

Government championed strategies to overcome the barriers to public building energy efficiency retrofit projects



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ABSTRACT

Knowledge of the barriers and coping strategies for retrofitting government buildings for energy efficiency is essential for the success of these types of complex retrofitting programs. This study utilised thematic findings from two focused groups consist of government employees from two States within Australia to create a comprehensive list of barriers to retrofitting public building stock for energy efficiency and associated strategies to address them. Thematic analysis revealed that a lack of political will, financing protocols, department/agency capability, industry capability, quality assurance and misaligned incentives, are the key barriers to public building energy efficiency retrofitting projects. To address such barriers, research revealed that a government championed top-down approach is required. A key strategy identified was enabling government departments and agencies to take on debt to fund retrofit initiatives that would derive returns, in terms of reduced energy utility costs, over the short-medium term. Other important strategies included having a mandatory energy efficiency retrofitting policy, dedicated financing mechanism, flexible procurement model, facilitation team and list of pre-qualified professionals.

1. Introduction

Climate change and resource scarcity are prompting the adoption of sustainable practices in each sector around the world. Buildings are one of the largest users of energy, accounting for 32% of total global final energy use and 19% of total energy-related greenhouse gas (GHG) emissions (Lucon et al., 2014). Under the business-as-usual scenario, both the energy consumption and the associated GHG emissions of buildings are projected to increase due to population growth, increased building stock and lifestyle changes (Levine et al., 2007; Urge-Vorsatz et al., 2012). This continued growth in energy consumption and GHG emission are contributing to global average temperature increase and may lead to catastrophic climate change-related events in future. The growing levels of energy consumption and climate change are also posing a significant challenge to the development of “Sustainable Cities and Communities”, was indicated as being one of the key sustainable development goals mentioned by world leaders in September 2015 at a United Nations summit (Nations, 2015). One of the key targets to

achieve this goal is to adopt and implement integrated policies and plans towards resource efficiency and mitigation and adaptation to climate change (Nations, 2015). Improving energy efficiency in both new and existing buildings provides a feasible least-cost solution in that regard. Particularly, retrofitting existing buildings are the key to a sustainable future because the vast majority of the buildings that we currently occupy, and their respective energy and water use profiles, will be with us for the long-term (ASBEC, 2016; DECC, 2014; Ma, Cooper, Daly, & Ledo, 2012; Tobias, 2012). To promote a greater rate of energy efficiency retrofit projects for buildings, various policy instruments have been adopted in many countries around the world. In China, building energy consumption increased by 1.7 times between 2000–2014 (Huo et al., 2018). Their 13th Five Year Plan included a target of reducing the energy intensity by 15% by 2020 (Government of China, 2015). In 2011, the Chinese government also issued a plan of energy-efficiency retrofits in public buildings (MOF & MOHURD, 2011). National efficiency goals of Germany included a primary goal to reduce the energy demand in the building sector by 80% by 2050 (BMW &

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BMU, 2010). Their mid-term goal is to reduce the heating demand by 20% by 2020. Under the 2012 “Energy Efficiency Directives (EED)” (EED, 2012) and 2010 “Energy Performance of Building Directives (EPBD)” (EPBD, 2010), the member countries of the European Union are required to set minimum energy performance requirements for new buildings’ as well as major renovation and retrofit. The UK government has committed to reducing CO₂ emissions by 80% by 2050 from 1990 levels with interim targets of 26% by 2020 (Jones, Lannon, & Patterson, 2013).

In the USA, the Energy Policy Act of 2005, expanded under the Energy Independence and Security Act of 2007, requires that all existing buildings must reduce energy consumption by 30% by 2015, compared with 2003 levels, through building upgrades and efficient appliances (Doris, Cochran, & Vorum, 2009). In 2011 the Obama administration pledged to make commercial buildings 20% more efficient by 2020. An executive order was issued with a goal to design all new federal buildings to achieve net zero energy starting in 2020 (Climate Policy Initiative, 2013).

In Australia, the Energy Efficiency in Government Operation (EEO) policy was introduced in 2006 according to which minimum performance standard for government office buildings should be NABERS (National Australian Building Energy Rating System) 4.5 star (Wasburn, 2007). The Commercial Building Disclosure (CBD) program, which came into effect on the 1st November 2010, requires the owners of Australia’s large commercial office buildings to provide energy efficiency information to potential buyers or lessees (Australian Government, 2018). In 2008, the City of Melbourne launched a program to retrofit 1200 CBD buildings to achieve 4.5 star NABERS by 2020 (The City of Melbourne, 2016). The NSW government also adopted Energy Efficiency Action Plan (EEAP) in 2013 to deliver high standard building retrofit programs to achieve 4-star NABERS energy and water rating in 50% of NSW commercial floor space (NSW, 2013). The government of Victoria and South Australia also adopted various programmes to retrofit the public building stocks under their portfolio (GBE strategy, 2013; GGB, Greener Government, 2016).

However, retrofitting existing buildings is a complex process, and there are a number of barriers that hinder building retrofitting projects (BPIE, 2011; DECC, 2014; Marquez, McGregor, & Syme, 2012). Overcoming these barriers requires the design and implementation of workable strategies that will effectively promote energy efficiency investments and actions. While there are a number of existing studies that outline the barriers to energy retrofitting and suggest possible coping strategies, there is a lack of research particularly covering the barriers and coping strategies to retrofit public building stock (i.e. schools, library, museums, etc) which are prohibiting the uptake of energy retrofitting. Based on an extensive literature review Bertone et al. (2016) summarised a number of barriers and challenges of retrofit projects some of which may be applicable to public buildings. In another study Bertone et al. (2018a) briefly mentioned some barriers and coping strategies for public building retrofitting project. However the study lack systematic identification of top barriers to retrofit project and the relationship between the barriers. Moreover, no recommendations were provided regarding how to implement the coping strategies in government building retrofitting program. Public sector is fundamentally different from non-government sector in terms of organizational goals, decision making, financing, procurement process and accountability which can pose unique set of barriers on public building EER projects. This study seeks to understand how the public building retrofitting barriers are different from existing retrofitting barriers reported in the literature and identify the top barriers and associated coping strategies from the perspective of the personnel employed within government departments or agencies. In addition, a framework to implement the identified coping strategies to overcome the barriers has been proposed. The paper has been structured as follows: Literature review on barriers to energy efficiency retrofitting (EER); Characteristics of public building EER; Methodology section describing the process of data

collection; Results and discussion section presenting the outcome of this study; Recommendations for the government while establishing an EER program for public building; and Conclusions outlining the contributions of this work.

2. Literature review on retrofitting barriers

Building energy retrofitting process involves a number of stakeholders from different areas such as the building owners, investors, consultants, contractors, etc. These stakeholders face various retrofitting barriers which are hindering the smooth completion of retrofitting projects as well as the uptake of retrofitting activities in potential existing buildings (Thomas, 2015). Through an extensive survey across all European Member states, Buildings Performance Institute Europe (BPIE) identified four main categories of barriers that have a particular impact on building retrofitting (BPIE, 2011): 1) Financial, 2) institutional and administrative, 3) awareness, advice and skills and 4) separation of expenditure and benefit. The UK Department of Energy and Climate Change identified four main barriers to the uptake of energy efficiency opportunities: 1) embryonic markets, 2) lack of information, 3) misaligned financial incentives, and 4) undervaluing energy efficiency (DECC, 2014). Similar categories of barriers were also identified by the Climate Policy Initiative (2013) and Marquez et al. (2012). In addition to these identified barriers, Thomas (2015) revealed that uncertainties with new energy efficiency technologies is also a potential barrier.

From the four pilot commercial building energy retrofitting programs in China, Hou, Liu, Wu, Zhou, and Feng, 2016 revealed a number of issues including unclear stakeholder obligations, difficulty in coordinating multiple parties, and retrofit implementation causing disruptions to the normal use of buildings which decreased owner’s willingness to retrofit. Weiss, Dunkelberg, and Vogelpohl (2012) revealed a number of factors that caused building owners to have an aversion to energy efficiency refurbishment measures, including: a lack of interest in energy efficiency issues, lack of financial means, aversion to borrowing, lack of a long-term perspective, and dubious contractors. In another study, Achtnicht and Madlener (2014) observed that most building owners wait until building components are approaching the end of their useful life, before considering options for renovation or replacement. Caputo and Pasetti (2015) revealed that the common barriers of an energy retrofit project in Italian municipalities were: a lack of awareness about the energy problem, difficulties setting goals for the local governments, difficulties with data collection, and lack of expertise in the municipalities to analyze the data and develop an effective plan. Castleberry, Gliedt, and Greene (2016) investigated the factors that may influence public school retrofitting projects. Their results revealed that certain socioeconomic variables (e.g., population size, average household income, and average property value) may influence a district’s implementation of energy-saving technologies and practices.

