Energy Efficiency Measures and Data Needs. The Case of the European Building Portfolio Owners

(article starts on next page)

PAPER • OPEN ACCESS

Energy Efficiency Measures and Data Needs. The Case of the European Building Portfolio Owners

To cite this article: C Camarasa *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **503** 012101

View the article online for updates and enhancements.

Energy Efficiency Measures and Data Needs. The Case of the European Building Portfolio Owners

C Camarasa[1], E Roussou[1], H Wallbaum[1], A Sousanabadi Farahani[1]

[1]Chalmers University of Technology

E-mail: camarasa@chalmers.se

Abstract. In line with EU Directives, European building portfolio owners are required to bring their stock to nearly Zero Energy Building (nZEB) standards by 2050. To fulfil this goal in a timely and cost-effective manner, they will need to have a comprehensive understanding of their buildings' condition, as well as consistent information on viable energy and low-carbon technology measures. Currently, in Europe, there is a lack of knowledge of what energy efficiency measures are being implemented in residential buildings. It is also unknown what are the decision-making processes behind the selection of these measures. On this basis, the aim of this study is to shed light on (1) what energy efficiency measures are currently carried out across European building portfolio owners (BPOs), (2) how are these measures selected (i.e. decision-making processes and information sources), and (3) what data would be needed to foster the uptake of low carbon energy efficiency technologies. The applied methodology combines desk research on scientific and grey literature, with findings in the field of building maintenance & operation. The later based on semi-structured interviews with 23 selected private and public BPOs across 7 European countries: Sweden, UK, Germany, Denmark, Italy, Spain and Switzerland. Results show that the most often implemented actions are the maintenance of the roof and the upgrade of the heating system. Measures are decided based on a combined planned and "reactive" (i.e. problem/solution) approach. The data that is typically used by BPOs is basic building information, such as gross floor area or year built. Although currently unavailable, the most often solicited evidence by the BPOS in favour of energy efficiency and low carbon technology measures is related to energy consumption and other user data.

1. Introduction

At the United Nations Climate Conference (COP21) held on December 2015 in Paris, the European Union (EU) and its 28 Member States were among the first to submit its Intended Nationally Determined Contributions (INDCs), aiming at reducing GHG emissions by 40% by 2030 [1][1]. In Europe, residential buildings constitute approximately 75% of the building stock, accounting for circa 30% of the EU´s overall energy demand and emissions [2]. Furthermore, about 35% of the residential stock is over 50 years old and more than 70% is deemed as energy-inefficient [3]. Given this challenge, the EU has

---

[1] Relative to 1990 levels.

appointed two main decrees: (1) the Energy Efficiency Directive (EED) [1], and (2) the Energy Performance of Buildings Directive (EPBD) [2].

To reach nZEB standards, most of the European building stock will require extensive renovation [4,5]. The ability to predict the forthcoming renovation expenditures would enable building portfolio owners (BPOs) to efficiently utilize resources and lower budgetary pressures to fulfil carbon reduction targets [6]. Reliable building data is, hence, key to develop strategies to preserve and operate a building over its service life with a reasonable investment of financial and natural resources and, ultimately, achieving nZEB standards. However, there is presently a lack of knowledge on the energy efficiency measures are taking place across building portfolios in Europe and if they are fulfilling the EED and EPBD [8,9]. Based on this information gap, the aim of this study is to shed light on the measures currently taking place in residential building portfolios across Europe, the decision-making processes and the evidence base behind these measures, as well as the data needs to support the large-scale deployment of low carbon energy efficiency technologies towards nZEB standards.

The remainder of the paper is organized as follows; in the following section the research method design, operationalization and data analysis are described (section 2). Results are presented in section 3. Finally, section 4 discusses the results and extracts conclusions from the main findings.

2. Method
The applied methodology combines (i) desk research on scientific and grey literature and (ii) findings in the field of building maintenance & operation, based on semi-structured interviews. The interviews were conducted to 23 selected private and public BPOs and/or consultancies across 7 European countries: Sweden, UK, Germany, Italy, France, Denmark, and Ireland.

2.1. Semi-structure interview procedure
To test the relevance and validity of the overall goal and method of this study, four guided qualitative interviews with experts were conducted between September and October 2018. The insights gained from these interviews, along with a systematic literature review, served as a valuable basis for identifying the research tool (i.e. semi-structured interviews) and designing the items used in the questionnaire. The target group of the questionnaire were private and public housing/portfolio owners and real estate related consultancies, involved in maintenance strategies and implementation measures. A draft questionnaire was reviewed by 3 market experts and pre-tested by 3 target representatives. The semi-structured interviews were then conducted between 11/2018 to 05/2019. The data was collected from the retrieved BPOs and analysed using Excel.

