broader technical and environmental context. Pilio's efforts have demonstrated that it is possible to develop networks of citizen scientists and demand-side participation outside the utility infrastructure. These networks have the potential to simultaneously serve their participants and contribute to broader scientific and policy goals, such as minimizing the "data gap" in the non-domestic sector in the UK.

CO2 ESTATES TALKS SENSE AND MONEY TO CRE INVESTORS

Whereas Pilio focuses on SMEs, CO2 Estates focuses on CRE investors. Their current services include a combination of physical energy audits and metered data collection to deliver insight into asset and operational energy efficiency respectively. Their software, Carbon Estates, through data analytics and retrofit simulation provides decision-support for energy efficiency risk management and building improvement. CO2 Estates uniquely look to compliance-driven audits and how they can be re-engineered into data capture opportunities using Carbon Estates. A recent focus has been upon calculated energy ratings (Energy Performance Certificates – EPCs). Through this work, CO2 Estates' engineers have found that initial EPC assessments make overly conservative judgments. For example, where the assessor has been unable to verify data, they assume worst case scenario values as an alternative to undertaking further investigation. A more detailed, subsequent analysis can ensure the results better reflect reality, and therefore provide a more robust basis for decision-making. Additionally, their software tool appraises energy efficiency measures against multiple, qualitative and quantitative assessment criteria. This includes the level of disruption towards landlords or tenants associated with their implementation. Finally, landlords do not have full access to operational energy data, even from smart metered buildings. This is particularly true in multi-let office buildings and retail premises such as shopping malls, where the tenant-occupied and shared spaces in the buildings are metered separately. This means that "whole building" performance is similarly split. Of the gaps that CO2 Estates sees in the market, however the largest one that needs mending the gap between financial and information models.

To close the gap between financial and information models, CO2 Estates has proposed the development of a European-wide software platform to act as a decision-support tool for CRE investors, fund and asset managers. Such a platform would help them generate a better understanding of energy efficiency risks and opportunities across their existing property portfolios, as well as forming an integral element of due diligence processes upon property acquisition.

The proposed database will be unique in regard to the type of energy performance data it references. The application would centralise all forms of energy performance data, both building energy models and metered consumption figures, for demonstration of asset efficiency (e.g., energy models, EPCs etc.) and operational performance (e.g., metered data, DECs) respectively. Through this collective dataset, a holistic understanding of building energy performance could establish a baseline for identifying energy performance risk and opportunities. The software would thus support informed and data-centric decision-making with regards to building energy performance improvement. We believe that to successfully transition to a low carbon built environment, data analytics at scale must form a key component of the solution. Through centralisation of the data sets described above, intelligent data analytics can efficiently identify building-specific, retrofit strategies across thousands of properties.

In order to ensure use of the tool to achieve the overarching aim, it must be aligned with existing energy assessment methodologies across the European member states, namely those arising from the Energy Performance of Buildings Directive (European Union 2002) and Energy Efficiency Directive (European Union, 2012). The proposed application would look to the underlying data used to calculate the resulting energy performance rating, whether that be in the form of a building energy model, or a summary of metered consumption data. The ability to undertake European-wide building energy performance analysis, whilst satisfying the individual member states' statutory compliance requirements, would add tangible value to CRE investors with property portfolios that are situated throughout Europe. CRE property owners are actively seeking a single application that centralises portfolio-wide data for effective energy performance risk analysis, whilst ensuring they are legislatively compliant across Europe. A key objective of this project will be the examination and development of a data collection strategy to support the development of the software platform.

The novelty of the proposed software platform is therefore threefold: in the type and scale of data it centralises, in the form of decision-support provided – specifically designed around the needs of CRE – and most importantly in its analytical capabilities for automated retrofit analysis.

At a macro level, such a software database would deliver the EU with a comprehensive, centralised energy performance dataset, for the existing, commercial building stock, to inform policy making. Some member states currently hold national databases, but these are limited to a small proportion of the commercial building stock, as assessments are typically undertaken when triggered by an initial property transaction. The proposed software would create an environment in which the dataset would be continually updated going forward to support property owners in tracking performance over time, thus prompting repeated assessment across entire portfolios, consisting of thousands of properties.

