Department of Energy & Climate Change

What are the factors influencing energy behaviours and decision-making in the non-domestic sector?

A Rapid Evidence Assessment

Centre for Sustainable Energy (CSE) and the Environmental Change Institute, University of Oxford (ECI)

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Project team

This project was undertaken by Centre for Sustainable Energy (CSE) in partnership with the Environmental Change Institute, University of Oxford (ECI). Dr Nick Banks of CSE managed the project and co-authored CSE's contribution with Zoe Redgrove. Other CSE staff working on the project were: Madeline Gunn, James Mullen and James Ryle. Dr Tina Fawcett delivered ECI's work with assistance from Ljilja Ristic and Sue Bird, University of Oxford librarians.

The views expressed in this report are those of the authors, not necessarily those of the Department of Energy and Climate Change (and the results will not necessarily reflect Government policy).

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Executive summary

Around 18% of the United Kingdom's (UK) total greenhouse gas emissions come from non-domestic buildings and a further 22% from industrial processes (usually housed within non-domestic buildings). Therefore, if the UK is to meet its target to reduce emissions by 80% in 2050, significant reductions in non-domestic emissions are needed. This will require thoughtful policymaking underpinned by realistic understandings of the way organisations make decisions about energy use. DECC has commissioned this research to gain an overview of existing research evidence relating to energy efficiency behaviours in non-domestic settings.

A Rapid Evidence Assessment

In order to be both timely and systematic this research used a Rapid Evidence Assessment (REA) methodology. The REA was built around answering a series of 7 research questions formulated by DECC and shown in full in Appendix 1. The questions covered the following themes:

- evaluations of government policies to improve energy efficiency behaviours;
- organisational strategies for driving energy efficiency;
- business investment and barriers to implementing energy efficiency;
- identifying the benefits and pitfalls of action on energy efficiency; and
- differences between organisations.

The quality of evidence

The REA was focussed on empirical research from the Organisation for Economic Co-operation and Development (OECD) countries carried out after 2000. In the course of the search over 6000 journal articles, and a wide range of grey literature were considered including around 600 conference papers and around 30 studies carried out for national and European governments. Application of exclusion and quality criteria resulted in the selection of 56 studies for further detailed analysis and these form the evidence base from which the report's findings are drawn. However, the evidence is not evenly distributed with some sectors and particular types of behaviour being much better researched than others. This should be kept in mind when interpreting review findings.

Development of a framework theory of behaviour in non-domestic settings

A conceptual "framework" or "model" has been developed to provide an outline theory of organisational behaviour and behaviour change. The framework seeks to integrate insights from organisational theory, sociology and economics. Using the conceptual framework allows us to draw common understandings from the diverse range of literature in the evidence base and also delivers some explanatory power. Combining the research base and the conceptual framework has allowed at least partial answers to be provided to all the research questions. These are outlined as follows:

Investment decision-making and barriers

Our evidence base contains many papers reporting findings that conflict with the conventional economic account of investment. Alternative or augmented theories are proposed.

1. **Business investments in energy efficiency generally appear to require very high rates of return, in some circumstances much higher than other**

investments with comparable risks. This has been termed the "energy efficiency paradox". The evidence suggests a range of reasons for this including: perception of risk; unwillingness to replace equipment before end-of-life; energy efficiency not being a strategic issue; a host of various "hidden" costs; and businesses not really being the rational profit-maximisers of classical economic theory.

2. **A number of authors point to hidden costs and bounded rationality as the primary explanation for the paradox.** They argue that the behaviour of organisations is economically rational as the apparent profitability of efficiency investments is not real. Hidden costs such as the cost of capital or the loss of productive capacity while technology is upgraded erode potential savings from efficiency to the point where it makes no sense to invest unless returns are very high. What is more, organisations can never optimise their information searches given resource constraints and must rely on partial accounts of energy efficiency opportunities.

3. **Our evidence suggests that hidden costs and bounded rationality can offer a partial account but are not a sufficient explanation in themselves.** Understanding organisational behaviour as the outcome of a much wider set of "socio-technical" factors offers a more useful approach which can resolve the "paradox" and suggest new policy approaches.

4. **This wider account questions the validity of the concept of "barriers" to efficiency.** Some authors argue that the idea of a set of barriers preventing organisations behaving "rationally" fundamentally misunderstands organisational behaviour, because the assumption of an underlying drive for economically "rational" behaviour is not considered valid. Our conceptual framework suggests redefining "barriers" as more like features of the socio-technical "landscape" influencing the diffusion of an energy efficient technology. So barrier "removal" will change the shape of the landscape, opening up new paths in some areas and making others more difficult to follow, but will not necessarily catalyse action.

5. **The strategic value of energy efficiency (conferring competitive advantage) may be the key influence on whether investment in efficiency will take place rather than profitability.** Unprofitable investments still go ahead if they can be shown to be strategic. Judgement of what constitutes a "strategic" investment will involve some degree of qualitative assessment, subjectivity and a view on the organisation's purpose.

6. **Investment decision-making is usefully understood as a process with a beginning, middle and an end.** The beginning (noticing the opportunity) and middle (creating a list of options) are particularly influenced by a range of processes and procedures including the attitudes and values of individuals, the perception of norms for a behaviour in the organisations' sector and the structure and capacity of the organisation. The last part, choosing between options using financial metrics, is the area that has historically received most attention.

7. **There are a number of circumstances which explain why energy is not salient nor its efficient use a strategic objective.** The strategic value of energy efficiency is linked to the salience of energy consumption in the organisation which is itself linked to the energy intensity of the organisation (units of energy consumed per unit of productive output), the size of the organisation and its sector or sub-sector.

Further findings on the differences between organisations are reported below.

8. **Other barriers lie in the way that efficiency savings are framed as a "gain" compared with the theoretical counterfactual case (of not investing in efficiency)**. This is because organisations are found to devote proportionally more resource to avoiding losses rather than making gains. Efficiency investments fall foul of this dynamic because they can only offer a theoretical gain with a risk attached and organisations are also risk averse. This suggests that reframing efficiency savings as "avoided losses" may be effective.

9. **Energy consumption is often found to be invisible to senior managers** because it is usually the responsibility of operations and facilities managers who, in larger organisations, will be some distance from senior management who set the strategic direction of the organisation. The closer in the hierarchy the individual with energy management responsibilities is to the CEO, the more likely the organisation is to have energy management activity. But the energy manager and the CEO should not be one and the same - in this instance energy management activity is found to drop away.

10. **Energy efficiency investments are often classified as discretionary maintenance costs** rather than investments in productive capacity. Many organisations have no classification for them at all. When classified as a cost they count against profit on the balance sheet as opposed to a classification as an investment in productive capacity which would count as an asset and therefore preserve profit. This classification can make it more difficult to raise capital or make the case for an investment in efficiency over other projects seen as more core to the businesses' activities.

11. **Access to capital is considered a key barrier for efficiency investment particularly for smaller organisations.** However, some studies argue that when energy efficiency is reconfigured as having strategic value, access to finance becomes easier – particularly in larger organisations.

12. **Non-energy benefits from improving the energy efficiency of buildings include**: improved staff productivity; tenant satisfaction; comfort; appearance; quality of light; better indoor air quality; ease of selling or leasing; and better equipment performance. Benefits identified from improving operational energy efficiency include: improved environmental awareness of employees, positive stakeholder perception of the company, enhanced corporate reputation and improved employee morale and productivity.

13. **Non-energy benefits of energy efficiency, such as improved public image or comfort for staff are critical to raising the strategic value of energy efficiency** – particularly in non-energy intensive sectors such as commercial offices where cost savings from improved efficiency will not make a significant difference to the organisation's cost base.

Differences between organisational energy behaviours are strongly linked to size and sector

14. **Multiple differences in organisational energy behaviour have been found and these are linked to sector and size characteristics**. In terms of size, larger

organisations are more bureaucratic and hierarchical which can lead to principal-agent problems as facilities staff tend to be some distance in the hierarchy from the senior managers setting the strategic direction of the organisation (see above).

15. **However, larger organisations also tend to have more strategy, more time and capacity to act on energy issues** and are more responsive to issues affecting their public image – including their performance on energy and environmental issues. Our evidence finds that larger organisations are more inclined to develop energy efficiency strategy and adopt certificated management systems such as ISO 14001. This is generally for reasons of demonstrating credibility to potential trading partners and bolstering the public image or brand of the organisation. Larger organisations are also better able to bear the costs of participation in Voluntary Environmental Programmes and will have better access to capital to allow borrowing for energy efficient investment and will accept longer payback periods.

16. **Lack of internal skills to interpret technical information and the time and capacity to plan energy management is a major barrier for smaller SME's.** Smaller Small and Medium Enterprises (SMEs) are also found to perceive a "cultural" barrier to participation in the energy efficiency and carbon mitigation agendas. We have evidence that small companies can feel that their contribution is insignificant and the energy saving agenda is more appropriately pursued by institutions and larger companies.

17. **The more energy intensive the sector is the more energy efficiency opportunities are noticed and acted upon.** For example, the extent to which energy audits are used is linked to the energy intensity of the sector.

18. **Energy consumption is also more salient in sectors which trade directly with the public such as retailers.** This is driven by the need to maintain brand and reputation. Sectors that work in environmentally sensitive areas such as forestry and oil and gas also tend to procure energy efficient office space to offset potentially negative reputational effects.

19. **Sector also affects energy salience in indirect ways**. For example, our evidence finds that sectors that have a major investment in the productivity of their staff, such as banking and finance, tend to lease energy efficient office spaces as these are considered more comfortable and beneficial to staff morale and consequently these greener offices help to maintain staff productivity.

Energy efficiency strategies differ across organisations and reflect their different motivations

20. **Motivations to adopt energy strategy vary between sectors and organisations and even within organisations**. Different motivations can lead to different types of strategy being adopted. For example the evidence finds that the adoption of an energy management system may particularly appeal to sectors motivated by the need to comply with both formal regulation and informal norms which apply to the sector. These are the highly regulated sectors such as utilities and oil and gas.

21. **As energy use is often invisible to management, energy management systems have a role to play in ensuring it becomes visible via monitoring, targeting and reporting**. A key finding for policy is the need to make energy more

salient, visible and its efficient use a strategic objective.

22. **The most successful strategies to deliver lasting change in workplace behaviours use a combination of technology change, feedback to users and norm activation** thereby increasing the visibility of energy consumption and providing tangible evidence of the organisation's commitment to improved environmental performance.

Evaluations of government policy

23. **Voluntary agreements and energy audits can successfully increase energy efficiency**, particularly in energy-intensive sectors, but only if designed, targeted, implemented and monitored in the right way. Voluntary agreements seem to work particularly well if negotiated at regional level and are underpinned with implementation of energy management systems. Audits are particularly embraced by energy intensive sectors but more attention needs to be paid to the reporting of technical information so that non-energy experts can make use of the recommendations.

24. **Environmental Management Systems and reporting requirements have potential to make energy use visible** to senior management and therefore to begin the process of making efficiency a strategic objective. Certified management systems (such as 14001) will particularly appeal to larger, more regulated organisations that have international trading partners or a strong public image to maintain.

Implications for policy

25. **Our evidence base suggests that an account of behaviour which highlights the strategic,** rather than profit maximising characteristics of investment decision-making, will suggest avenues for development of both more effective application of existing policies and new policy approaches.

26. **Making energy use visible and salient is an important first step on the way to energy efficiency becoming a strategic objective.** This means policy should encourage further institution of monitoring and reporting practices and, if appropriate, combine energy efficiency messaging with a broader eco-efficiency agenda.

27. **Policy is currently too focused on the last stage of decision-making** - evaluating alternatives via cost metrics - refocusing on the early and middle stages (noticing opportunities and assembling options) will provide new policy approaches.

28. **Energy behaviours are highly diverse but also patterned and linked in systematic ways to the size of an organisation, its sector, sub-sector and local and national context.** This means that behaviour can be modelled and that targeting of measures is both possible and desirable.

29. **The language of efficiency centred around payback rather than NPV, the classification of efficiency investments as costs rather than assets plus organisational tendencies to be risk averse all bias organisations away from investment in efficiency** over alternative investment which more clearly adds to the bottom line and productive capacity. There is a potential role for government in influencing how efficiency is reframed and how it is handled in organisations'

financial accounting.

30. **Interventions to workplace behaviour appear to have significant potential for energy savings in their own right in some settings** but should also be encouraged in non-energy intensive settings because they will encourage changes to organisational culture which should feed through to changes in investment decision-making.

Research gaps and recommendations for further research

Many research gaps have been identified. Some of the more significant are identified below:

31. **There is a mismatch between the distribution of high quality research and the distribution of carbon emissions across non-domestic sectors**. Retail and hospitality sectors are particularly overlooked given their significant carbon emissions.

32. **Decision-making in SMEs is also overlooked and the SME classification itself needs to be broken down.** Our evidence base has found quite different behaviour in small, medium and large SMEs for example. Small SMEs are particularly underresearched.

33. **Research into establishing an energy based segmentation of the market is needed.** Our evidence finds that the diversity of energy behaviours has some patterning - principally by size, sector and the interaction between the two. This suggests that a useful segmentation is possible. However, the evidence for the patterning is fragmented and partial. To fill the gaps, research into energy behaviours across a broad range of sectors and size categories is needed. This would underpin a segmentation of the non-domestic sector to be used in policy design and analysis.

34. **We found significant energy saving potential for interventions to occupant behaviour in some settings** however the evidence we have for this is concentrated in studies of offices and there are very few studies of the UK context. More research in this area is recommended to establish the potential across different sectors.

35. **We found very few robust policy evaluations. This is due, in part to a lack of a robust, transferable and straightforward methodology** or set of methodologies for evaluation of government energy. Integrating more robust evaluation into the design of individual policies should be a priority for government.

Section 1: Introduction

1.1 Research objectives

The aim of this project was to answer a series of research questions about organisational behaviour and behaviour change with regard to energy efficiency in the non-domestic sector. In brief, the questions covered the following themes:

- evaluations of government policies to improve energy efficiency behaviours;
- organisational strategies for driving energy efficiency;
- business investment in energy efficiency;
- barriers to implementing energy efficiency;
- identifying the benefits of action on energy efficiency; and
- differences between organisations.

The research questions are set out in full in Appendix 1.

1.2 Summary of approach

The study used a Rapid Evidence Assessment (REA) method in order to identify studies relevant to the research questions. REA is a more systematic approach to literature retrieval and review than a standard literature review. Briefly, it can be described as a systematic and documented process of searching for evidence, setting exclusion and inclusion criteria and data extraction from the materials found. For detailed reporting of the method used, see Appendices 2-5.

1.3 Description of search, data extraction and analysis phases

Sources of information were grouped in three classes for searching: 1) peer-reviewed journal articles; 2) conference papers; and 3) grey literature. Journal articles were searched using a systematic search strategy. Search terms were worked up in consultation with DECC, trialled and then finally deployed on six academic databases. Searches returned around 6000 articles and the title and or abstract of each was scanned for relevance. Conference proceedings from the three principle conferences reporting material in the field of non-domestic energy behaviour were hand searched (i.e. the entire proceedings were scanned manually). A list of conferences searched is provided in Appendix 2. A targeted approach was taken to identifying relevant grey literature. This included using personal knowledge within CSE, ECI and DECC; and DECC contacting potential generators of relevant studies, such as other government departments. Searching generated an initial database of around 400 studies which were placed on a reference management database (we used an application for this called “Mendeley”). . These papers and studies were then coded for their quality, the areas that they addressed and other pertinent characteristics. This allowed application of exclusion criteria to further reduce the numbers for consideration and ensure only relevant material was considered. For example, papers written before 2000 were excluded. The application of exclusion criteria reduced study numbers to around 200. Final selection of 50+ papers for detailed consideration was done through application of inclusion criteria filters. These criteria were based on a quality classification: only the best quality papers were selected. A full description of the quality criteria for a range of different paper types is shown in Appendix 2.

1.4 Distribution of the studies in the evidence base

Coverage of non-domestic sectors and behaviour types in our evidence base was concentrated in particular areas. A majority of papers cover either the industrial sector or are “cross-sector” (cross-sector papers address behaviours in a number of sectors). Further and higher education buildings have some representation, as do schools and commercial offices, but there is very little covering other sectors such as retail. Investment strategy is the most highly represented behaviour type, with this being concentrated in the industrial and cross-sector categories. Implementation of energy management systems is the next most represented behaviour type, again concentrated in the industrial and cross-sector categories. Occupant behaviour is most highly represented in cross-sector and further and higher education buildings. Innovation is the category with the least papers, again split between the industrial and cross-sector categories. We can conclude that the literature is concentrated in certain sectors and in certain behaviour types and consequently that research gaps exist. Further information on the distribution of the evidence base is shown in Appendix 2.

1.5 Plan of the report

This report is organised as follows: Section 2 presents the conceptual framework which has been used to underpin our interpretations of the evidence base. Section 3 presents our findings organised by theme rather than research question. Section 4: Conclusions discusses these findings and comes to some high level conclusions. Thereafter there are technical appendices which provide the detail of the search, the theoretical underpinnings of the conceptual framework and describe the other research tools employed.

Section 2: Conceptual framework

Drawing on the published literature, team expertise and the comments of peer reviewers, a conceptual framework was developed to provide an outline theory of energy-related behaviours in non-domestic settings and allowed the team to apply a common understanding of the various issues explored in the evidence base. The framework is summarised below in the form of diagrams and descriptive text.

2.1 Description of the conceptual framework

The frameworkl is an attempt to integrate insights from economic, organisational and social theory. Whilst recognising the value that all these disciplines can bring, the framework's principal theoretical assumptions are developed out of the widespread critique of the so called PTEM – the Physical Technical Economic Model[1] – the neo-classical economic model of decision-making as applied to energy behaviours. The framework tries to integrate accounts of behaviour which have economic rationality as their basis by placing this kind of thinking within the wider social and cultural context.

The framework has two key ideas :1 . Decision-making takes place in a "context" of social, technical and cultural interrelationships – sometimes called a "socio-technical" landscape..2. Decision-making is best understood as a process with a beginning, middle and an end, with each stage having a distinct purpose in the sequence. The end stage, where options are evaluated, is the stage which most resembles the neo-classical economic account but there are two stages upstream of this where it seems other kinds of factor are more in play (see below) The framework's context and processes are described further below. Further detail on the origins and development of the framework and its implications are provided in Appendix 4: Conceptual framework development.

2.1.1 Context of decision-making and behaviours

The structure of the contextual part of the framework has 5 layers (Figure 1). Working from the centre out we have: a) individual - the small dots within the various organisational sub-cultures; b) sub-cultural – the groups within the organisations often organised by job role represented by the shapes; c) organisational level and d) socio-technical external context, imagined as a "landscape"; constituted by the interaction of e) various kinds of factor in 4 domains. These domains are characterised as: 1) Material domain; 2) Market domain; 3) Social and cultural domain; and 4) Regulatory and policy domain. More detail on the various components of the framework is given in Appendix 4.

[1] The "PTEM" construct was originated by sociologist of energy consumption, Professor Loren Lutzenhiser.

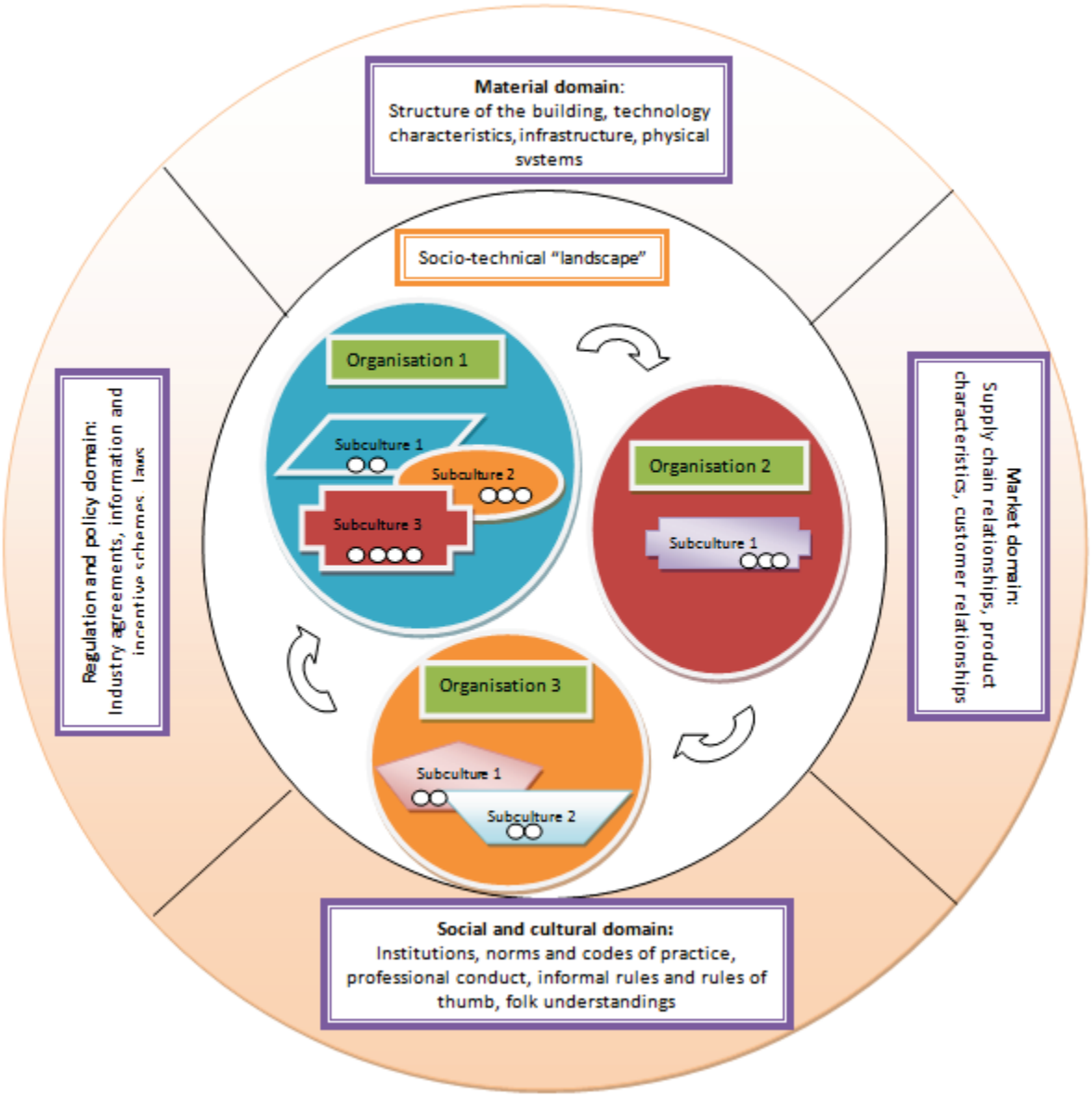

Figure 1: The conceptual framework

Our framework suggests that an organisation's energy behaviour is shaped by five levels of activity : 1) the decision-making and activity of individuals; 2) the interactions between the various subcultures within an organisation; 3) the independent "life" of the organisation inscribed in its procedures, history and ethos; 4) the relationships that the organisation maintains with other organisations in its supply chain; and 5) the socio-technical context constructed by the interaction of various types of factor. These are perceived and constructed by stakeholders within the organisation as a kind of "landscape" of possibility and opportunity. The process of decision-making takes place within this context of intersecting drivers and influences as described below.

2.1.2 Process of decision-making

The second component of the framework is decision-making itself. As indicated, this should be understood as a process with a beginning, middle and an end. A process model of investment decision-making is shown in Figure 2:

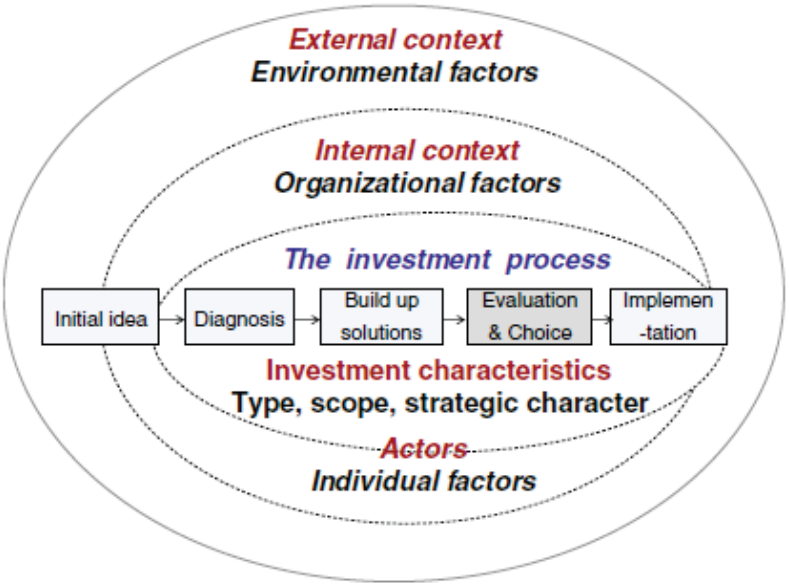

Figure 2: Cooremans' (2012) model of the investment process

In the beginning of the investment process there is issue identification where a new idea or issue is noticed and becomes salient. The values and culture of the firm and of individuals of the firm will be critical in filtering what is important and therefore noticed. In the middle there is the "diagnosis" phase where options are assembled and solutions are proposed. Finally there is the choice phase where the various options are evaluated - this may or may not be undertaken with formal economic analysis using the tools of the trade: Internal; Rate of Return (IRR), Net Present Value (NPV) and/or payback. It is this last phase that the neo-classical economic account pays most attention to, sometimes at the expense of seeing the larger picture (Cooremans, 2012).