2.2. Operationalization
In accordance with the overall aim and objectives of the study, we asked respondents to identify the company profile and their professional role. Then, respondents were asked to elaborate on maintenance strategies (if at all present in their organization) and existing implementation measures, as well as how do they take place. In addition, interviewees were asked about relevant parameters or indicators that could help them to execute appropriate strategies and measures, including the data sources that could help them in the deployment of energy efficiency measures. In terms of the content structure of the interviews, it consisted of 5 main parts: Part I, collecting information on the respondent profile (e.g. facility manager); Part II, related to the BPOs maintenance strategies; Part III: related to the BPOs relevant parameters and indicators; Part V, the denouement, addressing any additional thoughts or comments from the interviewee. The complete questionnaire can be accessed through this link[2].

---

[2] https://tinyurl.com/yytrxhsj.

3. Results

The goal of this study was to better understand current maintenance processes and data requirements across European BPOs to promote energy efficiency technology solutions. To this end the results have been divided into three main parts: (1) sample characterization, namely number and profile of the BPOs surveyed, including the number of dwellings and building typologies or handled in each case; (2) maintenance measures implemented across BPOs; and (3) current data uses and needs to foster the implementation of energy efficiency measures.

### 3.1. Sample characterization

The sample was composed of 23 housing associations across 7 European countries, together owning or managing a total of 1,040,201 dwellings. Given that the study was embedded in the EU H2020 DREEAM project[3], most of the selected BPOs were members of the consortium. The breakdown of the number of housing associations interviewed in each country and the respective number of owning or managing dwellings are indicated in Table 1.

Table 1. Number of surveyed participants and owning or managing buildings per country.

| Country	No. of participants (i.e. no. housing associations)	No. of dwellings (buildings)
Sweden	6	63,769 *(~1000)*
Italy	5	73,138
Germany	1	61,286
France	3	535,670
Denmark	1	16,500
Ireland	2	9,000
UK	5	280,838 *(19309)*
TOTAL	**23**	**1,040,201**

Building typologies are a set of model buildings with their own age of construction, geometrical, thermo-physical, equipment and energy performance properties [11]. The building composition and energy solutions vary substantially from one building typology to another. Characterizing and identifying the building typology is, therefore, critical in the study of energy efficiency measures, as it provides essential information about the building constructive composition and energy efficiency technically viable. Within this paper, BPOs were asked to characterize the building typologies that compose their portfolio. The goal of this question was to understand what their building compositions and viable solutions in each case were. Figure 1 represents the percentage of building typologies that were owned or managed by the interviewees from each country. As can be depicted from the results, large multi-family buildings are the most common typology, especially in the case of the German interviewee (90%). In Ireland this is semi-detached houses, twin or duplex represent nearly half of the stock (42%), and in Italy and UK small multi-family represent around 30% of their building portfolios. The breakdown of building typologies per interviewee can be found in Annex 1, figure A2.

---

[3] https://dreeam.eu/

Figure 1. Percentage of building typologies owned or managed in each country
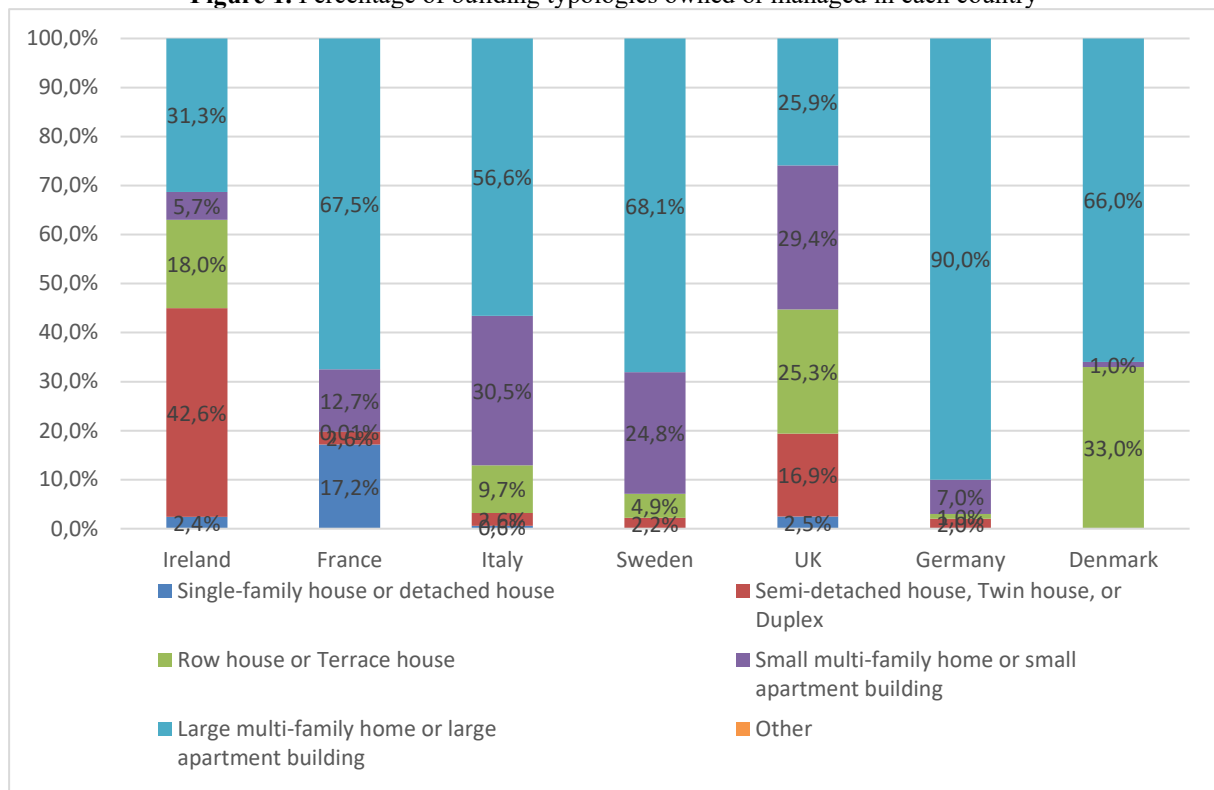
3.2. Measures across countries and building typologies

