Energy Management in Non-Residential Buildings in Norway: Learning through deconstruction of best-practice

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ABSTRACT

Energy efficiency (EE) in the built environment is at the core of EU policy aiming for climate-stabilization and security of energy supply. The field of EE embraces the development of concepts, methods and tools, relevant to the management and use of a building's operational energy. This paper presents the findings of a structured survey which aims to map the current level of awareness and degree of implementation of key energy management aspects in the Norwegian non-residential built environment. The survey portrays a deconstruction of the state-of-the-art of the methods that promise to improve the energy performance of non-residential buildings, including: Soft Landings, Continuous Commissioning, Building Performance Evaluation and Energy Performance Contracting. The questionnaire targets all relevant stakeholders, who are at least partly responsible for managing energy in existing non-residential buildings. Findings suggest over-reliance on technological approaches whilst disregard for soft management approaches and neglect for impact from building occupants. Findings will contribute to the design of EE methods which are based upon the prevailing approaches to energy management in non-residential buildings. The survey is part of a larger interdisciplinary Norwegian research project called MINDER (Methodologies for improvement of non-residential buildings day-to-day energy efficiency reliability) which brings together knowledge and expertise from social science, product design and facilities management.

Keywords

Energy-efficiency Improvement, Methodologies, Non-residential Buildings, Lead-user Innovation, Facility Management

1 INTRODUCTION

Energy efficiency (EE) is at the core of EU policy aiming for climate-stabilization and security of energy supply. The built environment accounts for 40% of the energy consumed in the European Union, thus making it an important sector for EU Energy Policy to focus on (Kyrö, Heinonen et al. 2012) . Furthermore, energy use in non-residential buildings in Europe has risen by a staggering 74% relative to 1990 levels (BPIE 2010).

By 2050, approximately 80% of the European building stock will be comprised of structures that, to this date, have already been built. As a result, retrofit solutions that aim to reduce the electricity consumption associated to a building´s operation and maintenance are of great importance (Aste and Del Pero 2013).

Similarly, decisions taken at the design phase of new buildings are of paramount value towards shaping the building´s expected energy performance (Jensen 2009, Bragança, Vieira et al. 2014); however, vast evidence suggests a mismatch regarding how design intent translates into actual energy performance. This issue is commonly regarded as the Energy Performance Gap (EPG) (Bordass, Cohen et al. 2004).

Organizations are naturally interwoven with their surrounding environment. Because of this, energy measures implemented at an organizational level have the potential to influence technological and behavioural change over the community that supports it. Therefore, in addition to affecting individual efforts to deliver low energy buildings, lack of awareness regarding the Energy Performance Gap has the potential to deter market opportunities towards large scale adoption of energy initiatives.

The range of available energy initiatives is vast. In general, their aim is to improve a building´s energy performance whilst generating a positive return on investment. Broadly, energy solutions can be classified either as “root-based” or “multi-method” approaches (de Wilde 2014, Valle and Junghans 2015).

Root-based approaches stem from the need to tackle specific energy issues that arise within particular phases during the life of the building. For example, further development of energy prediction systems, or advancements on energy efficiency technology in the areas of heating, ventilation, cooling and lighting.

On the other hand, multi-method approaches part from the assumption that the integration of the actors and technologies found across different stages in the life of a building contributes to improve a building´s overall performance (Berker et al. 2014). These methods can be characterized by strong use of hard tools (i.e. technological solutions), soft management approaches (e.g. briefings and workshops), or a combination of both.

However, the portfolio of energy solutions is so vast that it remains a great challenge for any organization to select and implement the practice that best suits their needs (Trianni, Cagno et al. 2014). Resources at the building level limit the extent to which any given energy management approach can be adopted. Furthermore, at the strategic level, compatibility amongst energy solutions and balanced use of organizational resources must be addressed in order to create synergy amongst energy practices.