2.1.3 Occupant behaviours

Although not depicted in the diagrams above, occupant behaviour is also addressed by the framework, but understood as an outcome which is less processual in character. Instead, occupant behaviour is influenced by a mix of habits, conscious and unconscious drivers such as perceived norms and comfort seeking. The contexts of occupant behaviours are particularly linked to the material structure of the building and its controls, formal and informal organisational procedures and the norms operating in an organisation.

2.2 Use of the framework

The model suggests a range of factors and drivers for energy behaviour both at organisational and occupant behaviour levels and suggests some relationships between these factors. By thinking in terms of the framework, we hope a deeper appreciation of the ways in which policy interventions will influence energy behaviours can be derived.

Section 3: Findings

Box 1: Key findings on business investment, barriers, costs and benefits

- It is not meaningful to think of the factors impacting on investment decisions as individual “barriers”, because in reality these factors will interact, and will be dependent on the context of the individual organisation nor should “barrier” removal be thought of as a precursor to “rational” behaviour.
- Businesses generally appear to require very high rates of return on energy efficiency projects before they will invest. Reticence to invest in energy efficiency despite reasonable rates of return is sometimes termed the efficiency “paradox”.
- Hidden costs (e.g. disruptions to production and information gathering) erode the apparent profitability of an efficiency investment and are considered by some to be the primary explanation for the “efficiency gap”.
- Other factors influencing organisations’ resistance to investment include perceptions of risk; unwillingness to replace equipment before end-of-life; energy efficiency not being a strategic issue and businesses not really being the profit-maximisers of economic theory.
- Energy management is usually the responsibility of operations staff who may be some distance from senior management in the organisational hierarchy. This contributes to energy use often becoming invisible to senior management. The closer that an energy manager is to the CEO in the corporate hierarchy the more likely that energy management activity will take place.
- Upfront costs are cited as a significant disincentive to invest in energy efficiency, particularly for smaller SMEs. Organisations also seem to be more sensitive to upfront cost than potential savings. Split incentives also create a “cycle of blame” resulting in underprovision of energy efficient office space.
- The size of the organisation has a direct influence on its capacity to notice, interpret and respond to energy efficiency opportunities: smaller organisations have much less capacity in this respect than larger ones.
- A business's assessment of the strategic character of an investment is important in whether it is taken forward. This directly impacts investment in efficiency as this is often categorised as a discretionary maintenance cost rather than investment in an asset which will strengthen profit. Therefore energy efficiency projects sometimes lose out to 'more important' investment opportunities.
- The salience of energy use and consequently energy efficiency is stronger in particular sectors and sub-sectors. The more energy intensive the sector, the more likely energy use is salient. Energy issues are also more salient in larger organisations and organisations that deal directly with the public. Making energy use salient via monitoring and reporting is one important route by which energy use can start to become more of a strategic issue, noticed by management.
- Payback is the most widely used metric for evaluating the financial benefit of efficiency savings, even in large companies, but places efficiency investment at a disadvantage compared with investment in productive capacity.
- There are many non-energy benefits from improving the energy efficiency of buildings including productivity, tenant satisfaction, comfort and enhanced corporate reputation. These are particularly important to making efficiency a strategic objective in non-energy intensive sectors.

3.1 Investment, “barriers”, costs and the context of decision-making

Research about business investment in energy efficiency is often framed in terms of the 'energy efficiency paradox' whereby there appear to be plentiful opportunities for firms to invest profitably in energy efficiency, and yet they do not do so. This is described as a “puzzle” and the research tends to look at reasons why firms do not invest, understanding these reasons as “barriers” to rational behaviour.

3.1.1 The problem with “barriers”

Before continuing the discussion of barriers and the so called efficiency paradox it should be noted that the very notion of a “barrier” is disputed by some energy theorists in the evidence base (e.g. Shove, 1998; Guy, 2006). This is because the language of barriers and their removal in order to close the “efficiency gap” assumes that organisations will behave rationally and in accordance with the classical economic model if individual barriers are removed. Instead, the conceptual framework and the evidence reviewed here suggest that behaviour is the outcome of “socio-technical” processes which have little resemblance to market actors attempting to maximise utility in a context of limited information and market imperfections. The term, “socio-technical” refers to a perspective which acknowledges the interrelatedness of *social* and *technical* aspects of an organisation or society as a whole. From this perspective the “barrier” concept should be rethought as a feature of the socio-technical landscape which influences the diffusion of an energy efficient technology or practice. These features are a “barrier” to the extent that they slow the speed, force an unwanted direction or encourage an undesirable form of technological diffusion. It is important to be clear that this perspective is not simply a semantic difference. The socio-technical view forces a more nuanced understanding of technological change which highlights, for example, that “barrier” removal will have multiple, perhaps unanticipated, effects because a complex system has been perturbed and that efforts to remove barriers should appreciate they are often sustained by a mix of technical, market based, cultural and social forces. Equally, it becomes clearer to see how barrier removal may be insufficient to catalyse the desired activity. However, rather than use a longer term, for convenience we retain the term, “barrier”. A typology of barriers, economic, organisational and behavioural (Sorrell et al., 2000) is shown in Appendix 5: Categories and types of barrier.

3.1.2 The energy efficiency paradox

Studies in our evidence base generally paint a similar picture of the so called efficiency paradox: profitable efficiency investment opportunities are often not taken and very high hurdle rates are usually imposed (e.g. paybacks of no more than 2 years with IRR’s of 50% or more (Decanio & Laitner, 2003)). Most studies find that conventional economic reasoning can explain some of this behaviour through recourse to notions such as bounded rationality and hidden costs; however where studies often differ is in their treatment of “barriers” including particularly “hidden costs” barriers. For some researchers, these can largely account for the non-investment behaviour because the efficiency investment is only apparently profitable. In fact when all costs, including the hidden ones, are taken into account profitability evaporates and consequently no action is taken. Consequently, in this view, firms do behave in an economically rational manner. For other researchers, the issue of hidden costs and profitability are red herrings as these are considered concepts that do not adequately describe the reality of organisational decision-making. They point to situations where hidden costs are minimal or non-existent and yet very high hurdle rates remain and investments in efficiency are not undertaken. We start with evidence on the existence of the paradox.

Anderson & Newell (2004) analysed a large dataset of medium-sized manufacturers which received energy audits as part of a US government programme. They found that the average payback period for projects which were taken up was 1-2 years, with the average implicit discount rate being 50%-100%; a very high hurdle rate, although consistent with that the investment criteria that these firms stated that they intended to use. It also seems the decision to invest will vary between different types of efficiency investment: Anderson & Newell, (2004) found that certain project types are more likely to be adopted than others, suggesting that there may be "many economic costs, benefits, risks, and other factors that simple financial measures do not capture". When the stated reasons for non-adoption are examined these authors conclude that non-adoption is largely the result of various "institutional factors" such as "bureaucratic restrictions".

This finding is supported by DeCanio (1998) who looked at the characteristics of lighting investments made by firms as part of "Green Lights", a US efficient lighting retrofit program. In theory, the risk barrier and associated hidden costs were not an issue as the lighting investments in the program were low risk, using well-known reliable technologies. The study found that required paybacks and IRRs differed between firms and were often very different to the risk-adjusted discount rate that would constitute the appropriate 'hurdle rate' for investments under conventional investment analysis. DeCanio concludes that there is "a large potential for profitable energy-saving investments that is not being realised because of impediments that are internal to private and public-sector organizations". These "internal impediments" are investigated in a second paper by DeCanio (DeCanio & Watkins, 1998) which examined how firm characteristics influenced participation in the Green Lights scheme. They found a number of firm characteristics were influential. Larger companies were more likely to join the programme, as were better performing companies. In terms of sector, utilities were more likely to join Green Lights and finance, insurance, real estate, and service companies were less likely to join.

In a third paper by DeCanio (DeCanio & Laitner, 2003) the authors identify three principle reasons why the profit-maximising model of the firm seems untenable: a) principal-agent problems (differences in objectives and skills between different individuals within the firm); b) problems of management control (it is difficult to manage the modern, complex organisation in a profit-maximising way); and c) bounded rationality (resource constraints will always prevent optimal information search and processing). The conclusion of the paper is that models assuming optimal economic behaviour by firms should be questioned and even abandoned in some cases. Instead, models embracing the "tangible realities of industrial behaviour" should be constructed. Once assumptions about optimal behaviours are no longer centre stage a range of non-price and information based policy is suggested. For example "measures that increase the salience of energy efficiency, voluntary pollution-prevention programs, labelling, smart standards, government demonstrations, information-gathering initiatives, and the facilitation of inter-firm and interpersonal networking are examples of the extended set of possibilities". We now further examine the evidence for various types of barriers before looking at evidence that extends the barriers account.

3.1.3 Hidden costs and overlooked issues of investment in efficiency

Examples of "hidden costs" include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analysing and applying information. Anderson & Newell (2004) report the following reasons for not making investments: opportunity costs (e.g. "lack staff for analysis / implementation") and various project risks (e.g. "risk or inconvenience to personnel") or "suspected risk of problem with equipment". It is argued that by failing to account for these additional costs of investment, studies may overestimate energy efficiency potential

(Sorrell, Mallett, & Nye, 2011). Sorrell et al. conclude that hidden costs are “are real, significant and form the primary explanation for the “efficiency paradox”.

Decanio (1998) finds that “transaction” costs (i.e. the costs of gathering and making sense of the information to inform energy efficiency investments) can explain a little of the variation in observed rates of return required for lighting investments. However, as discussed, the lighting investments analysed had no/low risk the technologies were well know, so there was no information barrier and yet a very wide variation in the required payback period was found. On this basis, DeCanio concludes that 'hidden costs' are not a sufficient explanation for variations in the required payback period implicit in organisations decision-making. Instead the variation amongst otherwise similar organisations is proposed to be an outcome of “organisational differences”. For example, DeCanio finds that public sector organisations require quicker paybacks than the private sector and larger organisations are marginally more prepared to accept longer paybacks. Cooremans (2007) takes up this point exploring the wide diversity in investment behaviour observed between firms and further arguing that some energy efficiency investments have such high rates of return that any hidden costs would be more than accounted for – yet these measures are still not undertaken. In addition, she argues, some efficiency measures have zero or insignificant cost and likewise are still not undertaken. On balance the evidence suggests that hidden costs do account for some but not all of the observed differences in investment behaviour and that an account of organisational behaviour would be improved by examining sectoral and organisational differences.

3.1.4 Energy management responsibility and organisational structure

A number of papers in the evidence base highlight potential issues arising because of the allocation of energy management responsibilities to management grades that are some distance in the hierarchy from the senior, strategy setting, grades. Prindle & Fontaine (2009) surveyed accountability for energy performance amongst 48 very large US companies which were acknowledged to be industry leaders for their energy management practices. In only 18 of these companies senior managers had energy responsibilities compared to facility level managers having this responsibility in 43 of the 48 companies. In 29 of the companies middle management grades **Error! Reference source not found.**had energy management responsibilities suggesting this role tends to be skewed towards the facilities / operational levels. In these circumstances we should expect to find what is termed, “information asymmetry” and consequently principal-agent issues: energy consumption will be less salient to senior managers because they are not responsible for it yet these individuals will make the strategic decisions that influence its consumption. Cooremans’ (2012) work clearly suggests that both energy use and even wider issues such as climate change and carbon management are often perceived as peripheral areas of concern by senior management. This is further evidenced in a study of 1500 UK business managers which finds scepticism about environmental issues at work increases with seniority, where 54% of directors were identified as “cynics” about carbon management and their ability to reduce their carbon impact (Wehrmeyer, Leitner, & Woodman, 2009). Martin et al. (2012) find that the closer the energy manager is to the CEO in the hierarchy of the organisation the more likely the company is to implement climate change and energy management systems. Given that energy managers are often some distance away from the CEO in the hierarchy, Prindle & Fontaine (2009) report a number of mechanisms that have been used to raise the salience of energy efficiency within organisations. These include taking into account the non-energy benefits of efficiency and bundling multiple energy efficiency projects into one larger budget item, “partly to overcome the difficulty of gaining corporate level attention for relatively small expenditures”.

The relationship between status of the officer with energy management responsibilities and the likelihood of energy management taking place has a limit: Martin et al. (2012) find that when the CEOs themselves takes on the role of climate change / energy manager then performance on energy issues can drop away. This is presumably because CEOs may not have the time to adequately address the management requirement. A lack of time to address energy issues or implement strategy was commonly reported amongst smaller organisations (where the CEO is likely to also take on multiple roles, including steering energy management (Vernon et al., 2003, Trianni & Cagno, 2012). A specific instance of a "principal–agent" problem widely recognised as resulting in a brake on energy efficient investment is the landlord-tenant relationship and the associated split incentives. Our evidence base contains a number of papers which have studied this.

3.1.5 Split incentives

In a qualitative study of the commercial office sector in the UK, Pett & Ramsay (2003) have identified the main agents for change in improving energy efficiency. These are identified as property managers, investors and occupiers. Property managers have the key linking role between occupier and investor, and influence the market through property evaluation as well as through contract management. Investors and occupiers can create demand, but this is mainly stimulated by their social and environmental stance, as most lack understanding of the opportunities for, and benefits of, energy efficient property so that "conservatism and vested interests across the property professions inhibit provision of the kinds of workplaces occupiers actually want" Pett & Ramsay (2003). This is reflected in a cycle of blame with each actor in the supply chain blaming another for the under-provision of energy efficient office space. Pellegrini-Masini & Leishman, (2011) find in their study of stakeholders in the UK commercial building sector that although there seems little interest at present in the energy efficiency of the office buildings there was a sense amongst their respondents that the situation was "rapidly" changing with corporate reputation being the principle driver.

A split incentive is also removed when suppliers of energy efficient buildings can charge more rent for the space. In the US, Eichholtz, Kok, & Quigley (2010) have found this effect and also find that "effective" rent is increased (i.e. rent x occupancy) - energy efficient office space is easier to let thereby increasing the actual rental revenue generated by the building. Pett & Ramsay (2003) identify the following drivers to the provision of more efficient office space: "corporate social responsibility or sustainable development policies or other ethical core values; UK Building Regulations; environmental reporting; benchmarking".

3.1.6 Upfront costs and access to capital

Sorrell et al. (2011) find that firms often state that access to capital and a reticence to borrow are among the most important barriers to energy efficiency investment. Other studies in the evidence base concur. For example, in a study of Swedish manufacturing SMEs, Thollander et al. (2007) report that a lack of access to capital was among the highest barriers to investment in energy efficiency, along with a lack of time and "other priorities for capital investments". However De Groot, Verhoef, & Nijkamp (2001), find that access to capital for efficiency investment is considered a relatively small part of the problem - if an investment is considered profitable then generally the money will be found. In contrast, their findings suggest that the most important barriers to energy efficiency investment are the existence of more attractive investment alternatives and the reticence to decommission equipment before it has come to the end of its useful life.

Certainly, perceptions of the risks attached to borrowing capital, despite potentially good returns seem to be a disincentive to investment in energy efficiency. However, this may not always be related to the idiosyncrasies of energy efficiency as an investment: the mere act of raising capital either through loans or equity finance can change the way that investors and other stakeholders value a company with knock on effects on the share price and internal management processes (Sorrell et al., 2011). Nonetheless, Anderson & Newell (2004) find that managers are more "sensitive" to upfront cost than to the possible savings: they find that upfront costs have more than double the effect of increases in energy prices in explaining the decision to adopt an energy efficiency measure. They conclude that "these results imply that a policy of subsidising energy-conserving technologies may be more effective in spurring the adoption of these technologies than a policy of taxing resource use". Similarly Harris et al. (2000), in a study of the implementation rates of measures identified in energy audits in Australia, find that the higher the cost of the recommendation the lower its implementation rate.

3.1.7 Noticing and using information

A number of the studies in our evidence base discuss the concept of "bounded rationality" as a major barrier to optimising investments in energy efficiency (e.g. Decanio et al., 2003)). Finite time, limited information and the cognitive capability of decision makers leads to sub-optimal decision-making for satisfactory rather than optimal investment decisions. De Groot, Verhoef & Nijkamp (2001) found that lack of information is a "principal source of market failures that can account for sub-optimal investment behaviour" and find size and sectoral differences in information use: large firms which have high levels of investment and facing strong competition are more likely to have knowledge on new technologies, while smaller firms, those that face limited competition, and those that invest little are less likely to have the required knowledge. Other studies in the evidence base support the view that smaller firms have less time and less technical skill to assess information. This has been found across all sectors. For example, Bohdanowicz (2005) found that knowledge of energy reduction schemes for the hotel sector were low, but especially so for smaller, unaffiliated (non-chain) establishments where the company did not have the resources to actively seek out information. Lack of technical skill and time to judge the merits of energy efficiency opportunities has also been found in smaller manufacturing companies (Trianni & Cagno, 2012).

Certainly, the smaller the organisation the less likely it is to have a dedicated energy or environmental manager (Martin et al., 2012). Consequently smaller organisations will tend to rely more on rules of thumb and folk wisdom although some studies have found that even large organisations use unreliable methods of discriminating investment choices such as using simple payback calculations (Anderson & Newell, 2004). Trianni & Cagno (2012) also find sub-sectoral differences in judging barriers to energy efficiency demonstrating that regardless of energy intensity (all the sub-sectors studied were manufacturers), sub-sectors can behave quite differently as a result of their unique history. They found that the textiles industry behaved quite differently to the wood, metals, plastics and metals industries in Italy, perceiving lower barriers to energy efficiency than the others. The authors attribute this to the individual circumstances of the textile industry in Italy at the time of the study which had recently endured a torrid period with a dramatically reduced number of companies operating, so that the remaining ones, were, by definition, better managed and more energy efficient than their counterparts. In sum, this evidence suggests that energy efficiency will be particularly attended to where there are resources for doing so and where it is considered to have strategic value. These assessments will be influenced by sectoral and sub-sector characteristics and the size of the organisation.

3.1.8 The importance of the strategic value of energy efficiency

Many studies indicate that the desire to save money is a prime motive for investment in energy efficiency. Databuild's report to DECC, *Unconstrained sector research*, based on interviews with 400 SMEs across all sectors and small public sector organisations, asks what organisations' motivations were for taking energy efficient actions. Depending on the measure (lighting, heating, insulation) between 60 and 80% indicate that cost saving is a motivation. Databuild conclude that across all business sectors and sizes, cost savings are the principal motivation to action. They also suggest that reducing environmental impact is important to some sites whilst for insulation activity, comfort is also a powerful motivator.

However the cost saving motivation is more nuanced than might be expected. When motivations across industrial and commercial sectors are compared, the authors find that industrial sites are significantly *less likely* than commercial sites to cite cost savings as a principal motivation to measures. Reducing environmental impact was generally more important and potentially tied in with company policies or compliance targets (note that the unconstrained sector is not regulated by the European Union (EU) Emissions Trading System (ETS) or The Carbon Reduction Commitment Energy Efficiency Scheme (CRCEES)) (DECC, 2010). This finding is not what might be expected given that the industrial sector is more energy intensive than the commercial sector and consequently energy costs will generally form a more significant element of an industrial organisation's cost base. This evidence suggests that there may be other features of efficiency investment opportunities which play a part in driving investment decisions including their wider strategic value.

In this respect two papers by Cooremans argue that the strategic nature of investments is more important than their profitability. She finds that although financial analysis tools such as NPV are used to determine the return on investments and communicate details of a project within a firm, this is done when the project already has support and whether or not projects get support depends on whether they are considered to be of strategic importance for the company (Cooremans, 2011). Cooremans defines 'strategic' as something which improves the competitive advantage of the company. However, it appears that energy efficiency is very often not considered as having a strategic purpose. Sorrell et al. (2011) report that where energy efficiency investments are categorised they tend to be treated as discretionary maintenance projects rather than either: a) an essential maintenance project (such as replacement of a damaged pump); or b) a strategic business development such as investment in new manufacturing plant. In their study of Australian firms adopting efficiency measures recommended as part of an energy audit, Harris et al. (2000) found that one of the most important reasons for measures not being implemented was that energy efficiency was overlooked by management as it was not considered part of the "core business". A project categorised as fulfilling a discretionary maintenance function is, by definition, not fulfilling a core or strategically important role. For Cooremans, (2011) this is critical as it is the level of strategic value attributed to a project rather than its raw profitability which is the principal driver of investment decision-making. This perspective leads to four further insights:

1. Judgement of what constitutes a "strategic" investment will be determined by a mix of "objective" and "subjective" factors. This judgement will consequently be subject to processes grouped under the bounded rationality label and, in addition, factors relating to the individual managers beliefs and values and the collective values and culture of the organisation.

2. The degree to which energy efficiency is considered strategic and therefore something worth noticing and acting on will be a function of its salience to the organisation which in turn is partly determined by the sector in which the organisation operates. For example, utility companies have been found to be more disposed to leasing energy efficient offices than finance companies (Eichholtz et al., 2010). Utility companies were also found to be more likely to participate in a US government lighting efficiency scheme (DeCanio & Watkins, 1998). Salience of energy use is also linked to the level of public scrutiny that a sector has. Public scrutiny is more evident in sectors which deal directly with the public such as the retail sector - this sector has been found to be more sensitive to energy efficiency issues than organisations leasing commercial office space (Janda et al., 2002). Equally the energy intensity of the organisation, measured as the percentage of the organisation's revenue that is spent on energy use, will influence the salience of energy efficiency in decision-making (e.g. De Groot et al., 2001).

3. Eichholtz et al. (2010) further find that the same kinds of behaviour e.g. the decision to lease energy efficient offices can be arrived at via distinctive types of motivation. The study uses a model of motivational "types" developed by Bansal & Roth (2000) which proposes that there are 3 main types of motivation for ecological resposnsiveness described as "competitive", "legitimation" and "ecological responsibility". These motivational types are in turn linked in predictable ways to the commercial culture prevailing in industrial sectors. So an oil company which is disposed by its sector's culture to seek legitimation (approval by peers and government) will lease efficient office space whereas a retailer, more motivated by a competitive basis for its ecological activity will also lease efficient office space where it perceives a competitive advantage in doing so.

4. The more that energy efficiency and energy management are the responsibility of senior managers the more likely it is that energy consumption will be considered an issue of strategic importance. However, in larger organisations operations managers who are closest to the issues of managing the organisation in an energy efficient manner are usually some distance from the senior management setting the overall strategic direction of the organisation – a "principal-agent" problem.

A table setting out how size and sector influence organisational capacity to respond to energy efficiency opportunities is shown in Appendix 6.

3.1.9 The categorisation of investment influences how it is assessed

Almost all of the companies surveyed by Cooremans (2011) said that they classify investments according to a pre-set typology, which then influences the analysis that the project undergoes, including the type of financial analysis, risk analysis, environmental impact, etc. For half of companies the investment category also determines the stages that a project must follow. Therefore, how a project is classified initially greatly influences the decision-making process. Our evidence suggests this is very important because the contingent aspect of energy efficiency "savings", whereby "savings" are only generated if they would not have happened anyway in a counterfactual scenario (i.e. a theoretical alternative scenario) gives energy savings a certain intangibility and lies at the heart of the way efficiency investments are classified differently to other investment types, or not at all. Cooremans (2011) reports that 50% of Swiss firms examined in her small survey had "no category" for energy efficiency investment.

Organisations also devote relatively more resource to avoiding losses than making gains: "foregone gains are perceived as less painful than losses" (Sorrell et al., 2011). As

efficiency savings are a form of gain (compared to the counterfactual alternative) this means that companies, given the choice, are biased away from accounting for the true cost of failing to make efficiency investments. This is also an argument for reframing energy "savings" not as gains but as "avoided losses" (see Goldstein, Martin, & Cialdini, 2007).

This is important because organisations, often with severe resource and time constraints and sometimes a lack of sufficiently qualified staff, rely on various heuristics to make decisions (see section on bounded rationality). These heuristics include classifications and categorisations, procedures and rules of thumb. Without a classification or appropriate procedures efficiency investments may be overlooked. Sorrell et al. (2011) report that where energy efficiency investments are categorised they tend to be treated as discretionary maintenance projects. This kind of categorisation will directly impact how likely a project is to attract funding for two reasons. Firstly, a project categorised as discretionary maintenance will appear on the balance sheet as a cost directly detracting from reported profit. In contrast, an investment in productive capacity will appear as an "asset", and will therefore not have an impact on reported profit. In theory it should be easier to secure investment for a project which will not impact the bottom line – especially where funding is sought internally. There may be a role for government here is helping organisations make energy efficiency investment comparisons on a level playing field.