In terms of the measures implemented across countries, maintenance is the most often completed one except for Germany, which is upgraded. The most often addressed building element across all countries is the roof and the heating system, except for Ireland, which is the ventilation system. When looking at the implemented measures per building typologies, it is noteworthy that the building typology where most actions have taken place are small multi-family and row-houses show, being the maintenance of the roof the most times completed.

Figure 2. Measures implemented across countries
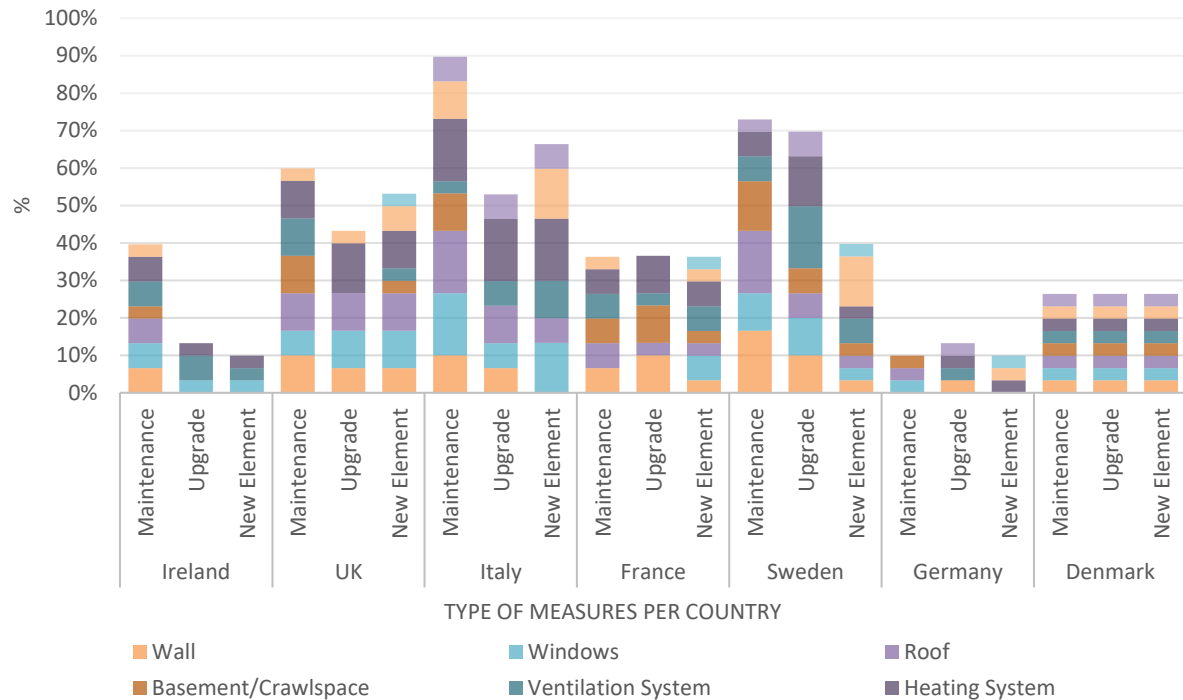
**Figure 3.** Measures implemented across building typologies
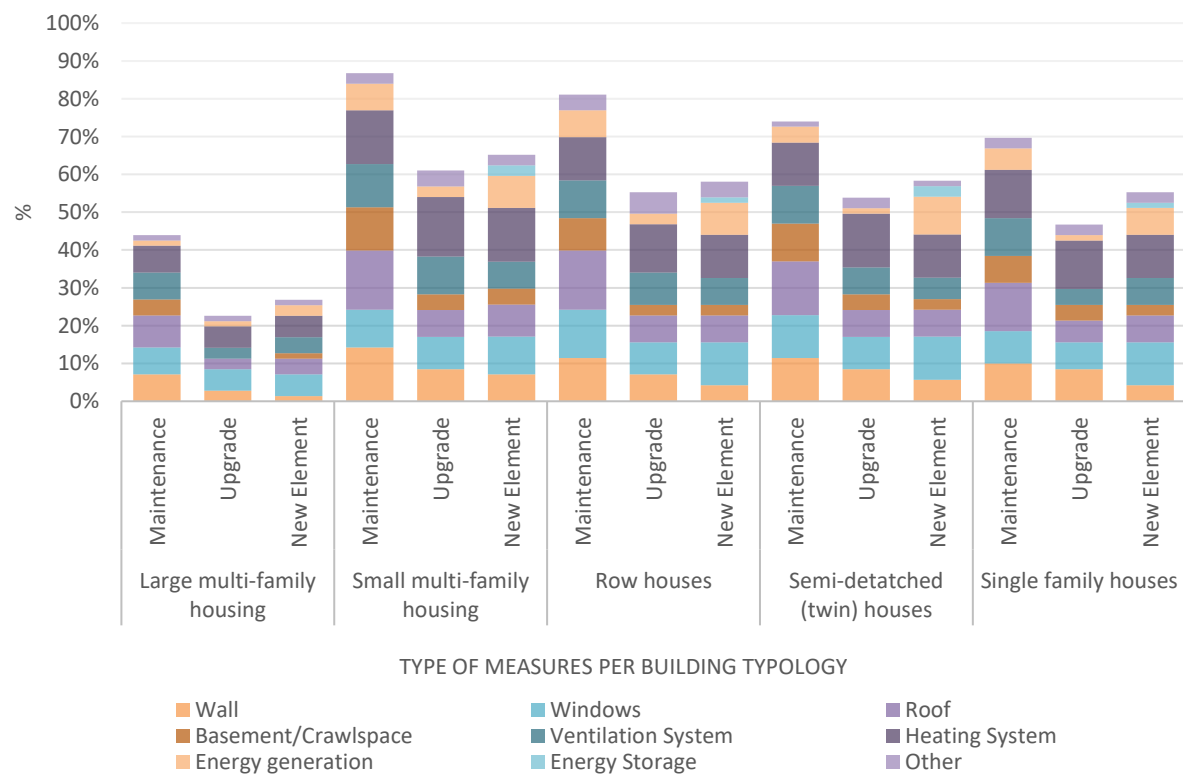
3.3. Decision-making behind implemented measures