In Australia, Ernst and Young (2015) grouped the retrofitting barriers in three broad categories: Financial, Knowledge and Time. The financial barriers include lack of motivation to invest, other priorities in the business and split incentives. In the knowledge barrier group, lack of knowledge and information on energy efficiency, negative perception regarding energy efficiency upgrade, lack of trusted information and absence of appropriate government policies were listed as the main barriers. Finally, the disruption to the tenants during retrofit and time-consuming paperwork associated with retrofit project were identified as the time barriers. For example, it was pointed out that the process for obtaining government grants (if there is any) is too onerous and the owners do not have the time to do it. Table 1 presents a review of building energy retrofitting barriers based on existing literature.

Table 1
Review of building energy retrofitting barriers.

Barriers	Sub-categories with description	References
Financial	<p>Lack of funds In many cases, building owners do not have sufficient capital to finance retrofitting activities.</p>	<p>(Climate Policy Initiative, 2013; BPIE, 2011; Marquez et al., 2012; Thomas, 2015; Weiss, Dunkelberg, & Vogelpohl, 2012; Achtnicht & Madlener, 2014; Castleberry, Gliedt, & Greene, 2016; Building-Melbourne, 2015; Amoruso, Donevska, & Skomedal, 2018; Bjørneboe, Svendsen, & Heller, 2018; Paiho & Ahvenniemi, 2017; Caputo & Pasetti, 2017) (DECC, 2014; Climate Policy Initiative, 2013; BPIE, 2011; Marquez et al., 2012; Weiss et al., 2012; Achtnicht & Madlener, 2014; Ernst & Young, 2015; Paiho & Ahvenniemi, 2017; Caputo & Pasetti, 2017) (DECC, 2014; Climate Policy Initiative, 2013; BPIE, 2011; Marquez et al., 2012; Thomas, 2015; Ernst & Young, 2015; Amoruso et al., 2018; Caputo & Pasetti, 2017) (Marquez et al., 2012; Thomas, 2015; Hou et al., 2016; Achtnicht & Madlener, 2014; Ernst & Young, 2015; de Wilde, 2014).</p>
	<p>Priorities in investments Owners are generally reluctant to invest money in the short term for longer term benefit. Priorities are given to what are perceived as core investments in staff and equipment over energy costs. Due to low electricity cost the incremental savings from energy efficient measures are quite small compared to the benefits from other investments.</p>	
	<p>Split-incentives The problem originates from the fact that when the entity who would pay the cost of retrofitting would not receive the full benefit. Uncertainties over financial gain In retrofitting project, the actual energy and cost savings may differ from the predicted savings due to the uncertainties involved with the assumptions of some key parameters during design, construction and operation stages. The uncertainties over financial gain sometimes make the owner/investor reluctant towards investing in retrofit projects.</p>	
Administrative barriers	<p>Government not acting as a strong driver If the Government demonstrates a strong commitment to policies that encourage sustainability (both incentives and requirements), this can create a long-term positive impact on building owners' propensity for upgrades.</p>	<p>(Marquez et al., 2012; Ernst & Young, 2015; Paiho & Ahvenniemi, 2017; Caputo & Pasetti, 2017) (Climate Policy Initiative, 2013; Amoruso et al., 2018)</p>
	<p>Lack of interdisciplinary expertise and collaboration Energy usage in buildings during design, construction and operation stage is influenced by many different professionals. In most cases, none of the involved professionals on a given project are expert in the field of building energy efficiency, but the responsibility for achieving energy efficiency is spread among them, thus implying a coordination challenge. Multi-stakeholder issues In a multi-owner building where the majority or all of the property owners have to approve a decision and make a financial contribution, it can be very difficult to proceed with energy savings investments.</p>	
Knowledge barriers	<p>Lack of information and awareness Sustainability or environmental performance is not usually understood well by many property managers, building owners, and occupants. Often building owners or occupants have very little knowledge about the consequences of their actions on energy usage and emission. Some building owners also have the perception that energy efficiency investment would not yield a return. Rather, the requirement of energy efficiency is treated as compliance and cost burden by some consumers.</p>	<p>(DECC, 2014; Climate Policy Initiative, 2013; BPIE, 2011; Marquez et al., 2012; Thomas, 2015; Achtnicht & Madlener, 2014; Caputo & Pasetti, 2015; Castleberry et al., 2016; Ernst & Young, 2015; Building-Melbourne, 2015; Amoruso et al., 2018; Bjørneboe et al., 2018; Paiho & Ahvenniemi, 2017; Caputo & Pasetti, 2017) (Climate Policy Initiative, 2013; Marquez et al., 2012; Thomas, 2015; Weiss et al., 2012; Achtnicht & Madlener, 2014; Ernst & Young, 2015; Building-Melbourne, 2015; Bjørneboe et al., 2018; Caputo & Pasetti, 2017) (BPIE, 2011; Marquez et al., 2012; Caputo & Pasetti, 2015; Bjørneboe et al., 2018; Paiho & Ahvenniemi, 2017; Caputo & Pasetti, 2017)</p>
	<p>Lack of motivation Despite being fully aware of the energy efficient program, some building owners are not interested in improving their buildings' efficiency unless the equipment is about to break or there is a concerning high level of vacancy that is affecting his rental income.</p>	
	<p>Lack of skills and knowledge of building professionals Skill shortages exist in both the contractor market responsible for the effective installation of energy saving measures, as well as in professional services, with few architects and designers familiar with how to specify a low energy renovation. Conflicting advice from professionals regarding the best way to renovate lead to skepticism amongst the consumer over the installation of energy efficient measures.</p>	
Social Barriers	<p>Interruption to building operation In most cases, the period of renovation may provide different amenities than the default. In the case of deep renovation, the entire building may need to be vacated which may involve practical and financial barriers associated with relocating the occupant for the period of the retrofit.</p>	<p>(Climate Policy Initiative, 2013; Hou et al., 2016; Weiss et al., 2012; Achtnicht & Madlener, 2014; Ernst & Young, 2015; Bjørneboe et al., 2018)</p>

3. Characteristics of public building in terms of EER

The uniqueness of the public sector in terms of organizational goals, decision making, financing, procurement process and accountability may pose unique set of barriers on public building EER projects. Unlike a non-government organization where the goal is to generate the highest profits, the public sector is more focused on serving the general public and fulfilling their pressing needs. Hence, the public sector prioritizes their investment based on public interests, needs and

concerns, which may not be undertaking EER projects. Also, the public organization cannot set their own goals and continuously find themselves pressed by legislative mandates and political forces. For example, the goals of a public organization can see big changes driven by electoral politics.

In terms of financing, public-sector managers have little control over their budget and rely on annual budget resources allocated to them as their primary financing tool for energy efficiency improvements which limits the scale of investment in energy efficiency (Mayer &

Ghiran, 2011). Financing restrictions make investments in energy efficiency more difficult to finance, particularly larger investments that will ultimately yield larger savings (Charters, 2008).

Procurement processes differ greatly in public organizations compared to non-government organizations. Any private organizations are able to use their revenue from sales and investments to buy things when they need them. Since public organizations are owned by government and are funded by tax revenue, public sector procurement is required to be conducted in a more transparent way. The procurement practice needs to adhere to a number of policies and regulations and has to be approved by several governing bodies. A business case on EER including the purchase of innovative energy efficiency technology may not successfully go through this incremental decision-making process. Also, suppliers often undergo background checks and other investigations to ensure their capability in delivering the project. All this process significantly slows down the project related decision making which may put financial strain on the suppliers (Zhang, Jin, & Khalfan, 2015).

Finally, the government organizations are subject to a specific kind of scrutiny. They are accountable for how the public money is being spent not only in terms of cost-effectiveness but also in terms of public good, social equity and fairness. The activities and accomplishments of public organizations hold a greater presence in the public eye which may play a significant role in their decisions regarding EER.