This research paper presents the findings of a structured questionnaire survey. The objective of the survey was to collect information about the awareness and current level of implementation of the key elements which construct the state of the art of the methods dealing with energy-efficiency reliability within the building sector in Norway. Case studies will follow and deepen our understanding regarding findings from the survey. Clarification of the state of the art situation in Norway aims to contribute to the further development of existing approaches dealing with energy performance, as well as to support their further diffusion.

2 METHODOLOGY

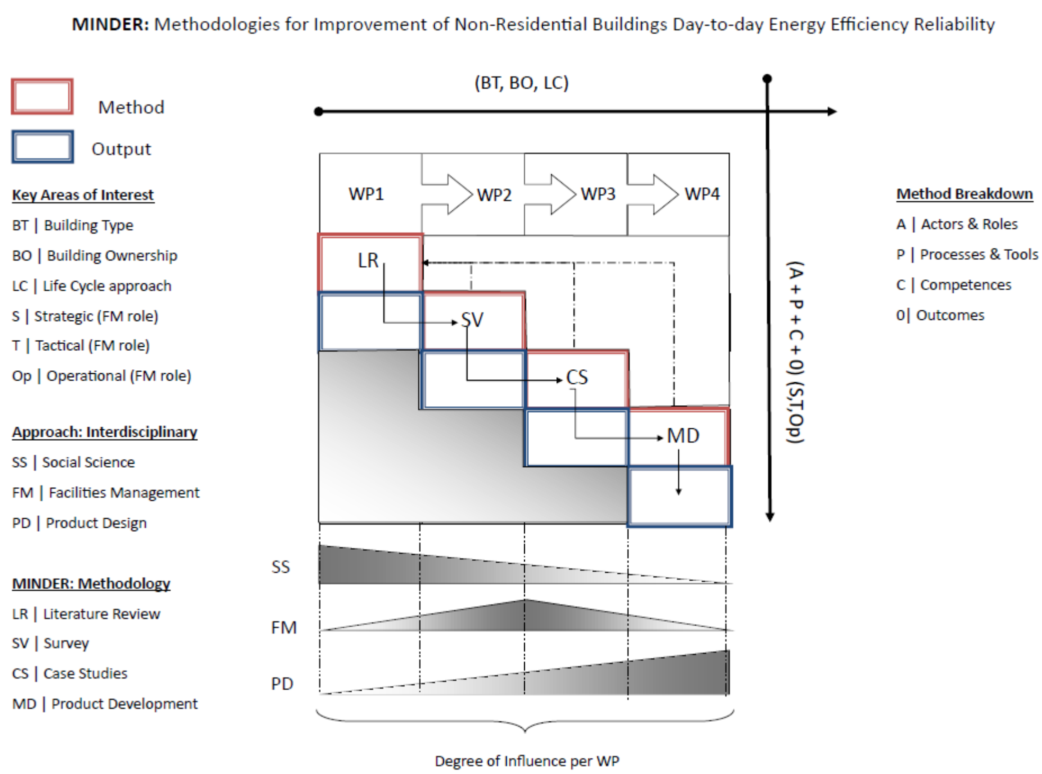
2.1. Overview of MINDER´s research framework

MINDER´s methodological framework stems from the assumption that the effective development and implementation of energy management strategies demands balanced integration of four components: 1) An actor who performs an action; 2) A tool or a systematic process used for performing the action; 3) Competencies required to effectively perform the action, and; 4) A desired outcome from the implementation of the action (See Fig. 1).

Based on the previous, the survey portrays a deconstruction of the state-of-the-art of the methods that promise to improve the energy performance of non-residential buildings. These methods include Soft Landings (SL), Continuous Commissioning (CCx), Building Performance Evaluation (BPE) and Energy Performance Contracting (EPC).

These practices were analyzed and the actors (A), processes and tools (P&T), competences (C) and desired outcomes (O) deemed representative of each method were extracted. A matrix was produced depicting the sum of the core elements that comprise the aforementioned practices.

