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ORIGINAL ARTICLE

The role of psychology and social influences in energy efficiency adoption

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Abstract Current energy efficiency policy and incentive programs tend to target economic motivations, which may misalign with other potentially important motivations arising from situational factors, individual differences, and social context. Thus, in this research, we review areas of work that have focused on psychological and social influences to energy efficiency adoption in commercial buildings. We then conduct an empirical scoping study interviewing 10 commercial building owners/managers (decision makers) and 10 experts/consultants (decision influencers) regarding perceived motives and barriers to energy efficient investments, decision-maker attributes, and the social context of the decision. Potential factors that emerge from the interviews, which are not yet extensively discussed in the energy efficiency literature, include owners/managers' resistance to change and the influence of investment funding origins on the decision. Our results also suggest potential heterogeneity in energy efficiency decision-making philosophies between the two groups. Interviewed owners/managers prioritize corporate social responsibility (CSR) and prefer internal consulting (e.g., building engineers). Conversely, experts/consultants do not emphasize CSR and are more concerned with external policies. These findings suggest that accounting for the decision maker and the social context in which decisions are made could enhance the design of commercial sector energy efficiency programs.

Keywords Energy efficiency · Commercial buildings · Expert elicitation · Psychological influences · Barriers

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Introduction

Commercial buildings account for approximately 20% of total energy consumption in the USA, and the Department of Energy (DOE) reports that savings of 3% each year for commercial buildings is achievable (Bin 2012; DOE 2015). In recent years, the US federal government has expressed interest in capturing these savings, by implementing national initiatives such as the Better Buildings Initiative in 2011 aimed to make commercial buildings 20% more efficient over the next 10 years. To date, only 4% of commercial building square feet have been committed to this challenge, saving on average 2% each year (DOE 2015; EIA 2015).

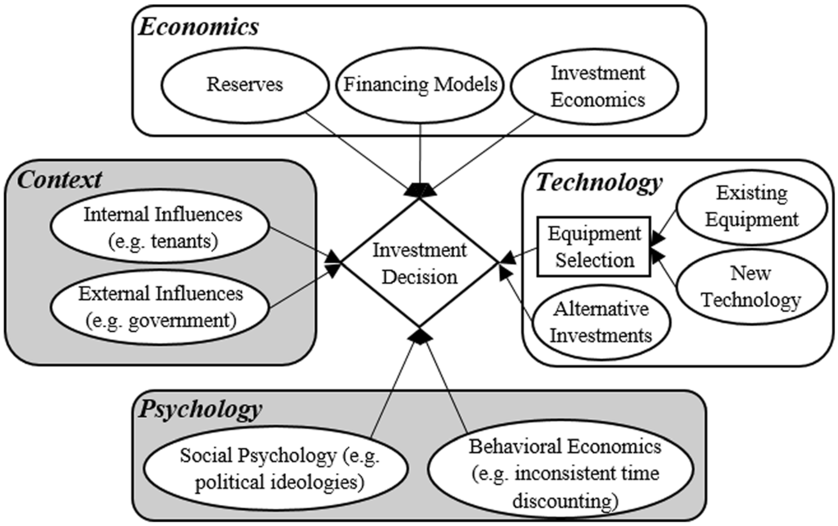


Fig. 1 The four main components of an EE investment decision profile for one individual: (1) Economics, (2) Technology, (3) Psychology, and (4) Context

One possible explanation for this may be ineffective policy and incentive programs (Gillingham et al. 2009). These programs often assume that commercial building owners are solely motivated by economic factors rather than situational factors, individual differences, and social context (Ludwig and Isaacson 2010; Weber and Stern 2011; Granovetter 1985). Ignoring psychological and social factors may reduce a program's effectiveness. For instance, public opposition to wind farms for esthetic or environmental reasons can delay or terminate wind energy development (Pasqualetti 2011), unfamiliar energy savings information (e.g., kWh units) can confuse potential adopters (Attari et al. 2010), and stakeholder preferences can derail transition pathways to cost-optimal energy portfolios (Trutnevyte and Strachan 2013). To aid in our examination of the various factors that may influence energy-efficient (EE) investment decisions, we develop an influence diagram. This diagram (shown in Fig. 1) summarizes the four main areas of literature explaining EE investment decisions made by a single decision maker: (1) Economics, (2) Technology, (3) Psychology, and (4) Context.

To illustrate how this diagram might characterize EE decision-making, consider a commercial building owner who is interested in installing a new lighting control. The owners' decision-making is subject to Economics (e.g., what sort of financing is available to me?), Technology (e.g., what are the new technologies available to me?), Psychology (e.g., how much do I value having a small capital investment today over the potential savings of a larger capital investment over time), and Context (e.g., will my tenets like having new lighting controls?). While much is known about influences related to Economics and Technology, less is known about how Psychology and Context contribute to EE investment decisions in large commercial buildings. Thus, our empirical scoping study focuses on Psychology and Context and expands on previous work in this space by drawing three distinctions: (1) our focus is on the commercial rather than residential building sector; (2) we look beyond the normative, expert opinions by also interviewing owners/managers (decision makers); and (3) interview findings suggested existence of heuristic decision-making that has not yet been explored in the commercial EE literature. In the next sections, we examine what is known about the four main components of EE decision-making and where our study diverges from the existing literature.

Economic and technology influences

First, we consider those factors related to Economics and Technology (Table 1). Economic influences can be both internal (e.g., capital constraints) and external (e.g., fuel prices) and are those related to project budgeting and the benefiting parties. For instance, limited or non-existent reserves and conflicting budget priorities between owners and engineers may dissuade decision makers from considering EE investments (Schleich 2009; Sorrell et al. 2000). Split incentives are also a significant deterrent in non-owner occupied commercial buildings—energy savings will bypass the owner if tenants pay the utility bills and thus reduce the owner's incentive to invest in EE (Schleich 2009).

Table 1 Economic and technological influences to energy efficiency adoption

Economic influences	References
Capital constraints	Schleich (2009), Sorrell et al. (2000), Ross (1986)
Principal-agent relationships	Sorrell et al. (2000)
Split incentives	Schleich (2009), Sorrell et al. (2000)
Hidden costs	Schleich (2009), Sorrell et al. (2000)
Fuel prices	Dahl (1993), Bohi and Zimmerman (1984)
Incentive programs	Gillingham et al. (2009), Geller et al. (2006)
Technological influences	**References**
Knowledge of technology	Du et al. (2014)
Low prioritization	Du et al. (2014)
Available EE technologies	Stephenson et al. (2010), Gillingham et al. (2009)
Renewable energy options	Stephenson et al. (2010), Gillingham et al. (2009)

Other economic influences include hidden costs (e.g., inferior performance of a new technology or overhead costs of energy management), fuel prices (e.g., high fuel prices tend to increase demand for EE, whereas low fuel prices lower demand—see Online Resource 1 for more information), and available incentive programs (e.g., direct rebates and on-bill financing) (Schleich 2009; Dahl 1993, Gillingham et al. 2009; Geller et al. 2006).

Technology options influence decision-making at a number of stages, as the owner must first acknowledge the current state of existing building systems before addressing the accessibility of new technologies. As such, cities vary in their conservation efforts as demonstrated by differing adoption rates of EE markers such as Energy Star[1] and organized 2030 Districts.[2] Explanations for this heterogeneity in commitment to building energy efficiency include availability of technologies and installers across the USA as well as existing building conditions in the real estate market (Gillingham et al. 2009; Kok et al. 2011). However, increasing the stock of EE technologies alone is insufficient; information presented in personalized and specific terms can influence EE decision-making (Jaffe and Stavins 1994; Howarth and Sanstad 1995; Stern 1992) (see "Psychological and contextual influences" section for more on the information deficit model). An EE investment decision maker with technical knowledge of the project can more readily understand how the equipment will operate in their specific energy management program and visualize how the technology will contribute to their building's primary function (Morgenstern et al. 2015; Du et al. 2014). Thus, knowledge should increase technology accessibility in the EE market and also reduce uncertainty of investment benefits (Farsi 2010).