3.1.10 Accounting for savings: the language of payback

Harris et al. (2000) find that 80% of firms in their study used "payback" as their primary method of evaluation of efficiency investments whilst just over 50% used "rate of return" and 30% used "positive NPV". This is presumably because payback is an easier metric to calculate, use and communicate than more sophisticated and accurate measures of the value of an investment such as NPV and IRR. Widespread use of payback as a principle method of evaluation has even been found in organisations with multi-million pound energy bills (Prindle & Fontaine, 2009). However use of "payback" rather than IRR or NPV establishes a completely different expectation of the investment. An investment evaluated by payback is only judged successful if it pays for itself in a reasonably short period of time. Its role in reducing costs and therefore increasing profits is not explicit using the language of payback. In contrast, the authors of this study contend, the language of NPV and IRR is immediately suggestive of the additional value the investment will bring to the organisation. Investments in productive capacity will invariably use NPV and IRR metrics rather than payback. This suggests that the case for investments in energy efficiency could be made more compelling through a shift in the metric used for their evaluation – from payback to NPV.

3.1.11 Benefits and pitfalls to organisations who have taken action

Most papers in the evidence base only focus on the energy and cost savings of energy efficiency. However there were some papers which looked at other benefits. Evidently non-energy benefits will be particularly important in catalysing energy efficiency behaviours in non-energy intensive sectors where cost savings from efficiency measures are inconsequential. Bicknell & Skumatz (2004) look at the importance of non-energy benefits to programme participants of four different utility programmes, drawing on 350 interviews with architects, engineers, owners and developers. They find that energy bill savings were not necessarily seen as the most important benefit by programme participants. The non-energy benefits identified by interviewees are: productivity; tenant satisfaction; comfort; appearance; quality of light; ease of selling or leasing; lower maintenance; safety; and better equipment performance. Similarly, Jennings & Skumatz (2006) evaluate the non-energy benefits of commissioning building services. Non-energy benefits experienced by

interviewees include improved comfort for building occupants, improvement in indoor air quality, improvement in light quality, improved productivity, reduced tenant complaints, correction of operational deficiencies, and lengthening of equipment lifetime. They find that the value of the non-energy benefits is sufficient to justify the cost of the commissioning work, without taking into account the cost savings from energy reductions.

Eichholtz et al. (2010) compared commercial buildings that have received an environmental label with comparable non-labelled buildings and found that a green label affects market rents; an increase of 3% per square foot, and a 7% increase in effective rent (rent x time let). A green label also increased the selling price by up to 16%. Therefore there is a benefit in terms of additional income for developers and owners of certified buildings.

Mori & Welch's study (2008) of ISO 14001 certification in Japan found that certification did not provide any recognisable environmental benefits, but it did result in improved environmental awareness of employees and positive stakeholder perception of the company. While there were few direct financial benefits of certification, those that had pursued certification felt that the costs were outweighed by improved access to international business opportunities. Prindle & Fontaine (2009) found that 29 (60%) of those companies explicitly considered co-benefits when examining potential energy efficiency investments. "Enhanced corporation reputation was the mostly frequently selected choice, followed by improved competitive positioning. Employee morale and productivity were also selected by many respondents". Cox et al. (2012) found, “a clear view from employers that cutting carbon emissions has significant knock-on benefits, including building organisational reputation, being seen as a pro-environmental brand, improving sales/customer retention, recruiting and retaining high quality staff, reducing operating costs and meeting regulatory requirements". The evidence suggests that there are clear non-energy benefits to energy efficiency. They may serve as additional incentives to adoption of behaviours and are particularly important for non-energy intensive sectors where there is less direct financial incentive to invest in energy efficiency.

We have found very little in our evidence base about pitfalls or unintended consequences. Energy efficient technologies and buildings can work less well than anticipated, and users may not get the best performance from efficient systems (e.g. Brown & Cole, 2009). These issues are well-known and discussed in detail in the more technically-oriented energy efficiency literature.

3.2 Energy efficiency strategies

Box 2: Key findings on strategies

- A wide variety of energy efficiency strategies were identified from 'do nothing' to 'sustained energy management'.
- Motivations to adopt energy strategy vary between sectors and organisations, and within organisations. Different motivations can result in differently designed strategies. For example, larger organisations are more likely to have a formal energy strategy because energy management is a natural extension of corporate social responsibility: larger organisations are more concerned with maintenance of their public image than smaller ones.
- Some types of strategy will appeal to particular sectors more than others. For example, the adoption of a voluntary energy or environmental management system such as 14001 will particularly appeal to sectors motivated by the need for legitimation and legal compliance. Organisations which deal directly with the public such as the retail sector are more likely to have a strategy than those which do not.
- Strategy is also linked to organisational structure. Larger organisations are more hierarchical and complex and therefore are more likely to have energy or environmental management systems as part of a requirement for formal management procedures throughout the organisation. Larger organisations are better able to fund this cost. Where staff with specific energy management responsibilities are in post, organisations are much more likely to have energy management activity. The closer these staff are to the CEO in the hierarchy, the more likely that the organisation actively manages its energy use.
- There are no studies which identify the relative importance of a technical versus behavioural approach in a single setting. The most successful strategies to deliver lasting change in workplace behaviours use technology and infrastructure upgrades to facilitate change in working practices. Best results were delivered when 'material' inputs were considered alongside individual and social factors.
- Interventions which influence occupant behaviour can deliver very significant energy savings in some settings. For example, our evidence base includes studies showing between 6 and 18% savings in university office buildings.
- There appears to be significant potential to use insights from social psychology in the design of occupant behaviour interventions

3.2.1 The variety of strategy

Given the huge diversity of appropriate energy management response depending on the size of the organisation, its sector and motivation, we should expect to find a correspondingly wide diversity of energy strategy. Russell (2005) examined the energy management practices of 10 very large companies headquartered in the United States and proposes 5 main types of energy "strategy". These types are summarised in Table 1.

Do nothing	Ignore energy improvement. Just pay the bill on time. Operations are business-as-usual or "that's the way we've always done it." The result is essentially "crisis management," in that energy solutions are induced by fire-drill emergencies and undertaken without proper consideration of the true costs and long-term impacts.
Price shopping	Switch fuels, shop for lowest fuel prices. No effort to upgrade or improve equipment. No effort to add energy-smart behaviour to daily Operations & Maintenance procedures.
Occasional Operations & Maintenance projects	Make a one-time effort to tune up current equipment, fix leaks, clean heat exchangers etc. Unable/unwilling to make capital investments. Revert to business-as-usual Operations & Maintenance behaviour after one-time projects are completed.
Capital Projects	Acquire big-ticket assets that bring strategic cost savings. But beyond that, day-to-day Operations & Maintenance procedures and behaviour are business as- usual.
Sustained Energy Management	Merge energy management with day-to-day Operations & Maintenance discipline. Diagnose improvement opportunities, and pursue these in stages. Procedures and performance metrics drive improvement cycles over time.

Table 1: Types of energy management strategy (from Russell, 2009)

All of these energy management "strategies" have their pros and cons – even sustained energy management has a downside in that it requires in-house talent, significant resource, cooperation and a capable "energy champion" to deliver it. Only "sustained energy management" would entail a mix of behavioural and project based strategy and is thought to be the optimal approach..: In a review of corporate energy efficiency strategies Prindle & Fontaine (2009) conclude that while "efficiency has often been a behind-the-scenes engineering function driven by technology investment, today's most successful efforts draw as much on human capital and culture change to drive results as they do engineering expertise and technology investment". Indeed the studies in the evidence base of voluntary agreements or long term agreements with various industrial sectors all describe a requirement, as part of the agreement, to implement a mix of "behavioural" and capital project based strategy. Most also require an energy management system to bind the various elements of the strategy together (Thollander, Danestig & Rohdin 2007; Stenqvist & Nilsson 2012). Our two studies of energy strategy in the UK higher education sector also report that institutions use a mix of behavioural and project based interventions (Dahle & Neumayer, 2001; Altan, 2010) – but not necessarily also using a formal energy management system to back them up.

3.2.2 Motivations for adoption of energy strategy

The conceptual framework suggests that motivations for the adoption of energy strategy will vary by sector, organisation size, organisation culture and the individual inclinations of staff. Papers by Dinica et al. (2007), Mori & Welch (2008), Khanna et al. (2007) and Janda et al. (2002), amongst others, explore motivations for adoption of energy strategy across different sectors and organisation sizes. Some clear relationships emerge from this work linking organisational drivers and the decision to adopt efficiency measures: larger organisations with a greater public exposure will tend to be more attracted to adoption of energy strategy for PR reasons. Energy and environmental strategy which is built on adoption of certified energy or environmental management systems is particularly attractive to larger organisations, possibly operating internationally, because it provides reassurance to potential trading partners. In addition organisations are more likely to adopt

an energy and environmental strategy when it aligns with corporate financial objectives such as a drive to create resource use efficiencies.

Other work in the evidence base shows how the values and attitudes of individual managers may be the key motivation to adopt a strategy. For example, Cordano et al. (2010), in a study of environmental management programs in the US wine industry, find that the perceptions of facilities managers around the norms of environmental stewardship in *other* wine companies were found to have a significant impact on a manager's decision to adopt an Environmental Management Strategy. This is pertinent especially for SMEs who rely heavily on informal networks for sector wide change. Sectors which have high "sector cohesion" - see Bansal & Roth (2000) might be expected to have stronger, more influential norms influencing decision-making.

Motivations to adopt an energy strategy will also vary within organisations. Jennings & Skumatz (2006) find that the various "non-energy benefits" from commissioning the energy systems of public buildings (e.g. improved comfort and air quality, improvements in reliability of plant, reduction in occupant complaints) are valued differently between different groups within the public sector organisations they studied. Facilities managers, for example, showed higher levels of interest in occupant related benefits such as indoor air quality whereas, not surprisingly, maintenance staff placed especially high value on correcting operational deficiencies. It seems different groups within an organisation will value energy efficiency strategy in different ways depending on their role within the organisation.

3.2.3 Strategy types and sector

Our evidence suggests that some types of strategy are more appropriate in some sectors than others and also that in some sectors there is little evidence of any widespread energy management strategy. For example, the adoption of a formal energy management system may particularly appeal to organisations in sectors of the economy that are primarily motivated by the need for legitimation and legal compliance such as oil companies, whereas elements of strategy which focus on innovating energy efficient processes may be particularly attractive to organisations with a more competitive motivation for energy efficiency such as the retail sector.

Pellegrini-Masini & Leishman (2011) find a lack of energy strategy in the commercial sector (office based organisations). They suppose this is because of the negligible cost of energy in an office based organisation's overall cost base and also because of the split incentives found when users of buildings do not also own them. A study by Janda et al. (2002) studied the responses of large and small office based and retail organisations to California's energy "crisis" of 2000 and find clear and explicable cross sectoral differences between the retail and office sector, but also a great deal of diversity within the sectors. Much of this is the result of the size of the organisation and whether it was part of a group or operated independently.

In general, the retail sector was much more concerned about rising costs and public opinion than the mix of companies occupying commercial offices. This is evidently because retailing is more energy intensive than office work and also because the retail sector directly interacts with the public, its customers, so that brand reputation is a key consideration. In addition, leasing arrangements and split incentives in the office sector often meant that price signals were not clearly received by either office occupants or building owners and their agents. Building owners could pass on energy price increases to their tenants and therefore had little incentive to change the efficiency of the building.

Amongst the retailers, where public image is critical, the authors found two quite different responses. In some cases *being seen* to save energy was more important than the actual energy savings themselves (because of a perception that the public were demanding that everyone play their part in tackling the crisis) – hence signing up to the relevant government scheme would be an appropriate course of action (see also Khanna (2007) on this point). In other cases the retailer was concerned that dimming lights, raising thermostat levels etc. would harm the shopping experience and so was resistant, but nonetheless did introduce energy saving measures because of cost concerns.

The structure of organisations often found in the retail sector also influenced the kinds of energy strategy that resulted. Amongst the stores that were part of a chain, energy management was often found to be delivered centrally and was backed with building management systems which allowed central operators to monitor energy consumption in respective parts of the company. Larger organisations like this also tended to have strategic mandates that were handed down from on high. In this respect the retailers had more capacity to react to the crisis and to develop appropriate strategic responses.

3.2.4 Strategy and organisational structure

A number of studies in the evidence base either explicitly or implicitly address the relationship between type of strategy and organisational structure. Structure is influenced by a range of factors including size and sector. Size, in particular, will determine the complexity of the internal structure and the types of roles that staff undertake. This is turn influences the capacity of organisations to address energy issues. Size will also influence the organisational culture and consequently the propensity to "notice" energy efficiency as an issue. Larger organisations generally have a greater concern to maintain their public image and need to control their operations and operators through procedures and policy and the adoption of strategy. This can lead to principal-agent problems.

Having a dedicated energy or environmental manager in post is found to be significantly and strongly associated with the likelihood of having energy/environmental management policy and systems (strategy). Climate friendly management practices are in turn strongly associated with higher productivity and better energy efficiency at the establishment level (Martin et al., 2012). The Martin et al. (2012) study also finds that the further in the hierarchy the environmental manager is from the CEO the less likely it is that environmental management takes place. Therefore, for the purposes of promoting energy efficiency the evidence suggests that it is important that a) an energy manager is in post and b) that this manager is in a fairly senior position. A number of studies in our evidence base suggest that larger companies are more likely to have an energy manager and more of the internal skills necessary to formulate and implement energy strategy (e.g. Trianni & Cagno, 2012).

However, studies in our evidence base suggest that in fact the appointment of energy managers is less frequent than might be expected. Dahle and Neumayer (2001) report that only 4 of the 16 universities studied in their sample had an energy manager in post. Note this study was conducted in 2001 – things may have changed in the meantime. Perhaps even more surprising is Prindle and Fontaine (2009) finding, from a survey of 48 very large US corporations, that only 29 of the 48 employ a full time energy manager. Given that all of the organisations in their sample had multi-million dollar energy bills, the absence of a dedicated energy manager in over a third of them is surprising and again serves to support Cooremans (2011) arguments around the lack of strategic value attached to energy use or energy efficiency by senior management.

In smaller non-industrial organisations the de facto energy manager will be the caretaker, or facilities management staff. In this regard Aune, Berker, & Bye (2009) propose that this group's role is often overlooked in development of energy management strategy and policy. Building operators are key intermediaries between the users of the building and the control of the building's energy services and are also the effective architects of an organisations' energy management strategy. Therefore it is important to investigate the various styles of this interaction. The study examined forms of energy management and found four types of building operator: 1) the "teacher"; 2) the "housekeeper"; 3) the "manager"; and 4) the "juggler". They suppose that a successful energy management strategy needs all four roles: the teacher to ensure liaison with building users; the housekeeper who has intimate knowledge of the building's energy systems, the high status manager who has the confidence and ability to act decisively and the juggler, capable of managing multiple contracts and relationships. They conclude that these various forms of "hands-on" energy management should be reconsidered as an integral part of professional building operation because building operators are uniquely placed to see both users and how energy is used and therefore to improve the interplay between systems and occupants - unlike contractors parachuted in to fix particular problems. A table setting out how size and sector influence organisational capacity to respond to energy efficiency opportunities is shown in Appendix 6.

3.2.5 Occupant behaviour strategies versus strategies aimed at technical upgrades

Many studies in the evidence base report the effects of strategies which are primarily technical in character, behavioural or a combination of both. Although we have studies which look at the impacts of a behavioural measure (such as energy champions) in isolation we have no studies which expressly seek to identify the relative importance of each respective approach (i.e. technical or behavioural) in a single specific setting. But several studies highlight the importance of adopting strategy which works with both behavioural processes and projects to transform the hardware. For example, Aune et al.'s study of building operator "types" suggests that the most effective operator will be an integration of all 4 types, particularly the "teacher" who works with building users and the "housekeeper" who is primarily focussed on transforming the technology. Most energy management strategies do seem to incorporate an element of staff engagement. Prindle & Fontaine (2009) find that ninety percent of their sample have employee engagement as a formal element of their corporate energy management strategy. What is perhaps surprising is that staff engagement was not a feature of 100% of those surveyed. The necessity for energy management to explicitly include building users is also the conclusion of a study of workplace initiatives for "low carbon behaviours" by Cox et al. (2012) for the Scottish government. This study examined the range of workplace interventions via a literature review, 27 interviews with intermediary organisations and 10 employer case studies. Their key findings are as follows:

- Although many initiatives focus on the individual, there is a need to achieve a balance between the individual, social and material factors affecting behaviour change;
- The most important success factors are building shared values through employee involvement and senior management commitment;
- The most successful projects joined up different kinds of low-carbon behaviours (energy, waste, transport etc); and
- Specific circumstances can offer unique opportunities for change (e.g. relocation; merger; major investment; change of leadership).

Cox et al., 2012 find that the most successful strategies used technology and infrastructure upgrades to facilitate change in day-to-day working practices; to provide feedback on the impacts of newly-adopted behaviours (e.g. energy monitors); and to provide a visual symbol of the organisation's commitment to improved environmental performance. The same study concluded that "material" inputs should be considered alongside individual and social factors as lasting behaviour change was best achieved when all three elements reinforced one another.

3.2.6 Interventions to occupant behaviour

Some studies in the evidence base do report the effects of behavioural interventions alone. These can be considerable. For example, Altan (2010) analyses the responses of 23 university energy managers to a questionnaire about their energy efficiency interventions. Although technical measures such as updating plant, controls, fabric upgrades and energy management systems dominated, there were also non-technical initiatives that achieved significant energy savings at a modest cost. For example, training energy champions was implemented by a third of respondents, all of which reported that it cost less than £1,000, with two thirds reporting it a success achieving energy savings of up to 18%.

Cox et al.'s (2012) case study evidence finds an array of other factors that were also helpful in implementing change including creating flexibility in schedules and routines to enable staff to contribute, using key "influencers" to lead behaviour change by example, providing regular feedback on the impact of schemes and making the most of technology as a visual symbol of change. These mechanisms operate by making energy use visible (feedback) and by presenting its efficient use as socially desirable (using "key influencers") and by using the visible investment in new technology as emblematic of cultural change within the organisation. This is in alignment with the conceptual framework which suggests that the way in which energy use is framed and presented in both decision-making and occupant behaviour contexts will be highly influential. This is because behavioural choices occur in a social context and consequently have social "baggage" attached to them, most particularly norms - our perceptions of how "significant" others behave (i.e. the groups of people whose behaviour we care about). These effects are evidenced in a study of the use of feedback and peer education (energy champions) in academic office buildings. These interventions resulted in a 7% and 4% reduction in energy use, respectively. Buildings that received the control group intervention - energy saving information alone - actually increased energy use by 4% (Carrico & Riemer (2011). This suggests that where information is provided by peers, for example, employees within the organisation who are assumed to share similar values (such as energy champions), then that information is more likely to be acted upon.

In addition to social processes, there are fundamental features of human psychology that will shape our responses to stimuli and information. For example, we have explored the impacts of loss aversion in the barriers section of this REA. Other examples of psychological effects influencing energy consumption choices and habits are a sense of personal efficacy and the psychological drive to reduce "cognitive dissonance" (the sense of discomfort experienced when one holds two conflicting ideas) both of which have been much explored in the domestic energy efficiency literature but very little in the non-domestic literature. Personal efficacy, the sense of individual effectiveness or ability to influence a situation, is a key construct of the Theory of Planned Behaviour which proposes that people are more likely to behave in a certain way if they know that it is possible for them to do so. One study in the evidence base that does suggest a role for personal efficacy in determining sustainability behaviours, including energy savings, in

workplace settings is provided by Plank (2011) who studies the attitudes of 20 staff within a London university building. He finds that positive environmental behaviours are more likely to occur when:

- The individual will perceive it as something that is distinctive about themselves;
- The cause for the positive environmental behaviour will be directly related to the individual rather than being attributed to impersonal or situational factors; and
- It is important that individuals believe that they have some control over events.

Elsewhere, Osbaldiston & Schott (2012) conducted a meta-analysis of the literature from social psychology exploring impacts of experimental interventions aiming to encourage greater sustainability. One of the behaviour types considered is “public” energy conservation which we have taken to be broadly applicable to workplace settings. Their results indicate that interventions termed "making it easy” and "justifications" are more effective than others in motivating public energy conservation. “Making it easy” uses mechanisms which increase the sense that the individual is able to control the behaviour in question and has some power over it (i.e. their personal efficacy), such as the ability to dim lights in an office using an intuitive control. “Justifications” describes interventions built around the provision of the reasons for performing a specific behaviour, such as why we are turning down the thermostat to 19 degrees this Winter.

Staats, van Leeuwen, & Wit (2000) find evidence that a combination of justifications, instructions, feedback and some normative information changed occupant behaviour in university administrative buildings. This intervention resulted in 6% reduction in gas used. Interestingly, the study found that the effect was maintained 1 year after the intervention.

The second key construct in the theory of planned behaviour is the perception of a norm for the behaviour in question. A powerful example in our evidence base showing the impact of a subjective norm on an occupant behaviour in a quasi non-domestic setting is provided by Goldstein et al. (2008) who studied the extent to which they could influence whether hotel guests reused their towels by manipulating the guest’s sense that there was a norm for doing so, both in the hotel generally and specifically in the room that the guest was staying in. Their results unequivocally demonstrate that the more we perceive that a norm is held by a group that is significant to us (in this instance hotel guests that have stayed in the same room) the more likely we will seek to conform with it. Norms may be particularly influential in a workplace context as the following studies illustrate.

This is supported by Lo et al. (2012), in their study of office energy related behaviours (such as printing) find that the most important drivers for energy efficiency in office spaces include positive employee attitudes, awareness, self-efficacy, subjective norms and habits. They also find that domestic habits are carried into the workplace and that perceived informal rules and social norms also determined energy behaviours. For example, some employees in their study left lights on in the daytime as it signalled to others that they were present in the office. Informal norms and habits of other staff also had the effect of reduced occupant energy use in some circumstances. For example, a perception of a printing “norm” had a sizeable impact on personal printing behaviour – people printed less when they thought there was a norm for printing less.

3.3 Evaluations of government policy

There is a very wide range of policy experience within the non-domestic sectors. Governments employ a variety of policies including regulations, voluntary programmes, market, information and fiscal instruments, on their own and in various combinations.

Policy operates at different levels of governance, from trans-national (e.g. EUETS) to regional or local levels. Policy also varies by end-use, building characteristics, sector and organisation size. In addition, policy approaches tend to change over time and vary between countries. This wide range is not evenly reflected in our evidence base which provides most evidence on policy related to process energy use in the industrial sector, national policies and on policy based on voluntary and information approaches. This obviously limits the certainty with which conclusions can be drawn.

Box 3: Key findings on evaluations of government policy

- Voluntary agreements (VAs), if designed, targeted, implemented and monitored in the right way, can deliver significant improvements in energy efficiency. There is most evidence for this in energy-intensive sectors, but some evidence that VAs may work in less energy-intensive sectors too.
- Factors critical to the success of VAs include: ambitious but realistic targets; supervision by a public authority with appropriate statutory powers and expertise; independent monitoring and evaluation; sanctions for non-compliance; and accompanying measures such as energy audits or technical assistance.
- Adoption of certificated Energy and Environmental Management (EMS) systems can lead to modest improvements in environmental performance and is particularly appealing to larger organisations with international trading partners and greater levels of public exposure.
- Energy audits, whether free, subsidised or paid for, can deliver energy efficiency. As with VAs, they are likely to be more effective in energy-intensive sectors. Audits are most successful when they are of high quality and recognise *all* the costs of energy efficiency.
- Adoption of innovative energy efficient technology is generally found when the technology is the "next step to take" (rather than a process requiring an interruption to existing production systems). The decision to adopt innovative technology has been found to be linked to decisionmaking within the wider network of firms operating in a sector.
- Other policies with a successful record include Demand Side Management programmes, voluntary labelling of green office buildings, and well-targeted support for industrial process innovation.
- The degree to which policy aiming to increase the cost of energy and therefore promotion of energy's efficient use is effective will vary by the energy intensity of the sector. Even huge price increases will be barely noticed in some non-energy intensive sectors.
- Facilities managers seem to be more responsive to upfront costs of efficiency measures than the potential for longer term savings suggesting that subsidy or enabling access to capital should be particularly important features of government policy. Subsidy for capital works is also, perhaps unsurprisingly, much preferred as a policy option over taxation of energy. However, taxation is more acceptable to firms when they are assured that it is applied fairly and will not disadvantage their competitive position.

3.3.1 Voluntary agreements

The policy type which is most highly represented in our evidence base is the voluntary agreement (VA), also known as a Long Term Agreement (LTA). These are typically

concluded between national governments and branches of energy-intensive industry, as an alternative to regulatory measures and include tools, timetables and targets. Our evidence base contains one review study which considers VAs across the EU (Rezessy & Bertoldi, 2011) with the other studies considering VAs in France (Chidiak, 2002), the USA (Koehler, 2007) and Sweden (Stenqvist & Nilsson, 2012), with three studies on the Netherlands (Dinica, Bressers & de Bruijn 2007; Farla & Blok, 2002; Rietbergen, Farla & Blok, 2002).