4. Research context

Australian Government Governments occupy over 25% of Australia's commercial building stock and collectively spend over \$1 billion annually on energy and water bills associated with their buildings (ANAO, 2009). Most of the buildings occupied by Australian government departments were constructed before the introduction of energy efficient building code or policies/programs and are energy inefficient. Therefore, in order to reduce the costs and the harmful GHG emissions, it is crucial to reduce the energy consumption through retrofitting these old and energy-inefficient government occupied building stock. Several State Governments in Australia have introduced energy efficiency policies/programs, which require the government departments/agencies to install energy efficient measures in their buildings following the retrofitting procedure outlined in those programs. Three of the state governments have been successful in implementing the energy efficiency policies and retrofit public buildings under their portfolio (Zou et al., 2017). Greener Government Building (GGB) program of Victoria invested \$134 million on upgrading 389 buildings under GGB program. Over the 15 years, these projects are estimated to achieve cost savings of \$335 million and the annual avoidance of 134,000 tons of GHG emissions (Victorian Government Purchasing Board, 2016). In NSW, 363 energy efficiency projects have been initiated since July 2012 under Government Resource Efficiency Policy (GREP) with projected cost savings of \$5.8 million (GREP progress report, 2017). With the introduction of Government Building Energy (GBE) Strategy, the energy efficiency of South Australian government-owned and leased buildings improved by 22.1% in 2014–2015, compared to the 2000–2001 baseline (South Australian Government, 2018). However, in two states of Australia, the public building retrofitting programs were not deemed to be adequately successful and were discontinued (Zou et al., 2017). This study aims to understand the barriers that contributed to the unsuccessful retrofitting programs in these two states.

5. Methodology

Focused group were used as the primary data collection method to solicit the perspectives of government officers on the barriers and coping strategies of implementing public building retrofitting projects (Bryman, 2016). Focus groups were selected over other qualitative research methods because they can generate information on the collective

views of the selected participants regarding retrofitting barriers and the overcoming strategies. This method is useful in generating a rich understanding of participants' experiences and beliefs. Unlike interviews, where the researcher asks questions and controls the dynamics of the interview session, the dynamics of the focus group discussion is also influenced by the experience and interaction of the participants. This is particularly important in this research to understand the retrofitting barriers faced by the various participants that are positioned within certain divisions of the government organisation as well as barrier and strategy causality between divisions.

Two focused groups were conducted in two states of Australia where public building retrofitting programs were not successful as stated in the previous section. The two state governments and participants involved in the focus groups are confidential. The criteria to select focus group participants were:

- Must be senior personnel (i.e. Director, Manager, Policy and Program Officer) in a government organization; and
- Must have at least 10 years of experience in development, funding, implementation and management of building retrofitting projects.

Following these criteria, two lists of participants were compiled with the help of our government partners in those two states. As our focus was to understand the barriers and strategies from the perspective of the personnel employed within government departments or agencies, the focus groups included participants from the public sector only. The selected participants were invited through an email containing the scope and agenda of the focus group session. The number of participants was 10 and 28 for the first and second hosted focused groups, respectively (Table 2). It is evident from Table 2 that 90% of the participants in State Government A and 82% of the participants State Government B were Director, Manager and Policy and program officer. Hence, it can be considered that the personnel characteristics for each of the focus groups in these two states were similar.

The focused group started with a half hour presentation from the research team to introduce the research topic, session objectives and the current best practices for retrofitting public buildings for energy efficiency. This was followed by a one and a half hour session including interactive thematic discussions. These discussions covered a wide range of retrofitting related topics including auditing, finance, procurement and mandates. During each thematic discussion session, each participant was requested to think about retrofit project barriers and coping strategies, from the perspective of their departments, as well as in the overall context of state government. The discussions were recorded and then transcribed for the analysis.

The collected data were analysed using a thematic analysis approach. This is a qualitative data analysis method that seeks to identify patterned meaning across a dataset (Bryman, 2016). The approach was particularly useful in this study since participants described similar barriers and coping strategies using different words. In this study, the themes of barriers and coping strategies were derived from a thorough reading of the transcripts of the discussions and the notes taken during the workshop. The topics that recurred more often were categorised as a theme using this analysis procedure. Repetition is one of the most common criteria for establishing the pattern; however, cautions were

Table 2
Position and number of focus group participants in each State.

Position description	State government A	State government B	Total
Director	1	6	7
Manager	5	13	18
Policy and program officer	3	4	7
Principal advisor	1	0	1
Program co-ordinator	0	4	4
Engineer	0	1	1

taken to make sure that identified themes are relevant to our research focus. The identified thematic barriers were then categorised depending on in which phase (e.g. building efficiency assessment, financing, procurement, etc.) of a retrofitting project they appear. Nvivo software was used to map the interactions between the identified barrier themes and the phases.

The data collected from the two focused groups were merged during the thematic analysis because both groups raised similar issues. The thematic analysis findings of the two focus groups were subsequently validated using an expert review panel consisting of two team leaders of public building retrofitting programs from two other state governments in Australia, as well as ‘Head of Policy’ from the Australian Energy Efficiency Council. The expert panel recommended the addition of only one additional barrier, which was the willingness of government to carry net-debt over the forward estimate period. This barrier is now included in the result section of this article.

6. Results and discussions

6.1. Barriers to retrofitting public buildings

Through thematic analysis of the focus groups data, 23 themes of barriers have been identified. These barrier themes were then categorized into four categories depending on their point of occurrence in a public building retrofitting program, namely: 1) Building efficiency assessment; 2) Financing; 3) Procurement; and 4) Raising awareness on energy efficiency. Fig. 1 shows the identified barrier themes under each category along with the number of participants whom mentioned that

particular theme. It should be noted that some of the themes are present in more than one category which means that those barrier themes can affect multiple phases of a retrofitting project. The interactions between the barrier themes and the categories are shown in Fig. 2.

6.1.1. Building efficiency assessment barriers

Fig. 1 shows that the top barriers within the building efficiency assessment category are *Lack of funding*, *lack of metering* and *lack of skilled consultants*. Monitoring and auditing to identify energy saving opportunities are expensive and require ongoing funding. Most of the existing public buildings stock either have no metering equipment or outdated metering systems which do not provide adequate information to assess the building energy efficiency. Due to a lack of funding, sometimes cheap metering technologies are installed which provide little value for effective decision making. Presently, there is also a lack of skilled and trusted consultants that can be relied upon to complete robust assessments on the energy efficiency of the building. Government officers perceived that some of the consultants were too focused on their own monetary interests rather than deriving solutions that were the most appropriate for the efficient operation of the clients building stock. These perceptions are resulting in mistrust on the assessment report provided by the consultants and ultimately introducing some degree of hesitation amongst the building owners regarding whether to invest or not (Curtis, Walton, & Dodd, 2017). As this participant described:

“Energy auditors are incompetent and do not have complete understanding of operation and requirements of the facility.....They just want