Although the commercial building EE literature is currently advanced on topics related to Economics and Technology, influences related to Psychology and Context are less explored. The next section highlights non-economic factors related to EE investment decisions as they are presently characterized in the literature and suggests areas for further research.

Psychological and contextual influences

Influences related to Psychology and Context (Table 2) include the decision maker's own set of individual differences and decision-making heuristics as well as social influences that could occur within the building (e.g., tenants) or from outside the building (e.g., other buildings).

Psychological influences are shown to be substantial forces in similar areas of pro-environmental behavior such as recycling, taking action towards pollution control, and implementing residential energy efficiency. In the recycling literature, we find that certain relevant attitudes (e.g., environmental concern) are more predictive of recycling if it requires a high degree of effort, which can be influenced by situational factors such as prompts, normative influence, and feedback (Schultz 1999). In addition to attitudes and situational factors influencing pro-environmental behavior, there also exist theoretical models that connect pollution mitigation behavior to moral norms against human and environmental harm (Stern et al. 1985). Moreover, studies in the residential sector find that non-price incentives (e.g., health and environmental benefits) increase participation rates in energy savings programs more effectively than messaging that focuses on economic benefits; this effect is enhanced in participants who claim having pro-

[1] Energy Star is an award assigned to high-performing buildings whose energy consumption is benchmarked on Portfolio Manager; both Energy Star and Portfolio Manager are maintained by the US Environmental Protection Agency (Colaizzi 2015).

[2] There exist 10 separate 2030 Districts, spanning Seattle to Stamford, with building owners committed to 50% reduction in energy use, water consumption, and transportation emissions by 2030 (2030 Districts 2015).

Table 2 Psychological and contextual influences to energy efficiency adoption

Psychological influences	References
Attitudes towards energy efficiency	Hirst and Brown (1990)
Heuristic decision-making	Wilson and Dowlatabadi (2007), Tversky and Kahneman (1974)
Time discounting	Min et al. (2013), Sanstad et al. (2006), Train (1985)
Uncertainty and perceived risk	Hirst and Brown (1990), Farsi (2010), Howarth and Sanstad (1995)
Corporate social responsibility	Corbett and Muthulingam (2007)
Contextual influences	**References**
Organizational structure	Sorrell et al. (2000), Cooremans (2011)
Societal norms	Sorrell et al. (2000), Bollinger and Gillingham (2012)
Community characteristics	McKenzie-Mohr and Smith (2011), Peschiera et al. (2010), Noll et al. (2014)
Corporate social responsibility	Corbett and Muthulingam (2007)
Stakeholders (e.g., tenants)	Eichholtz et al. (2010)
Sustainable legislation	Stephenson et al. (2010), Kok et al. (2011)
Building codes	Gilbraith et al. (2014), Hirst and Brown (1990)
Real estate market	Kok et al. (2011), Eichholtz et al. (2010)

environmental attitudes (Asensio and Delmas 2014; Bolderijk et al. 2013; Schwartz et al. 2015).

Explanations for pro-environmental behavior that extend beyond neo-classical economic theory, which characterize the residential sector, may also apply to commercial EE investment decision-making. For instance, a decision maker with pro-environmental beliefs may willingly invest in EE, reducing the significance of economics (should they be unfavorable) in their decision (Hirst and Brown 1990). Furthermore, decision-making heuristics, such as bounded rationality, can stifle EE investment action due to the investor's potentially limited knowledge of or search capacity for technologies/incentives, their misunderstanding of the EE technology functionality, or simply their lack of time for making a decision (Tversky and Kahneman 1974). Another heuristic, time discounting on investments, tends to discourage decision makers from EE investments due to their aversion for paying up-front costs (including an implied opportunity cost) for delayed cost savings (Hirst and Brown 1990). Time discounting may also be influenced by the availability of cost savings information and its corresponding certainty (Min et al. 2013). Empirical evidence suggests that owners have relatively high implicit discount rates compared to the market discount rates, ranging from 25% to over 100% (Sanstad et al. 2006; Train 1985; Ruderman et al. 1987). These high discount rates could suggest that commercial EE decision makers perceive higher uncertainty in returns on EE investments than other types of investments (Hirst and Brown 1990; Farsi 2010; Howarth and Sanstad 1995). Alternatively, a high implicit discount rate could suggest that investors are simply looking for short payback periods (e.g., 3 years) for energy efficiency projects, corresponding to high internal rate of return (IRR) values. As many EE investments fail to achieve rapid payback and a high IRR, some investors will find them unattractive, especially when considered in addition to other, necessary investments with low profitability (Venmans 2014). However, many energy efficiency investors do not even compute the IRR or compare them to the weighted average cost of capital (WACC), which would more often yield a positive investment decision if they agreed that projects with profitability higher than the WACC would increase overall profitability (Venmans 2014). Ultimately, it is difficult to attribute inaction on investments to single metrics, like discount rates, due to the complex set of decision factors, potential conflicting goals of the decision maker(s), and the lack of conformity on investment capital practices in this domain that often fly in the face of finance theory prescriptions (Cooremans 2012). It does seem that trepidation towards EE investments might be reduced if there exists some element of corporate social responsibility (CSR) motivated from within the decision maker (Corbett and Muthulingam 2007). CSR could also provide external motivation to a building owner who is considering EE by increasing competition in the commercial building community, which informs the decision maker's context of internal and external influences (Fig. 1).

Several studies have focused on how Context influences residential energy efficiency adoption. Often, social network analyses related to energy efficiency focus on residential consumers' responses to monitoring and reporting of electricity consumption, either privately or on a public benchmarking website (Peschiera et al. 2010; Asensio and Delmas 2014; Ayres et al. 2012;

Fischer 2008; Jain et al. 2013). For instance, in a randomized field study of 600,000 US households, Allcott (2011) found a 2% reduction in energy consumption after Opower provided Home Energy Reports. Furthermore, Peschiera and Taylor (2012) demonstrated an inverse relationship between residential energy consumption and the number of comparable peers. Economic sociologists also posit that residential consumer action is embedded in social relations and that community forums or neighborly competition may inspire EE investment decisions and increase technology diffusion (Granovetter 1985; Bollinger and Gillingham 2012). Therefore, it seems plausible that these social influences could also infiltrate commercial building EE investment decisions. Yet, these direct social influences might be harder to trace due to the complexity of the stakeholder structure and decision process within the commercial sector (Cooremans 2012).

Another source of external influence on the decision context includes the informational materials available to the decision makers. Indeed, some energy efficiency policies aim to promote desired behaviors and investments by simply increasing information dissemination and closing the value-action gap that persists when members of society espouse pro-environmental values but do not act in accordance with them (Shove 2010). However, this theory of behavior change, coined the information deficit model, fails to address why some inventive program communications may result in non-activity or worse, increased resistance to invest (Sturgis and Allum 2004). In fact, information conduits are just as important as the energy information. Lutzenhiser et al. (2002, p. 35) found in a series of expert interviews that energy efficiency decision makers have varying levels of skill and expertise in different professional domains and decision contexts, "all of which affect their ability to access, process, and act on energy information." Additionally, in an interview study of organizations who participated in an energy audit program, Goitein (1989) found that lack of information was one of the least likely barriers to energy efficiency to be listed (cited less often only by "not having a good contractor"). As such, these complex dimensions of information diffusion and decision-making are little understood in the context of commercial building energy efficiency investments.