Figure 1 MINDER research framework



2.2 Selection of a sample of building owner organizations

The structured survey was sent to a representative sample of non-residential building owners from organizations in Norway. The organizations are members of the Norwegian Facilities Management Network (NfN) and some are also members of NBEF (Norwegian Facilities Management Association) and partners of the Centre for Real Estate and Facilities Management at NTNU.

NfN has strong interest in the improvement of management, operation, maintenance and development of commercial and public buildings. Its main purpose is to promote the active exchange of information, knowledge and experiences between accredited members and between other relevant networks, including the fields of research and education.

By April 2014, NfN had a total of 49 registered member organizations, ranging across several economic activities, including: oil & oil services (18%), office sector (18%), health (18%), property (14%), banks (10%), industry (7%), education (7%), transport (2%), telecommunications (2%), trade 2%) and media (2%).

53% of its members belong to the private sector and 47% to the public sector. A complete picture of the types of buildings owned by members of NfN is not available at the date of producing this paper; however, data collected at a recent networking event from a sample of 16 NfN member organizations (32% of total members) revealed that: 56% use office building, 25% use a mixed-use building, 13% use university buildings and 6% use health related buildings. Out of those who selected “mixed-use” building, 75% included office building within their open-ended alternatives. Other building types included industry, schools, commercial and workshops.

Norwegian building regulations (TEK) identify 11 types of non-residential buildings, including: commercial, office, kindergarten, school, university, nursing home, hospital, sports facility, culture, light industry and hotel (Junghans 2012).

The energy-saving potential of the existing Norwegian non-residential building stock is expected to account for 3,130 GWh/year in 2020. Office buildings represent the second largest source of energy saving potential amongst all types of non-residential buildings in Norway; this is, 672 GWh/year just between “trading houses and retail buildings” with 937 GWh/year and “school buildings” with 397 GWh/year (ENOVA 2012).

Thus, from the data available to date, it can be said that NfN member organizations own, manage or use at least two thirds of the most relevant non-residential building types with high potential of energy savings in Norway.

Results from the survey will help to describe how energy management is currently being approached in the Norwegian non-residential built environment. In turn, these findings will enable the development of methods, concepts and tools that build upon the prevailing energy management characteristics of the Norwegian non-residential building sector.

Furthermore, this knowledge can provide insightful information towards the development of bottom-up meets top-down strategies for large scale implementation of these practices.

2.3. Overview of survey structure

The structured survey consisted of 20 closed questions, grouped into four sections.

1. Section I: gathered basic information about the respondents and their roles within the selected building;
2. Section II: assembled information relevant to the role of the respondents regarding the management of energy in their building;
3. Section III: looked into the level of awareness and implementation of the key energy management aspects in the organizations.
4. Section IV: collected information on the perception of the respondents on particular energy management topics.

3 SURVEY FINDINGS

3.1 Conduction and respondent rate of the survey

The survey was launched in August 2014 and targeted representatives from all 49 member organizations of NfN.

Potential respondents were contacted by e-mail through the Board of Directors of NfN, and were advised that their answers should reflect the reality of the building they own or manage.

21 representatives from member organizations answered the call to complete the survey. Responses with less than 30% of completed responses were not accounted for. The total amount of valid responses is therefore 15, or 31% of the total sample.

3.2 Profile of respondents and respondents rate

73% of respondents selected office building as the type of building they occupy. This is followed by health (13%), education (13%), and other (7%).

Respondents were asked about their relationship to the property or building of their selection. Alternatives included building owner, building manager or end-user. Respondents could select one or a combination of these alternatives. The term “stand-alone” is used whenever respondents selected one and only one of the alternatives.