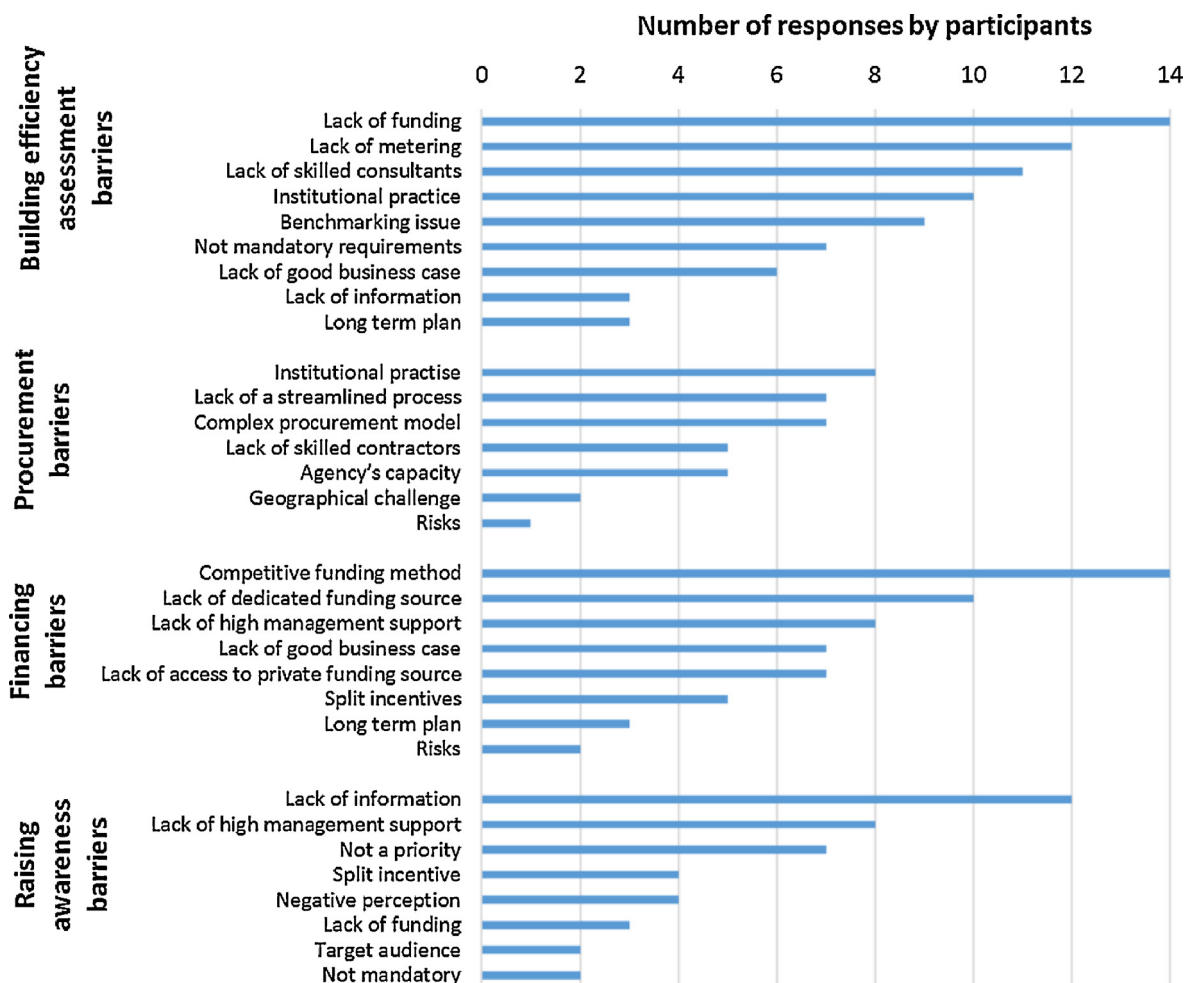


Fig. 1. Themes of retrofitting barriers under each of the categories and the number of responses.

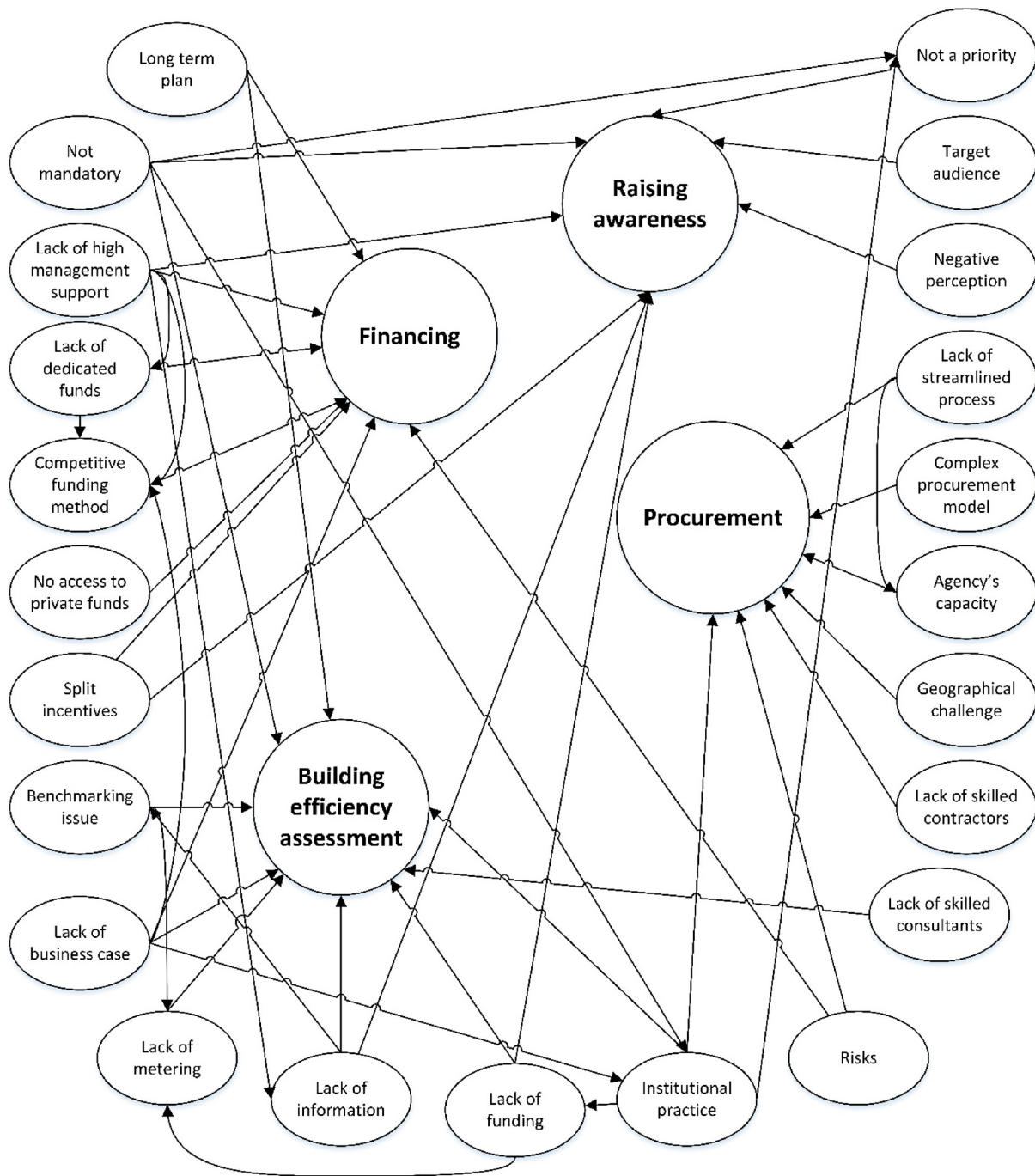


Fig. 2. Barriers to public building energy retrofitting.

to make money out of their expertise”

Institutional practice is a barrier which includes an agency’s usual practice that inhibits a building efficiency assessment. In most cases, a piecemeal approach is followed regarding the installation of monitoring equipment without a systematic long-term data collection plan. Continuous data monitoring of changes in energy usage before and after an intervention is often not considered a high priority by senior management. The low priority of energy efficiency assessments also acts as a barrier to raising awareness for energy efficiency in the agency.

There is a lack of benchmarking data for different functional facilities under different climate conditions which is prohibiting the accurate assessment of building energy efficiency. Again, this is partly due to the lack of metering data from different functional facilities. Also,

there is a concern that current certification schemes in Australia are not capable of providing true energy assessment of different building types. The absence of any mandatory energy efficiency requirement was also viewed as one of the major barriers to conducting energy efficiency assessments. The lack of mandatory requirements coupled with limited accountability contributes to an institutional context that does not motivate building asset custodians to procure energy efficiency retrofits.

Another barrier is the agency’s capability in preparing retrofit business cases that will secure sufficient funding support. There is also a lack of guiding documentation on how a government department/agency can undertake an energy efficiency retrofit program. Moreover, collecting detailed building information such as drawings, plant data, etc. during the auditing stage is often very difficult. Due to the

downsizing of government, there are not enough personnel with sufficient expertise to provide the necessary information for benchmarking the building. Similar observations were made by [Caputo and Pasetti \(2015\)](#) in the case of Italian small municipalities. Therefore, retrieving the necessary information through employing external consultant firms requires money, which in turn increases the budget. Finally, the agency's long term plan also affects their investment decisions regarding energy efficiency retrofit projects. This includes whether to invest in or demolish an aged asset, heritage issues, etc.

6.1.2. Financing barriers

The top financing barriers identified by the participants are *competitive funding method*, *lack of dedicated funding source* and *lack of high management support*. It is difficult for the government agencies to obtain funds from the treasury department to deliver energy efficiency project when there is a tight fiscal environment, and/or other funding priorities placing pressure on the facilities management budget. Therefore, in this competitive funding model, it is difficult to secure funding for energy efficiency projects. Lack of knowledge and experiences in putting together a good business case and lack of a dedicated funding source for water and energy efficiency is worsening this issue. Moreover, there are no incentives for the government agencies for retrofitting their building stock. Lack of higher management support across the agency and state government are also hindering the investment on retrofitting in current competitive funding model as well as the introduction of relevant incentives and dedicated financing mechanisms. Lack of high management support in the agency also acts as a barrier to raising awareness regarding energy efficiency in the agency. The following quote from one of the participants depicts the same picture:

“Due to cost-cutting, it is hard to find money for proactive projects.....Department of Finance funding model makes the retrofit difficult.”

Some participants mentioned the barrier of having no access to private funding source to fund their retrofitting project. Given the circumstances of current tight budget conditions, the private funding sources could get their retrofitting projects over the line. The split incentive is also one of the major barriers against retrofitting investments. There were frustrations regarding where the energy savings benefits end up. The following quote is a typical example that captures this frustration:

“Where do the savings go? It is not kept in the agency who achieved the savings through retrofitting. Rather, the Treasury reduces the OPEX (operational expenditure) budget in the following year [due to the savings achieved]”

A similar finding was also reported by [Hou et al. \(2016\)](#) in their study where it is mentioned that in government-owned buildings, the benefits of energy savings cannot be shared with staff which in turn result in the lower initiative for energy efficiency projects in this type of buildings. Finally, the risks involved with these kinds of projects, particularly the uncertainties about the savings, are also deterring the agency in making any investments.