The French and American studies did not provide evidence that the VAs in question had delivered energy efficiency or environmental performance improvements. The French study analysed the national experience with voluntary agreements for greenhouse gas reduction over the period 1990-2002, in the aluminium production and glass packaging sectors. Chidiak (2002) suggested that the reductions observed in emissions per unit of production could not be attributed to the VA with any degree of certainty, and that instead they seem to have been triggered by other environmental regulations, and above all, by industry's investments in technology modernisation and cost reduction efforts. The study suggests that the VAs were poorly ambitious, and therefore incapable of leading to changes in behaviour beyond business-as-usual developments.

The USA paper considered experience with a wide range of Voluntary Environmental Programs (VEPs) – not just those targeting energy efficiency. Koehler's (2007) conclusion is that the programs that targeted production processes did not seem to generate significant pollution abatement. Although Koehler concludes that VEPs in the US have not been effective, on the whole, at reducing environmental impacts, she argues that when VEPs are explicitly linked to financial gains they can achieve environmental results. This should also lead to greater participation. This is supported by her finding that "final goods" producers (i.e. manufacturers that produce products that are directly consumed by the public rather than other organisations in the supply chain and which therefore have a greater stake in projecting a benign public image) are more disposed to take part in VEPs.

Khanna et al. (2007) find similar size effects in their study of motivations for the adoption of: a) Voluntary Environmental Programmes and b) environmental management practices (EMPs) in 689 facilities across 6 industrial sectors. Like Mori & Welch (2008) they find strong evidence that larger facilities are more likely to participate in VEPs. They propose that this could be because a) larger firms generally need to court the public recognition accompanying VEP participation; b) the design of VEPs is better suited to larger organisations - for example, multi-nationals would benefit from having a standard set of management practices that can be replicated across the organisation; and c) larger organisations are better able to bear the cost of participation in a VEP.

Although Koehler (2007) finds that VEPs seem to have been largely ineffective in the US context, adoption of ISO 1400 does seem to lead to modest performance improvements. It is suggested that this may be due to 14001's requirement for periodic third-party auditing which imposes a certain rigour on the system. The benefits of certification and the operation of voluntary environmental programmes are considered further in 3.3.2.

These papers demonstrate that VAs can fail to deliver environmental improvements if their targets are insufficiently challenging, in the absence of tools to help deliver change and without sufficiently rigorous monitoring and governance. Koehler (2007) acknowledges that the adversarial culture between regulator and regulated in the US may have resulted in the relatively poor performance of the VEPS (these were promoted by the Environmental Protection Agency). She draws two conclusions. Firstly, that VEPs may be more

successful in different national contexts and secondly that state rather than federal agencies may be more effective in establishing VEPs. This finding on the importance of understanding local context and utilisation of local networks is anticipated by the conceptual framework.

National context may also be a contributing factor to the relative success of the VEPs reported in the remaining papers. These give examples of successful VAs, identify factors which have been critical to success, and make suggestions for further improvements. Dinica et al. (2007) found that a VA promoting energy efficiency in the industrial sector in the Netherlands was ultimately successful, supporting multiple policy goals relating to improved competitive advantage of Dutch firms, reducing energy consumption for security of supply reasons and contributing to the implementation of Dutch climate policy. They cite factors for success as “a bottom-up formulation of the quantified policy goal, governmental participation in the financing structure for policy outputs, an independent expert playing a key role in the development of a good information structure and [most importantly], a simple implementation structure - the same actors and institutional arrangements are used for all policy instruments and the policy program has only one official goal”. However, they warn that firms are unlikely to adopt VAs if they are unable to relate the adoption to the achievement of a companies' own goals and cannot see how the efficiency measures will aid them with an improved market position and/or brand image.
Rezessy & Bertoldi (2011) provide an up-to-date review of EU experience of VAs. They include VAs from 10 countries, including two UK policies: Climate Change Agreements and Energy Efficiency Agreements with transport fuel suppliers. They conclude that to be successful a VA needs a proper institutional framework, which includes the following features:

1. Ambitious but realistic targets (quantified commitments) set by legislation or national policy beyond business-as-usual, which are the outcome of a transparent preparation and negotiation process. These targets must cover a major part of an industrial branch.
2. A public authority with appropriate energy statutory powers and expertise needs to be in charge of the agreements. There must also be a culture of trust and cooperation between public authorities and targeted sectors.
3. An effective and independent monitoring and evaluation mechanism based on robust indicators and followed by third party verification with reporting made public.
4. Credible and enforceable mechanisms to discourage non-compliance.
5. Accompanying measures, such as free or subsidised energy audits, technical assistance and information are in most cases needed to facilitate the implementation and success of agreements.

Farla & Blok (2002) also stress the key importance of ensuring high-quality supervision and monitoring of the evaluation process, suggesting that this is a necessary prerequisite of a reliable and effective new generation of long-term agreements. Rezessy & Bertoldi (2011) conclude that a VA policy package which builds on this framework can be a very effective tool for delivering electricity savings in the industrial sector (which is not covered by EU Emissions Trading System (ETS)). VAs also could form an important part of the policy portfolio targeting non-energy intensive industrial branches. Rietbergen et al. (2002) also conclude that VAs can be valuable policy instruments, if accompanied by ambitious target setting, effective supporting measures and reliable monitoring procedures. In summary, the balance of evidence is that, particularly for energy-intensive industrial sectors, high quality VAs can deliver significant improvements in energy efficiency.

3.3.2 The value of certificated Energy and Environmental Management Systems

A common strategy for energy management is the implementation of an Energy or an Environmental Management System (EMS). These systems set out a range of integrated management practices prescribing, for example, what should be monitored and how often, when and where to report energy consumption and how to set targets. These systems can be certified as having met particular standards: the best known of these are the International Standards Organisation's 14001 standard for environmental management and EMAS –the European Eco Management and Audit Scheme standard. These standards have much in common and are designed to be well integrated. ISO have recently introduced a specific Energy Management Standard, ISO 50001 which also shares a similar structure to 14001.

Our evidence base contains three studies which examine the evidence for the effectiveness of adoption of an energy or Environmental Management System. Mori & Welch (2008) sampled Japanese companies and find that larger companies are more likely to adopt 14001 and that their motivations for doing so were less to do with projecting a green image to end consumers (the public) and much more concerned with satisfying the expectations of international trading partners and various stakeholders in the supply chain. Evidently, larger companies are more likely to have international trading partners and extended supply chains and consequently exhibit a greater need for 14001.

Khanna et al. (2007) find that larger organisations are no more likely than smaller organisations to have environmental management *practices (*rather than certificated systems such *as* 14001*)*. This suggests that the official recognition accompanying a formal VEP is particularly attractive to larger organisations over and above any environmental benefits that participation may bring. Koehler (2007) reviews the effects of various voluntary environmental programmes in the US including voluntary implementation of 14001. As well as more general conclusions about VEPs having been largely ineffective in the US context she also presents mixed evidence on the effectiveness of 14001 certification. It appears that 14001 certification is associated with a greater propensity for firms to engage in no or low cost measures which may include energy efficiency, however more costly pollution abatement measures are no more likely to take place in a certified facility than a non-certified facility.

On balance the evidence suggests that adoption of certificated Environmental Management System can lead to modest improvements in the environmental performance of an organisation, especially where improvements result from no or low cost measures. However motivations for adoption of a *certificated* Environmental Management System seem largely driven by a need to respond to reputational pressures and consequently this behaviour is particularly associated with larger organisations which have a greater exposure to public and stakeholder opinion.

3.3.3 Energy audits

There are a number of papers covering energy audits in our evidence base, two of which specifically evaluate the effects of a policy of introducing a requirement for audits, and a number of others which look at the role of energy audits in overcoming barriers to energy efficiency. The policy evaluation papers are from Australia, covering the experience of firms in ten industrial sectors (Harris et al., 2000) and from Denmark, covering all enterprises with electricity consumption exceeding 20 MWh/yr (Larsen, Leth-Petersen,

Kjaerbye, & Rieper, 2006). A study by Schleich (2004) is from Germany and relates to energy audits in the commerce and services sector.

The Australian firms studied took part in the government's Enterprise Energy Audit Program (EEAP), which provided a subsidy of 50% of the cost of an energy audit (with a maximum payment cap). The study looked at whether firms chose to take measures identified as cost effective by the audit, and found that each firm implemented nearly five out of six measures recommended. The authors concluded that investment in energy efficiency is complex and other factors apart from economics influenced decision-making, such as a cost/risk analysis of acquiring information and investing in new technology. The study identified four types of risk which need to be recognized in investment decision-making. These were: adjustment costs during implementation; constantly changing information; adjustment costs after installation; and potential costs associated with breakdown. The authors suggest EEAP worked because it addressed the complexity of energy efficiency. In the Danish case, econometric analysis suggested there was no evidence that the free energy audit programme had led to a reduction in consumption of electricity. Contrary evidence came from closer analysis of ten case studies, which showed between 7 and 20% reduction of electricity use in their first year, but these cases were chosen because they had high savings potential, and were not typical of the wider population. The authors suggest action was not taken across the population as a whole because electricity was typically a small part of an organisation's costs.

The study which looked at evidence on use of audits in German commercial and service sector organisations (Schleich, 2004) was part of a larger investigation into barriers to energy efficiency. Survey data was gathered from 1,800 firms asking whether they had had an energy audit "recently" and what sort of organisation carried out the audit (engineering firm, utility, industry association or other). Use of audits was found to be positively correlated with the energy-intensity of the sector. Bradford & Fraser's (2008), study of UK SMEs also supports this conclusion. They find that firms in the manufacturing sector respond most favourably to the offer of free energy audits as compared with commercial sector organisations who viewed audits "unfavourably". This is attributed to the energy intensity of these respective sectors.

The Schleich study concludes that energy audits do reduce barriers to energy efficiency but suggests that not all external energy efficiency consultants are equally effective: engineering firms appear to be more successful than industrial sector associations or utilities, probably because they provide better information on technological and organisational energy efficiency measures. Taking this evidence together, it suggests that energy audits, whether free, subsidised or paid for, can deliver energy efficiency. However, audits are likely to be more effective in more energy-intensive sectors, and will not necessarily deliver change in organisations where energy use is a small part of the cost-base. It also suggests that providing an effective energy audit involves recognising *all* the costs to an organisation of investing in efficiency, not just the monetary ones as highlighted in the conceptual framework.

It is also necessary to pay attention to the quality of the audit, which may be related to who carries it out. Our discussions of barriers suggest that badly presented or poorly formulated audits will incur further "transaction costs" as non-technical staff struggle to make sense of audit findings and technical/operational staff struggle to transpose technical detail into compelling arguments for investment - arguments that must be listened to by senior staff who may see no strategic benefit in energy efficiency. Issues relating to staff resources who are able to make sense of audit findings will be particularly acute in smaller

organisations. The discussion of barriers also makes a number of suggestions for how energy efficiency recommendations cane be more engagingly presented.

3.3.4 Government support for R&D and innovation

In order for organisations to adopt energy efficient technologies, the technologies have to be developed and brought to market in the first place. Although supporting Research & Development (R&D) may not be a major focus of government energy efficiency policy (more usually residing in industrial policy), there is one very interesting paper in the evidence base looking at government intervention to stimulate the R&D of energy-efficient technologies (Blok et al., 2004). The research is based on four international case studies, two in paper/board making and two in steel making, and uses a framework of "technology networks" to understand the role of (multiple) firms in developing more energy-efficient process technologies. The authors find that technological development in the manufacturing industry is characterised as being heavily constrained by the existing production process. To be adopted, the innovative technology has to be recognised as the "next-step-to-take" and tends towards "system optimisation" rather than complete renewal of the production process. Technological development is also a slow process and the technology networks which deliver energy efficiency improvements vary considerably. This complexity, the long time scales, and the many factors beyond energy efficiency which influence decision-making mean that effectively stimulating the development of industrial energy-efficient technologies is difficult. The authors introduce the concept of "momentum" which can help governments decide when and whether to intervene to support R&D in a technology network.

This paper provides a different perspective on decision-making in firms from the other papers on policy evaluation, explicitly characterising it as strongly linked to decision-making within a wider network of firms. This kind of effect is anticipated by the conceptual framework whereby the interaction between firms in the same sector and within the supply chain has a powerful influence on decision-making within firms. This process is discussed implicitly and explicitly in our evidence base. Dieperink et al. (2004), in their study of diffusion of energy efficient innovations in Dutch industry, give a number of examples of how the configuration of other actors in a firm's supply chain have either enabled or disabled technological diffusion. An instance of an enabling effect is demonstrated by the diffusion of Combined Heat and Power (CHP) systems which became quite rapidly diffused in the Netherlands following the creation of joint ventures between manufacturers, energy companies and financial institutions. An instance of the latter is the non-diffusion of condensing boilers which remained a niche product for many years in the UK because installers refused to specify them – despite the offer of a subsidy to the householder.

Other evidence points to the *perception* of the behaviour of other firms in the same sector as influential (e.g. Cordano et al.'s (2010) study of Environmental Management System in the wine industry) (i.e. whether a norm is evident). Our evidence base also indicates that the power of the perceived norm will be stronger in some sectors than others. This is linked to the "field cohesion" of the sector. Field cohesion describes the density of interactions between actors in the same sector (Bansal & Roth, 2000). These authors argue that sectors which have very high field cohesion, and which operate in environmentally sensitive areas such as the oil industry, energy utilities and forestry companies, tend to be slow to innovate because there is an overriding concern to protect the interests of their industry as a whole – innovation or markedly superior performance can make other industry players look bad. Consequently, sectors with high field cohesion will have powerful trade associations and industrial lobby groups to protect their industry, maintain its public image and ensure the industry is seen to be acting together on key

issues. However, once a player has taken an innovative step then the other players in the sector will all quickly follow suit. Therefore government R&D support in sectors characterised by high field cohesion will do well to work with the umbrella groups that shape the thinking of the sector as a whole – such as trade associations.

3.3.5 Certification of buildings

Eichholz et al. (2010) set out to produce systematic evidence on the economic value of certification of green buildings in the USA. To do this they gathered evidence on the rental / sale value of commercial and office buildings which had an environmental or Energy Star label (voluntary labelling systems) and comparable buildings without certification. The results showed that an otherwise identical commercial building with an Energy Star certification will rent for about 3% more per square foot; the difference in effective rent is estimated to be about 7%. The increment to the selling price may be as much as 16%. The authors suggest that these results provide evidence on the importance of publicly provided information in affecting the choices of private firms about energy use, and that the private market does incorporate this information in the determination of rents and asset prices. They conclude that this information program would seem to be a sensible use of public resources. In the UK there are also some voluntary standards which focus on environmental and energy performance, particularly for new buildings, most notably BREEAM (www.breeam.org). However, the situation differs from the US in that UK buildings are required to have an Energy Performance Certificate at the point of sale or rental, which offers tenants / owners information on the energy efficiency of the building. Thus the market information available is more widespread than in the US.

3.3.6 Demand Side Management

“Demand side management” (DSM) is a term generally used to refer to regulated energy efficiency programmes funded by US utilities, which operate in both the domestic and non-domestic sectors. The two papers in our evidence base (Eto et al., 1996, Horowitz, 2004) assess the effectiveness and cost of DSM programmes in the commercial sector. In addition, Horowitz considers market transformation approaches which work with the entire vertical supply chain of a technology (i.e. they target supply as well as demand). The market transformation approach grew in prominence during the 1990s effectively replacing the DSM approach.

Both Horowitz and Eto considered the DSM programmes to have delivered significant savings, and Eto et al. suggest that the programmes were found “on the whole” to be cost effective. The programmes Eto et al. evaluated were largely rebate schemes applied to a variety of technologies, including lighting, heating, ventilation and air conditioning, with a small number of direct installation programmes. Similarly the DSM programmes evaluated by Horowitz primarily relied on rebates to encourage greater uptake of energy efficient technologies. Both studies used aggregate data to analyse the effect of these programmes, and did not examine individual organisations.

These papers represent a small fraction of a large amount of literature from the US which evaluates and debates the merits of various designs of DSM programmes. Other papers, which were not judged of sufficient quality to be included in the evidence base, include less positive assessments of DSM programmes. However, the US experience of a utility commitment to generate savings in the non-domestic sector is of some interest because this kind of policy has not been used in the UK. Instead utility sponsored non-domestic DSM activity in the UK is confined to the small number of organisations who participate in the balancing mechanism used by National Grid. However with the arrival of smart metering, increasing pressures on gas and electricity distribution networks and trends such

as the increasing electrification of heating and transport, there may be very good reasons to consider the US approach. Further research is required which particularly evaluates behavioural features of non-domestic DSM programmes.

3.3.7 Fiscal measures and subsidies

There is very little information in the evidence base which directly explores the impacts of fiscal measures and subsidies on energy behaviours. However, as an indication of how increases in energy prices may impact firms' decision-making we can examine motivations to invest in energy efficiency. In this respect many studies indicate that the desire to save money is a prime motive for investment in energy efficiency.

The variable impact of increasing energy cost across sectors is explored in a paper by Janda et al. (2002) which examines the response of retail and commercial organisations to the California energy crisis of 2001. This saw retail prices of electricity rise by as much as 230%. Janda finds that despite these huge prices increases many organisations in the commercial sector barely noticed the increases. Retail organisations were more responsive. The non-responsiveness of the commercial sector was attributed to a mix of factors - principally that energy is a small part of the sector's cost base and also that leasing arrangements can mask energy price signals.

De Groot et al. (2003), in their study of 135 Dutch companies spread across nine industrial sectors, find that policy measures such as subsidies and fiscal arrangements are considered, hypothetically, as influential in steering investments towards higher energy efficiency but firms want to maximise their freedom in deciding how to cope with the government's desire to improve environmental performance. The firms in the study stated that they would be extremely likely to react to an increase in energy taxes by introducing energy saving technologies and increasing their prices - it may also drive in-house innovation into new technologies. Economic subsidies were found to be preferred to taxes, and voluntary agreements were appreciated more than minimum standards. Acceptance of taxes increases if measures are taken to minimise adverse effects on a firm's competitive position - it is not the effectiveness of taxes that concerns firms but rather distributional and adverse impacts. Related to this, firms were found more likely to accept international rather than national policy measures so that a level playing field is maintained. This preference for subsidy over taxation is hardly surprising, however, there appears to be (limited) empirical evidence to suggest that it may actually be more effective in stimulating adoption of energy efficient measures in some sectors. Anderson & Newell, (2004) find that managers are more sensitive to upfront cost than to the possible savings: they find that upfront costs have more than double the effect of increases in energy prices in explaining the decision to adopt an energy efficiency measure and conclude that "a policy of subsidising energy-conserving technologies may be more effective in spurring the adoption of these technologies than a policy of taxing resource use".

Section 4: Implications and recommendations

Box 3: Implications and recommendations

- Reframing energy efficiency investment decision-making as a process taking place within a social and historical context removes its "paradoxical" characteristics and suggests new avenues for policy making.
- "Barriers" are usefully redefined as features of a socio-technical landscape influencing diffusion of technologies.
- Energy behaviours are highly diverse but also patterned and linked in systematic ways to the size of an organisation, its sector, sub-sector and local and national context. This means that targeting of measures is both possible and desirable.
- Energy efficiency is much more likely to become a strategic objective when energy consumption becomes salient. This means instituting monitoring and reporting practices and, if appropriate, combining energy efficiency messaging with a broader eco-efficiency agenda. Energy management systems have a role in ensuring energy remains part of the organisational conversation even where senior management are not engaged with the issue.
- The strategic characteristic of energy efficiency is key to ensuring efficiency opportunities are noticed and acted upon and government can act in various ways to ensure that energy efficiency takes on strategic characteristics, including measures such as mandatory reporting.
- Investment decision-making should be understood as a process with a beginning, middle and end. The policy focus at present is on the last part of the process – evaluation between alternatives using financial metrics. The policy community could usefully begin to work with the earlier stages – how energy efficiency is noticed as an issue and how various solutions are brought together.
- The language of efficiency centred around payback rather than NPV, classification of efficiency investments as costs rather than assets plus organisational tendencies to be risk averse all militate against investment in efficiency over alternative investment which more clearly adds to the bottom line and productive capacity. There is a role for government in influencing how efficiency is reframed by organisations.
- Interventions to occupant behaviour hold significant potential both in directly creating savings and indirectly via changing organisational culture and hence decision-making.
- Individuals and groups within organisations are an important locus of decision-making and are often overlooked by policy
- Multiple research gaps have been identified. These include a need for more research focus on particular economic sectors (e.g. retail, or organisation types such as SMEs), for overlooked stages in decision-making, on application of social psychology principles and on design of occupant behaviour interventions.
- Interactions between organisations in the supply chain have been found to be highly influential in some settings. More research is needed to develop policy approaches using this insight.
- The evidence for patterning suggests research to segment the non-domestic sector should be possible allowing, for example, tailored and targeted policy approaches to be developed and policy effects to be modelled more accurately.
- Multi-method studies and experimental studies with control groups are both under-represented in the evidence base.

4.1 Implications

4.1.1 Removing the efficiency "paradox"

Our evidence suggests that the fact that firms do not invest in some apparently profitable energy efficiency projects is only a "paradox" if the context of energy efficiency decision-making is ignored. Of course, organisations use economic arguments in their thinking about energy efficiency but these are set within a wider context of procedures, norms, rules of thumb, hierarchies, cultures and subcultures, friendships, material possibilities and market pressures. We have also learned that where energy efficiency investments are being ignored in favour of other investments, it is not reassurance about technology which is required, but an increase in companies' perception of energy efficiency's strategic importance. We have further learned that the strategic character of efficiency is linked to sector, to size and even on occasion to the individual dispositions of senior managers. Recognition of this opens new possibilities for effective policy-making using mechanisms and techniques which do not frame efficiency investment as only an issue of price, cost and information. Examples are: understanding and manipulating local conditions which bear on an organisation's behaviour (for example its competitors, local supply chain etc.); instituting further energy consumption reporting requirements which begin to create a link between company brand or reputation and energy efficiency (likely to be particularly effective in some sectors such as retail), making more use of professional networks and trade associations; supply chain analysis; working with trigger points such as relocation; targeting individuals and groups of individuals (such as facilities managers) within companies and the application of social psychology in the design of occupant behaviour interventions.

4.1.2 Revisiting barriers

We conclude there is a need to redefine a barrier as a feature of the socio-technical landscape influencing the diffusion of an energy efficient technology. This perspective suggests that removal of a barrier will change the configuration of the landscape allowing new behavioural possibilities to emerge and discouraging others and also that barriers will tend to be interrelated. The policy implication is that the system maintaining the barrier must be tackled rather than focussing only on removing individual barriers.

4.1.3 Non-domestic energy behaviours are patterned

Although we have found a great variety of energy behaviours, the evidence suggests that types of behaviour are patterned. Size, sector and sub-sector have all been found to be influential on behaviours in consistent and predictable ways. Effects are complex though because size and sector interact. For example, as our evidence base shows, a small independent hotel will behave quite differently to a hotel which is part of a large chain: these organisations are in the same sector but operate differently because of the size difference. This patterning can be used in various ways by the policy making community: to target information and guidance, to design effective policy interventions and to model policy effects. A table setting out how size and sector influence organisational capacity to respond to energy efficiency opportunities is shown in Appendix 6.

4.1.4 Measures can and should be targeted

Targeting of policy measures is vital because the "non-domestic sector" does not exist. Instead there are many sectors and sub-sectors, organisations of different size, groupings within organisations, individuals all of which can have distinctive motivations, behaviours and responses to policy. Different sectors will tend to have certain motivations when it comes to acting on efficiency messages, based on field cohesion and issue salience e.g. "competitive", "regulatory" and "ecological responsibility" orientations. This suggests that

implementing energy management systems, mandatory reporting and having certification of energy management that can be recognised by the supply chain will appeal preferentially to some identifiable sectors. We further conclude that because the size of the organisation so clearly impacts on the organisation's capacity to act, policy should be targeted accordingly. For example given that smaller firms are less likely to have dedicated energy management staff or the resource to appoint an energy /environment manager this suggests an effective area for public policy targeted at smaller organisations would be increased availability of technical expertise that can enable smaller organisations to design energy / environmental management systems tailored to suit their needs.

4.1.5 Raising salience of energy use is an important first step to adoption of energy strategy and energy management procedures

Energy use is often invisible to management and, particularly in some contexts such as the commercial office sector, its efficient use has a non-strategic character. In these circumstances the implementation of energy strategy is greatly encouraged when energy consumption becomes visible via making it salient. This means instituting monitoring and reporting requirements, talking about non-energy benefits of efficiency such as improvements to comfort and linking energy efficiency to wider agendas around eco-efficiency (see below).Certificated energy and environmental management systems hold some promise for ensuring efficiency becomes part of an organisation's conversation around these issues because they institute certain procedures, monitoring and reporting requirements and agendas which must be adhered to and which are consequently less dependent on whether senior management are engaged. However, in the short term we shouldn't expect certificated Environmental Management Systems to lead to rapid adoption of efficiency measures as these are often adopted for reasons of brand building and smoothing access to new markets, rather than energy and environmental performance improvements per se.