Aside from external social influences (e.g., commercial owner peers and energy efficiency campaigns), Context for a commercial building owner could also include organizational/internal influences, legislation, and the real estate market. Organizational influences are those related to the composition of the building ownership/management structure as well as the mission of the organization.

In fact, in the commercial building sector, one should likely reject the unitary rational actor model in favor of an organizational decision-making perspective that incorporates power dynamics, as organizations are often comprised of a collection of actors with individual objectives that could be in conflict (Goitein 1989; Janda 2014; Pfeffer 1992). For instance, a dedicated EE coordinator in a management team may identify opportunities more effectively than a building engineer who is primarily concerned with keeping the building systems in good condition and pleasing the tenants (Cooremans 2011). Indeed, Stern et al. (2016) identifies addressing and improving in-house energy expertise, empowering building operators, and using information technologies such as social media throughout the organizations as opportunities for reducing commercial energy consumption. Building stakeholders, such as tenants, influence decisions by requesting reductions in energy costs and improvements in air quality (Eichholtz et al. 2010). Building energy codes, such as those established by the American Society of Heating, Refrigeration, and Air Conditioning (ASHRAE) or the International Energy Conservation Code (IECC), mandate inclusion of EE technologies and practices in new construction designs (Gilbraith et al. 2014; Lutzenhiser et al. 2001). However, energy codes and other EE legislation may be futile if there exist information gaps (Attari et al. 2010), rebound effects (Thomas and Azevedo 2013; Sorrell et al. 2009), or capital constraints that undermine compliance with energy legislation (Hirst and Brown 1990). Therefore, policy makers should bridge the normative component of commercial building EE policy with the descriptive component in order to design behaviorally realistic prescriptions that yield energy savings at a level comparable to other successful initiatives such as the CAFÉ standards or appliance efficiency standards (Geller et al. 2006; Taylor et al. 2015).

The existing commercial building EE literature currently addresses several important influences; however, it may omit additional behavioral and social factors addressed in other domains that may be pertinent here. This study aims to identify those additional factors and clarify the distinction between influences related to Economics/Technology and Psychology/Context. The next section entails the development and implementation of an interview protocol designed to explore EE investment decisions, followed by an explanation of the analysis methods ("Analyses" section) employed in this study. The "Results" section outlines the results of the cognitive interviews; the "Discussion" section provides a discussion of implications of these results relating to EE policy, and the "Conclusion" section concludes with suggestions for future work.

Materials and methods

It is difficult to reach commercial building owners/managers due to their limited time and often limited resources (e.g., building staff). This may be one reason why many energy efficiency studies that employ a behavioral sciences approach tend to focus on the much more accessible residential sector. Therefore, we ascertained that it was best to first employ an interview study to explore what factors might be prevalent in the commercial building population before developing and implementing a survey. Since we obtained a smaller, non-representative sample, we do not make statistical claims of these findings. However, our interviews did allow us to explore the various factors that decision makers intuit are important as well as to compare these factors to those already identified in the literature.

Interview protocol

The interview protocol was informed by the mental models approach, which is a systematic method for determining knowledge gaps between experts and laypeople in order to design effective risk communications (Morgan et al. 2002). The mental models approach primarily involves three steps: (1) normative research, (2) descriptive research, and (3) prescriptive research (Morgan et al. 2002). Normative research includes a review of the literature and consultation with experts to identify the key information that needs to be communicated to the public (expert model). Next, descriptive research is performed through interviews and surveys with laypeople to determine their knowledge, values, and beliefs about the information experts deem important and how they actually make decisions (lay model). Finally, through a systematic comparison of expert and lay models of decision-making, prescriptive research identifies gaps in knowledge or differences in perception and values to be addressed through a risk communication. These risk communications avoid pitfalls resulting from the presumption that a researcher knows in advance the full set of potentially relevant beliefs, knowledge, and values, as well as the terms in which they are intuitively expressed. Historically, these communication materials aided the public in making informed judgments about risks associated with such topics as health and climate change (Downs et al. 2008; Bostrom et al. 1994). In our study, we adapted this approach to identify potentially important factors influencing EE decision-making between owners/managers and experts. Comparing these two groups is particularly useful for determining existing knowledge differences regarding the Psychological (perhaps unrecognizable in consulting meetings) and Contextual (potentially effective information conduits) influences.

In our interviews, we were particularly interested in Psychology and Context, as we found this to be less examined in the commercial EE investment decision literature. Therefore, our reported findings reflect this focus. Furthermore, since the commercial EE literature regarding the Psychology of commercial EE invests is relatively limited, our protocol was less informed in this area and discussions were more organic. The protocol was designed to encourage interviewees to openly discuss their perspectives on large commercial building energy efficiency. We developed two different versions of the interview protocol: one for EE experts (see Online Resource 2) and one for building owners/managers (see Online Resource 3). The overall structure and content of the protocols were similar and are briefly summarized in the paragraphs below (see Online Resource 4 for further details). The protocol was pilot tested in April 2015 for comprehensiveness by two energy efficiency consultants from Chicago and two scholars of behavioral decision sciences from Carnegie Mellon University in Pittsburgh.

The first part of the interview started with open-ended questions. The first set of discussion topics considered market gaps or energy policies in Pittsburgh and included questions such as the following: "Can you describe what, if any, areas of the market have had less penetration in regard to energy efficiency?" The second set of topics allowed the interviewees to openly describe what they think might motivate or prevent EE investments and included questions such as "What do you believe motivates building owners/managers to pursue energy efficiency?" Finally, the third set of open-ended questions allowed participants to discuss the extent to which building owner/manager investment decisions are motivated by social influences: "Can you tell me more about how opportunities to invest in your building came to your attention?"

The second part of the interview involved three ranking exercises. Participants were asked to rank 17 motivations and 20 barriers to EE investments in order of descending importance, where 1 = most important and 17 (or 20) = least important. They were asked to add any seemingly missing concepts, and tied rankings were also permitted. Additionally, owners/managers performed the same ranking exercise for a set of 24 social influences. The items contained in each of the three sets were informed by the literature (Groot et al. 2001; Hirst and Brown 1990; Gillingham et al. 2009; Schleich 2009; Stephenson et al. 2010; Kok et al. 2011), discussions during the pilot tests, and additions provided by the interviewees (see Online Resource 5). Finally, interviewees answered demographic questions, reported on their interview experience, and noted any topics missing from the protocol.

Recruitment and participants

Our sample included building experts and owners/managers of large commercial buildings having an area of ≥ 50,000 ft^2 in Pittsburgh. We interviewed a total of 20 participants—one group of 10 experts and one group of 10 owners/managers. Plateauing concept saturation curves for each group (see Online Resource 6) confirmed sufficient sample sizes (Morgan et al. 2002).

We collaborated with Pittsburgh's Green Building Alliance (GBA) to recruit much of our non-representative sample and employed snowball sampling methods to recruit the remainder (Berg 2001). Snowball sampling involves participants listing any social connections they believe might be interested in participating in an interview. Seven experts and nine owners/managers were affiliated with the GBA's Pittsburgh 2030 Districts. We recruited from both of Pittsburgh's 2030 Districts—Downtown and Oakland—which comprises 70% of the real estate square footage in Pittsburgh. We assumed that expert involvement in the 2030 Districts did not drastically bias their EE knowledge. We did not make the same assumption for owners/managers. However, we defined "energy efficient" as a combination of varying levels of commitment and internal/external competition (see Online Resource 7). In Pittsburgh, for instance, an owner/manager might compete in the Green Workplace Challenge, which involves a high level of *commitment* and *external competition*; together, these two attributes of energy efficiency programs can lead to high actual achieved energy savings in the building (Pittsburgh Green Workplace Challenge 2015). Irrespective of EE labeling, the intention of this study was to elicit a set of concepts related to the behavioral and social impacts to EE investment decisions. We do not make claims regarding the prevalence of these concepts in the population of owners/managers in Pittsburgh or elsewhere.