As aforementioned, the ability to predict the forthcoming renovation expenditures would enable BPOs to efficiently utilize resources and lower budgetary pressures to fulfil nZEB standards [6]. To gain insights as to how BPOs are currently deciding on the building measures, interviewees were first asked on how the building measures were decided. They were provided with several options; through a "planned" approach (i.e. actions are executed based on a pre-established procedure, e.g. Annual strategy based on buildings' condition assessment), through a "reactive" approach (i.e. act whenever a problem is encountered, e.g. a window breaks so it is repaired or replaced); or through a combination of the above. Once this had been addressed, BPOs were asked about the frequency of the maintenance measures. Within the questionnaire three main answer options were provided: periodic maintenance (i.e. the building and its components is checked at fixed intervals to see that all the elements and facilities are properly functioning); condition-based maintenance (i.e. appraisals in which the state of the building(s) is evaluated, including functional, safety and aesthetic evaluation of the subject or components); or, again, a combination of the above. These questions were followed-up by queries on the decision-making process behind this selection of the measures, more specifically interviewees were asked: "How are the decision-processes being done, i.e. who is involved, who is making the decisions? who is executing? How are they making these decisions?". This was an open-end question in which respondents were asked to elaborate in a qualitative manner.

Out of the 23 cases, 20 interviewees (86.9%) stated that they operate in a way that combines planned (measures are executed based on a plan) and reactive processes (act whenever a problem is encountered, e.g. a window breaks so it is repaired or replaced). The remaining 3 respondents (13.1%) operate based merely on a planned workplan. In planned maintenance, most of the respondents (73.9%) indicated that they operate in a combination of periodic and condition-based plans, while 17.4% stated that they operate solely based on the evaluation of their portfolio's condition and 8.7% on a standard period alone. In terms of the periodicity, 8.7% of the BPOs indicated that they operate based on a three-year plan while another 8.7% stated that they follow a five-year plan. In both cases, the plans are revised annually. When it comes to how the decision-making processes are taking place, most BPOs indicated an assessment is performed on the stock based on the lifecycle estimates for the different components, in relation to their current condition. Some of the respondents stated that they also reach out to their tenants through surveys. In this context, the case of the Danish interviewee is noteworthy, as decision-making relies heavily on and is done in close cooperation with the representatives of the "tenants' democracy".