4.1.6 Reframing efficiency as a strategic benefit

We can conclude from the work of Cooremans and others in the evidence base that the practitioners such as the energy policy community and energy agencies seeking to promote energy efficiency should emphasise the strategic character of energy efficiency, talk about non-energy benefits (for example on staff comfort), building corporate reputation, improving resilience of energy systems and move away from discussions that revolve solely around cost and energy savings. This means the arguments for energy efficiency as a relevant and positive contribution to business performance have to combine economic considerations with additional benefits. Government can help make energy a more strategic issue by introducing further labelling, monitoring and reporting requirements and promoting voluntary schemes for energy and environmental management (such as ISO 14001). Energy can also be made of greater strategic importance by linking it to broader sustainability concerns – waste and water for example. This would enable energy efficiency to be communicated and promoted as a core element of the broader concept of eco-efficiency. In addition, by linking energy efficiency with for example, water efficiency, new possibilities for synergies and further cost reductions begin to open up.

4.1.7 Seeing the full process of decision-making offers new opportunities for policy

The conceptual framework describes the whole process of decision-making which begins with how energy efficiency opportunities are noticed, however the evidence suggests that it is the evaluation and choice phase right at the end of decision-making which is overwhelmingly the stage that is most researched. Therefore we recommend that

understanding of decision-making would be much improved by extending the stages that are considered to include the earliest stages. In particular there is insufficient research exploring what determines whether and when efficiency opportunities become salient to an organisation meaning that they are noticed and given detailed consideration. We have clear evidence, for example that there are times when changes to energy management practices are more likely, so called “trigger points” which include changes in management and relocation (Cox et al., 2012 and Dieperink et al., 2004).

4.1.8 The language of energy efficiency

Our evidence base find that energy efficiency can fall foul of common practice for categorising investments – it is often considered an item of discretionary maintenance and consequently will be considered a cost, detracting from bottom line profit, rather than an investment in productive capacity and therefore an asset. Efficiency savings are also a counterfactual “gain” (i.e. they only materialise if the alternative reality would not have otherwise happened). This is reinforced by the use of payback to evaluate the value of an efficiency investment rather than NPV or IRR. The contingent aspect also has an element of risk to it, and, when combined with the fact that organisations tend to be more loss averse than gain seeking, means that efficiency is often overlooked as a means of strengthening profits and building the assets of an organisation. We conclude that there may be a role for government in finding ways to encourage a reframing of efficiency savings – as “avoided losses” for example – and to encourage accounting for its benefits using metrics which highlight its potential to add to the bottom line rather than just pay for itself (e.g. using NPV rather than payback).

4.1.9 Occupant behaviours

Changes to the organisational value system via interventions to occupant behaviours will be influential in the more deliberative processes underlying organisational decision-making (e.g. investments). Therefore, even where interventions to stimulate occupant behaviour change may have little potential for energy saving in themselves they are nonetheless to be encouraged because they should influence the culture of an organisation with knock-on effects for strategic thinking, investment and procurement decision-making, where larger efficiency savings may result.

4.1.10 Don’t forget individuals and groups

Although much of the research reported here has concerned social processes and the relationships between organisations in supply chains or sectors it is clear that that groupings of staff within larger organisations are also a factor in driving behaviours – for example, senior management will value efficiency differently to operations or finance staff (Jennings & Skumatz, 2006). Individual beliefs, attitudes and values also play a role – especially those of the senior managers that are shaping the strategic direction of the organisation. For example, Pellegrini-Masini & Leishman (2011) find that employees’ and managers’ personal attitudes do affect organisational dynamics in respect of adoption of energy efficiency in UK office buildings. Individual beliefs and values will be particularly important in SMEs, where management functions are concentrated on one single or very few individuals. Our evidence base suggests that in this context, decisions are particularly likely to be made on the basis of informal priorities and criteria rather than on institutionalised decision procedures. Recognising the importance of groups and/or individuals in influencing decision-making opens up potentially new avenues for policy influence such as via working with professional bodies to create networks and peer support mechanisms and targeting key individuals within organisations. There may also be

opportunities to build on interventions to domestic energy and environmental habits, bringing these into the workplace and vice versa.

4.2 Recommendations

4.2.1 Reframing the origins and maintenance of energy behaviours

The neoclassical model of decision-making is contested by many papers in the evidence base suggesting that an energy efficiency "gap" will remain so long as policy makers and researchers retain the Physical Technical Economic Model. But this means understanding the full complexity of organisational behaviour which is difficult and expensive. Instead, a number of practitioners have called for more localised and contextual approach to policy making (De Groot et al., 2001; Shove, 1998; Lutzenhiser, Kunkle, & Biggart, 2001). Our evidence base contains examples where this has been found to be effective; for example, using more local policy making mechanisms appeared more effective for the implementation of voluntary agreements (Koehler, 2007). The diversity of decision-making encountered in our evidence base, which has been found to be influenced by dimensions such as size, sector and sub-sector, also suggests that a fine grained, localised approach to policy-making may be more effective. Clearly, a research agenda that has this approach as its starting point will tend to focus on the contextual and the local, calling for different kinds of research than are currently undertaken.

4.2.2 More research is needed into the interactions between firms in the same sector's supply chain

A number of papers in the evidence base suggest that supply chain and peer to peer relations are highly influential in decision-making (e.g. the diffusion of Combined Heat and Power technology in the Netherlands - see Dieperink et al., 2004). Also certain sectors are clearly more "cohesive" than others and our evidence base suggests that this can directly influence an organisation's responsiveness to norms. However, we have found very few studies that explore how the network of organisations in any particular supply chain can be influential in driving energy efficiency behaviours.

4.2.3 Development of a typology of organisations

The patterning of this diversity by known dimensions (sector, size) suggests that policy makers can generate a segmentation of the market to be used in a sensitive characterisation of the non-domestic sector which pays attention to local and contextual factors. However we must caution that the usual sector definitions are very broad and can mask differences. The manufacturing sector, for example, covers a multiplicity of different kinds of organisation in various sub-sectors each with different histories and market rules in operation so that even where energy intensity is similar, energy behaviours amongst sub-sectors may be quite different. A more fine grained approach, which understands that different types of organisation think differently about energy would fit well with the policies such as voluntary agreements. Typologising and targeting has been a favoured approach for domestic policy-making in the environmental space (Defra, 2008) - the theory in the conceptual framework and the evidence found here suggests something similar may be possible in the non-domestic sector. To build this typology a significant piece of research is needed which systematically examines energy behaviours across various size and sector dimensions.

4.2.4 Further research into influencing occupant behaviour is needed

Our evidence base has found evidence of the influence of a number of key social and psychological constructs on occupant energy behaviour including procedural knowledge, social norms and a sense of personal efficacy. Our evidence also suggests that the

potential for savings from interventions to occupant behaviours can be very significant and that interventions founded on principles from social psychology can achieve dramatic changes to behaviour (Goldstein et al's (2008) hotel towel study being one of the best known examples). Yet study of the application of social psychology insights to non-domestic energy behaviours appears very sparse in the literature. We believe a focussed piece of research examining this field in detail for its potential in the non-domestic sector and in determining research gaps would be very useful.

4.2.5 The existing evidence is patchy and certain sectors and small and medium enterprises are particularly underrepresented.

Research was particularly clustered in the industrial[2] and commercial office sectors, leaving most of the other sectors under-researched by comparison. In particular, there was very little specific research on the following sectors: retail, schools, government estate, sports, public offices, heritage and entertainment, healthcare, transport and communications. This distribution of research is unrelated to the relative carbon emissions of each sector. The retail and hospitality sectors for example are very large emitters but have little research associated with them. Because of the research focus on the commercial office and industrial sectors, the overall picture is a concentration on energy efficiency in larger, private sector organisations, with much less focus on the public sector, social enterprise and voluntary organisations of any size, and less focus on all types of SME. There is also a need for greater focus on the differences between firms at the sub-sectoral level. Use of terms such as "manufacturing" or SME misses many important differences between organisations.

4.2.6 Methodology for policy evaluation research is often poorly developed

A wide variety of methods has been used by studies in the evidence base to investigate their research questions – from surveys and econometric models to interviews and document analysis. However, there were relatively few studies using mixed methods, providing both qualitative and quantitative insights. Some of the best policy evaluation studies took this approach (e.g. Rietbergen et al., 2002), as well cross-checking quantitative results using different data sources. Given that research on energy efficiency behaviours is generally interested in quantitative outcomes as well as understanding why these outcomes resulted, more mixed-methods research would seem a good idea. Trials of policies and initiatives which make use of control groups clearly have advantages in terms of the certainty of results delivered. However, there are very few controlled trial experimental designs within the research base. Undertaking this type of research, particularly for interventions which potentially deliver measurable change within a short time frame, would increase the quality of evidence available to decision-makers.

4.2.7 Methodology for evaluating impacts of interventions and non-energy benefits of energy efficiency

Non-energy benefits can be identified, using particular methodologies, but this is seldom done outside of the US, where such research is carried out in a US-specific regulatory context. Our evidence has shown that organisations clearly value, and are motivated by non-energy benefits such as improvement of corporate reputation but we also have evidence that a lack of a formal methodology for their measurement may discourage investment in interventions in energy efficiency (Altan, 2010). Although there are ISO standards for measuring carbon savings from interventions and voluntary and regulated

[2] The industrial sector itself is very diverse in terms of energy use, with a study quoted in Hammond et al. (2008) identifying around 350 separate combinations of sub-sectors, devices and technologies.

standards for the purposes of accounting for carbon credits, there seems very little suited to SMEs.

4.2.8 There is a need for more research on energy behaviours centred on types of energy end-use

We feel that it is important to get an end use perspective because systems of provision of energy services are very different and consequently vary in the terms of appropriate policy response. Lumping all end uses together under a general category of “energy use” will mask opportunities for energy efficiency interventions. For example, in office buildings heating and cooling is provided by centralised building services whose specification and operation is usually out of the control of tenants, whereas specification and operation of lighting systems is often under tenant control. We have found very little research that takes this perspective.

4.2.9 There is insufficient robust impact-evaluation evidence of government policies

The study has found a lack of rigorous, transparent and publicly-available policy evaluation. In addition, the studies that do exist have used very different standards of evaluation and choice of methods. This makes it difficult, if not impossible, to compare across studies (Rezessy & Bertoldi, 2011). If a standard methodology for the evaluation of government interventions and programmes were to be developed, more and better policy evaluation would be forthcoming and evaluation of impacts across a range of policy types would become possible.

4.2.10 Research to address reporting and accounting for energy

We find that there is limited evidence on:

- The impact that different forms of energy reporting have on organisations’ likelihood of increasing their energy efficiency. Comparisons of the requirements of different types of energy management system would be particularly instructive.
- The most effective form and structure for energy audits and how they are most effectively integrated in wider programmes including requirements for energy management systems, financial incentives, training, ongoing monitoring and support.
- The appropriate metrics for evaluating and “framing” energy efficiency recommendations. Our evidence base suggests that widespread use of payback over other metrics such as NPV may discourage efficiency investments.
- There is insufficient evidence on the way energy efficiency investments are categorised and the impact that this may have on whether finance is made available and the hurdle rate that is required.

Section 5: References

Altan, H. (2010). Energy efficiency interventions in UK higher education institutions. *Energy Policy, 38*: 7722. Kidlington, United Kingdom.

Anderson, S. T., & Newell, R. G. (2004). Information programs for technology adoption: the case of energy-efficiency audits. *Resource and Energy Economics*, *26*(1): 27–50.

Aune, M., Berker, T., & Bye, R. (2009). The missing link which was already there: Building operators and energy management in non-residential buildings. *Facilities,* 27, 44–55. Department of Interdisciplinary Studies of Culture, Center for Technology and Society, Trondheim, Norway.

Axon, C. J., Bright, S., Dixon, T. J., Janda, K.B., & Kolokotroni, M. (2012). Building communities: reducing energy use in tenanted commercial property. *Building Research & Information*, *40*: 461–472.

Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Academy of Management Journal*, *43*(4): 717–736.

Bartlett, D., & Kane, A. (2011). *Going Green: The Psychology of Sustainability in the Workplace Green buildings: Understanding the role of end user behaviour.* The British Psychological Society, Leicester.

Bicknell, C., & Skumatz, L. A. (2004). *Non-Energy Benefits (NEBs) in the Commercial Sector: Results from Hundreds of Buildings*. ACEEE Summer Study on Energy Efficiency in Buildings (pp. 10–22).

Biggart, N. W., & Lutzenhiser, L. (2007). Economic Sociology and the Social Problem of Energy Inefficiency. *The American Behavioral Scientist*, *50*(8): 1070–1087.

Bradford, J., & Fraser, E. D. G. (2008). Local authorities, climate change and small and medium enterprises: Identifying effective policy instruments to reduce energy use and carbon emissions. *Corporate Social Responsibility and Environmental Management*, *15*(3): 156–172.

Brown, Z., & Cole, R. J. (2009). Influence of occupants' knowledge on comfort expectations and behaviour. *Building Research & Information*, *37*: 227–245. Taylor & Francis.

Carrico, A. R., & Riemer, M. (2011). Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education. *Journal of Environmental Psychology, 31*:1–13.

Chidiak, M. (2002). Lessons from the French experience with voluntary agreements for greenhouse-gas reduction. *Journal of Cleaner Production, 10*: 121–128.

Cooremans, C. (2011). Make it strategic! Financial investment logic is not enough. *Energy Efficiency*, *4*(4): 473–492.

Cooremans, C. (2012). Investment in energy efficiency: do the characteristics of investments matter? *Energy Efficiency, 5*: 497-518.

Cordano, M., Marshall, R. S., & Silverman, M. (2010). How do small and medium enterprises go “green”? A study of environmental management programs in the U.S. wine industry. *Journal of business ethics*, *92*(3): 463–478.

Cox, A., Higgins, T., Gloster, R., Foley, B, Darnton, A. (2012). The Impact of Workplace Initiatives on Low Carbon Behaviours. *Scottish Government Social Research.*

DECC. (2010). Unconstrained sector research, London.

Dahle, M., & Neumayer, E. (2001). Overcoming Barriers to Campus Greening: a Survey Among Higher Educational Institutions in London, UK. *International Journal of Sustainability in Higher Education, 2*: 139. Emerald Group Publishing Limited, West Yorkshire.

De Groot, H. L. F., Verhoef, E. T., & Nijkamp, P. (2001). Energy saving by firms: Decision-making, barriers and policies. *Energy Economics, 23*: 717–740.

DeCanio, S. J., & Watkins, W. E. (1998). Investment in energy efficiency: do the characteristics of firms matter? *Review of Economics and Statistics, 80*: 95–107. MIT Press.

Decanio, S. J. (1998). The efficiency paradox: bureaucratic and organizational barriers to profitable energy-saving investments. *Energy Policy*, *26*(5): 441–454.

Decanio, S. J., & Laitner, J. A. “Skip.” (2003). The Role of a Dynamic Marketplace in the Adoption of Industrial Efficiency Innovations. *ACEEE Summer Study on Energy Efficiency in Industry* (pp. 51–65).

Dinica, V., Bressers, H. T. A., & de Bruijn, T. (2007). The implementation of a multi-annual agreement for energy efficiency in The Netherlands. *Energy Policy, 35*: 1196–1212.

Eichholtz, P., Kok, N., & Quigley, J. M. (2010). *Doing Well by Doing Good? Green Office Buildings*. *The American Economic Review, 100*: 2492–2509.

Farla, J. C. M., & Blok, K. (2002). Industrial Long-Term Agreements on Energy Efficiency in The Netherlands. A Critical Assessment of the Monitoring Methodologies and Quantitative Results. *Journal of Cleaner Production, 10*: 165. Elsevier Science, Oxford

Goldstein, N.J., Martin, S., & Cialdini, R. (2007). *Yes! 50 Secrets from the Science of Persuasion*. Profile Books.

Goldstein, Noah.J, Griskevicius, V., & Cialdini, R. B. (2008). A Room with a Viewpoint: Using Social Norms to Motivate Environmental Conservation in Hotels. *Journal of Consumer Research, 35*: 472–482.

Guy, S. (2006). Designing urban knowledge: competing perspectives on energy and buildings. *Environment and Planning C: Government & Policy*, *24*(5), 645–659.

Harris, J., Anderson, J., & Shafron, W. (2000). Investment in energy efficiency: A survey of Australian firms. *Energy Policy*, *28*: 867–876.

Howard-Grenville, J. a. (2006). Inside the “Black Box”: How Organizational Culture and Subcultures Inform Interpretations and Actions on Environmental Issues. *Organization & Environment*, *19*(1), 46–73.

Janda, K., Payne, C., Kunkle, R., & Lutzenhiser, L. (2002). What organizations did (and didn’t) do: Three factors that shaped conservation responses to California's 2001 “crisis.” *ACEEE Summer Study on Energy Efficiency in Buildings,* pp. 117–128.

Jennings, J., & Skumatz, L. A. (2006). Non-Energy Benefits (NEBs) from Commissioning in Schools, Prisons, and Other Public Buildings. *ACEEE Summer Study on Energy Efficiency in Buildings*, pp. 138–148.

Khanna, M., Koss, P., Jones, C., & Ervin, D. (2007). Motivations for Voluntary Environmental Management. *Policy Studies Journal*, *35*(4): 751–772.

Koehler, D. A. (2007). The Effectiveness of Voluntary Environmental Programs - A Policy at a Crossroads? *Policy Studies Journal*, *35*: 689–722.

Larsen, A., Leth-Petersen, S., Kjaerbye, V. H., & Rieper, O. (2006). The Effect of Energy Audits in Danish Industry--Evaluation of a DSM Programme. *Energy Studies Review*, *14*: 30–41.

Lo, S. H., Peters, G.-J. Y., & Kok, G. (2012). Energy-related behaviors in office buildings: A qualitative study on individual and organisational determinants*. Applied Psychology: An International Review*, *61*: 227–249.

Lutzenhiser, L., Kunkle, R., & Biggart, N. W. (2001). Market structure and energy efficiency: The case of new commercial buildings*. California Institute for Energy Efficiency.*

Martin, R., Muûls, M., De Preux, L. B., & Wagner, U. J. (2012). Anatomy of a paradox: Management practices, organizational structure and energy efficiency. *Journal of Environmental Economics and Management*, *63*(2): 208–223.

Mori, Y., & Welch, E. (2008). The ISO 14001 environmental management standard in Japan: Results from a national survey of facilities in four industries. *Journal of Environmental Planning and Management*, *51*: 421–445).

Osbaldiston, R., & Schott, J. P. (2012). Environmental sustainability and behavioral science: meta-analysis of proenvironmental behavior experiments. *Environment and behavior*, *44*: 257–299).

Pellegrini-Masini, G., & Leishman, C. (2011). The role of corporate reputation and employees’ values in the uptake of energy efficiency in office buildings. *Energy Policy*, *39*(9): 5409–5419.

Pett, J., & Ramsay, L. (2003). Energy efficiency in commercial offices: who can transform the market? (pp. 729–739).

Plank, R. (2011). Green behaviour: Barriers, facilitators and the role of attributions. In D. Bartlett (Ed.), *Going Green: the psychology of sustainability in the workplace*, pp. 47–58. British Psychological Society, Leicester.

Prindle, W., & Fontaine, A. de. (2009). A Survey of Corporate Energy Efficiency Strategies. *ACEEE Summer Study on Energy Efficiency in Industry* (pp. 77–89).

Rezessy, S., & Bertoldi, P. (2011). Voluntary Agreements in the Field of Energy Efficiency and Emission Reduction: Review and Analysis of Experiences in the European Union. *Energy Policy*, *39*: 7121–7129.

Rietbergen, M. G., Farla, J. C. M., & Blok, K. (2002). Do agreements enhance energy efficiency improvement? Analysing the actual outcome of long-term agreements on industrial energy efficiency improvement in The Netherlands. *Journal of Cleaner Production*, *10*: 153–163). Utrecht University, Netherlands.

Russell, C. (2005). Energy management pathfinding: Understanding manufacturers' ability and desire to implement energy efficiency. *Strategic Planning for Energy and the Environment*, *25*(3): 20–54.

Schleich, J. (2004). Do energy audits help reduce barriers to energy efficiency? An empirical analysis for Germany. *International Journal of Energy Technology and Policy, 2*(3): 226-239.

Shove, E. (1998). Gaps, barriers and conceptual chasms: theories of technology transfer and energy in buildings. *Energy Policy*, *26*(15): 1105–1112.

Sorrell, S., Mallett, A., & Nye, S. (2011). Barriers to industrial energy efficiency: A literature review. *United Nations Industrial Development Organization*, Vienna.

Staats, H., van Leeuwen, E., & Wit, A. (2000). A longitudinal study of informational interventions to save energy in an office building. *Journal of applied behavior analysis*, *33*(1): 101–4.

Stenqvist, C., & Nilsson, L. J. (2012). Energy efficiency in energy-intensive industries-an evaluation of the Swedish voluntary agreement PFE. *Energy Efficiency*, *5*: 225–241.

Stephenson, J., Barton, B., Carrington, G., Gnoth, D., Lawson, R., & Thorsnes, P. (2010). Energy cultures: A framework for understanding energy behaviours. *Energy Policy*, *38*(10): 6120–6129.

Thollander, P., Danestig, M., & Rohdin, P. (2007). Energy policies for increased industrial energy efficiency: Evaluation of a local energy programme for manufacturing SMEs. *Energy Policy*, *35*: 5774–5783.

Trianni, A., & Cagno, E. (2012). Dealing with barriers to energy efficiency and SMEs: Some empirical evidences. *Energy*, *37*: 494–504.

Defra. (2008). A framework for pro- environmental behaviours. *Defra,* London.

Vernon, J., Essex, S., Pinder, D., & Curry, K. (2003). The “greening” of tourism micro-businesses: outcomes of focus group investigations in South East Cornwall. *Business Strategy and the Environment*, *12*(1): 49.

Wehrmeyer, W., Leitner, A., & Woodman, P. (2009). Lean and Green Leadership for a low-carbon future. Chartered Management Institute, London.

Appendices

Appendix 1: Research questions

The research questions described in the Invitation to Tender are outlined below:

RQ1 What evaluations exist of government policies (national, regional and local) to improve energy efficiency behaviours in non-domestic settings and what can they tell us about what factors are more important in driving success?[3]

RQ2 What research is there on the strategies non-domestic organisations have adopted for driving energy efficiency? How do strategies targeted at upgrading equipment to be more energy efficient, using controls and management systems more effectively or cultural change within organisations compare? What can the research tell us about the key factors/facilitating conditions that have driven success or contributed to failure?

RQ3 What does the research tell us about business investment in energy efficiency and the ability of businesses to value the potential benefits? How do businesses learn about what could be done and what reassurance is required? What does the evidence tell us about the relative importance of investment in energy efficiency compared to other business investments?

RQ4 What does the research tell us about the main barriers for implementing energy efficiency policies and practices within non-domestic organisations and how, if at all, they have been overcome?

RQ5 What have been the key benefits to organisations who have taken action? What, if any, evidence is there of pitfalls and unintended consequences? What research is there on the costs to organisations of undertaking action?

RQ6 What does the evidence tell us about differences between organisations? What motivates some organisations to become energy efficient but not others?

RQ7 What does the research tell us about the importance of factors such as country, size, sector, tenure, energy intensiveness and engagement with different technologies?

RQ8 How robust is the evidence base? What are the key gaps in the research evidence and what are the priorities for future research in the UK?

[3] Evaluation of EU ETS was specifically excluded from this review, as it is the subject of a separate piece of research underway for DECC.