6.1.3. Procurement barriers

One of the top barriers of energy efficiency procurement as mentioned by the participants is the institutional practice. The procurement model in the government is too complex, more costly and inefficient. It becomes more intensive in the case of energy efficiency procurement. Current procurement practice of selecting the lowest quote is prohibiting the purchase and installation of energy efficiency products as these are comparatively more expensive than the traditional products with similar functionality. As one participant described:

“Procurement is a big problem.....always go for cheapest quote which is never best value. The procurement model has too many rules and

regulations and requires excessive levels of approvals”

Also, there is a lack of a streamlined process for energy efficiency procurement. Currently, there are no clear guidelines describing the procedure and listing the available procurement options for energy efficiency product. The agency normally lacks the knowledge and competency required for energy efficiency procurement and energy performance contracting (EPC).

Lack of a skilled contractor for installing retrofit measures was also identified as a barrier to procurement. Finally, for geographically large Australian states where the small government occupied buildings (e.g. police stations, council office) are distributed throughout the state, there are a number of geographical and logistical challenges to procure energy efficiency products for those small isolated buildings.

6.1.4. Raising awareness barriers

The main barrier against raising energy efficiency related awareness is the lack of information. The majority of the government agencies are not educated or informed of the benefits of energy efficiency. They are informed about the energy problems but do not have the necessary awareness and consciousness to face these problems and solve it ([Caputo & Pasetti, 2015](#)). The facility managers are not trained or motivated to look for energy efficiency opportunities. As a result, there is a lack of understanding about where the energy is being consumed and the impact. Also, there are no forums or engagement groups to build internal knowledge and capacity regarding energy efficiency as well as no information sharing between the agencies. Lack of high management support in providing necessary information have worsened this issue. The following quote from one of the participants explains this situation:

“We have no idea about where energy is consumed and what are the real opportunities.....Energy is very cheap, does not draw any attention from the top officials of government. It is hard to convince them with success stories”.

Moreover, retrofitting the building for energy efficiency is not seen as a core business of the agency, and therefore it normally sits at the bottom of the priority list. This applies to any commercial buildings and not limited to government building only ([Curtis et al., 2017](#)). Unless it is not mandatory, there is no urgency or desire to learn and act to increase the energy efficiency.

Similar to the financing, the split incentive is also a major barrier to raising awareness. The government pays the energy bills, and as a result, the agencies do not think about energy retrofitting initiatives. This phenomenon was also observed by [Hou et al. \(2016\)](#). As this participant described:

“People paying bills are different to people who can implement retrofitting. People need to change their habits. They don't pay the bill so they don't care”

Negative perceptions regarding energy efficiency are also influencing the people's behavior regarding energy efficiency. The energy retrofitting activities are normally seen as too complex as well as not perceived achievable. In addition to that, the unsuccessful retrofitting programs in the past also influence their opinion. As a result, there is strong resistance amongst the staff to change their perception and behavior.

Finally, no funds are available to the agency for organizing any awareness raising program. Also, some participants raised the issue regarding who should be the target audience for this kind of awareness-raising programs. It was suggested that such awareness raising programs should focus not only the agencies and its staff but also the politicians and high-level governments so that they introduce appropriate policies to retrofit public buildings.

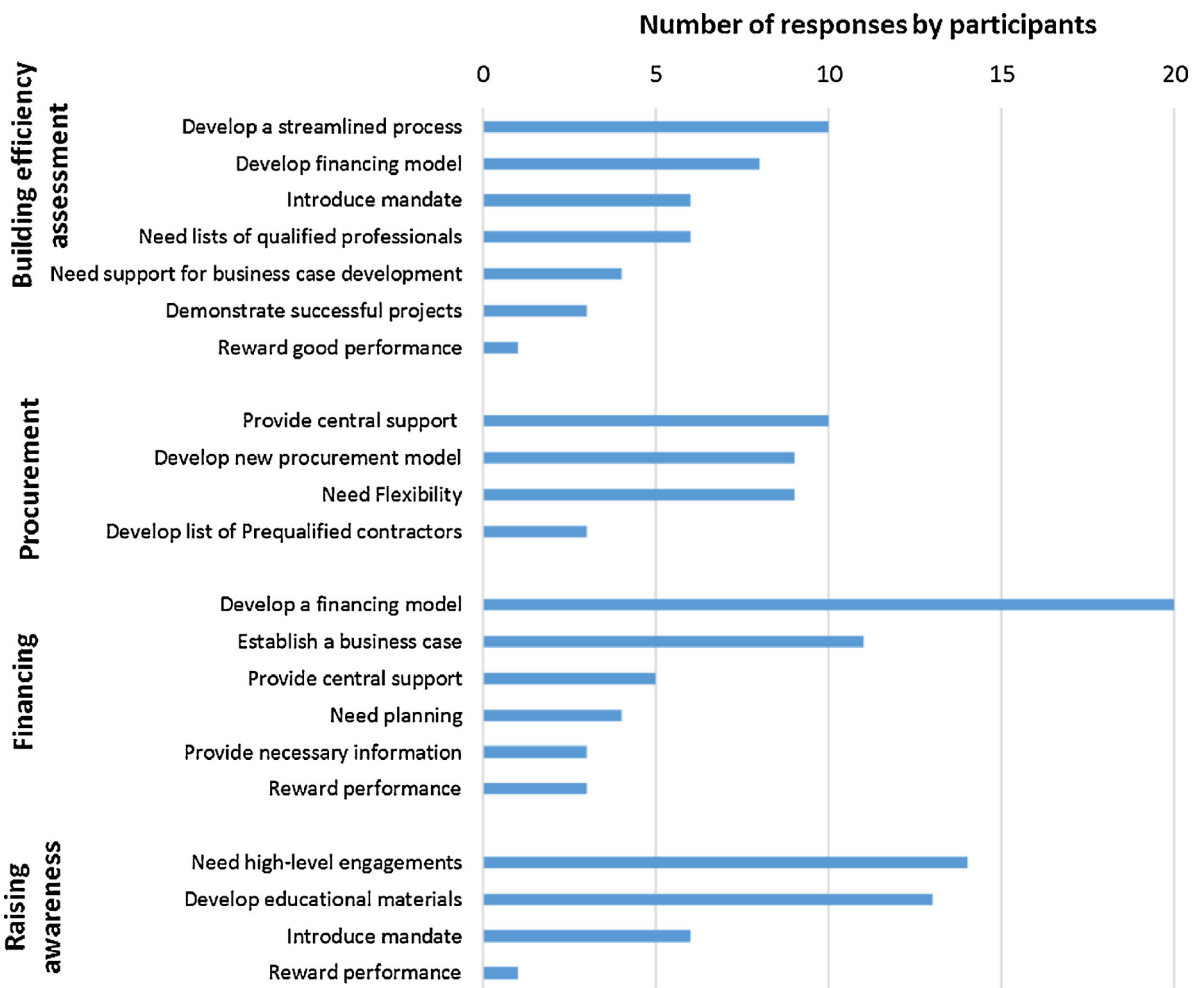


Fig. 3. Themes of strategies to overcome the retrofitting barriers under each category and the number of responses.

6.2. Strategies to overcome the barriers

The strategies that were suggested by the participants to overcome the previously identified barriers are presented in Fig. 3. The interactions between the coping strategies and the barrier categories are shown in Fig. 4.

6.2.1. Strategies to overcome building efficiency assessment barriers

The best strategy to overcome the barriers to building energy efficiency assessment is the development of a standard common assessment method and a complete and standardized certification scheme. It may also include directions regarding how to do opportunity analysis and install energy efficient measures. Next is the development of a financing model to purchase and install monitoring equipment. It is also an important strategy to overcome financing barriers and has been described in detail in the later section. There were also suggestions regarding making the energy audit mandatory for each government agency and publishing the efficiency report in the foyer of the building.

A blend of technology and engineering skills are required to get the right information from the auditing. To assist the agency with the trusted information regarding building energy efficiency, it is very important to organize education for the professionals and develop a pre-qualified list of energy auditors.

Moreover, to justify the expenditure on building efficiency assessment and gain high management support, the agency should be provided with necessary training and support in developing a viable business case for the building efficiency assessment. Also, this business case support was considered as one of the top priorities to overcome the

financing barriers as shown in the later section of this paper. Examples of some successful retrofitting projects would be helpful to show potential benefits of metering as well as develop an evidence-based streamlined process that works.