Of the total 20 participants, 60% were male. Most participants were between the ages of 25 and 54 (70%), and the remainder were over 54 (30%). The majority of owners/managers had pursued Energy Star and LEED (70%); this group included representation from class A commercial office buildings, hospital campuses, and university campuses. Experts included those from EE consulting, academia, real estate, and policy. Each interview took approximately 1 hour to complete and was audio-recorded; participants were compensated with a $50 Amazon gift card for their time. Online Resource 8 provides additional demographic information.

Analyses

Coding

All interviews were transcribed either directly by the lead author or split into 5-min audio files and processed by transcribers recruited though Amazon Mechanical Turk.[3] The lead author checked all Mechanical Turk transcription file for errors before compiling each interview. Using NVivo,[4] the lead author performed an open-coding procedure, which is an inductive and iterative approach for comparing responses of the two groups (Straus 1987). While coding open-ended responses, the lead author assigned each common or new concept in the

[3] Mechanical Turk is an online forum where "workers" are compensated for assisting in research, such as participating in an experiment or transcriptions. Web link: https://www.mturk.com/mturk/welcome

[4] NVivo is a qualitative data analysis software by QSR International. Web link: http://www.qsrinternational.com/

interviews to one or multiple codes (short labels that summarize the content). The lead author developed a master code by performing a first-round assessment of the 10 expert interviews. Next, the lead author consulted with the second author on coding scheme, made refinements, and performed a second iteration of coding on the expert interviews. The lead author used this refined master code to assess the 10 owner/manager interviews, and additional codes were created for any new findings. Finally, the lead author recoded the expert interviews with the new codes. A second coder independently coded the interviews, and a final assessment resulted in a Cohen's kappa coefficient of 73% agreement. The Cohen's kappa coefficient is a measure of inter-rater reliability, which considers the pairwise agreement between the coding schemes of two coders while taking into account the amount of agreement that could be expected to occur through chance (Cohen 1960). The major code groups are summarized in Table 3, and a full list of subcodes under these categories can be found in Online Resource 9.

We calculated frequency of mentions for single subcodes for each participant and compared the overall frequencies between the two groups. For instance, we compared the number of mentions for the subcode titled EEClowpriority ("energy efficiency is a low priority in Pittsburgh") between experts and owners/managers to gain an understanding of how these two groups perceive the EE climate in Pittsburgh. Additionally, we developed pairings for the subcodes and calculated frequencies of mention to determine which interactions occurred most often. As an example, we looked at a combination of the subcode titled ESTARpositive ("Energy Star mentioned positively") with a subcode such as RBEpositive ("owner/manager has positive relationship with building engineer"). Finally, we studied the number of participants mentioning each subcode or subcode pairing to gain an understanding of the potential difference in prevalence of certain concepts between the two groups.

Table 3 Major code groups

Code group	Description of excerpts
EE definition	Interviewee definition of energy efficiency
Metering	Utility measurement type (e.g., submetering)
Work experience	Interviewee work experience
Relationship with building engineer	Relationship betw. building engineers and owners/managers
Investment decision process	How EE investment decisions are made
Organization details	How experts describe their organization
Reason for repeated business	Explanations for why a client/consultant relationship is lasting
EE climate	Perception of Pittsburgh's building EE climate
Market gaps	Perception of lagging building sectors
Market gap solutions	Suggestions for closing the gap
Energy Star designation	Perception of Energy Star
Energy Star target goals	Suggested improvements to Energy Star
LEED certification	Perception of LEED
LEED target goals	Suggested improvements to LEED
Mandatory energy benchmarking	Perception of mandatory energy benchmarking in Pittsburgh
Mandatory energy auditing	Perception of mandatory energy auditing in Pittsburgh
Perception of EE public subsidies	Perception of EE public subsidies
Motivations	Perception of EE motivations
Barriers	Perception of EE barriers
Social influences	Perception of EE social influences
Pro. societies—purposes	Perception of the role of professional societies
Pro. societies—level of involvement	Level of involvement in professional societies
Building technologies	Aspirational/difficult technologies to implement

Ranking data

Ranking results were explored first by frequency and secondly incorporating their ordinal component. To compare the number of listings between experts and owners/managers, we developed dot plots representing the number of unique listings in each category. Since only the owners/managers ranked social influences, it was unnecessary to perform comparative analyses. Next, ranking plots and simple descriptive statistics helped to further characterize the ordinal component of the barriers, motivations, and social influence rankings. Finally, the ranking data was supported by some key findings from the open-ended discussion portion of the interviews.

Results

Coding results

Overview

Our analyses revealed 95 unique responses from 10 experts and 10 owners/managers in Pittsburgh. Overall, participants most frequently discussed financing and budgeting for EE investments, organization and jurisdiction of decisions, and economic barriers (Table 4). This interview study was designed to be exploratory research aimed at uncovering important factors to commercial building EE investment decision-making and potential policy interventions that could be informed by the decision-making behavior.

In this paper, we further analyze the subcodes in the context of (1) investment decision process and (2) potential public policy interventions. The investment decision process category includes budget details as well as technical information required to make EE decisions. This category comprises 268 mentions, and 100% of the participants discussed it at some capacity during their interview. The potential public policy category includes discussions regarding mandatory energy benchmarking, mandatory energy auditing, and public subsidies. Combined, participants mentioned topics in this category 92 times, and 100% of the participants discussed this topic category at some capacity during their interview. Each of these topic categories are discussed in further detail in "Discussions of investment decision process" and "Discussions of potential public policy interventions" sections. In the last section of coding results, we discuss some potentially emerging topics in the field of EE investment decision-making.

Table 4 The three most frequently discussed topics among the interviews with all participants ($n = 20$)

Subcode	Description	No. of mentions	% Of participants (no. of participants)
IDPfinancing& budget	What the decision maker targets in incentives, financing, and budget of EE investment decisions	63	70% (14)
IDPorganization	Chain of command and jurisdiction in EE investment decisions	53	85% (17)
BAReconomic-not.split.inc.	Economic or financial barriers to EE investment decision unrelated to split incentives	48	75% (15)

These subcodes represent unique items that fall under broader topic categories. For instance, IDP represents the investment decision process code and BAR represents the barriers code

Discussions of investment decision process

A large portion of the open-ended interview protocol was aimed at characterizing the EE investment decision process simplified in Fig. 1. The dual protocols allowed for comparison of the cognitive model of the investment decision process between experts and owners/managers. Figure 2 illustrates the total number of mentions by each group throughout the interview, categorized by each component.

Online Resource 10 includes a full description of what subcodes are in each component of the investment decision process; Context includes 37 subcodes,

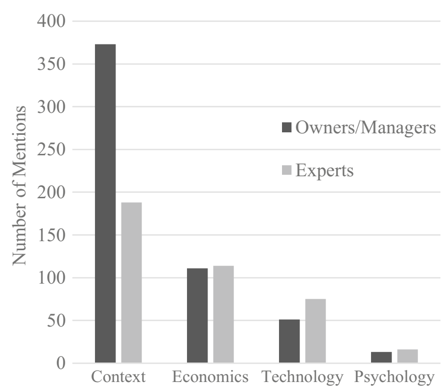


Fig. 2 Comparison of number of mentions regarding the four components to EE investment decision-making: (1) Context, (2) Economics, (3) Technology, and (4) Psychology. Each bar represents the total number of mentions throughout the open-ended interview section

Economics includes 6 subcodes, Technology includes 4 subcodes, and Psychology includes 4 subcodes. In this figure, the number of mentions in each of the EE investment decision components has a similar decreasing pattern for both groups of participants. However, owners/managers tended to discuss the contextual influences to the decision-making process more than experts. Table 5 includes combined and simplified subcodes to illustrate the most commonly discussed topics between the two groups.