Appendix 2: Method for identifying documents for the research base

Overview

The search strategy is mapped below:

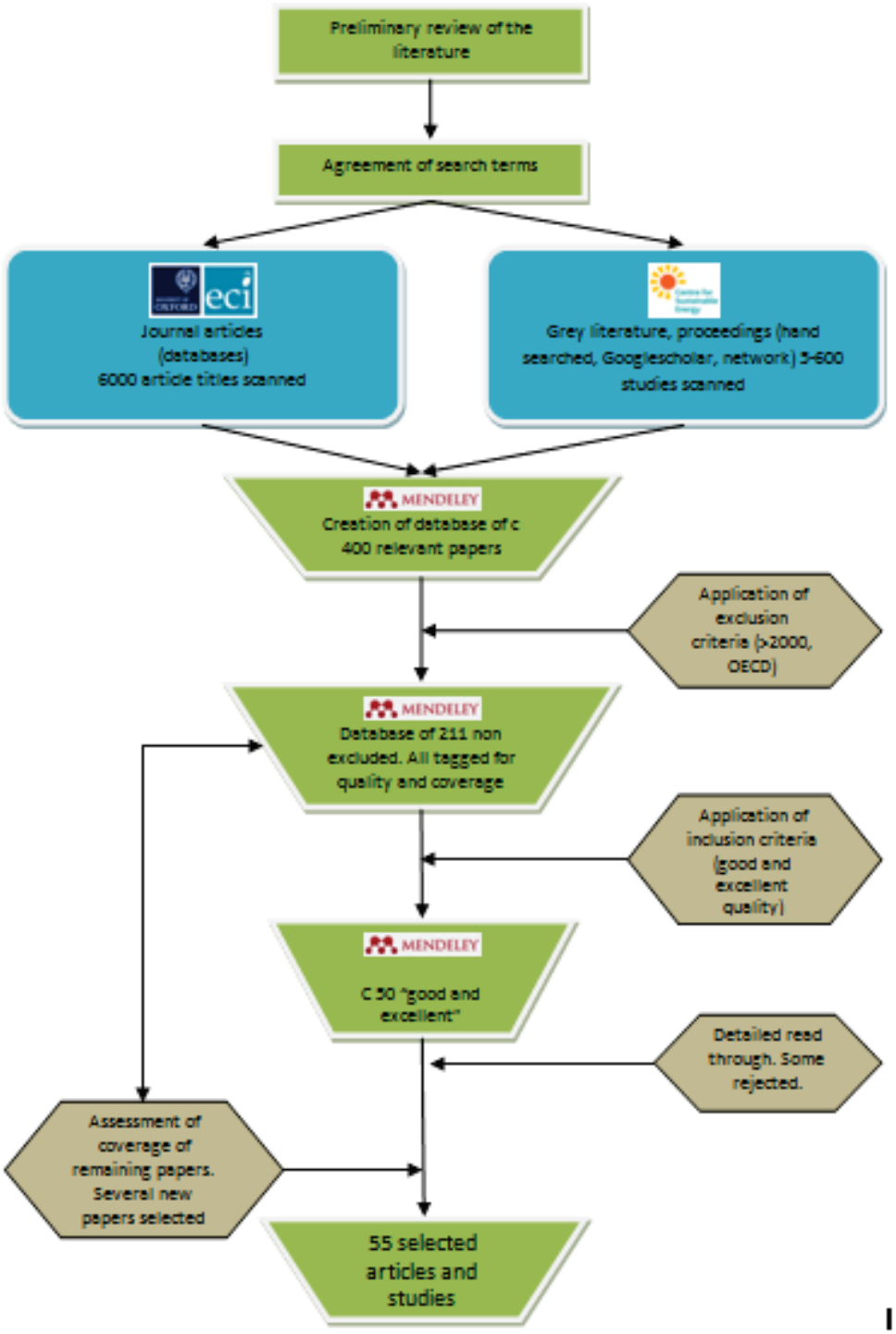

Figure 3: Map of the search process

We now describe the technical detail of the search process. Sources of information were grouped in three classes for searching:

- Peer-reviewed journal articles
- Conference papers
- Grey literature

The search strategy for each is explained. This is followed by a description of the exclusion and inclusion criteria which were applied to all types of literature. The appendix concludes with reflections on the process.

Setting up the search for journal articles

In order to search for relevant journal articles, a list of six research databases was chosen based on advice from Oxford University librarians. These were: Scopus, International Bibliography of Social Science, INFORM Global Trade and Industry, Web of Knowledge, Econlit, and PsychInfo. Between them, they cover the scientific, technical, social scientific, energy policy, business and economics literature. Searching was carried out using a list of 45 search terms, developed in partnership with DECC and Oxford University librarians. This list of terms was tested in initial searches, and a reduced set of terms and combinations of terms was developed which were shown to deliver high numbers of relevant articles. In total, across all databases, 105 searches were carried out, and from these 6,188 article titles (and abstracts if necessary) were scanned for relevance. This resulted in 255 articles of potential interest, which was 4.1% of the articles scanned.

"Energy" terms	**"Action/Operation" terms**	**"Buildings" terms**	**"People" terms**	**"Discipline" terms**	**Economics terms**
7	**11**	**10**	**9**	**5**	**3**
energy efficiency	behav*	non*domestic or nondomestic	occupant	socio-technical	opportunity cost
energy consumption	decision making	non*residential or nonresidential	worker	psychological	strategy
energy demand	technology adoption	commercial	student	sociological/social	corporate social responsibility
demand reduction	technology diffusion	buildings	owner	organisational theory	
energy conservation	(social / technical / institutional /organisational/ behavioural) change	industrial	organi*ation (organization, organisation)	innovation theory	
energy management	social (or human) dimensions	retail	tenant		
demand side management	supply chain management	schools	manager		
	management	further and higher education	operator		
	operation	government estate	facilities		
	commissioning	hotels, inns and restaurants			
	innovation				

Table 2: List of key words

The key words are arranged in six columns: people, energy, buildings, action/operation, discipline, economics. If searches were carried out using one word from each column, this would lead to 104,000 possible combinations (and more combinations if searches with less than 6 words used), which equates to over half a million searches if using five different databases. It was not feasible to undertake this number of searches, and strategies for identifying the most useful key words and combinations of key words were employed (where ”useful” means ”most likely to identify highly relevant studies”).

Limiting key word combinations in journal searches

Scopus contained the highest number of relevant journals, and was used for the first wave of searches, to test the proposed search strategy and inform searches of the other databases[4].

Preliminary searches indicated that searches generally needed three terms, linked by AND statements, to produce a manageable number of results. Using just two terms, for example “energy efficiency” and “behav*” generated too many results (1,271).

Each term in the “buildings” and “people” list and the terms “workplace”, “firm” and “business” (as requested by DECC) were searched in combination with “energy efficiency”’ and “behav*”. “Energy efficiency” and “behav*” were used because they seemed to be the most pertinent energy and action/operation terms given DECC’s research questions. The “buildings” and “people” terms which delivered most potentially relevant references were “building”, “industr*”, “commercial”, “business” and “occupant”.

To test the effects of using “energy efficiency” and “behav*” rather than other Table 2 options, each of the energy terms was tested in combination with “behav*” AND “commercial” (which was chosen because it returned a mid-range number of references in earlier searches), and each of the action/operation terms with “energy efficiency” AND “commercial”. This confirmed that “behav*” and “energy efficiency” did deliver the highest number of relevant results, with the next best terms being “management” and “energy conservation”.

Preliminary tests showed the “discipline” terms in Table 2 were not helpful in delivering results, and these were not used in any further searches. It was decided to use “economics” terms in Table 2 only when searching the EconLit database. The general conclusions were that:

- “energy efficiency” AND “behav*” AND buildings / people terms returned some relevant references in most cases – these should form the basis for most searches
- “energy conservation” and “management” should be used in searches for all databases.
- where possible “energy efficiency” OR “energy conservation” should be used as one of the search terms (use of OR statements not possible in some databases).
- “non-domestic” and “non-residential” are not useful search terms – very few journal articles use them in the title / abstract / keywords.

Several other key words did not return results in Scopus (see

[4] All the databases allow slightly different types of search. For example, Scopus does not allow use of strings of OR terms (so, e.g., all energy terms cannot be used as a string of OR terms), and this influences the search strategy.

Table **8**) and so their use was not prioritised in the other databases. In addition to the searches run on key words in Table 2, a small number of specialised searches, on e.g. energy audits and feedback, were run in response to DECC interest in particular topics.

Identification of databases for searching for journal articles

Specialist Oxford university librarians advised using the following databases for searching journal articles in this area: Scopus, Proquest, Web of Knowledge, Econlit. They advised against using Google Scholar – because it is a search engine not a database, so it is not possible to save, sort or manage searches as with the others.

Scopus
"The largest abstract and citation database of research literature and quality web sources". Includes over 7,200 titles in physical sciences and over 5,300 titles in social sciences and humanities.

Proquest: International Bibliography of Social Sciences
This database includes over two million bibliographic references to journal articles and to books, reviews and selected chapters dating back to 1951. It is unique in its broad coverage of international material and incorporates over 100 languages and countries. Over 2,800 journals are regularly indexed and some 7,000 books are included each year.

Proquest: ABI-INFORM Global
This database is one of the most comprehensive business databases on the market. It includes in-depth coverage for thousands of publications, most of which are available in full text and the latest business and financial information for researchers at all levels." Subject coverage: Business, Economic conditions; Corporate strategies; Management theory; Management techniques; Business trends; Competitive landscape and product information; Accounting; Finance.

Proquest: ABI-INFORM Trade & Industry
This database includes in-depth coverage of companies, products, executives, trends and other topics. With ABI/INFORM Trade & Industry users can study and compare specific trades and industries, including telecommunications, computing, transportation, construction, petrochemicals and many others.

Web of Knowledge
Searches a range of databases, the most relevant of which is probably Web of Science. *Web of Science* itself consists of nine databases containing information gathered from thousands of scholarly journals, books, book series, reports, conferences, and more. Its citation databases cover over 12,000 major journals in sciences, social sciences, arts and humanities.

OvidSP: EconLit
Produced by the American Economic Association, EconLit indexes and abstracts more than 550 international economic journals. EconLit source material includes journal articles, essays, research papers, books, dissertations, book reviews, and working papers. The database contains more than 350,000 records and covers subjects from accounting, consumer economics, monetary policy, labour, marketing, demographics, modelling, economic theory, planning, and more. Years of coverage are 1969-present with approximately 26,000 records added annually.

Ovid SP: Psychinfo

PsychInfo is an electronic bibliographic database providing abstracts and citations to the scholarly literature in the psychological, social, behavioural, and health sciences. The database includes material of relevance to psychologists and professionals in related fields such as psychiatry, management, business, education, social science, neuroscience, law, medicine, and social work. It includes articles from 2500 journals.

Focusing journal searches

In addition to limiting the number of key word combinations, it is also important to use other search options to try and focus results on the most relevant articles. The following initial inclusion criteria were used in all searches:

- Results from journals only
- Results from physical and social sciences only (life and medical sciences are excluded)
- Results from 1990 onwards only

Where significantly more than 150 journal results were returned, these were ranked in order of relevance (by the database), and only the top 150 were considered.

For Proquest ABI-INFORM Trade & Industry where thousands of results were typically returned per key word search, in addition NOT “domestic” OR “household” was used to try to focus results further. Otherwise NOT criteria were avoided.

Recording journal searches

All search results were been recorded. Within the results returned, the researcher identified all papers which *could* be of relevance, and put bibliographic details into Mendeley. Mendeley identified papers already in the database – this is the difference between the number of papers tagged and the number of new references (not previously found). Papers in Mendeley were tagged with details of the search terms used and the database from which they were extracted.

Search results

A total of 105 searches were undertaken, and as a result of these 6,188 references were scanned – that is the titles were read for relevance, with abstracts also read if necessary. From those references, a total of 255 unique articles was added to the database. The databases differed in the percentage of new relevant references found, with Scopus, IBSS and EconLit providing the highest relevance rates. These rates were influenced in part by the order in which the databases were searched (which is as per the order in Table 3), and the degree to which the journals included overlapped with other databases.

Database	Searches	References found	References scanned	Relevant references (initial judgement)	% of scanned which might be relevant
Scopus	47	2063	1940	125	6.4
Proquest – International Bibliography of Social Sciences (IBSS)	9	202	202	18	8.9
Proquest – ABI-INFORM Global and	16	12347	1782	61	3.4

Trade&Industry					
Web of Knowledge[5]	6	3396	807	13	1.6
EconLit	19	796	620	37	6.0
PsychInfo[6]	8	8562	837	1	0.1
TOTAL	**105**	**27366**	**6188**	**255**	**4.1**

Table 3: Number of references extracted

Searching

Conference papers

The search strategy for conference articles was to read through all article titles in particular conference proceedings. The conference proceedings were chosen for relevance, and were:

- European Council for an Energy Efficient Economy (ECEEE) – 1993 onwards;
- American Council for an Energy Efficiency Economy (ACEEE) – 1994 onwards;
- International Energy Program and Evaluation Conference (IEPEC) – 1997 onwards;
- Behaviour, Energy and Climate Change (BECC) – 2007 onwards; International
- Energy Efficiency in Commercial Buildings (IEECB) – 2000 onwards.

Relevant papers were identified first by reading through all article titles in each year's conference proceedings and then reading the abstracts of those whose titles appeared relevant. This resulted in 73 articles of potential interest being identified.

Grey literature

A targeted approach was taken to identifying relevant grey literature. This included using personal knowledge within CSE, ECI and DECC; and DECC contacting potential generators of relevant studies, such as the Energy Saving Trust. A list of potential sources of grey literature was prepared, key individuals were identified and then contacted with a request to advise on studies and reports of relevance to the project. The list of those contacted is shown below:

UK University research departments
Nottingham University - Horizon
Surrey University - Resolve
Environmental Change Institute, University of Oxford
International Institute for Sustainable Development, de Montfort University
Tyndall Centre at Psychology School, Cardiff University
Centre for Energy Policy and Technology (ICEPT) Imperial College, London
University College London, Energy Institute
UK Energy Research Centre (UKERC) - energy demand research area - energy in buildings programme
University of Bath (energy use in industry)
Energy agencies, energy NGOs, consultancies and think tanks
Severn Wye Energy Agency (particularly work on prisons and SMEs)
Arup
Price Waterhouse Coopers (particularly "ethicability" framework with Roger Steare consulting)

[5] The six most promising searches (based on search terms returning most results in other databases) were used with Web of Knowledge. Since this only gave a success rate of 1.6%, no further searches were carried out with this database.

[6] PsychInfo produced very few results, so only eight searches were made.

Association for Conservation of Energy (ACE)
Databuild
Consumer Focus
Toshiba labs
Bill Bordass
Trade and professional associations
Energy Services and Technology Association (ESTA)
Institute for Environmental Management and Assessment (IEMA)
Royal Institute of Chartered Surveyors (RICs)
Chartered Institute of Building Services Engineers (CIBSE)
Institute of Directors
The British Electro technical and Allied Manufacturers Association (BEAMA)
British Property Federation
UK and European Government departments
Defra
DECC
BiS
European Commission (Interreg, FP7, Intelligent Energy)
Scottish government
Welsh Assembly Government
UK Government agencies and Quangos
National Audit Office
Carbon Trust
Environment Agency
Energy Saving Trust (used to do SME work)
WRAP
International government departments and agencies
US Embassy Research Service
Environmental Protection Agency (EPA) - US government
International organisations
Wuppertal Institute
World Resources Institute
International energy agency (IEA)
Dutch Energy Agency (ECN)
Buildings Performance Institute Europe (BPIE)
Swedish Energy Agency

Table 4: Sources of grey literature

Exclusion criteria

Having completed the searches as described above, there were over 550 references in our database. The target number of documents to be analysed in detail was 50-60, so a method was needed to reduce considerably the number of documents under consideration. Given the number of documents, exclusion rules needed to be applied by reading only the titles and abstracts. In consultation with DECC, a set of exclusion criteria were agreed. The following were excluded from further consideration:

- Papers which did not directly address one or more of the key research questions.

- Documents published prior to 2000. This criterion was not applied to theoretical papers.
- Papers based on empirical work from non-OECD countries only (e.g. China / India).
- Papers on the "non-energy benefits" of energy efficiency programmes, which were narrowly focused on energy efficiency measures within (US) utility programmes by creating estimates of benefits which will work with their funding rules. Research which identified non-energy benefits from energy efficiency measures (through for example case studies or surveys) was not be excluded.
- Where papers with very similar content were published in different journals, either the earlier paper (usually) or the paper from the less prestigious journal (if this judgement can be easily made) was excluded.
- Where conference papers and journal articles had very similar content, the conference paper was excluded.
  Although the evidence review only examined primary research and reviews of primary evidence, theoretical papers were included at this stage as a small number were considered to be helpful in building the conceptual framework.

At the end of the exclusion process, 233 papers remained.

Inclusion criteria

Papers were classified according to study type (i.e. descriptive; modelling; comparisons (testing the effect of an intervention); qualitative; theoretical), sector, industrial energy type, and behaviour / decision type.

Methodological quality was used as the criterion for inclusion in order to select the best remaining papers. Papers were rated 1-4 on quality where 1 indicated poor quality and 4 indicated excellent quality

A set of descriptions of quality from poor (1) to excellent (4) were developed for five types of study: descriptive; modelling; comparisons (testing the effect of an intervention); qualitative; theoretical.

Quality was assessed through reading abstracts and methodology sections. Fifty five documents (including 5 theoretical) were identified as of "excellent" and "good" quality. This formed the database of documents used for further analysis using the Data Extraction Template. During this process some studies were excluded on closer reading, and a few studies were subsequently identified, and being of high quality, were included. A number of papers were classified independently by more than one researcher, to check whether judgements about quality were in agreement. Most judgements were in agreement. In a small number of cases, researchers differed about whether a paper should be classed as "good" or "excellent", but as both these classifications resulted in inclusion for further analysis, these differences did not have an adverse effect on the final result.

Validation of search strategies

The papers identified by this Rapid Evidence Assessment have been compared with those selected in a more specialised literature review. Sorrell, S. et al. (2011) produced a report which reviewed 160 articles on barriers to industrial energy efficiency. It picked out a small number of particularly useful articles for further examination. This included five articles which met our search criteria– four of which were included in our database, and assessed as "good" or "excellent" quality. We had other articles by the authors of the "missing" article. This demonstrates that our search strategy has found the majority of material which

an extensive expert review has judged as most valuable. This comparison offers evidence that the Rapid Evidence Assessment has been effective in identifying the relevant literature.

Reflections on results

Some types of relevant research are likely to be under-represented as a consequence of the search strategy adopted. Because the focus of the research (and key word searches) has been on energy efficiency in combination with behaviour, there are far fewer papers from Building Research and Information – an important journal on energy use and policy in the built environment – than might have been expected.

Papers which are about equipment use in buildings, may not include any "buildings" words in their abstract / titles / key words, and hence may not have been found in this Rapid Evidence Assessment . For example, one of DECC's suggested papers, provided as an example of the kind of reference that had been found useful (Howarth, R B et al., 2000, The economics of energy efficiency: insights from voluntary participation programs, *Energy Policy* 28(6-7): 477-486) was not picked up by the search.

Papers come from 39 different journals. By far the dominant journal is *Energy Policy* which was the source of 26 articles. The only other journals from which five or more articles came are: *Business Strategy and the Environment*; *Energy Efficiency*; and the *Journal of Cleaner Production*. Considering this, and the full list of journals, it is possible that the energy efficiency and policy aspects of the Rapid Evidence Assessment may be represented more fully than decision-making processes and the general understanding of organisational behaviour. In summary, the areas of literature most likely to be under-represented are:

- energy use in buildings (as opposed to process energy use);
- appliance and equipment energy use;
- general understanding of organisational behaviour.

Distribution of the final studies selected by sector, quality and behaviour

Papers were coded by which non-domestic sector they covered and which types of behaviours they addressed. For sector we used a classification developed by The Carbon Trust[7]. This classification was used in their "Building the Future" today report[8] and was useful in that the report attributed the relative proportion of carbon emissions to each sector (2005). This allowed the team to prioritise sectors for coverage . The Carbon Trust's distribution is shown in Figure 4.

[7] Sectors are classified as follows: industrial, retail, hotels, inns and restaurants, commercial offices, schools, further and higher education, government estate, sports, public offices, heritage and entertainment, healthcare, transport/communications and miscellaneous.

[8] See www.carbontrust.com/media/77252/ctc765_building_the_future__today.pdf page 30.

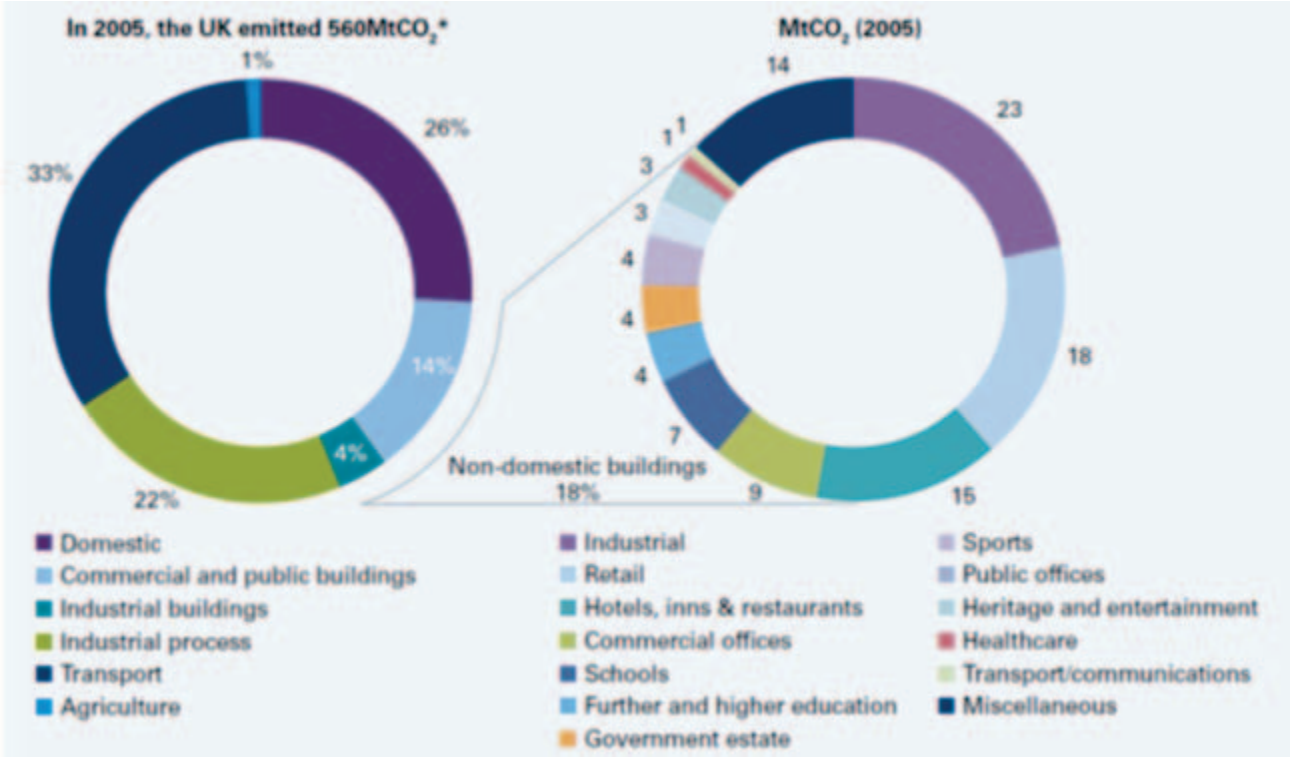

Figure 4: non-domestic emissions by sector

Coverage of non-domestic sectors and behaviour types in our evidence base was concentrated in particular areas. A majority of papers cover either the industrial sector or are cross-sector (cross-sector is used where the paper does not concentrate on a specific sector). Further and higher education buildings have some representation, as do schools and commercial offices, but there is very little covering the other sectors. Investment strategy is the most highly represented behaviour type, with this being concentrated in the industrial and cross-sector categories. Implementation of energy management systems is the next most represented behaviour type, again concentrated in the industrial and cross-sector categories, but with more representation for educational buildings. Next comes occupant behaviour, most highly represented in cross-sector and further and higher education buildings. Innovation is the category with the least papers, split between the industrial and cross-sector categories.

The following tables illustrate the distribution of the studies, in terms of behaviour type studied, sectors covered, and quality of the research. Note that in all tables, if papers cover more than one behaviour type or sector type they are counted more than once, which means that the total sums to more than the total number of papers. The tables are colour-coded from red (no papers) to green (highest number of papers), and the colour-coding is relative within each table.

Table 5 shows the distribution of papers across sector and behaviour type. The majority of papers cover either the industrial sector or are cross-sector (cross-sector is used where the paper does not concentrate on a specific sector). Further and higher education buildings have some representation, as do schools and commercial offices, but there is very little covering the other sectors. Investment strategy is the most highly represented behaviour type, with this being concentrated in the industrial and cross-sector categories. Implementation of energy management systems is the next most represented behaviour type, again concentrated in the industrial and cross-sector categories, but with more representation for educational buildings. Next comes occupant behaviour, most highly

represented in cross-sector and further and higher education buildings. Innovation is the category with the least papers, split between the industrial and cross-sector categories.

	B1 - Investment strategy and procurement	B2 - Occupant behaviour	B3 - Implementation of energy management systems	B4 -Innovation	**Total**
S1 - Industrial	14	1	7	2	24
S2 - Retail	0	0	0	0	0
S3 - Hotels, inns and restaurants	2	1	0	0	3
S4 - Commercial offices	3	2	0	0	5
S5 - Schools	0	2	4	0	6
S6 - FE and HE buildings	1	4	3	0	8
S7 - Government estate	0	0	1	0	1
S8 - Sports	0	0	0	0	0
S9 – Public offices	0	0	1	0	1
S10 - Heritage and entertainment	0	0	0	0	0
S11 – Healthcare	0	0	0	0	0
S12 – Transport and communications	0	0	0	0	0
S13 - Miscellaneous	0	0	2	0	2
S14 –Cross sector	17	5	6	3	31
Total	37	15	24	5	

Table 5: Behaviour type by sector

Table 6 below shows the distribution of papers across quality and sector. Quality is rated from 1 to 4, with 4 being the highest quality. Quality is concentrated around level 3.