3.4. Relevant parameters and indicators: current data uses and needs to favour energy efficiency measures

To evaluate alternatives and make informed choices, companies must have reliable and timely data upon which to make their decisions. In the case of the BPOs, data resources are needed to be able to select and trace effective plans for the maintenance and upgrade of their buildings including energy efficiency upgrades. According to the surveyed BPOs, the type of data currently being used varies substantially across countries (figure 4). The most often selected one is basic building data (e.g. gross floor area, year built, etc.), followed by cost data (e.g. technology prices). The least often used data is user-related information (e.g. the number of people per dwelling, hours occupied, etc.), along with market data (e.g. how could the asset/building value change depending on different measures being implemented in the building, enhance the ability to rent or sell, etc.). In the UK, data sources are mostly related to basic building data. In Ireland cost, basic building and user-related data. In the Italian interviewed BPOs, it is basic building data. For the French parties, it is cost, basic building and energy consumption data. In Sweden, mostly cost data and basic building data were indicated. Finally, the participants from Denmark and Germany have stated that all types of data are regarded as equally important and useful.

Figure 4. Data relevance for day-to-day work across countries
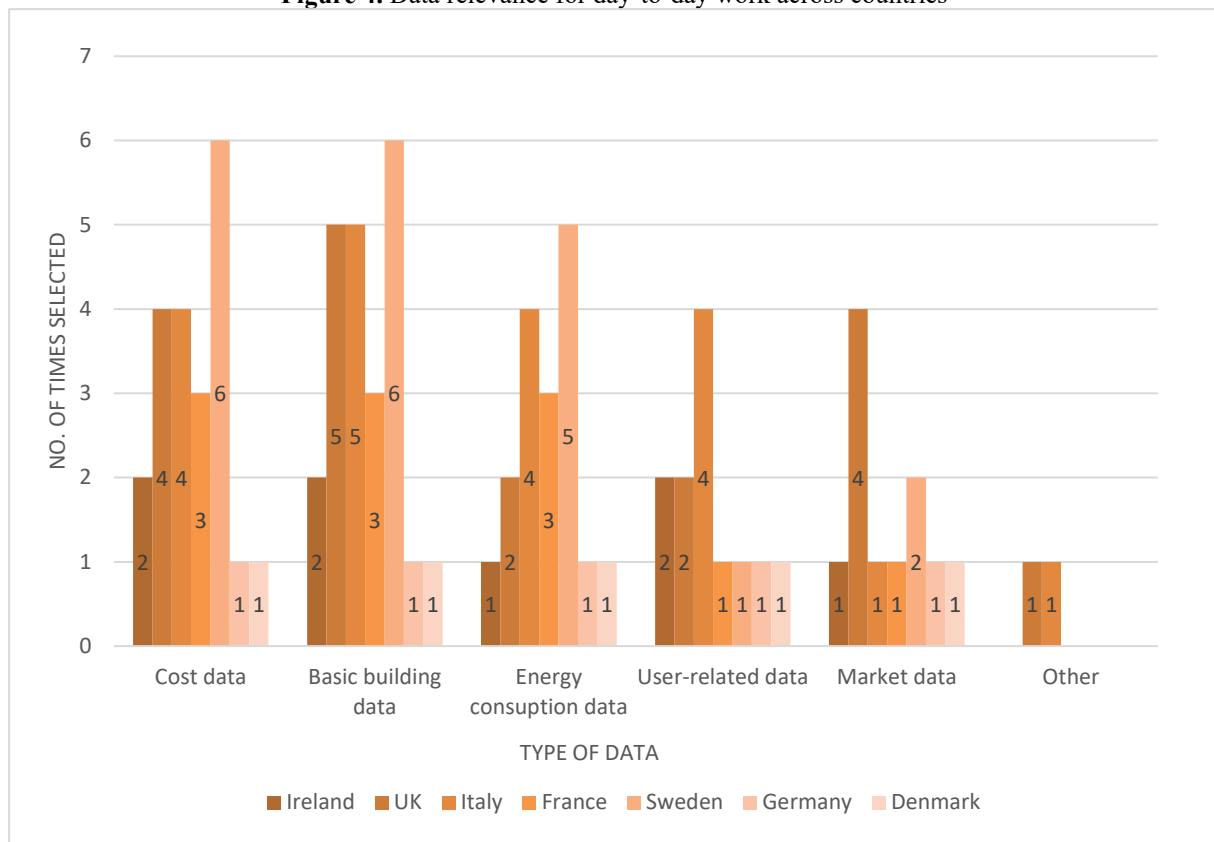
In terms of what kind of data (or the resolution of this data) is currently not available in their organisation but could this data be useful to promote energy efficiency solutions (figure 5), data needs vary substantially across countries. The most often selected energy consumption data and could be used mainly for improving the quality, transparency and accountability of the organisation, as well as enhancing the efficiency of energy services. In overall evaluations of benefits per users are the most valuable information to promote energy efficiency and low-carbon solutions, especially in the case of Italy. This is followed by occupant data and environmental impacts & energy efficiency. For BPOs in Sweden technology descriptions and prices are also very relevant.