Table 5 Frequency of mention table depicting interview discussions surrounding the investment decision process

Investment decision process	Number of mentions (number of participants) Expert	Owner/manager
Context		
Organization (chain of command, jurisdiction)	26 (9)	27 (8)
Goals and strategy (investment strategies)	8 (4)	31 (7)
Investment consultant	0 (0)	32 (10)
Barriers related to organizational and social influences	43 (9)	24 (8)
Motivations related to organizational and social influences	60 (9)	47 (10)
Social influences mentioned during interview	47 (7)	123 (10)
Discussion of building staff	6 (4)	98 (10)
Economics		
Investment financing and budgeting	18 (4)	45 (10)
Desired economics of investment	20 (8)	25 (9)
Barriers related to economics	53 (8)	24 (7)
Motivations related to economics	23 (7)	17 (6)
Technology		
Investment information (technical details of equipment)	19 (8)	17 (7)
Decision maker pilot tests the equipment	0 (0)	9 (4)
Barriers related to building systems	38 (8)	16 (7)
Motivations related to building systems	18 (6)	9 (5)
Psychology		
Fear of change	13 (4)	4 (3)
Mental accounting	1 (1)	0 (0)
Agenda setting	1 (1)	3 (2)
Rewarding work	1 (1)	6 (4)

Numbers in parenthesis represent total number of participants in each group that mentioned the concepts during their interview

Owners/managers discussed their investment financing strategies and desired project economics more frequently than experts. There was much disparity in the various budgeting strategies described for EE investments; participants mentioned rotating funds, energy service contracts, and combined budgets (e.g., utility and EE projects). Budget responsibilities also varied across owners/managers; some managers had authority to implement projects not exceeding $50,000 in capital expenses, while other managers needed owner approval for every purchase. Despite the differences in budgeting practices, most experts and owners/managers tended to agree that decision makers focus on simple economic indicators, such as simple payback period,[5] which varied depending on the building type.

> "*This is a generalization, but certain federal governments are looking for upwards of a 15-yr payback, higher education looks for upwards of a 10-yr payback, healthcare looks for 5- to 6-yr payback, commercial office building owners are looking for somewhere between 3- and 5-yr paybacks, and industrial sector is looking for less than a 3-yr payback.*" (Participant EE2)

Aside from economics, owners/managers also frequently mentioned investment goals and strategies as a large part of their EE investment decision process (31 mentions, 70% of owners/managers).

> "*We try to be strategic about our investments – we do multiple analyses to find the different building energy hogs across our portfolio. We have what we call the good, the bad, and the ugly. The good buildings don't need much investment, just operational tweaks. The bad and ugly might need more retrofits.*" (Participant OM2)

In fact, the goals sometimes involved non-economic attributes of an investment such as maintaining innovative competitiveness in the building sector.

"*It's more of the innovation behind those projects and trying to be the company that's setting the first step into some of that new work.*" (Participant OM2).

[5] Simple payback period is the period of time required to recoup the funds spent on an investment; for an EE investment, this would be the amount of time required to recoup the funds from the annual energy savings.

Whereas, the experts tended to think that owners/managers' goals more often centered on economics.

> "*And they usually show interest in one specific thing. Like they'll latch onto, 'Oh, I want to save money on my energy bills,' or they'll latch onto, 'Oh, you'll do my utility analysis for me.'*" (Participant EE5)

Additionally, owners/managers discussed their processes for investigating opportunities, which often involved consultants assessing their systems and performing pilot tests before implementing a technology throughout their building portfolio. The Investment Consultant subcode included the number of times owners/managers discussed this process and their stance on reaching out to a consultant for advice. Owners/managers that did work with consultants found them through trusted networks.

> "*We invite people to bid based on their qualifications and experience – both experience with use and others. Then once you have been invited to bid, you are sort of pre-qualified for the project. We get five or six people that we believe are a good fit for the project.*" (Participant OM4)

It seemed that without that experience or trust in place, owners/managers might avoid consultants.

> "*My experience with consulting groups is that just because you can come in and say that changing a setpoint is going to make a difference, you still need to sit down and talk with my building engineers – because maybe they already tried and it doesn't work.*" (Participant OM1)

Discussions of potential public policy interventions

The next most frequently discussed topics involved potential EE policy interventions (Table 6) such as mandatory energy benchmarking, energy audits, and public subsidies.

Owners/managers were fairly neutral about energy benchmarking, but preferred if it was disaggregated by building types so that inherently large consumers (e.g., hospitals) were not penalized. Experts and owners/managers agreed that mandatory energy auditing resulted in funding issues—both for the audits as well as the recommendations outlined in the audits.

> "*It's an unfunded mandate. In some cases you can measure it [energy efficiency] or you can do it, but you don't have the money to do both.*" (Participant OM4)

Furthermore, experts believed that mandating energy audits would not lead to action if the owners/managers were uninterested in energy efficiency.

> "*I think it's beneficial when people do it voluntarily, because then they're more bought into it. If they don't like it or don't want it, they're probably not going to implement the solutions anyway.*" (Participant EE7)

Although experts felt positively about public subsidies, owners/managers were sometimes uncertain of their eligibility or did not understand program requirements (e.g., monitoring and verification).

> "*They watch you so much and if you don't do it right then you have to pay them back. So there are strings attached. I like small governments.*" (Participant OM6)

Supporting this finding, experts who spoke positively of public subsidies also mentioned information as a major

Table 6 Total mentions regarding EE policy interventions

	No. of mentions (no. of participants)	
Public policy interventions	Expert	Owner/manager
Mandatory energy benchmarking		
Positive	15 (9)	8 (6)
Negative	2 (1)	8 (5)
Methodology	4 (3)	2 (1)
Mandatory energy auditing		
Positive	6 (6)	3 (3)
Negative	6 (4)	8 (6)
Methodology	4 (3)	2 (2)
Public subsidies		
Positive	9 (6)	3 (3)
Negative	1 (1)	2 (2)
Methodology	4 (4)	5 (4)

barrier to EE investments (50% of the experts mentioned both concepts) and participants thought that it was important to have organizations dedicated to summarizing all funding opportunities and technologies available to the decision makers.

> "*You need organizations to hand it to managers on a silver platter, 'Look, this is what you could be doing, we will give you all the information you need to do it.' …I mean probably 75% of our projects are paid [with incentives]. Once again, I don't think there's enough companies out there to pass along the information.*" (Participant OM5)

Other studies also illustrate information gaps, such as a misunderstanding of the most effective investments for conserving energy (Attari et al. 2010) and more classical market failures (e.g., inadequate provision of incentive information) leading to low adoption rates of EE technologies and utilization of public incentives (Jaffe and Stavins 1994; Swim et al. 2014).

Potential emerging topics

A few concepts arose in the interviews that are, to our knowledge, not currently or heavily considered in the building EE literature. These items were coded as Fear of Change (17 mentions, 35% of participants), Mental Accounting (1 mention, 5% of participants), Agenda Setting (4 mentions, 15% of participants), and Rewarding Work (7 mentions, 25% of participants). Fear of Change was described differently by various participants, but included barriers related to technical knowledge and reluctance to implement a new system.