6.2.2. Strategies to overcome financing barriers

The best strategy to overcome financing barrier is to develop a financing model to provide easy access to required finance for the energy efficiency upgrade. The financing model should be developed by the Department of Treasury and Finance or any other state government department that is in charge of the retrofit program. It can be either in the form of allocation of a budget to be used in energy efficiency upgrade or a budgeting policy to support the retrofitting program from the maintenance budget. As a potential financing model, the revolving loan fund (RLF) mechanism was mentioned by some participants. RLF is a pool of capital from which loans can be issued for retrofitting projects and the borrowers repay the loan through the achieved cost savings. The money is then used to make additional loans which makes it an ongoing financial tool that increases continuously due to interest paid (Bertone et al., 2016). The Energy Efficiency Government Program in NSW, Australia uses Revolving loan funding mechanism for retrofitting the public buildings under their portfolio (GREP, 2014). The fund has been in place since 1998 and currently, has a cap of AUD\$95 million.

The next top priority is establishing a method to support the agency in preparing the business case. The best way to do this is to put together a facilitation team who can provide necessary support and guidance on how to develop a best business case for getting required finance from the treasury. As this participant explained:

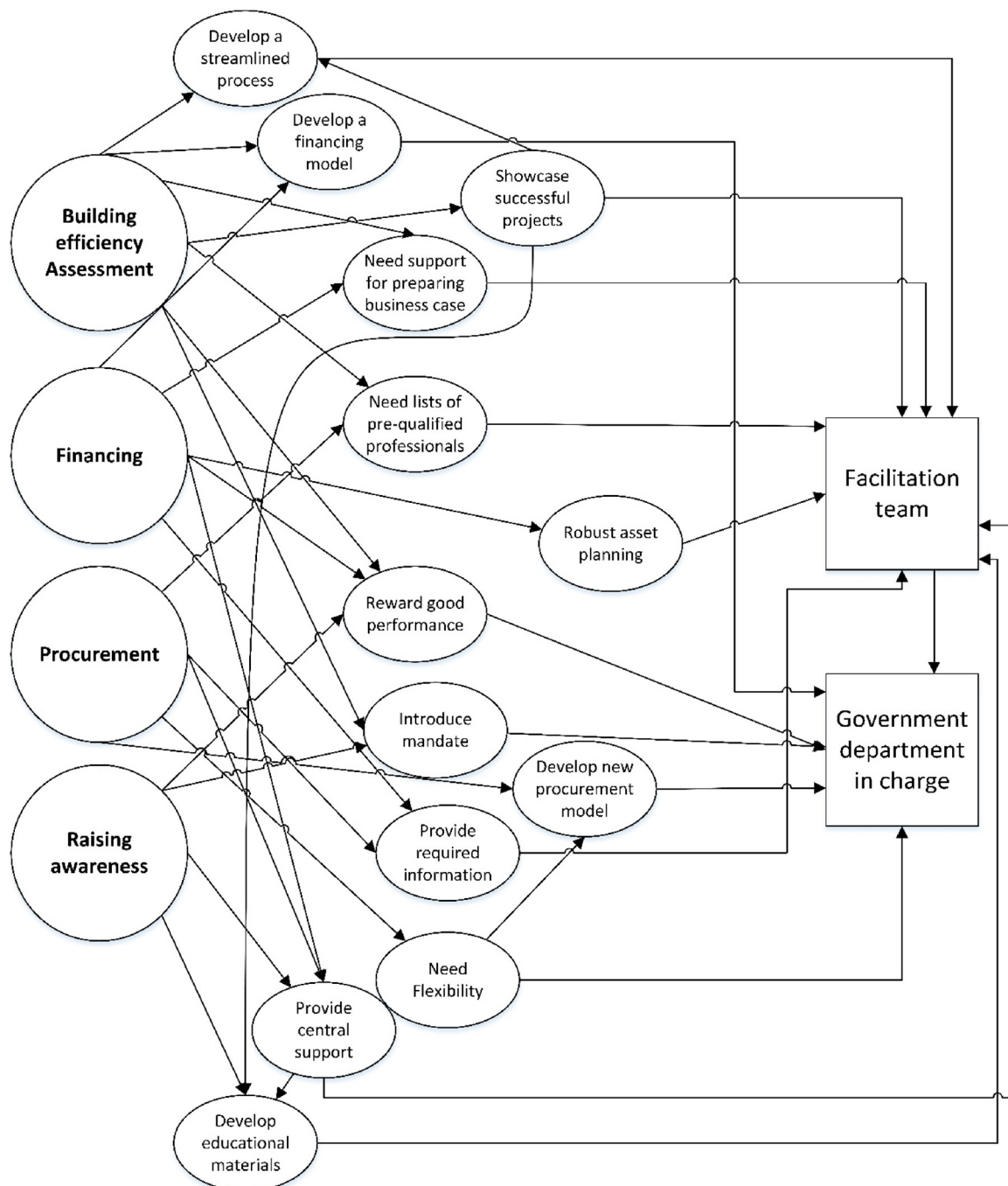


Fig. 4. Strategies to overcome the retrofitting barriers in public buildings.

“We need business case-professional development program. Start SEDO [Sustainable Energy Development Office- was responsible for managing the previous retrofitting program in the State where this participant works] again to help the agencies.”

The facilitation team can also help the agency in other aspects of retrofitting projects such as planning of retrofitting projects, communication between treasury and agency, sharing lessons learned from retrofitting projects in other agencies and states, selecting qualified professionals during auditing and procurement, etc. Finally, robust asset management is also important to overcome the financing barrier. Including energy efficiency in other capital work project through proper planning would increase the energy efficiency of the building at minimum costs. For example, by planning the energy efficiency

upgrade with planned infrastructure maintenance, the empire state building in New York was retrofitted with only USD 13 million (only 14% increment of initial budget). The upgrade resulted in annual cost savings of USD 4.4 million which means the payback period was only three years (Al-Kodmany, 2014).

6.2.3. Strategies to overcome procurement barriers

To overcome the procurement barriers, most of the participants preferred to have a central support from the state government. It may include providing standard procurement documents, detail procurement guideline, clarification of procurement process, etc. Again, the facilitation team as mentioned before is in an excellent position to help the agencies in providing the necessary procurement support.

Next, is making the procurement process flexible for the agency by

allowing a wide range of solutions and accepting different strategies during the energy efficiency procurement. For example, allowing the agency to incorporate energy efficient measures during the maintenance of equipment in an existing contractual arrangement. There is also a need to develop new procurement model for energy retrofitting project. It was pointed out that rather than looking at the cheapest quote of purchase and installation, life cycle costing should be considered while procuring energy-efficient technologies. The relevant government department should come forward with new procurement model. According to one of the participants:

“BMW [Building Management and Works department in an Australian State] can procure and offer a model to assist selection. They can clarify procurement process and provide necessary flexibility by allowing a wide range of solution.”

The new procurement model can also include a package for retrofitting the properties at discrete regional locations. For example, a process of bundling the small government building sites to a big cluster so that it is attractive to the contractor to implement EPC. Finally, a list of pre-qualified contractors should be developed so that the agency can easily find someone with required technical expertise.

6.2.4. Strategies to overcome the barrier to raising awareness

Developing required educational materials is the number one priority to raise awareness amongst the agency staff regarding the potential benefits of energy efficiency. Some of the ways as mentioned by the participants are developing websites with required information, highlighting the successful projects, sharing new research and information and government supported awareness training program. It is also important that those programs be designed appropriately to pass the key messages as one of the participants suggested:

“More basic education program should be introduced linking the science with dollars in a way people understand”

There is a need for centralised high-level support to develop the educational materials and also organise the awareness training program. In addition to that, the higher level support can be used to persuade the seniors in an agency to retrofit their building, provide leadership and make a strategic plan.

Another important coping strategy as pointed out by the participants is the introduction of appropriate mandatory policies to shift the energy efficiency project upwards in the priority list of the agency. Finally, if compliance with building retrofit programs remains voluntary, the government could introduce performance rewards for those departments and agencies that have achieved savings targets which in turn will motivate the agency to participate in these kinds of programs.

6.3. Implementation of the identified strategies

The identified strategies to overcome retrofitting barriers can be successfully implemented through a “Central Facilitation team” and the “Government department in charge” as shown in Fig. 4.

The central facilitation team can help to develop a streamlined process for building efficiency assessment, develop a strong business case, develop and maintain a list of qualified professionals, showcase successful projects and develop educational materials and provide necessary information and support. However, the focused groups identified some barriers that may hinder the development of a facilitation team which are discussed later this section.