Figure 5. Correlation between BPOs data needs and potential uses of this data
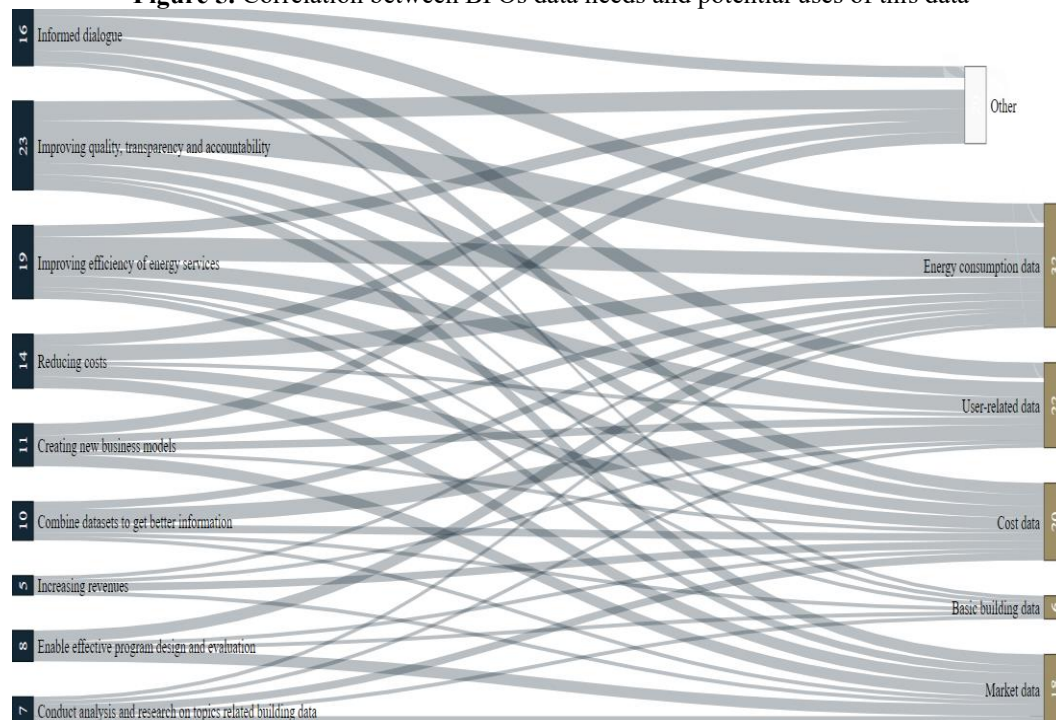
4. Discussion and conclusions

Results from this study show that the number of managed and owned buildings varies substantially among European BPOs. However, the type of measures implemented does not differ much across the sample. The most often implemented action across buildings is maintenance of the roof or of the heating system. According to various sources [3,4], these are in fact some of the most cost-effective energy efficiency retrofit measures that can be applied to multi-family buildings in the EU context. This also suggests that cost-effectiveness can be a leading driver in the selection of the retrofit measure that is implemented in the portfolio. What remains unexplored is the exact energy improvement of these actions conveys, that is, if they are leading towards a nZEB standard of the portfolio or rather to a sub-optimal level of energy improvement.

Another aspect that does not vary across the surveyed BPOs is the approach by which the building measures are decided. In most cases (87%) it is a combined "planned" (measures are executed based on a plan) and "reactive" approach (i.e. act whenever a problem is encountered, e.g. a window breaks so it is repaired or replaced). Despite the alignment in their approach, it remains unclear how these plans are developed, based on what are the exact information or priorities. Currently, BPOs state that to carry out their day-to-day work they are hinged on basic building information such as gross floor area, year built, etc., but it has not been stated what the exact type and source of the data is, the quality and resolution it has, and to what extent this information influences or determines their actions (especially in the case of planned actions or measures). To this end, follow-up interviews would be needed to gather additional insights on the exact data input used, its sources (i.e. reliability and resolution), as well as the level of influence this information would have in the decision-making.