> "*The facilities people aren't working all the time… so if an Energy Manager came in, they would require more work and that would result in a Fear of Change. And the [facilities] people don't always choose the projects, but they are certainly instrumental in the savings over time.*" (Participant EE7)

One expert explained that owners/managers spend money differently in their homes than they do on their buildings—this was coded as Mental Accounting.

> "*It's this mentality that it's somebody else's money that makes it easier to do things. The downside of that is it makes it very easy to pollute… it makes it easy to do any kind of abuse when it's not affecting them.*" (Participant EE9)

Agenda Setting was used to code any discussion of how the financial institutes or funding sources dictate spending in the building (e.g., requiring CSR).

> "*This is a more recent trend that we've found… buildings that are backed by some kind of fund are often constrained… investors definitely want to see that their money is being spent on ecological activities.*" (Participant EE9)

Finally, some owners/managers believed that their engineering team pursued EE goals because it was a rewarding work—we coded these discussions as Rewarding.

> "*I think it pushes the team that works here…it kind of works when you feel good about what you do - Energy Star really makes you come to work and push yourself.*" (Participant OM5)

These emerging concepts may warrant additional follow-up studies of large commercial building owner/managers.

Ranking results

In this section, we explore the results of the ranking exercises performed on barriers, motivations, and social influences. As shown in Fig. 3, experts tended to list

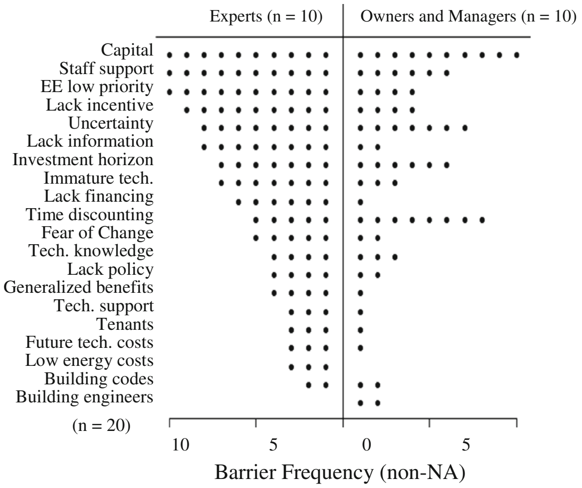
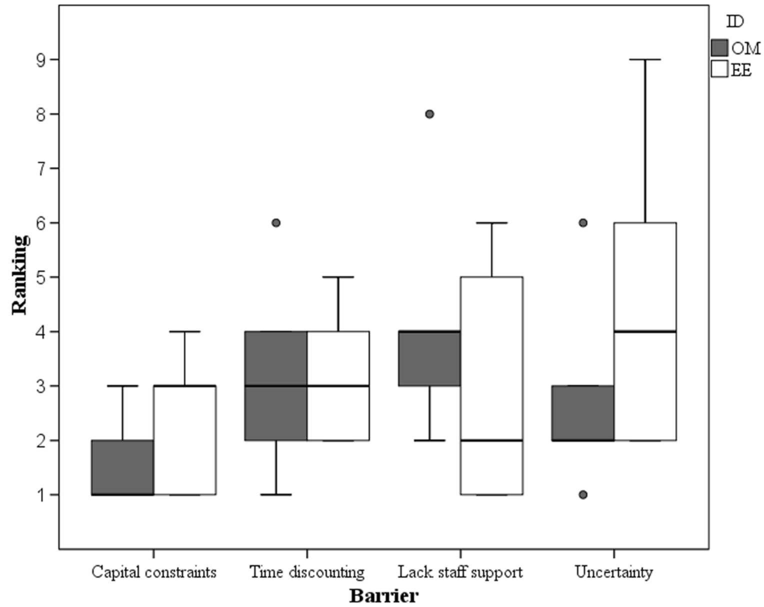


Fig. 3 Dot plot comparing number of barrier listings between experts and owners/managers

Fig. 4 Side-by-side box plots depicting differences in selected barrier rankings between experts and owners/managers. Lower rankings indicate higher importance (1 = highest importance and 9 = lowest importance)



more barriers than owners/managers; however, both groups agreed upon economic barriers such as Capital (capital constraints), Uncertainty (uncertainty of savings), Investment Horizon (investment will not pay off in the time horizon of building ownership), and Time Discounting (savings are not immediate).

From our interviews, we find a stark difference in the number of listings between experts and owners/managers for EE Low Priority and Lack Information (information regarding technologies, incentives, or available funding); it seems that experts may perceive these as strong barriers to EE investment decision-making. Indeed, during the open-ended discussions, experts expressed the belief that EE was a low priority among owners and managers.

> "*I can tell you that after you develop a building and you have a management company managing it, all they're worried about is keeping the building occupied. The whole issue of making a building energy efficient is outside of the skillset of most managers… if there is cash flowing and their buildings are filling up, maybe that is sufficient.*" (Participant EE1)

However, owners and managers did not readily admit to not prioritizing energy efficiency as illustrated in the ranking results depicted in Fig. 3 and open-ended interview results (EE Low Priority: 15 mentions by 7 experts compared to 3 mentions by 3 owners/managers).

> "*If two projects had the same return on investment, and one of them was an energy project and one was a non-energy project, you would value the energy project higher.*" (Participant OM4)

An econometric study by Schleich (2009) demonstrated organizations underestimating internal priority setting as a barrier to EE investments; however, our finding may suggest a difference in perception of prioritization between experts and owners/managers.

To compare expert and owner/manager rankings of these barriers, we developed side-by-side box plots (Fig. 4). Average ranking for the set is 3.7 with a standard deviation of 2.4 and a maximum ranking of 13 (1 = highest importance, 13 = lowest importance). See Online Resource 11 for the full set of barrier box plots. Generally, both groups agreed that economic barriers (Capital, Time Discounting, and Staffing) have relative importance in EE investment decision-making; however, owners/manager rankings suggest that uncertainty of savings is a larger deterrent for EE investments than experts may currently assume.

From the open-ended discussions, we also find that economics are the most often discussed barrier to EE

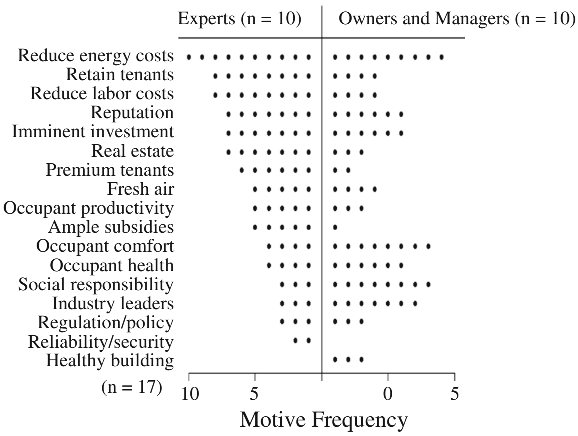


Fig. 5 Dot plot comparing number of motive listings between experts and owners/managers

investment decisions (34 mentions by 8 experts and 14 mentions by 7 owners/managers). Economic barriers are coded as those barriers mentioned in the interviews that relate to topics such as lack of capital reserves and debt aversion.

> "*Medium sized manufacturers. They probably represent the biggest sector in Pittsburgh's economy. They operate on such a margin that they don't have the personnel to devote to [energy efficiency] – they're worried about making payroll and getting product out the door.*" (Participant EE10)

Some of the most common code pairings for economic barriers include discussion of building technologies the participants deemed aspirational (13 pairings), discussion of professional societies providing insight (13 pairing), and lack of information available to decision makers regarding available technologies and funding opportunities (12 pairings).