	Quality: 1	Quality: 2	Quality: 3	Quality: 4	Total
S1 - Industrial	1	2	11	3	17
S2 - Retail	0	0	0	0	0
S3 - Hotels, inns and restaurants	0	1	1	2	4
S4 - Commercial offices	0	1	2	1	4
S5 - Schools	0	0	4	0	4
S6 - FE and HE buildings	0	1	3	1	5
S7 - Government estate	0	0	1	0	1
S8 - Sports	0	0	0	0	0
S9 – Public offices	0	0	1	0	1
S10 - Heritage and entertainment	0	0	0	0	0
S11 – Healthcare	0	0	0	0	0
S12 – Transport and communications	0	0	0	0	0
S13 - Miscellaneous	0	0	1	1	2
S14 –Cross sector	1	3	13	5	22
Total	2	8	37	13	

Table 6: Quality by sector

Finally, Table 7 shows behaviour type by quality.

	B1 - Investment strategy and procurement	B2 - Occupant behaviour	B3 - Implementation of energy management systems	B4 -Innovation	Total
Quality: 1	2	0	2	0	4
Quality: 2	5	3	1	1	10
Quality: 3	21	6	11	3	41
Quality: 4	8	4	4	1	17
Total	36	13	18	5	

Table 7: Behaviour type by quality

Data extraction

Having assembled a database of documents, a Data Extraction Template was developed in partnership with DECC. This contained over 150 fields into which information from each document was extracted and critically reviewed. The data fields include descriptions of the main research questions, methods, findings, policy conclusions, and an extensive analysis of the quality of the study including any weaknesses the research team felt existed in either methods or conclusions. This extracted data (together with the original papers / reports if necessary) was used to analyse the evidence base.

Analysis

For the analysis phase, individual researchers were allocated documents from the research base which clustered around this project's research questions, so that each researcher specialised in an individual research question, making the analysis coherent and comprehensive.

Appendix 3: Details of key word searches carried out for each database

Table 8: Scopus search terms and results

Search terms			Journal articles	Number checked	New references (not found previously)	Tagged as non-domestic
	AND	AND				
"energy efficiency	behav*	tenant	4	4	**	**
"energy efficiency	behav*	owner	10	10	**	**
"energy efficiency	behav*	organi*ation	28	28	**	**
"energy efficiency	behav*	operator	6	6	**	**
"energy efficiency	behav*	non*domestic / non-domestic	0	0	**	**
"energy efficiency	behav*	non-residential	6	6	**	**
"energy efficiency	behav*	commercial	56	56	**	**
"energy efficiency	behav*	building	230	230	**	**
"energy efficiency	behav*	industr*	203	203	**	**
"energy efficiency	behav*	retail	7	7	**	**
"energy efficiency	behav*	school	13	13	**	**
"energy efficiency	behav*	"further education"	0	0	**	**
"energy efficiency	behav*	"higher education"	1	1	**	**
"energy efficiency	behav*	"government estate"	0	0	**	**
"energy efficiency	behav*	hotel	0	0	**	**
"energy efficiency	behav*	inn	0	0	**	**
"energy efficiency	behav*	restaurant	0	0	**	**
"energy efficiency	behav*	workplace	6	6	1	0
"energy efficiency	behav*	firm	31	31	11	5
"energy efficiency	behav*	business	71	71	37	2
"energy efficiency	behav*	occupant	53	53	3	0
"energy efficiency	behav*	worker	6	6	1	0
"energy efficiency	behav*	student	10	10	1	1
"energy efficiency	behav*	manager	13	13	1	1
"energy efficiency	behav*	facilities	42	42	16	0
"energy consumption"	behav*	commercial	70	70	57	3
"energy demand"	behav*	commercial	13	13	7	0
"demand reduction"	behav*	commercial	3	3	2	1
"energy conservation"	behav*	commercial	38	38	22	2
"energy management"	behav*	commercial	21	21	9	0
"demand side management"	behav*	commercial	8	8	4	0
"energy efficiency"	decision-making	commercial	16	16	12	1
"energy efficiency"	technology adoption	commercial	9	9	7	3
"energy efficiency"	technology diffusion	commercial	6	6	3	0
"energy efficiency"	social dimensions	commercial	0	0	0	0
"energy efficiency"	human dimensions	commercial	0	0	0	0
"energy efficiency"	supply chain	commercial	0	0	0	0

	management					
"energy efficiency"	Management	commercial	217	217	194	15
"energy efficiency"	Operation	commercial	178	178	137	1
"energy efficiency"	Commissioning	commercial	14	14	5	1
"energy efficiency"	Innovation	commercial	29	29	16	1
"energy efficiency"	behav*	feedback	36	36	1	0
"energy efficiency"	Management	feedback	32	32	1	1
"energy conservation"	Feedback		176	150	3	2
"energy efficiency"	Feedback		247	150	1	0
"energy audit*"	behav*		13	13	2	1
"energy audit*"	Management		141	141	9	8

**** This** data was not retained

Table 9: Proquest - International Bibliography of Social Sciences, search terms and results

Search terms				Journal articles	New references (not found previously)	Tagged as non-domestic
	AND	AND	NOT			
"energy efficiency" OR "energy conservation"	behav*		domestic OR household	80	59	7
"energy efficiency" OR "energy conservation"	management	building		32	26	4
"energy efficiency" OR "energy conservation"	management	commercial		9	2	1
"energy efficiency" OR "energy conservation"	management	industr*		76	61	6
"energy efficiency" OR "energy conservation"	management	retail		2		0
"energy efficiency" OR "energy conservation"	management	school		1	0	0
"energy efficiency" OR "energy conservation"	management	"higher education"		1	0	
"energy efficiency" OR "energy conservation"	management	"further education"		0	0	
"energy efficiency" OR "energy conservation"	management	hotel OR restaurant		1	0	

Table 10: Proquest - Databases: ABI/INFORM Global + ABI/INFORM Trade + Industry, search strategy and results

Search terms				Journal articles	Number checked	Tagged as non-domestic	New non-domestic refs
	AND	AND	NOT				
"energy efficiency" OR "energy conservation"	behav*	building	domestic OR household	897	150	15	13
"energy efficiency" OR "energy conservation"	behav*	Commercial	domestic OR household	536	150	14	6
"energy efficiency"	behav*	industr*	domestic OR	1399	150	15	4

OR "energy conservation"			household				
"energy efficiency" OR "energy conservation"	behav*	Retail	domestic OR household	167	150	11	3
"energy efficiency" OR "energy conservation"	behav*	school	domestic OR household	773	50	0	0
"energy efficiency" OR "energy conservation"	behav*	"higher educatio n"	domestic OR household	91	91	4	2
"energy efficiency" OR "energy conservation"	behav*	"further educatio n"	domestic OR household	2	2	0	0
"energy efficiency" OR "energy conservation"	behav*	hotel OR restaura nt	domestic OR household	121	121	11	4
"energy efficiency" OR "energy conservation"	managem ent	building	domestic OR household	2163	150	24	15
"energy efficiency" OR "energy conservation"	managem ent	Commer cial	domestic OR household	1003	150	17	3
"energy efficiency" OR "energy conservation"	managem ent	industr*	domestic OR household	3321	150	19	6
"energy efficiency" OR "energy conservation"	managem ent	Retail	domestic OR household	253	150	9	0
"energy efficiency" OR "energy conservation"	managem ent	school	domestic OR household	1279	50	0	0
"energy efficiency" OR "energy conservation"	managem ent	"higher educatio n"	domestic OR household OR "higher education press"	118	118	5	3
"energy efficiency" OR "energy conservation"	managem ent	"further educatio n"	domestic OR household OR "higher education press"	4	0		
"energy efficiency" OR "energy conservation"	managem ent	hotel OR restaura nt	domestic OR household	220	150	3	2

Table 11: Web of Knowledge – search strategy and results

Search terms			Article references	Number checked	Tagged as non-domestic	New non-domestic refs
	AND	AND				
"energy efficiency" OR "energy conservation"	behav*	building	301	150	2	1
"energy efficiency" OR "energy conservation"	behav*	commercial	57	57	1	0
"energy efficiency" OR "energy conservation"	behav*	industr*	234	150	5	0

"energy efficiency" OR "energy conservation"	management	building	1011	150	1	0
"energy efficiency" OR "energy conservation"	management	commercial	248	150	9	2
"energy efficiency" OR "energy conservation"	management	industr*	1545	150	15	8

Table 12: Econlit – search strategy and results

Search terms		Article references	Number checked	Tagged as non-domestic	New non-domestic refs
	AND				
energy efficiency		995			
behavio*r		95439			
energy efficiency	behavio*r	52	52	11	5
energy efficiency	Management	95	95	20	12
energy conservation	behavio*r	45	45	4	3
energy conservation	Management	22	22	1	0
energy efficiency	building*	81	78	8	0
energy efficiency	Audit	3	3	1	0
energy efficiency	opportunity cost	0	0	0	0
energy efficiency	Strategy	54	54	5	4
energy conservation	Strategy	10	10	0	0
energy efficiency	corporate social responsibility	0	0	0	0
energy audit		9	9	2	1
energy efficiency	industr*	323	150	12	7
energy efficiency	Commercial	36	36	8	0
energy efficiency	Firm	40	40	12	5
energy efficiency	Retail	10	10	1	0
energy efficiency	higher education	2	2	2	0
energy efficiency	School	1	1	1	0
energy efficiency	Hotel	3	3	2	0
energy efficiency	organi*ation	10	10	1	0

Table 13: PsychInfo – search strategy and results

Search terms		Article references	Number checked	New non-domestic
	AND			
organizational behaviour	Buildings	360	150	1
organizational behaviour	energy expenditure	7	7	0
organizational behaviour	management OR business management OR management decision-making	2700	100	0

organizational behaviour	Innovation	620	100	0
energy expenditure		2603	100	0
organizational behaviour	higher education	80	80	0
organizational behaviour	environment OR built environment	1986	150	0
built environment		206	150	0

Appendix 4: Conceptual framework development

The conceptual framework was needed because:

1. Studies and papers are written for a variety of audiences and originate from a variety of theoretical perspectives. In order to draw common understandings from the literature it is necessary to have a framework which can accommodate and situate the diverse and disparate perspectives.
2. The framework gave the team some explanatory power. It particularly assisted in the synthesis phase of the work: bringing together findings of the various studies in a coherent narrative, suggesting solutions to unresolved issues, identifying gaps and allowing new research propositions to be formulated.
3. The framework allowed a categorisation of influential "factors" influencing behaviour which allow DECC and other practitioners to judge *where* they can exert an influence of the behaviour of organisations. For example, where an energy behaviour examined in the review is described as primarily influenced by factors which tend to fall in the "regulatory domain" then policymakers have a clear indication of where their efforts should focus if changes to the specific behaviour in question are sought.

Origins of the framework

The suggested framework is based on a review of energy/behaviour studies originating from a variety of standpoints: principally organisational theory, sociology of energy use and social psychology. The framework found its initial impetus from a theoretical study by Axon et al., (2012) of stakeholders in the commercial office space but particularly uses the thinking of various respected social scientists in the field of energy and buildings including Dr Loren Lutzenhiser, Portland State University (e.g. work in Biggart & Lutzenhiser, (2007), Professor Simon Guy, University of Manchester (see Guy, 2006) and Professor Elizabeth Shove, University of Lancaster (Shove, 1998).

The emerging framework was tested amongst project staff in a workshop context for its ability to accommodate various types of influential "factor" and to suggest how organisations respond to energy efficiency opportunities. Finally the framework was sent for peer review by two members of DECC's social science expert panel. Both reviewers gave constructive feedback which was subsequently incorporated. It has also been examined by Dr Mike Page of the School of Psychology, University of Hertfordshire who affirms a broad theoretical congruence with approaches he and his team have developed to understand energy and environmental behaviours of SMEs.

Theoretical basis and implications

The framework is an attempt to integrate insights from economic, organisational and social theory. Whilst recognising the value that all these disciplines can bring, the framework's principal theoretical assumptions are developed out of the widespread critique of the so called PTEM – the Physical Technical Economic Model[9] – the neo-classical economic model of decision-making. In simple terms the framework seeks to embed and transform accounts of economic rationality by situating decision-making within its social and cultural context. Its basic assumptions and their rationale are described below.

[9] The PTEM construct was originated by Loren Lutzenhiser.

Behaviour is a socio-technical outcome

In this study we are interested in 4 main types of energy efficient practice: 1. Investment in efficient technology or procedures 2. Energy efficient occupant behaviour 3. Adoption of energy efficient strategy and 4. Energy efficient innovation (e.g. development of new energy efficient technology). Our approach to conceptualising adoption of these practises differs from the prevailing paradigm known as the Physical-Technical-Economic Model. In the PTEM view, if “technical knowledge is rigorously tested and demonstrably proven, and if market forces are not ``disturbed'' then consumption choices should be made rationally, with the ``right decisions being taken by millions of individual consumers, both at home and in their place of work''. The role of government is clear: ``to set the background conditions and prices such that consumers will take decisions which are both in their own and the national interest'' (Guy, 2006).

This view has been repeatedly contested by scholars across a range of fields including economics. It is beyond the scope of the REA to resolve this debate. However it is clear from the papers studied in this REA that firms (and individuals) are not only concerned with maximising profit and that economic rationality is at the very least “bounded” and perhaps should be redefined as “socio-commercial” rationality so that the various social forces impinging on “rational” decision-making are acknowledged.

The widespread theoretical and empirical critique of the PTEM model has resulted in a large body of literature which places a much greater emphasis on understanding organisational decision-making as an outcome of social and cultural processes. This is expressed in “bounded rationality” accounts at one end of the spectrum which maintain that decision makers are essentially acting rationally albeit with limited information, hidden costs and with attitudes and values playing a part, through to more full blooded socio-technical accounts which allow only a tightly circumscribed role for economic rationality and point instead to a whole gamut of other interwoven processes in their accounts of organisational behaviour. Guy summarises the distinctions between to the two conceptual frameworks in the following table:

Table 1. Ways of seeing energy efficiency in buildings.

	Techno–economic	Sociotechnical
Buildings	materially similar, physical structures	material product of competing social practices
Energy-efficient design	replicable technical solutions	outcome of conflicting sociocommercial priorities
Energy-saving action	individual, rational, decisionmaking in a social vacuum	socially structured, collective choices
Technological innovation	series of isolated technical choices by 'key' decisionmakers	technical change embedded within wider sociotechnical processes
Market failure	existence of social barriers	lack of perceived sociocommercial viability
Image of energy consumers	more or less rational	creative, multirational, and strategic
Role of social science research	evaluation of technical potential and the detection of environmental attitudes and nontechnical barriers	identification of context-specific opportunities for technological innovation
Energy policy	provision of information, granting of subsidies, and setting of regulations	forging of context-specific communities of interest, and promotion of socially viable pathways of innovation

Table 14: Techno-economic versus socio-technical accounts of energy efficiency behaviours. From Guy (2006) Op. Cit.

Decisions are taken by individuals and groups.

Two particular features of the table above merit further discussion here. Firstly, the contrast of energy saving actions as the outcome of socially structured collective choices versus individual rational decision-making represent, in our view, two extremes of a continuum. Although nothing takes place in a social vacuum it is clear than in some contexts there are instances of individual decision-making driving corporate behaviour – for example very senior staff acting virtually alone can sometimes single-handedly bring about corporate culture change. Equally, it is also apparent that some behavioural choices arise from socially structured collective processes. There is also a middle part of the continuum: in some contexts, individuals and collectivities of individuals, albeit influenced by the social and cultural grouping that they are members of, are the primary influence in decision-making.

This is the theoretical space occupied by many theorists. For example Pellegrini-Masini and Leishman find that employees and managers' personal attitudes do affect organisational dynamics in respect of adoption of energy efficiency in UK office buildings (Pellegrini-Masini & Leishman, 2011). Similarly, Cordano et al. (2010) find that the subjective norm of managers in the US wine industry regarding their employees and peers' adoption and implementation of environmental management systems was the best predictor of whether they too implemented energy and environmental management programmes. There is also evidence that attitudes to energy and environmental issues can cross from the domestic environmental to the workplace. For example, Lo, Peters, & Kok, (2012) find that home energy habits spilled into the workplace.

Here our framework differs somewhat to the dominant socio-technical view. We do believe that individuals and their associated attitudes, values and frames for seeing the world can have a direct influence on organisational behaviour. These need not necessarily be the individuals at the top of the hierarchy. For example formal or informal leaders (shift supervisors or leaders of subcultures – the "old hands") can shape organisational culture.

A framework capable of accommodating individual behaviour is also important for the purposes of dealing with studies examining occupant behaviour and various interventions which can influence this - for example implementation of energy consumption feedback systems and improved controls. Occupant behaviour was the primary focus of the Scottish Government's recent report on workplace initiatives and low carbon behaviours (Cox et al., 2012). The conceptual framework used in this work uses a hierarchy of factors driving individual behaviour as its basic structure. The model is reproduced in Figure 5 below:

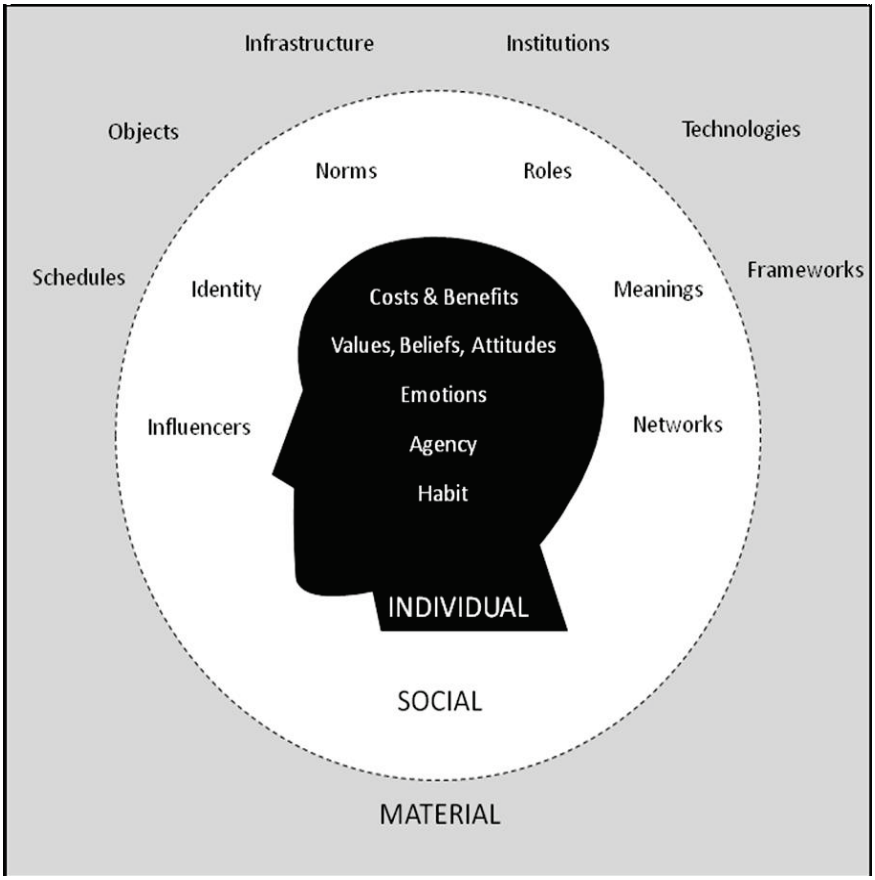

Figure 5: The Individual, Social and Material (ISM) contexts model

This model is particularly appropriate to understanding occupant behaviours - the primary focus of the Workplace Initiatives study but we feel is less useful for explaining organisational decision-making. This latter objective must explicitly take greater account of the processes giving the organisation itself a voice and life of its own (rather than only the individuals within it). That organisational life will be evidenced in its procedures, its history, its "way of doing things" and approaches to new opportunities, in short its culture.
So individual decision-making is important but so are collective forms of decision-making and attendant social processes. As well as formal hierarchy and written procedures shaping decision-making there are also informal mechanisms at work – the existence of sub-cultures which tend to form around particular job roles each with distinct agendas e.g. senior and middle management, estates dept, administration etc. Each grouping will have formal and informal relationships with one other, variable levels of power and influence and pursue particular agendas within the organisation.

This is a long held understanding that has been explored in multiple contexts and for multiple purposes. For example identification and mapping of the subcultures within organisations, particularly factories, was the cornerstone of post-war work by industrial psychologists seeking to find ways of boosting efficiencies in product output and tackling other issues such absenteeism and staff turnover[10]. By working with sub-cultures, understanding their respective agendas, informal procedures and interaction with one another, clear strategies were developed which had dramatic impacts on productivity and avoided potentially destructive and clumsy interventions.

Studies continue to show the importance of the interplay of sub-cultures within organisations in driving corporate decision-making and ultimately behavioural outcomes. Howard-Grenville (2006) concludes that, “an organisation’s culture and in particular its constellation of sub-cultures, shapes how environmental issues are interpreted and acted on”. Shared sub cultural meanings guide the members’ problem setting, what they select for attention and how they label the problem.

In addition to relationships between formal and informal groupings within the organisation creating culture, the organisation itself has a kind of life of its own: its history, procedures, size and area of business will collectively create an organisational “culture” and “way of doing things” that embed the individuals and groups of individuals within. There is a patterning to this: organisations tend to be internally structured in distinctive ways depending on their size and sector (Bansal & Roth, 2000). These habits and organisational dispositions are themselves formed over time in response to the context in which the organisation operates - socio-technical network around it and the interactions of the various groups and players within it.

These various interactions at different levels are shown in Figure 6

[10] See the seminal work of Elton Mayo as reported in Chapter 3 of The Social Psychology of Industry, J.A.C. Brown, 1954. Pelican

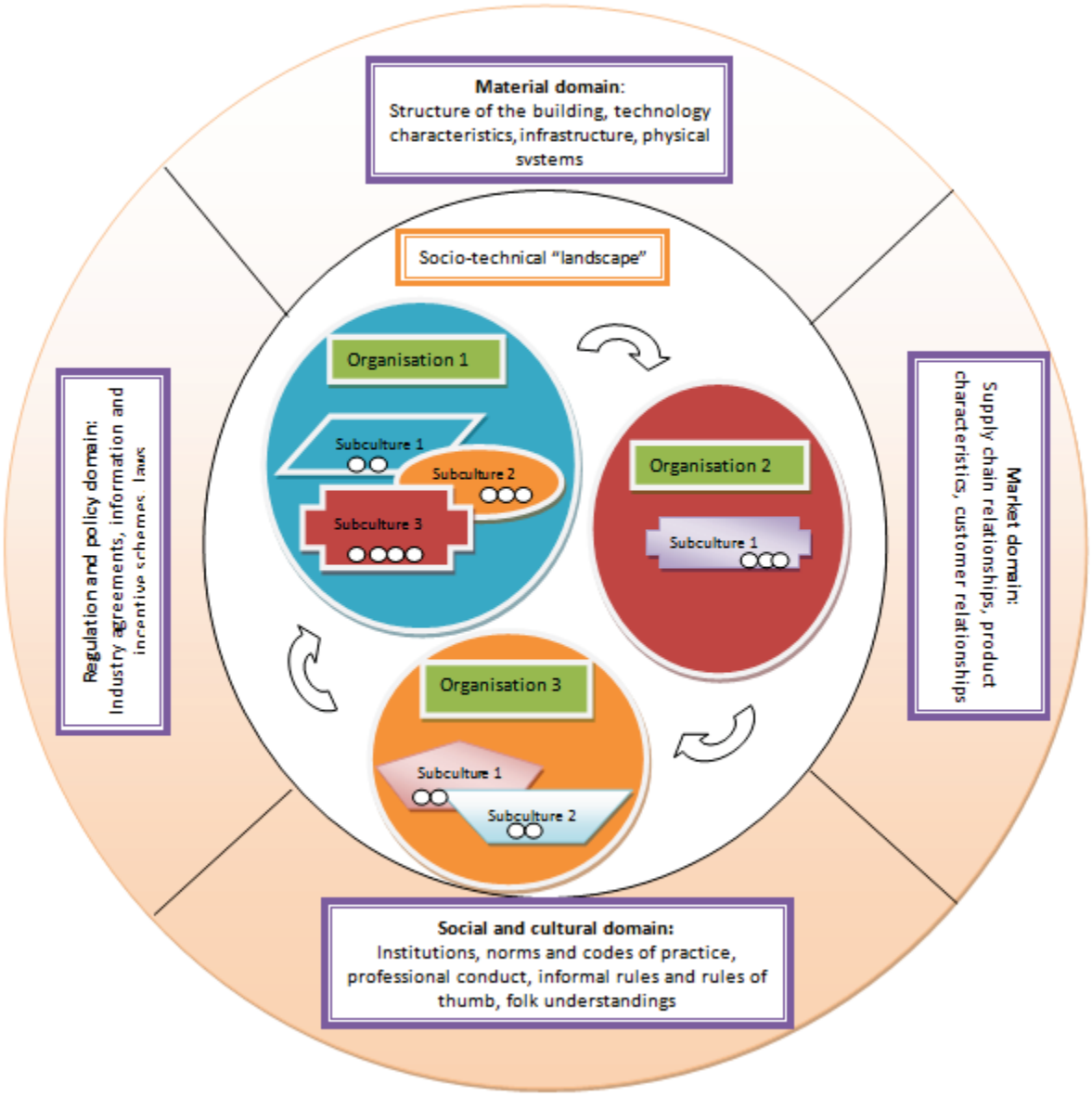

Figure 6: Conceptual framework

Decision-making is a process embedded in an internal organisational context.