The decision should be based not only on information but also on the right information. If energy efficiency solutions are to be promoted, BPOs should have the necessary input to support their actions and implement these solutions in the most cost-effective manner. In this sense, it is noteworthy the lack of overlap between the data that is currently being used in their day-to-day work (i.e. basic building information) and the data that would be needed to promote further energy efficiency technology solutions (i.e. energy consumption and user-related data). This finding suggests that BPOs don't have a solid information ground on which to base their decisions in favour of energy efficiency measures. This

is indeed a hurdle to transition into nZEB standards, hence, to fulfil the EED and EPBD and achieve carbon reduction targets. The fact that BPOs don't have the sufficient and/or appropriate information to make decisions in favour of energy efficiency measures is also a risk when considering "lock-in" effects. A lock-in effect refers to "committing to a pathway of infrastructure use and environmental impacts that is difficult to diverge from" [4]. In the context of energy efficiency and buildings, "lock-in effect" entails any measures undertaken in the building which might hinder a substantial fraction of the savings' potential to be achieved through a comprehensive energy-efficient retrofit. Thus, the fact that BPOs don't have enough and/or the right type of information needed to identify energy efficiency and low carbon technologies might lead them not only to not implement them in a timely manner, what is more, lock-in their implementation in the future.

The lack of data across countries also suggests that BPOs in Europe could benefit from an information tool, tailored to their decision-making processes and providing a systematic overview of the building condition including environmental and user benefits of energy efficiency. However, the fact that the people who are involved and their decision-making processes and structures vary across the different BPOs can create a market barrier in the upscaling of such information tool. Mostly due to the fact that, although the approach and data needs can be similar, each BPO might give different angles in terms of functional requirements, input data, etc..

5. Outlook and limitations

This study gives a general overview of some of the current measures being implemented in residential building portfolios across EU countries, the decision-making process, as well as data, uses and needs to favour the uptake of energy efficiency and/or low carbon technologies. In order to have further insights or understanding of decision-making processes, data sources and impact that those data sources would have in the final decisions, follow-up interviews will be required. Also, to make further data analysis or inferences (i.e. statistical power) about the data uses and current energy efficiency measures, this study should be complemented by bigger sample size, meaning more interviews should be conducted.

Annexes

Annex 1: Sample characterization

Table A1: Breakdown of interviewee´s profile

| COMPANY NAME	COUNTRY	POSITION
#1	Sweden	Technician / Administrative staff / Site worker
#2	Sweden	Project lead / Site manager
#3	Germany	Project lead / Site manager
#4	France	Manager + Project lead / Site manager
#5	Denmark	Project lead / Site manager
#6	Ireland	C-Level*
#7	Sweden	Technician / Site worker
#8	Italy	C-Level*
#9	Italy	Consultant/ Technician
#10	Italy	C-Level*
#11	Italy	Manager
#12	Sweden	Manager
#13	Sweden	Property development manager
#14	Ireland	Manager
#15	UK	Manager
#16	France	*Not specified*
#17	UK	Manager
#18	Italy	Project lead / Site manager
#19	UK	Director
#20	Sweden	Manager
#21	UK	Director
#22	France	Director
#23	UK	Manager