Stand-alone building managers (50%) represent the largest group amongst respondents. This may refer to third party Facilities Management companies, contracted for the purpose of operating and maintaining the building. The extent to which this group can decide to implement an energy initiative may be constrained by the willingness to invest from building owners and or building users. 29% of respondents are stand-alone building owners. This group may include property developers with intention to either sell or rent a property, each with particular incentives -or lack of- to invest on and continue to manage energy initiatives (Novakovic et al. 2012).

The formality with which energy management is approached in the organization was also assessed. Descriptions for each energy management approach were provided. 73% of respondents indicated that energy management is formally addressed within their organization. This means that a strategy is in place and specific roles required for formal implementation are assigned. In contrast, 20% of respondents indicated an informal approach to energy management. Results are therefore perceived representative from organizations that formally address the implementation of energy management initiatives.

Additionally, the survey explored the level of responsibility (i.e. strategic, tactical or operational management levels) of the respondent regarding the management of energy in their organizations. 40% of respondents indicated that their role lies at the strategic level. Arguably, professionals at this level hold sound knowledge regarding the overarching energy management framework in the organization. 33% of the respondents positioned their role at the operational level. Detailed information regarding actual level of implementation of key energy management aspects is likely to be held at this level. Therefore, the views from this group are considered of high relevance to the study. Respondents at the Tactical level represent only 20% of the sample. Due to low rate of response from this group, their views are not considered to be representative but may be considered on a case by case basis.

3.3 Measuring awareness and level of implementation of energy management aspects

Respondents were presented a list of key energy management elements relevant to the implementation of a selection of energy management methods. Using a scale from 1 to 5, where 1 is never and 5 is always, respondents were asked to rate the level to which these elements are used in their organizations. Definitions and examples were provided where necessary to minimize the risk of response drop-out.

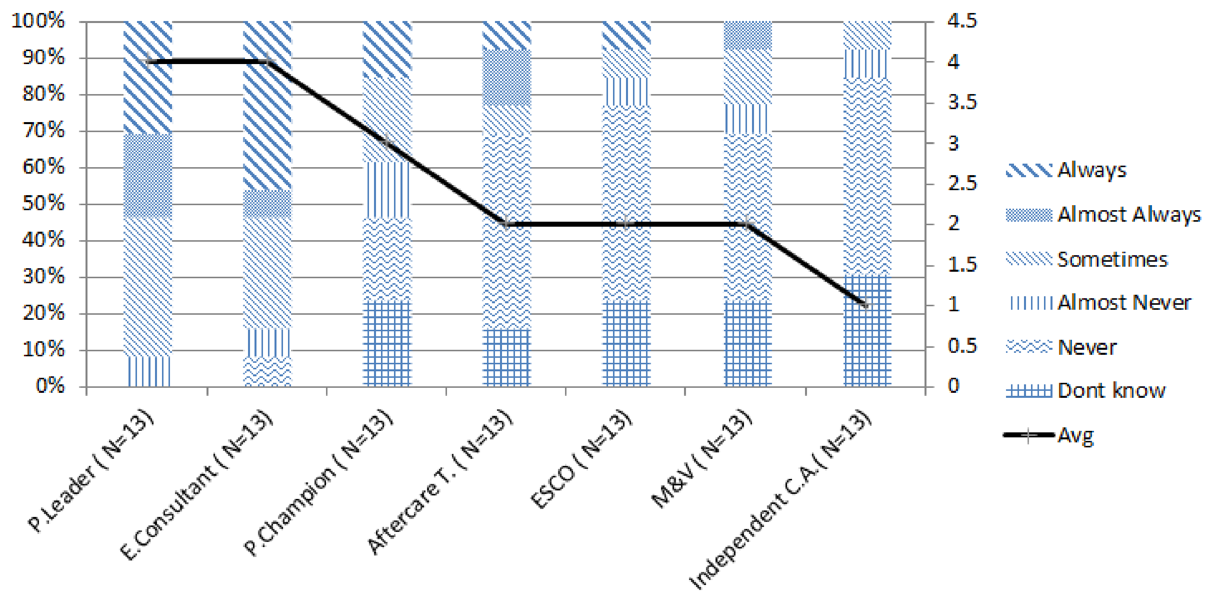
3.3.1 On actors and roles

A list of “actors” relevant to the implementation of a selection of management methods was provided, including: Project Leader, Project Champion, Energy Consultant, Energy Service Company (ESCO), Measurement and Verification Energy Specialists (M&V) and Independent Commissioning Authority (See Fig. 2).