On the other hand, the “government department in charge” is responsible for developing a suitable financing mechanism, introducing incentives and rewards to encourage retrofitting, developing a suitable procurement model, providing flexibility in the procurement process and introducing a mandate. It should be noted that the government is also responsible for establishing the facilitation team as mentioned above. The government department in charge is usually the one which

holds and allocate the resources for retrofitting, e.g. Department of Treasury and Finance. The most challenging task for the government is imposing a mandate regarding energy efficiency retrofitting. There are a number of factors that may prevent the government from imposing such mandate on the agency. In the following section, the possible barriers and coping strategies of introducing a mandate, identified by the focus groups, are discussed.

6.3.1. Barriers to establishing a facilitation team and possible solutions

The primary barrier is the availability of resources. Considerable costs and efforts are required to establish a suitable team. The government departments lack expertise on energy efficiency projects and finding the correct people from within the department is challenging and requires extensive efforts. On top of that, the current shrinking government workforce is also posing a significant barrier to the formation of a facilitation team. Secondly, there is a perception amongst the agency that they might lose control over the project if the facilitation team is involved. There is a lack of understanding about the importance and value of a facilitation team for the successful delivery of an ongoing building energy efficiency project. Moreover, there is reluctance amongst the agencies to work together with a central agency and share key information with other government agencies or groups. Finally, the willingness of government is also an important factor to establish a centralized facilitation team.

To overcome these barriers, there is a need to develop expertise amongst the government department via training. Also, the government need to introduce a collaborative process between key agencies to draw the experts and include them in the facilitation team. As one participant mentioned:

“As BMW [Building management and works] have some expertise, they could draw some expertise from other key agencies (water, energy) and assist and drive efficiency.”

If needed, consultants or experts may be hired through a competitive process. This will ensure a transparent process for the appointing team, eliminate any potential conflict of interest and will be acceptable to the agencies. Use of some successful retrofit projects delivered by the facilitation team will serve to demonstrate the value of their service and also enhance their acceptance within the agencies. Overall, there is a need to have a whole of government approach where the central government creates the core team of project initiation and procurement experts along with a network of dispersed energy efficiency champions within various departments and agencies.

6.3.2. Barriers to introducing mandatory policies and possible solutions

The top barriers are the *willingness of government* and *acceptability by the agency*. The introduction of partisan government policy is not favorable to achieve the long-term energy efficiency target. Whenever there is a change in government at the State or Federal level, there are also significant shifts in sustainability-related policy, mandates and funding (Zou et al., 2017).

Also, sometimes the introduced mandate is not acceptable to the agency because it is seen as an increased cost of the project by the agency and there is no funding available to cover that additional cost to meet the mandatory target. Also, as mentioned in the previous section, the agency does not get the benefit of savings achieved. Moreover, there is a perception amongst the agency that the mandatory targets are not achievable. Determining a realistic and achievable target was also identified as one of the main barriers to the introduction of a mandate.

To introduce a successful mandate, the most important step is to ensure that the mandated target is realistic and is followed by detail guidelines regarding how to achieve it. To show the effectiveness of a mandate and credibility, as a first step, certain relatively easy retrofits that yield a predictable, rapid return of capital could be mandated.

If a mandate comes with detail guidelines and is appropriately resourced (funding source, procurement support etc.) it will be accepted

Table 3
Comparison of public building retrofitting barriers identified in this research with previous studies.

Barrier categories	Previous Studies	Current findings relating to Public organization
Financing	<ul style="list-style-type: none"> ● Limited capital and high investment cost of EER ● Priorities in investment is profit driven. ● Reluctant to invest money in the short term for longer term benefit. 	<ul style="list-style-type: none"> ● Difficult to obtain funds from treasury in tight fiscal cycle. ● No provision to borrow money from private sector. ● Investment priorities are driven by public needs. ● Partisan government policy regarding energy efficiency investment. ● No appetite to increase net debt over forward estimate period ● Unlike private organizations, there are no government subsidies to drive EER.
Split Incentive	<ul style="list-style-type: none"> ● Split incentive issue arises when the owners spend money for EER but tenants get the benefit. 	<ul style="list-style-type: none"> ● Split-incentive issue arises when the organisation cannot retain the savings achieved from EER. Rather, their OPEX is reduced from next year.
Procurement	<ul style="list-style-type: none"> ● Do not have any specific procurement barriers. 	<ul style="list-style-type: none"> ● Complex and lengthy procurement model which requires excessive level of approvals. ● Lack of streamlined process for energy efficiency procurement. ● Geographical and logistical challenges to procure energy efficiency products for public buildings distributed in large states.
Motivation	<ul style="list-style-type: none"> ● There is a lack of motivation to retrofit as long as the building is functional and generating income. 	<ul style="list-style-type: none"> ● EER generally sits at the bottom of the priority list unless mandated by state government.
Information and awareness	<ul style="list-style-type: none"> ● Lack of knowledge of building owners or property managers regarding energy efficiency. ● Energy efficiency is treated as compliance and cost burden. 	<ul style="list-style-type: none"> ● Lack of knowledge and support of high-level government officials who are responsible for introducing public buildings retrofit program. The local government agencies have no control over that.

by the government agency. While developing the mandatory policy, lessons can be taken from successful mandating models from other jurisdictions. Last, but not the least, the governments need to have firm determination and strong political will to impose appropriate policies and mandates to prioritize building efficiency upgrade projects. There is a strong need to lobby the government to introduce necessary mandating policies and other supporting mechanism.

6.4. Comparison of public building retrofitting barriers with previous findings

The comparison of public building retrofitting barriers identified in this study (section 6.1 and 6.3) with the previous findings (Table 1) revealed that while there are similarities in the types of barriers, the studied public organizations experienced some unique barriers which were not reported previous studies. A summary of the differences is presented in Table 3.

7. Recommendations

The literature review of retrofitting barriers as well as current findings revealed that in profit-oriented organizations (i.e. private sector), a 'pull' approach for energy efficiency retrofitting projects would be more appropriate through introducing various incentives (DECC, 2014; Thomas, 2015). Retrofit programs receive more attraction in cases where government subsidy levels are higher (Hou et al., 2016). However, to ensure retrofit quality, the subsidy can be provided in several installments once the critical milestone is achieved (Hou et al., 2016). On the other hand, a push approach is preferred for a public organization where the primary goal is not making a profit. Based on our research, we have formulated a top-down policy recommendations framework for public buildings retrofitting program as illustrated in Fig. 5.

At the top governments need to have strong determination and willingness to develop a public building retrofitting program and take on debt beyond the forward estimate period. The retrofitting program should include a mandate on government agencies to undertake viable retrofitting activities in their buildings. As reported by Caputo and Pasetti (2015), the energy issue can-not be left to the willingness of the single local governments or agencies; there is a need for a better organization and coordination of the bodies involved in energy planning. If needed, the central/national government policy can be customized to cater for the local needs and achieve local impacts (Hou et al., 2016).

Therefore, any mandate should arise from consultations among local and central administrations, in order to make the plan effective (Caputo & Pasetti, 2015). However, personal communication with Energy Efficiency Council of Australia's "Head of Policy" and Senior Manager of Victorian Greener Government building (GGB) team revealed that governments' willingness to take up energy efficiency programs is mostly influenced by 'net debt' over the forward estimate period (typically, this is four years in Australia). Following is the quote from the Victorian GGB program team:

"There is an elephant in the room. This elephant is the main barrier to uptake of energy efficiency projects by governments. It is the willingness of governments to take on debt for programs such as these. Net debt is the most important financial indicator for most governments. And the most important timeframe is the forward estimates period - i.e. the next 4 years. There is no way to implement EE [energy efficiency] retrofits at government buildings without increasing government net debt. Energy efficiency projects typically have a quick payback, but it's normally longer than 4 years. This means it will increase net debt over the forward estimates period. Governments will acknowledge the long-term benefits of EE projects but the most important numbers to them are the amount of net debt over the forward estimates period. As a result, EE will be seen as a cost, rather than a saving. And there are not many votes to be won by improving the EE of government buildings. There are more votes in a new hospital, school, train line, etc."

Moreover, a mandate will be ineffective unless it is supported by the suite of other identified coping strategies such as procurement guidelines, facilitation team support, to name a few. The central or national government should be more supportive, providing all the necessary information, resources and help to the state and local governments and agencies (Hou et al., 2016). To minimize the net debt, least-cost retrofit projects having a rapid payback period can be mandated. Raising awareness through developing educational materials and training programs would also be helpful. Among others, this can be done in the form of a "one-stop shop" of resources from government organizations with the necessary information regarding energy retrofits (Curtis et al., 2017).