Next, we compare motive listings and rankings between the two groups. In a dot plot of motives (Fig. 5), we do not see quite the discrepancy in the total number of listings between each group. However, we do find that owners/managers tend to list motives related to CSR (Occupant Comfort, Social Responsibility, and Industry Leaders) more often than experts.

Average ranking for the motive set is 4.2 with a standard deviation of 2.9 and a maximum ranking of 14 (see Online Resource 12 for the full set of motive box plots). Both groups listed Reduce Energy Costs with the highest frequency and, similarly, ranked this with the highest relative importance (Fig. 6). Ranking results depicted in the box plots also illustrate the potential discrepancy in expert and owner/manager opinion of motives associated with CSR (i.e., Occupant Comfort, Industry Leaders, and Social Responsibility).

However, during the open-ended discussions, we found that both experts and owners/managers tended to discuss motivations related to CSR such as mission and leadership (26 mentions by 7 experts and 14 mentions by 5 owners/managers).

> "*It goes back to motivation. This stuff isn't a technology issue, it's a value issue.*" (Participant EE6)

> "*I think the people can change when there is a change from the top. If management says, 'We're going to do this – we now want to focus on sustainability, it's important to our business,' then the team will get on board.*" (Participant EE8)

Often, participants who described motivations related to CSR also discussed the benefits of Energy Star (11 code pairings), LEED certification (10 code pairings), and mandatory energy benchmarking (10 code pairings).

Only the 10 owners/managers were asked to list their perceived social influences to building EE investments (Fig. 7). Internal influences, such as building engineers, tenants, and employees, were often listed as influential sources in EE investment decision-making. Conversely, owners/managers avoided listing sources representing a certain technology or product such as renewable energy companies and controls contractors.

Next, we compared the social influence rankings with box plots; average ranking for the social influence set was 4.8 with a standard deviation of 3.3 and a maximum ranking of 16 (see Online Resource 13 for the full set of box plots). Selected box plots may suggest that owners/managers may value information received from utility companies and the government similar to how they value information from internal sources, such as their building staff (Fig. 8).

Discussion

A few thematic patterns emerge from the interview data. Some of these ideas map onto the influence diagram (Fig. 1) explained in the "Introduction" section, while

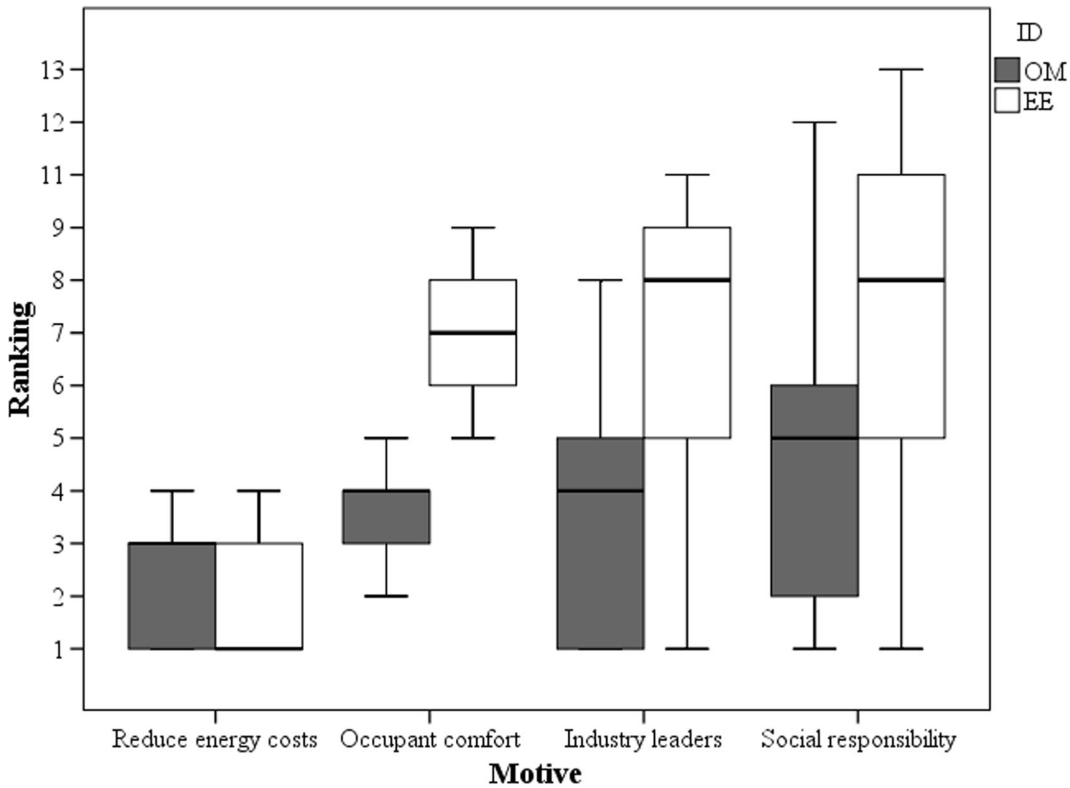


Fig. 6 Side-by-side box plots depicting differences in selected motive rankings between experts and owners/managers. Lower rankings indicate higher importance (1 = highest importance and 13 = lowest importance)

other ideas are promising concepts not yet heavily studied in the EE literature: (1) heterogeneity among experts and owners/managers regarding value of CSR, (2) differing approaches to the investment decision process between experts and owners/managers, (3) owners/managers trust in various information sources, and (4) emerging behavioral concepts related to EE investment decision-making.

Heterogeneity among experts and owners/managers regarding value of CSR

During the open-ended questions, both groups often discussed the compelling role of corporate social responsibility in EE investment decision-making. However, when asked to rank motivation cards, experts found others to have greater relative importance. Experts only listed Social Responsibility and Being Industry Leaders six times with average rankings of 8 (recall, 1 = most important and 13 = least important), while owners/managers ranked these items 15 times with average rankings of 4.5. These findings suggest that it may be beneficial for experts to illustrate CSR benefits to EE investments when communicating with owners/managers of large commercial buildings. Furthermore, a benchmarking policy may be attractive to owners/managers who are inclined to reduce energy consumption in an attempt to signal CSR, which as a result may minimize the issue of split incentives between owners and tenants (Stern et al. 2016). One might consider the following hypothesis: When two investments have similar economics, owners/managers of commercial buildings are more likely to pick the one with CSR benefits.

Differing approaches to the investment decision process between groups

As shown in Table 5, experts and owners/managers differed greatly in their approach to the investment decision process. The most distinct differences occurred in their discussions of goals and strategy and the role of an investment consultant in decision-making. The number of mentions of "goals and strategy" is nearly four times higher for owners/managers as it is for the experts.