Energy Consultants and Project Leaders are the most used actors, with 54% of responses indicating these are almost always or always used. The formal appointment of Project Leaders may be indicative of formal approaches to energy management, consistent with findings from Section I of the survey. However, nearly 40% of respondents indicated that the role of Project Leader is used only some of the times. Considering that 70% of respondents indicated to follow formal approaches to energy management, it becomes unclear whether organizations are fully embracing the level of responsibility demanded by formal energy management approaches.

The high level of awareness and implementation of Project Leaders and Energy Consultants could be explained by two factors: First, their long known presence in the energy industry, but perhaps more importantly, the fact that they can both be employed either as stand-alone roles or as complementary to other methods. For example, a Project Leader may be appointed as counterpart to an ESCO, or even to an outsourced Energy Consultant.

Figure 2 Awareness and current level of implementation of Actors and Roles



The roles of Energy Service Company (ESCO), Monitoring and Verification (M&V) and Independent Commissioning Authorities (C.A.) rank the highest amongst the list of actors that remain unknown amongst respondents (23%, 23% and 31% respectively).

Furthermore, even when respondents are aware of these actors, results indicate considerably low levels of implementation.

3.3.2 On processes and tools

Respondents were presented a list of twelve (12) Processes and Tools, containing both hard tools and soft management approaches (See Fig.3).

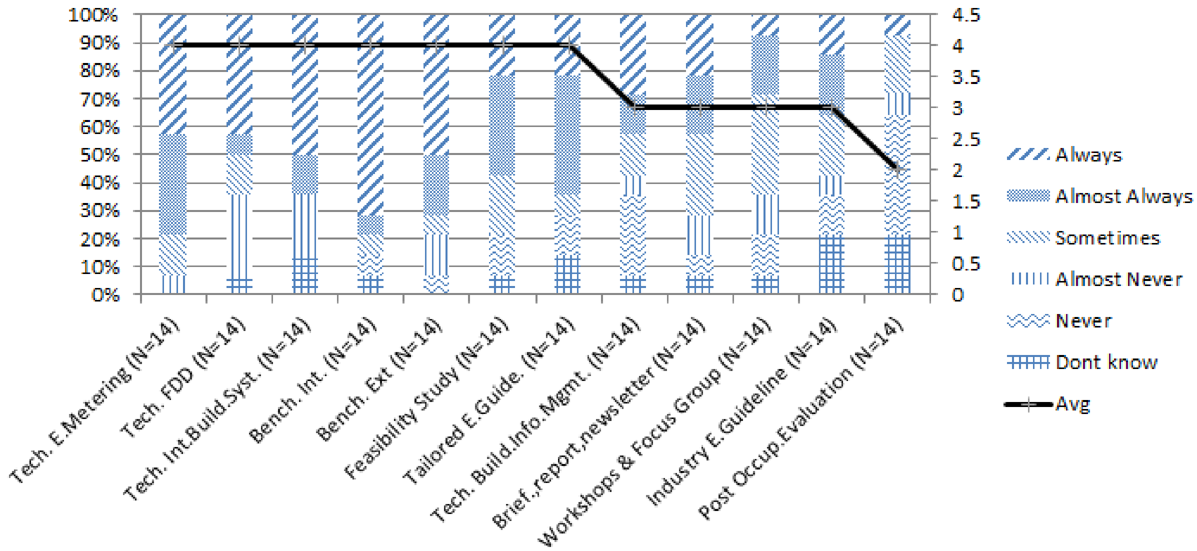
Results indicate a clear tendency amongst respondents to favor technology-based Processes or Tools. Four out of the five processes and tools that are most used by respondents are directly or indirectly associated to the need for investment in technology. These include: Technologies for detailed energy metering, energy benchmark exercise (external and internal) and technologies for the integration of building systems (e.g. BMS).