The government needs to introduce a dedicated financing mechanism and a streamlined procurement process for energy efficiency retrofit projects so that individual departments/agencies can access the required funds for their project. A review of different available financing and procurement mechanisms for energy retrofitting projects are available in Bertone et al. (2016). Amongst the different financing

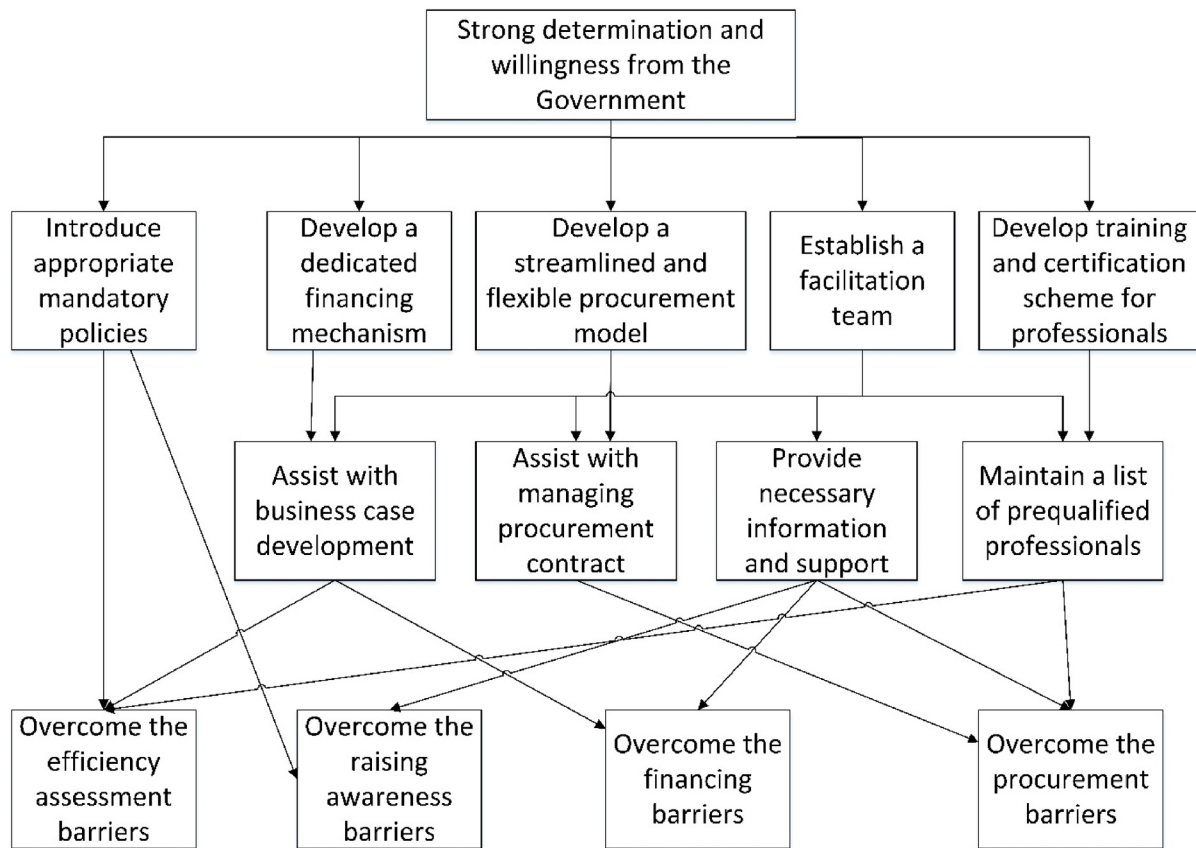


Fig. 5. Top-down strategic approach to overcome the barriers of public building energy retrofitting.

mechanisms available, the revolving loan fund was found to be the most suitable funding method for public building energy retrofits (Bertone et al., 2018b). Also, governments should reward those departments and agency that achieve mandated building retrofit targets. One way of doing this would be to allow government departments and agencies to retain any operational savings achieved through energy efficiency retrofits rather than decreasing their operational budget. These retained funds could be used to fund future retrofit projects (an internal revolving loan fund). In addition to that a streamlined and flexible procurement model should be developed which can shorten the time required during procurement as well as allow the government agencies to accept wide range of solutions in a retrofitting project. A number of public building retrofitting projects around the world prefer EPC-based procurement method (DECC, 2015; Shonder, Morofsky, Schmidt, Morck, & Mervi, 2010). The authors' personal communication with the NSW Energy Efficiency Government Program team revealed that government agencies are reluctant to use EPC because it is an expensive and time-consuming process. They are moving towards a risk-based procurement method in their public retrofitting project. A recent study also demonstrated how appropriate financing and procurement options would boost the government building energy retrofitting rate (Bertone et al., 2018b).

The government should create an expert facilitation team to support their departments and agencies with retrofit project planning, business case development, complex procurement process, finding qualified professionals and providing necessary information and training. A facilitation team and whole of government protocol is more cost-effective than requiring each department to create their own procedures and team that deliver energy efficiency retrofit projects. Some successful national and international public building retrofitting programs have used this facilitation team approach to help the government agency to retrofit their building. For example, in Australia, the Greener

Government Building Program of Victoria (GGB, Greener Government, 2016) and Government Resource Efficiency Program of New South Wales (GREP, 2014) have a central facilitation team to support the government agencies. In Canada, such assistance is provided by the Federal Buildings Initiative (Shonder et al., 2010). Similar services are provided in Finland by Motiva, which acts as a link between ESCOs and their potential clients by developing contracting models and tools and marketing the EPC concept (Motiva Oy, 2009). The role of the project facilitator in the U.S. Department of Energy's Energy savings performance contract (ESPC) program – administered by Federal Energy Management Program (FEMP) – provides another model for delivering this assistance. FEMP project Facilitators (PFs) are expert consultants for technical, financial, and contractual issues and help to optimize the financial value of ESPC projects.

Presently there is a lack of specialists with extensive experience in carrying out energy retrofitting activities (e.g. auditing, exploration of suitable retrofit measures, measurement and verification, etc.). To overcome this issue a certification scheme can be used to train and certify the qualified professionals. In Australia, The Energy Efficiency Council developed one such certification scheme that provides professional certification for individuals who lead and manage comprehensive energy retrofits of commercial buildings (Energy Efficiency Council, 2018). In addition, the government can set some clear protocols around skills required to carry out these kinds of projects and can also develop a list of pre-qualified professional for the agency to use so that they do not need to spend time on checking the capabilities of the consultants and contractors. For example, in Australia, the Greener Government Building Program of Victoria (GGB, Greener Government, 2016) and Government Resource Efficiency Program of New South Wales (GREP, 2014) developed a list of pre-qualified energy service providers for their agencies to ensure highest standards of service.

8. Conclusions

Through focus groups with departmental and agency personnel employed within two Australian state governments, this study discovered the barriers and coping strategies to retrofit public buildings stock. The novelty of this research lies in the fact that it has explored the barriers and overcoming strategies from the perspective of government departments and agencies, unlike previous studies on retrofitting barriers.

Public organizations face some unique barriers while retrofitting their building. It is difficult to undertake energy efficiency project due to budget constraints of an individual department. Even if the department or agency has the capacity to bear the cost, the long-term nature of the overall project (i.e. upfront capital plus small ongoing monitoring cost) does not fit within short-term government budgeting cycles. Retrofitting projects are generally not considered as the core function of a particular government department, meaning that retrofitting initiatives are often pushed to the bottom of budget priority lists. Also, the way that government budgets and responsibilities are set up means that they provide little incentive to prioritize energy efficiency retrofits. Departments and agencies are often penalized for achieving energy efficiency savings, by having their operational budget reduced by the treasury in the next financial year due to the reduced energy costs to operate their buildings.

Procuring energy efficiency retrofit projects within government is also complex. A lack of support and risk adverseness of senior government executives often impedes the procurement of energy retrofit projects. Also, the government does not have any appetite to increase their net debt over the forward estimate period.

A top-down approach is proposed to develop a successful government building retrofit program. At the top, governments need to show determination and be willing to take on debt beyond the forward estimate period in order to fund feasible retrofit projects. Other key enabling strategies include mandatory retrofitting policies, dedicated financing mechanism, flexible procurement model, a facilitation team and list of pre-qualified professionals. The presence of all of these elements within a comprehensive retrofitting strategy would accelerate the current laggard rate of energy efficiency retrofits within government building asset portfolios.

In presenting these findings, we acknowledge the limitations of our research. Our findings, whilst informative, are based on the experiences of focus groups participants of those two states. While we have discussed all possible barriers and strategies to retrofit buildings in the focus groups, there might be other perspectives, barriers and opportunities. These concerns were countered by having the work reviewed by the experts from two other Australian States and the head of the policy of energy efficiency council. Also, some key factors that were identified as being very crucial in this study may be less relevant for other regions. However, the present findings have implications for governments seeking to develop appropriate policies and strategies for a successful public building energy retrofit program.

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