Decision-making takes place within this external and internal social and cultural context and needs to be understood as a process with a beginning, middle and an end. Cooremans' process model is shown in Figure 7 below:

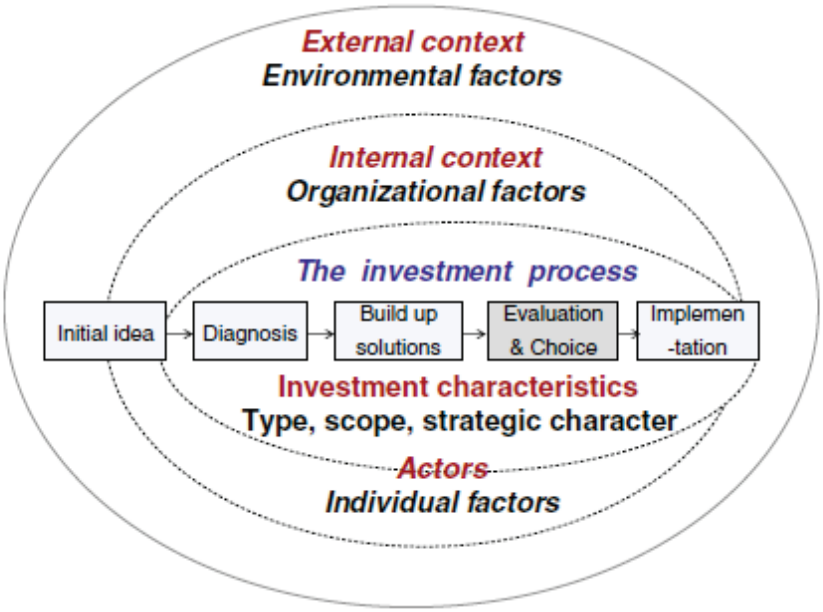

Figure 7: Cooremans' (2012) model of investment

In the beginning of the investment process there is issue identification where a new idea or issue is noticed and becomes salient. The values and culture of the firm and of individuals of the firm will be critical in filtering what is important and therefore noticed. In the middle there is the "diagnosis" phase where options are assembled and solutions are proposed. Again internal and external context, procedures and policies will be influential. Finally there is the choice phase where the various options are evaluated - this may or may not be undertaken with formal economic analysis using the tools of the trade: IRR, NPV and/or payback. There is plenty of evidence that often these methods are not used properly or sometimes at all. It is this last phase that the neo-classical account is most concerned with (Cooremans 2012).

With reference to stakeholders in commercial offices, Pellegrini-Masini and Leishman (2011) also describe a decision-making process embedded within a wider context: they define a theoretical framework which, "explains the interaction between resource factors, organisational dynamics and the drivers and barriers implicated in the decision-making of pro-environmental business practices". This framework also has the aim of "integrating the techno-economic and socio-psychological levels of analysis". They too have a role for individual decision-making which assumes the agency of the individual whilst acknowledging the influence of the individuals' perceptions of social and cultural factors - e.g. norms and values respectively. This model allows integration of a range of other theory drawing on psychology and social psychology (such as the widely used Theory of Planned Behaviour (TPB)[11]) to be situated within a conceptual model embracing the role of individuals and groups of individuals (forming sub-cultures within an organisational context). Pellegrini-Masini and Leishman's simple model is shown in Figure 8 below:

[11] For example see Parker, R. (2011) Green Organisational Performance: Behavioural Change Interventions based on the theory of planned behaviour pp 36-47 in (Bartlett & Kane, 2011)

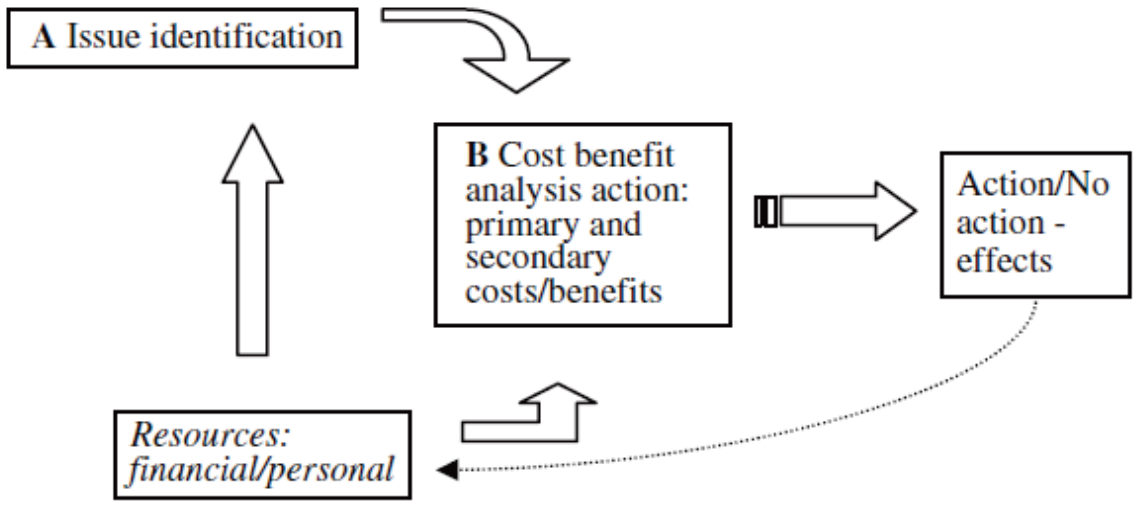

Fig. 1. Process of proenvironmental policy adoption.

Figure 8: Model of organisational decision-making re uptake of energy efficiency in office buildings.

At the heart of this model is a cost-benefit analysis – a rational and deliberative process. However, the "primary" and "secondary" costs and benefits referred to include some factors which aren't usually included in standard PTEM model such as reputational benefits. The model also moves away from the profit maximisation focus at the heart of PTEM, instead positing a range of costs and benefits which are more strategic in character[12]. In addition, the idea of "issue identification" as a critical antecedent of the cost benefit analysis draws in non PTEM or "PTEM plus" theory - the identification of what is or is not important is generally considered to be largely a function of organisational and individual culture and to be open to influence via carefully designed interventions which draw on insights from social psychology in particular[13].

Dieperink et al. (2004) also develop a conceptual framework to explain uptake and adoption of energy efficient innovations. This too highlights the importance of considering decision-making as a process with various phases. They state, "the [internal] decision-making process is usually overlooked, but should be placed at the core of any explanation of innovation uptake of energy saving technologies". They conclude that for an innovation to be adopted, a firm must pass through 4 stages of a decision-making process which are all influenced by company context, company characteristics, economic and technological aspects of the innovation, and wider macro-developments that have an influence on the organisation. The four stages of the process are: 1) a serious enough occasion to arise for a firm to distract attention from its core activities and consider adopting a new technology; 2) a non-constraining initial perception of the quality of the innovation and its benefit for the firm; 3) the nature of decision-making *procedures*, mainly influenced by the firms characteristics (procedural culture and organisation etc), to determine the rational thoroughness of the assessment, and 4) an assessment of the technology in terms of the

[12] Primary costs/benefits are: 1. The rate of return of an investment or a new business practice 2.The capital cost of an investment 3. The costs and benefits originated by regulation. Secondary or primary costs/benefits are: 1. Increased reputation. 2. Increased employees' commitment 3. Increased attractiveness to jobseekers. 4. Increased marketability of products/services. 5. Increased attractiveness towards investors 6. Increased management competences

[13] A handbook of social-psychological techniques that are readily applied to workplace contexts is: Yes! 50 Secrets from the Science of Persuasion. (Goldstein, S. et al 2007).

effort given to an economic analysis, which assessment criteria are applied, and what values they are given. We consider how to conceptualise the Dieperink's organisational culture and procedures next.

Organisations are embedded within a broader socio-technical context

The array and presentation of choices is determined by the interaction of various kinds of factors – these can be grouped as "material", "regulatory-policy", "market" and "social-cultural". These domains were selected on the basis that they offer a comprehensive division of all types of influential factor. Their use emerged from a review of the theoretical work and a brainstorming session amongst the project team.

The theoretical basis of the framework is the proposition that distinct forms of (energy related) behaviour emerge from the interactions between the organisation and the social, infrastructural, regulatory and market context in which it is embedded. This is a "socio-technical" perspective where social, technological, regulatory and economic factors are integrated as co-evolving forces that shape behaviour: defining the range of behavioural choice and making some choices more difficult than others. A useful way of envisaging this is as a landscape with valleys, mountains and obstacles.

The relationship between organisation and context is a dynamic one because the embedding context shapes the organisation's procedures, culture and decision-making which in turn influence the context in which the organisation operates. For example, the context shapes the organisation's responses to energy efficiency opportunities as they are presented to the organisation. The organisation may or may not respond to the opportunity. If, and when it does, it will create infrastructural and social/cultural changes both within itself and externally: e.g. a new supply chain for a new (efficient) technology may be established, a new set of messages about the organisation's "brand" or standing relative to competitors in the same sector may be created and disseminated. These effects change, perhaps very subtly, the embedding context – which will therefore impinge on the organisation in new ways. The relationship is therefore continuously evolving and dynamic.

In navigating this landscape some routes - or technological choices - will be much more favourable than others. This is a rather different way of understanding technology adoption. In fact Shove, (1998) likens the contrast to the PTEM as a conceptual "chasm". However, "having jumped across the conceptual chasm, the landscape changes dramatically: once obstructive barriers collapse to reveal a perfectly ordinary scene of socio-technical regimes: some favouring the adoption of energy saving methods, others not" Shove (1998). How can we think about this "socio-technical regime" or "context"? Stephenson et al. (2010) attempt to forge a model of "energy culture" which describes this context (Figure 9).

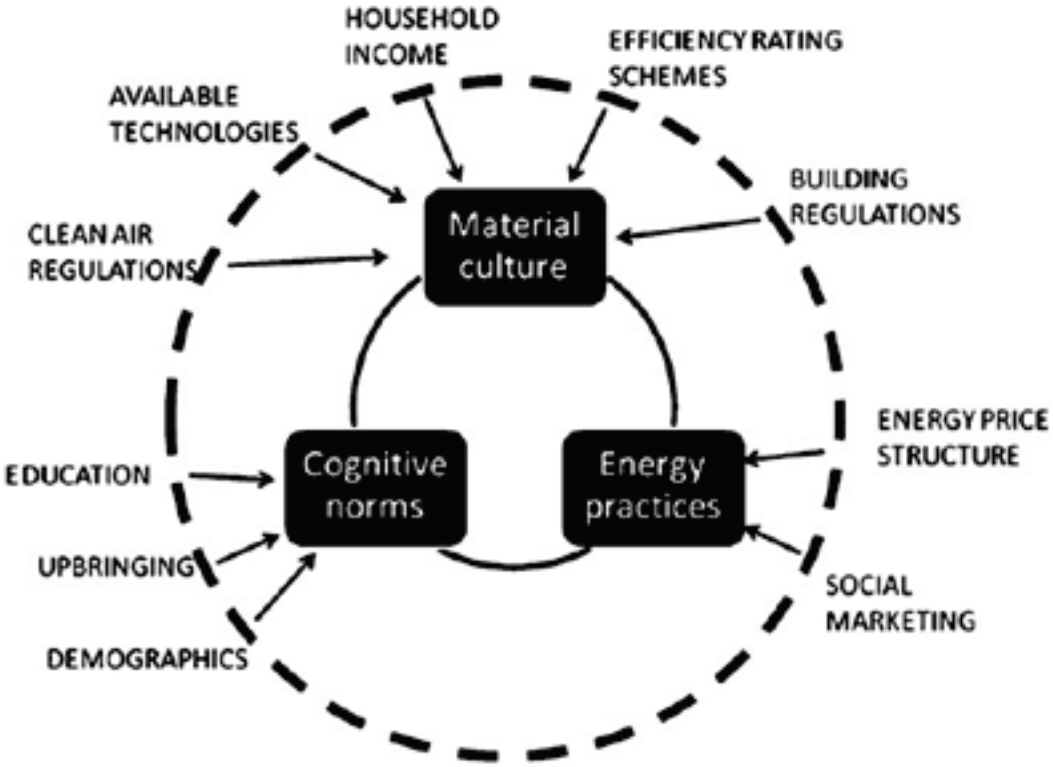

Figure 9: a model of energy culture shaping behavioural response

Although the model is primarily developed for application to domestic contexts the authors consider that it can be used across the piece. Its principal interest for the framework proposed here is that it recognises the importance of the context of behaviour made up of "factors" of various kinds and that there is a value and explanatory power in differentiating between various types of factor (the model was expressly developed to help in the design of public policy). Also that it is integrative – bringing together social factors with factors related to "material infrastructure" and "energy practices". These factors are themselves influenced by a wider set of factors such as energy price structure and clean air regulations.

The proposed conceptual framework draws on this idea – of an embedding context of various factors which originate in certain domains. This is done for the purposes of clarity and to aid in the analytic power of the framework. In practice we know that regulation, infrastructure, forms of technology and social processes all co-evolve and cohere in various changing configurations which continuously rewrite the rules of the game, the range of possible behavioural responses and the capacity of organisations to respond[14]. Together these factors create what has been called a "socio-technical" space –determining both what is visible - e.g. a technology or a recommended procedure - and what an organisation will consider "normal", "desirable" and "required". Organisations are themselves part of the socio-technical soup and also interact with each other in distinctive ways which in turn has an influence on how decisions are made.

For example, consider the development of Green Deal regulations. These regulations emerge in response to a recognised need to change something in the material

[14] This understanding is exemplified in texts such as, The Social Organisation of Technological Systems, eds. Wiebe E. Bijker, Thomas P. Hughes and Trevor Pinch. MIT Press 1987.

infrastructure of our society – the energy performance of homes and small businesses. This itself serves a social agenda (greater equity, environmental preservation). After a process of consultation with a variety of stakeholder groups all with their own social, cultural and political agendas the regulations are drafted and passed into law. These new laws will change the rules of market, creating new opportunities for some types of economic activity and depressing the opportunities for others. Green Deal measures will feed from a presumed social /psychological demand to make one's home or business more energy efficient in order to save money, be greener, do one's bit, build brand etc. As a result, buildings will undergo transformation of their material structure. The changes to the material structure will directly influence buildings occupant's behaviour - enabling some kinds of behaviour and discouraging others. The changes will also influence occupant thinking e.g. via mechanisms such as cognitive dissonance. Consequently, having taken actions under the Green Deal, more may well follow. This will in turn influence the markets for Green Deal goods and services. Further regulation may be required to influence the development of these new markets - and so on. This example is an attempt to demonstrate that there is a continuous interaction between material, regulatory, social and market domains.

This perspective allows us to quickly understand how the socio-technical landscape will be different in different sectors: the range and type of behavioural choice will change and be continuously changing in distinctive ways as the rules of the sectors' particular game are continuously rewritten. Therefore there is a patterning to decision-making in different sectors which is capable of identification. An understanding of the decision-making style and underlying motivations in a sector or sub-sector can be put to good use in policy design. For example the oil industry sector has high "sector-cohesion"(Bansal & Roth, 2000) – there are relatively few players, they all know each other's business, they have very strong trade associations and advocates that protect the industry as a whole. This tends to mean that industry players all think in a similar way, will not jump until all others in the sector also jump, there is less need for competition and consequently innovation and the sector is mainly responsive to regulatory pressures in driving ecological (and possibly energy efficient) reform of its business.

Application of the framework to the question of "barriers" to efficiency

The language of barriers and their removal in order to close the "efficiency gap" belongs in the realm of the Physical Technical Economic Model whereby it is assumed that organisations will behave rationally and in accordance with the classical economic model if barriers are removed. Socio-technical accounts of energy use, as have been discussed in the conceptual framework, would dispute this assumption, arguing instead that observed behaviour is the outcome of socio-technical processes having little resemblance to market actors attempting to maximise utility in a context of limited information and market imperfections.

Shove, for example, states: "an alternative socio-technical analysis would provide a socio-technical theory of energy efficiency, which is how problems relating to energy efficiency such as the efficiency gap should be re-framed and analysed (i.e. in terms of a social, contextual analysis). This requires new languages and research agendas to 'redefine the problem'; abandonment of the ideas of technical potential, non-technical barriers to be overcome, and linear models of technological diffusion". In this socio-technical view barrier removal is better thought of as a reshaping of the socio-technical landscape, somehow changing the rules of the game and therefore the available paths that diffusion of an (energy efficient) technology may take – e.g. widespread take up or confinement to a niche. In any event none of these paths have utility maximisation as their ultimate

destination. As Guy (2006) states a market “failure” created by “social barriers” is reconceptualised in the socio-technical model as “lack of perceived socio-commercial viability”.

Biggart and Lutzenhiser (2007) also point to the need to reconceptualise the energy efficiency paradox and the associated language of barrier removal and indicate the possible pitfalls for policy makers in continuing to allow the PTEM model to dominate thinking: “economic decision-making does not occur outside of other social relations. Beliefs, social structure, culture, power relations and other non-economic considerations are often implicated in energy decisions. Failure to include these in a meaningful analysis cannot lead to a full understanding or sound prescriptions” (p 1076).

This critique leaves the review with something of a dilemma. On the one hand we find that the bulk of researchers, policy makers and practitioners think in terms of the PTEM, generating and expecting analysis using the toolbox of terms and ideas this model has created, including ideas around barriers and their removal. And on the other hand, we find a profound critique of the PTEM’s fundamental assumptions from respected theorists in the field which go so far as to suggest that failure to acknowledge their arguments will result in unsound “prescriptions”.

Resolving the theoretical debate is evidently beyond the scope of this review and so a pragmatic course is followed: the analysis that follows acknowledges that that the notion of a barrier is contested and further recognises that policy built solely around barrier removal may not achieve its objectives even where barriers have demonstrably been “removed” because of underlying problems in the assumptions of the barrier removal model. However, in the absence of tractable theoretical framework capable of readily reconceptualising the literature on barriers into a form that is both useful to DECC and within the scope of this review, the analysis will proceed using a modified barrier model. The model is modified by drawing attention to the theoretical context in which the “barrier” is framed and the conclusions that are made about what the effects of its removal might be.

Appendix 5: Categories and types of barrier

Sorrell et al.,(2011) describe the following categories of barrier.

Table 1
Classification of barriers to energy efficiency based on Sorrell et al. [6].

Theoretical framework	Theoretical barrier	Comment
Economic non-market failure	Heterogeneity	A technology or measure may be cost-efficient in general, but not in all cases.
	Hidden costs	Examples of hidden costs are overhead costs, cost of collecting and analyzing information, production disruptions, inconvenience, etc.
	Access to capital	Limited access to capital may prevent energy efficiency measures from being implemented.
	Risk	Risk aversion may be the reason why energy efficiency measures are constrained by short pay-back criteria.
Economic market failure	Imperfect information	Lack of information may lead to cost-effective energy efficiency measures opportunities being missed.
	Split incentives	If a person or department cannot gain from energy efficiency investments it is likely that implementation will be of less interest.
	Adverse selection	If suppliers know more about the energy performance of goods than purchasers, the purchasers may select goods on the basis of visible aspects such as price.
	Principal-agent relationships	Strict monitoring and control by the principal, since he or she cannot see that what the agent is doing may result in energy efficiency measures being ignored.
Behavioral	Bounded rationality	Instead of being based on perfect information, decisions are made by rule of thumb.
	Form of information	Research has shown that the form of information is critical. Information should be specific, vivid, simple, and personal to increase its chances of being accepted.
	Credibility and trust	The information source should be credible and trustworthy in order to successfully deliver information regarding energy efficiency measures. If these factors are lacking this will result in inefficient choices.
	Inertia	Individuals who are opponents to change within an organization may result in overlooking energy efficiency measures that are cost-efficient.
	Values	Efficiency improvements are most likely to be successful if there are individuals with real ambition, preferably represented by a key individual within the top management.
Organizational	Power	Low status of energy management may lead to lower priority of energy issues within organizations.
	Culture	Organizations may encourage energy efficiency investments by developing a culture characterized by environmental values.

Appendix 6: Table of size and sector influences and organisations capacity to respond to efficiency opportunities

The table below summarises the main effects of size and sector across 3 key aspects of an organisation's capacity to respond to energy efficiency opportunities: structure and hierarchy, skills and resources and strategic value of energy efficiency.

	Size effects	Sector effects
Structure and hierarchy	1. Larger organisations will have more strategy and bureaucracy derived from a central source so that the various elements of the organisation can operate without personal oversight. This means that an energy or environmental strategy is a more natural fit with a larger organisation's management systems and can be deployed over a large number of activities quite efficiently. 2. However larger organisations can experience principal-agent problems particularly where energy efficiency is not considered as having strategic value – operations staff who are most concerned with increasing energy efficiency can be several rungs away from senior management in an organisation's hierarchy. This will directly impact the likelihood of recommendations becoming implemented. 3. The closer the energy manager is to the CEO in the organisation's hierarchy the more energy management will take place. 4. In smaller organisations the values and attitudes of senior managers will tend to be more influential in shaping energy management than in larger organisations.	1. Some sectors have greater "sector cohesion" than others – sector cohesion is the density of interaction between players in the supply chain. Sectors with high cohesion, such as the oil industry, will tend to act together to protect their industry's collective interests. 2. Our evidence suggests that high sector cohesion can stifle energy efficient innovation if it casts others in the same industry in a bad light. On the other hand it is also suggested that once an organisation in a cohesive sector has transformed its management then others will quickly follow suit. Perceived norms are important in driving behaviour in sectors with high sector cohesion.
Skills and resources	1. Smaller organisations will tend to have less time and technical skills to consider energy efficiency opportunities, to sift and process relevant information. 2. Larger organisations will have greater resources to employ dedicated energy or environmental managers 3. Larger organisations are better able to bear the costs of	1. Energy intensive sectors will often employ an energy manager. However in non-energy intensive sectors or sectors where buildings are most commonly leased (such as commercial offices) the de facto energy manager will usually be the caretaker or building operator. The important role of this individual is often overlooked for these sectors. 2. Sectors which experience

	participation in Voluntary Environmental Programmes. 4. Larger organisations will have better access to capital to allow borrowing for energy efficient investment and will accept longer payback periods.	relatively high levels of competition are more likely to search out innovative and potentially energy efficient technology. 3. Some evidence suggests that sectors may impose different hurdle rates e.g. public sector organisations require shorter paybacks that private sector organisation in the US.
Salience of energy use and strategic value of energy efficiency	1. Our evidence suggests that larger organisations are more likely to lease green office space and are also more likely to adopt certified energy and environmental management systems such as ISO 14001. This is proposed to be because larger organisations tend to have a greater investment in protecting their public image and are also more disposed to establish credibility with international trading partners. In both instances apparent energy efficient behaviour and evidence of energy management give energy efficiency a strategic value. 2. We have some evidence that smaller organisations tend to feel that assisting government meet its institutional objectives (e.g. climate change targets, energy targets) is more the responsibility of the bigger players. There is less sharing of high level agendas on energy efficiency.	1. The energy intensity of a sector influences the salience and strategic value of energy efficiency. Energy audit findings are more widely adopted and considered more favourably in energy intensive sectors whilst sectors where energy use is a small part of the cost base are less likely to have energy strategy in place. 2. Sectors which are closer to the public in the supply chains, sometimes termed final goods producers, are more disposed to take part in Voluntary Environmental Programmes to maintain a benign public image. 3. The more highly regulated a sector the greater the likelihood of participation in a Voluntary Environmental Programme 4. Sectors which have an overriding stake in ensuring the comfort and morale of their staff such as legal and financial services sectors are more likely to lease green office space: energy efficient offices are considered a more comfortable and hence productive environment. 5. Sectors which operate in environmentally sensitive areas such oil and gas and forestry are more likely to lease green office space in order to offset potentially negative reputation effects. Equally sectors where energy is salient because it is part of their business are more likely to have energy management activity underway.

Table 15: Size and sector influences on organisational capacity

Appendix 7: Project materials and legacy

Full completed data extraction template as a spreadsheet

All papers in the evidence base have been added to the data extraction template in an Excel spreadsheet. It contains information on study characteristics and content, as well as quality assessments and critical analysis by the researchers who extracted the papers.

Mendeley database

Free web-based database software Mendeley has been used to store documents used in this study and to share them with DECC and amongst team members. For all documents, publication details including an abstract (where available) are recorded in the database. For journal articles, there is a record in the “tags” field of the research database from which the paper came, and in the “notes” field of the key words combination used to find the paper.

Journal articles which have been accessed via Oxford University’s library system cannot be supplied to DECC as part of this project, as that would be breaking copyright law. All other material, which is not subject to copyright restrictions, and which is available electronically, is included in the database.

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