Detailed energy metering and internal energy benchmarks are the two most used tools amongst respondents, with 80% of respondents indicating that they always or almost always use these tools.

Conversely, 80% of the least used processes or tools are those associated to soft management approaches. These include: energy workshops, focus groups, briefings and newsletters.

Post Occupancy Evaluation (POE) stands out both as the least known tool amongst respondents (over 20% of respondents are not aware of it), and as the least used tool amongst those respondents who are aware of it (over 50% of respondents never or almost never use it).

Figure 3 Awareness and current level of implementation of Processes and Tools



3.4 Measuring perception on energy management issues

Respondents were asked to give their opinion on a series of statements relevant to energy management issues. They were asked to rate these statements in a scale from 1 to 5, where 1 means to completely disagree and 5 means to completely agree.

3.4.1 On the impact of building occupants over energy consumption

In response to the statement: "*Building occupants do not have a significant impact on the energy performance of my building",* 43% of respondents expressed agreement with this statement, with an equal share of respondents (43%) expressing disagreement. The remaining 14% of respondents neither agrees nor disagrees with this statement.

This suggests that the influence of building users on the energy performance of the building they occupy remains unclear. Lack of consensus on the subject may be influenced by the energy ambition level of the building they occupy. For example, building owners who have invested heavily in energy saving technologies may perceive that the extent to which end-users can affect the buildings´ performance is low.

This view is supported by the fact that half of the respondents (50%) perceive that "the impact of building occupants on energy performance can be solely managed through technology solutions".

The relation between the role of the respondents (i.e. Strategic, Tactical and Operational) and their perception regarding the impact of building users on energy consumption was also assessed.

Results suggest that professionals at the Operational level may be more aware of the influence that building occupiers exert on the energy use in the building. Results may be explained by the higher level of interaction that building operators have with building users, when compared against professionals situated at the tactical or the strategic level.

3.4.2 On barriers to energy management

The perception of respondents regarding the barriers hindering the implementation of energy management measures was assessed. A list of seven issues was provided and included the following key topics: finance, knowledge, awareness and organizational resistance to change (See Fig. 4).

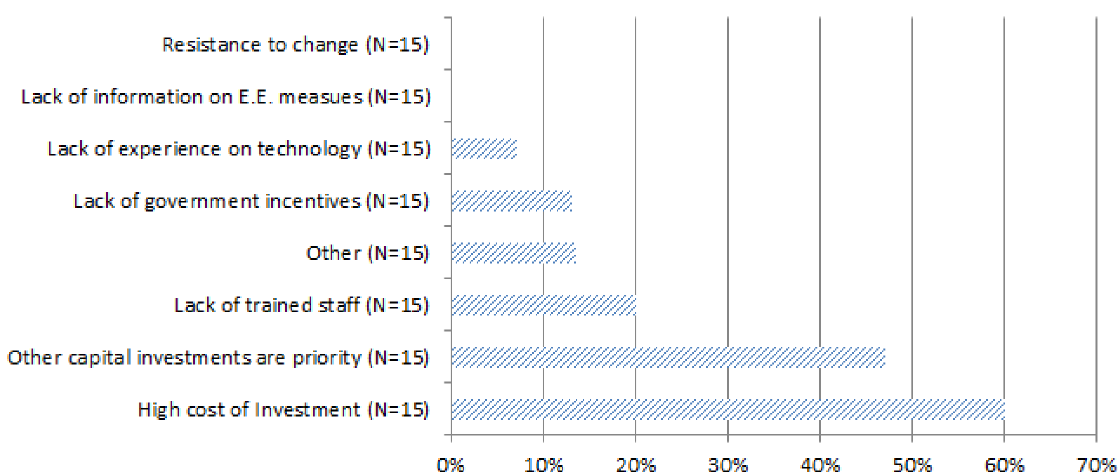
60% of respondents indicated that "perceived high cost of energy investment" is the top hindrance preventing the uptake of energy initiatives. In addition, nearly 50% of respondents indicated that within their organizations, other capital investments are perceived as more important.