*(CEO, COO, CFO, etc.)
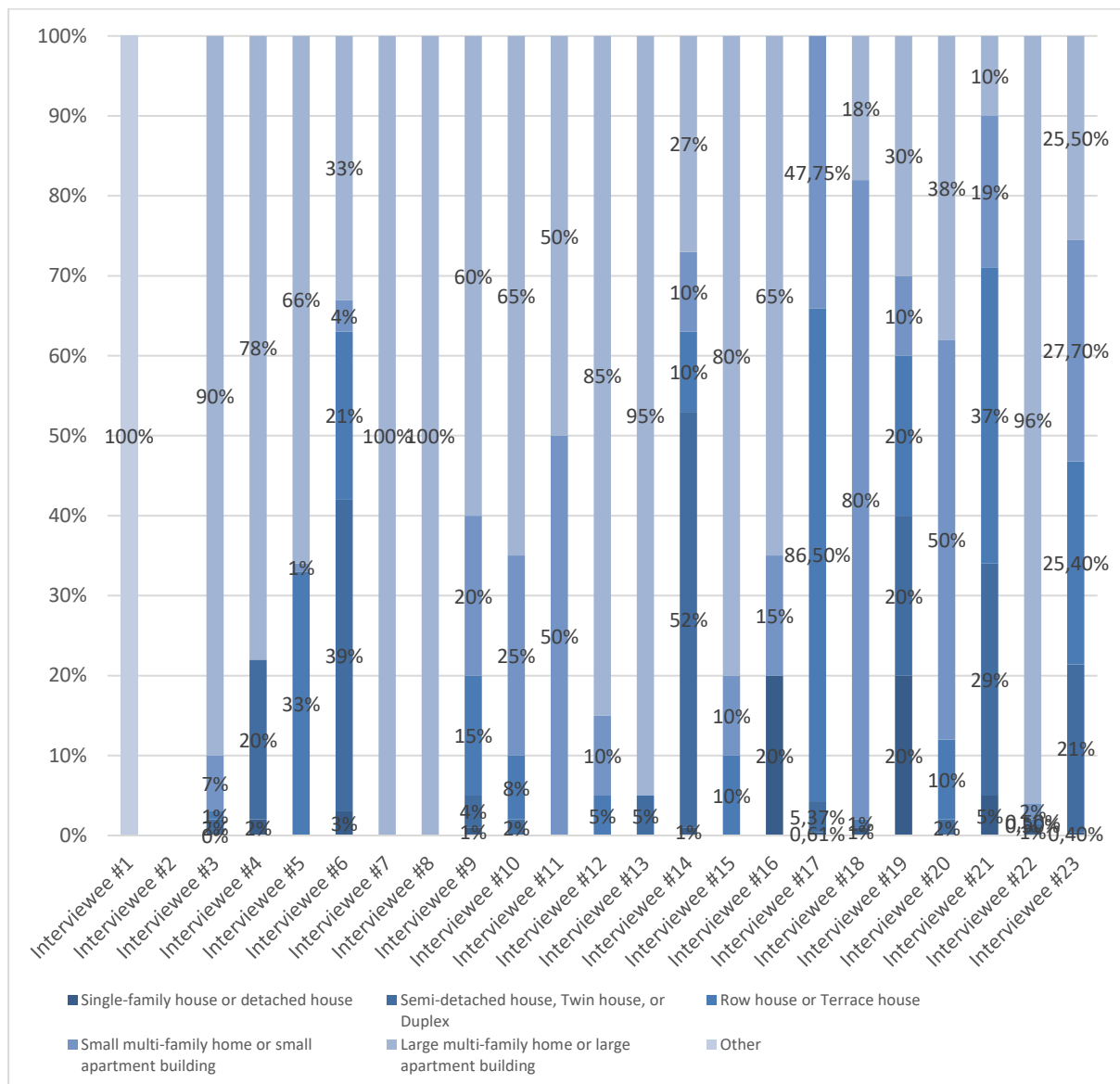
Figure A2. Building typologies per interviewee

References

[1]   https://unfccc.int/files/focus/indc_portal/application/pdf/adpeu.pdf (accessed November 28, 2018).

[2]   Buildings - European Commission, (n.d.). https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings (accessed November 28, 2018).

[3]   Marina Economidou, Bogdan Atanasiu, Chantal Despret, Marina Economidou, Joana Maio, Ingeborg Nolte, Oliver Rapf, EUROPE'S BUILDINGS UNDER THE MICROSCOPE, (n.d.). http://bpie.eu/wp-content/uploads/2015/10/HR_EU_B_under_microscope_study.pdf (accessed May 17, 2017).

[4]   Buildings - European Commission, (n.d.). http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings (accessed October 9, 2015).

[5]   C. Camarasa, C. Nägeli, C. Salzer, S. Saraf, Y. Ostermeyer, Specific Barriers to Massive Scale Energetic Refurbishment for Sample Markets in Europe, in: 2015.

[6]   A. Farahani, H. Wallbaum, J.-O. Dalenbäck, Optimized maintenance and renovation scheduling in multifamily buildings – a systematic approach based on condition state and life cycle cost of building components, Constr. Manag. Econ. (2018) 1–17. doi:10.1080/01446193.2018.1512750.

[7]   P./ Preview, ISO 15686-3 Buildings and constructed assets-Service life planning-Part 3: Performance audits and reviews Bâtiments et biens immobiliers construits-Prévision de la durée de vie-Partie 3: Audits et revues des performances, 2002. https://www.sis.se/api/document/preview/902334/ (accessed August 5, 2019).

[8]   S. Ostermeyer, Y.; Camarasa, C.; Naegeli, C.: Saraf, Building Market Brief Switzerland, n.d.

[9]   M. Mangold, M. Österbring, H. Wallbaum, L. Thuvander, P. Femenias, Socio-economic impact of renovation and energy retrofitting of the Gothenburg building stock, Energy Build. 123 (2016) 41–49. doi:10.1016/j.enbuild.2016.04.033.

[10]   R. Czaja, J. Blair, E. Blair, Designing surveys : a guide to decisions and procedures, 2013. https://books.google.se/books?id=laQgAQAAQBAJ&dq=designing+surveys+blair+gaza&hl=es (accessed August 28, 2018).