This approach enables rapid access to thousands of properties and their associated data at the portfolio level. Portfolio holders have a need for easily accessible energy performance data for regulatory legislative compliance and for measurement, benchmarking and improvement to manage risk and maximise the value of their investments. CO2 Estates believes this proposed product will facilitate energy performance improvement of assets within the private rented sector, enabling further value to be derived. This could be in the form of increased asset value and improved market performance for property owners, and a broader range of energy efficient and comfortable working environments for commercial tenants.

Discussion and Conclusions

Previous papers have looked at the financial structure and opportunities of the market for upscaling energy efficiency (Rockefeller & Deutsche Bank 2012; Stuart et al. 2014), or at

the technical mechanisms underpinning this process, either at the portfolio level (Franconi, Bendewald & Anderson 2014) or building level (Ma et al. 2012). Previous work has also looked at different "players" in the commercial buildings market and sub-markets (Innovologie 2004). This paper has looked at "players" in the retrofit software analytics market. It has found that efforts to understand and standardize this market are more developed in the US than in Europe. This greater level of effort is certainly correlated with better data quality, perhaps even caused by it. Nevertheless, the players in the market in both regions are mostly small start-up companies, whereas the clients for these services are mostly enormous commercial real estate firms.

As data quality increases in Europe (e.g., through EPCs, DECs, and smart metering), will the pattern of evolution for retrofit software-as-a-service look similar, and continue in this vein? Or will a Microsoft of building data analytics develop? Only time can tell. The current diversity of players allows each company to develop unique offerings, as shown in the case studies. The kind of energy, innovation, and enthusiasm that small start-up companies have is undeniable. However, the question of CRE firms engaging in automated self-regulation based on 3rd party proprietary software platforms poses some potential policy challenges for both governments and firms.

From the CRE perspective, these are global companies with global portfolios. Each small software provider uses its own algorithms and IP to devise solutions which need to work – technically, economically, and legislatively – at the level of the physical property being retrofitted. Within their EU portfolios, CRE firms need to satisfy EU legislation and demonstrate compliance, but the EU regulations allow member states to vary these mechanisms. So it is currently an open question how well a US or UK software solution will work – economically and legislatively – in France or Portugal or Sweden. Some amendments would need to be made to translate from member state to member state, but how onerous and varied these amendments would be remains to be seen. Within the other regions, which do not have these same legislative drivers placed on the building owner, CRE firms would be able to use platforms that are not "limited" to the compliance-centric reporting/data analysis. However, these platforms cannot be used in the EU regions. This suggests that for a while longer, either more software firms will enter the market to capture different geographic areas, or existing firms will try to augment their existing tools to adapt to new territories. There is not as yet a platform that delivers a truly global solution.

In terms of data collection and knowledge, the B2B solution of private software firms working with CRE firms certainly poses some questions about data ownership and availability for the pursuit of the public good. Some firms – notably Pilio and CO2 Estates – are quite interested in using their tools to enable research and knowledge exchange. Both these firms are actively working with researchers on various projects designed to enhance public knowledge. This is laudable, but not required. Some sectors of the market in the UK (e.g., the UK retail sector) are developing public/private/academic "data safes" to store anonymized information about the sector that can be used for further analysis of trends. A B2B solution coupled with a publicly available data safe for CRE might provide a solution that enables insight into processes that would otherwise be almost entirely proprietary.

Concerns about the robustness of various software solutions is also still an issue, particularly in the "low-touch/no touch" realm. Several questions remain unanswered, but are worth pursing through further as Franconi, Bendewald and Anderson (2014) have shown. All building data analytics software are not equal, but are some more equal than others? Within the software itself, what "mastery" is required, and do the tools yield different results depending on who is wielding them? Finally, there is the question of the quality of the input data itself. Until the quality of the input data is assured, the quality of the output will be questionable.

From a policy perspective, probably the greatest concern is the coverage of the whole non-domestic market, not just the largest actors. In a B2B framework, the larger CRE actors will be the biggest beneficiaries of streamlined processes and solutions at the portfolio level. Market actors with smaller portfolios (and budgets) may suffer, including SMEs and the "data poor".

Will the CRE industry be able to support change from within, at a level that really matters, based on information and algorithms? Does industry-led, non-governmental regulation pose additional risks or benefits to society? Resolving these questions is beyond the scope of this paper, but by raising them the authors hope to provoke further debate and discussion.

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