Considering the tendency to favor technology solutions that require some level of financial investment, it is reasonable that financial aspects lay at the core of the energy management decision-making process.

In stark contrast, issues such as "lack of information on technologies" and "resistance to change" were not perceived as hindering the uptake of energy management initiatives. However, it remains unclear whether the latter is a result of the evidenced lack of use of stakeholder engagement approaches. Therefore, the authors acknowledge the need for further qualitative investigation in the context of barrier analysis.

The relation between building ownership (i.e. owner, manager or end-user) and perception on barriers was assessed.

Figure 4 Perception on barriers hindering implementation of energy management initiatives



86% of building managers perceived that the high capital cost of energy initiatives was preventing the implementation of energy management initiatives, against 50% of building owners who share the same view. Also, just 25% of building owners perceive that other capital investments are prioritized before investment on energy efficiency, against 42% of building managers who also perceive this to be a barrier.

This could be explained by the fact that building owners are more likely to have the power to decide how and when to invest, whereas building managers must abide to the decisions or interests of the other stakeholders (i.e. owners and users).

This may also suggest that stand-alone building owners are failing to acknowledge energy management as their ultimate responsibility and therefore, tend to disregard the burden of investment.

4 DISCUSSION

Approaches to energy management amongst respondents seem to be characterized by three main aspects:

Firstly, the use of basic energy management actors, namely Project Managers and Energy Consultants, and remarkably low rates of awareness and adoption of specialized Actors such as ESCO, Independent Commissioning Authority and Monitoring and Verification specialists. It remains unclear whether most of the Actors associated with expert knowledge are not present in the Norwegian market, or whether their potential to improve energy performance is not yet clear in the local industry.

Secondly, the use of energy management tools that rely on technological solutions, such as energy metering and systems for building automation, whilst disregarding the use of stakeholder engagement tools such as briefings, workshops and focus groups. Findings suggest that technology based initiatives are being approached as “fit and forget” solutions, which in turn, may reinforce split opinions over the impact that building users have over the energy performance of the building they occupy. Findings also suggest that the value of soft management approaches is not fully understood.

Thirdly, the perception that financial issues represent the main hindrance regarding the adoption of energy management initiatives. Findings suggest building ownership influences the degree to which financial investment is perceived to affect the decision making process. For example, building owners with intention to sell may invest in energy initiatives as means to increase property marketability; however, their incentive to continue to manage these initiatives is likely to drop after the property has been sold and benefits are transferred to the buyer.

Finally, disagreement amongst strategic, tactical and operational roles may suggest a lack of knowledge flow within the FM profession. In turn, disruption of knowledge flow may translate into energy initiatives that fail to address the behavior of building occupants.

5 CONCLUSION

Two different but related strategies will follow the conduction of the survey. The qualitative case studies (WP3) will provide insight into the state of the art in current energy efficient building operation and by that deepen the image that was created by the survey.

Issues regarding the preference over particular actors, processes and tools will be of interest. The correlation between the different energy management elements will be further explored.

The research focus will be to analyze in depth the context and critical success factors in a limited number of 10-15 cases in which at least certain aspects of the methods have been implemented.

These qualitative case studies will be based on semi-structured interviews with facilities managers, operation personnel and end-users in these buildings. The interviews will be complemented through observation at the building and studies of strategic documents.

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