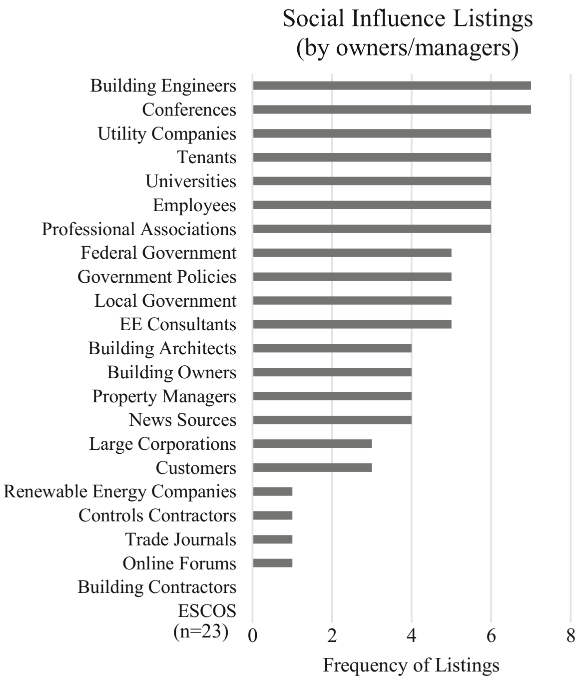


Fig. 7 Bar chart representing the number of times each social influence type is listed by the 10 owners/managers interviewed in this study. The maximum number of listings is eight (building engineers and conferences), and the minimum is zero (building contractors and ESCOs)

Specifically, it seems that owners/managers are focused on meeting company goals such as improving occupant comfort or maintaining innovative competitiveness, which was often highlighted in their open-ended responses as well as their motivation rating frequencies shown in Fig. 5. In this instance, it seems that experts tend to overlook the strategic logic potentially in place with owners/managers' decision-making, instead focusing on the economic barriers to energy efficiency investments. The experts' emphasis on economic barriers is shown by how they mentioned Economic Barriers in open-ended questions (Table 5) two times, the benefits of Public Subsidies to investments (Table 6) three times, and Lack Financing six times more than did owners/managers. One possible explanation for this difference is that owners/managers may evaluate how energy efficiency equipment helps them achieve overarching core business goals and not just economic goals. Indeed, Dutton et al. (1989) found that organizational context influences the dimensions of an issue that are most salient to the decision maker. Future study should further examine these contextual factors and how they might influence owner/manager decision-making.

Owners/managers trust in various information sources

During the ranking exercises, it was apparent that owners/managers valued input from internal sources such as their building engineers and tenants. Conversely, they did not tend to list social influences affiliated with certain technologies, such as controls contractors. When asked to explain their ranking rationale, many owners/managers admitted feeling pressured by vendors or energy service contractors.

> "*Sometimes I don't trust [ESCOs], because they push their product. I usually go for people that are running the same thing you're running, they're trying to do the same thing you're doing.*" (Participant OM6)

Similarly, some owners/managers discredited EE consultants, because they believed that the consultants' goals (making a profit) ultimately misaligned

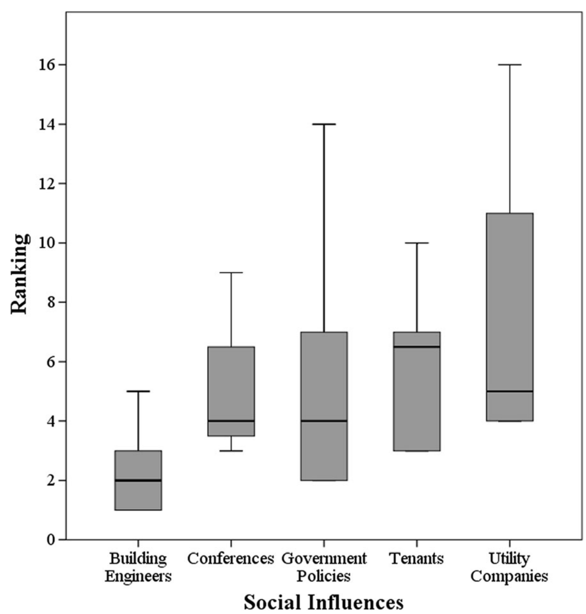


Fig. 8 Box plots depicting owner/manager rankings of selected social influences to EE investment decision-making. Lower rankings indicate higher importance (1 = highest importance and 16 = lowest importance)

with their goals (save energy). Most owners/managers expressed trust in their building engineering team, who often interfaces with the controls contractors, ESCOs, and vendors.

> "*My guys are really good. They like learning about this stuff [energy efficiency], so they went to school for it. I'm confident in their abilities.*" (Participant OM1)

Therefore, a bad relationship between engineers and contractors may result in a bad relationship between the owners and contractors. Indeed, Beamish et al. (2000) identify trust networks among owners/managers and contractors as a means to minimize risk aversion related to the adoption of new energy efficient technologies, providing a mechanism for demystifying innovative products/practices. To mitigate reliance on contractors, perhaps offering training services for building engineers may be an alternate and effective way to increase EE. These findings inspire hypotheses such as the following: Owners/managers of commercial buildings trust information regarding EE investments more when they come from their building engineering team than if they come from external consultants.

Emerging behavioral concepts related to EE investment decision-making

Several concepts arose from the interviews between experts and owners/managers that are not yet considered or heavily discussed in the EE investment decision literature. These concepts were coded as Fear of Change, Mental Accounting, Agenda Setting, and Rewarding (Table 7):

For instance, Fear of Change might be defined as resistance to change, which is explained through routine seeking, emotional reaction to imposed change, cognitive rigidity, and short-term focus (Oreg 2003). Fear of Change has minimal mention in previous building EE studies involving focus groups for commercial building performance (Hall et al. 2013), open-ended interviews in multi-family residential buildings (Hauge et al. 2013; Vogel et al. 2015), and surveys regarding new construction and technology diffusion (Gambatese and Hallowell 2011). Conversely, a manager's high technology adoption rate might be explained by their self-perceived lack of responsibility for the funding. As such, Mental Accounting suggests that funding origins impact spending patterns (Thaler 1985). Furthermore, financial institutes mandating sustainable investments seem to resemble R&D Agenda Setting (Frickel et al. 2009). Finally, social demand characteristics, team collaboration, and job satisfaction are topics heavily studied in Organizational Behavioral Sciences that may explain why pursuing energy efficiency can influence the performance of building engineers (Orne 1962; Rosenstein 2002). Each of these emerging concepts warrants its own hypothesis—one example might be as follows: Owners/managers of commercial buildings are deterred from making an EE investment if their engineering staff is reluctant to install the new technology.

Conclusion

This paper discusses the findings from open-ended interviews with 10 experts and 10 owners/managers in Pittsburgh. This research characterizes potential non-economic factors associated with EE investment decisions made in large commercial buildings. Specifically, the authors are interested

Table 7 Emerging concepts in EE decision-making

Code	Concept	References
Fear of Change	Resistance to change Aversion to technology	Oreg (2003) Craske et al. (2013)
Mental Accounting	Mental accounting	Thaler (1985)
Agenda Setting	R&D agenda setting	Frickel et al. (2009)
Rewarding	Social demand characteristics Team collaboration and job satisfaction	Orne (1962) Rosenstein (2002)

in exploring the social influences and behavioral decision profiles of EE investment decision makers.

Findings from this scoping study identify several policy implications. First, policy makers and incentive program designers should focus on delivering economic incentives as well as social and behavioral incentives. Secondly, policy makers should carefully consider their methods for conveying program information. When considering potential information conduits, it is important to consider the dynamics of the building engineering team as well as the owner/manager's current perceptions of various social influences. For instance, owners/managers may perceive the government and/or NGOs as neutral sources capable of delivering unbiased, trustworthy information regarding building EE investments.

Additional research is necessary to determine the potential efficacy of these suggested policy implications on a population of owners/managers. For instance, a follow-up detailed survey study of large commercial building owners could characterize the prevalence of these identified thematic patterns. A similar survey study among experts could allow for systematic comparisons between groups (i.e., experts and owners/managers) as well as within groups (i.e., types of experts ranging from academics to energy efficiency consultants). Findings from this interview study also suggest that social influences do play a role in decision-making; therefore, one might perform a social network analysis of owners/managers to characterize how concepts identified in this study propagate through a network. In sum, our work aims to target late adopters by cataloging the distinctions and ranges of energy-efficient building manager attributes as well as deepening the understanding of identified barriers through employment of a social network perspective. Integrating behavioral and social drivers with economic factors in energy efficiency policy may be the necessary catalyst for yielding substantial savings in support of US national efforts, such as the Better Buildings Initiative.

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Compliance with ethical standards

Conflict of interest The authors declare they have no conflict of interest.

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