Department for
Business, Energy
& Industrial Strategy

INVESTING IN ENERGY EFFICIENCY

Investigating the Total Costs to Business

BEIS Research Paper Number 18

September 2017

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Executive Summary

Introduction

Eunomia Research & Consulting Ltd (Eunomia) in collaboration with Verco Advisory Services Ltd (Verco) and the Centre for Sustainable Energy (CSE), is pleased to present this report to the Department for Business, Energy and Industrial Strategy (BEIS) in respect of investigating the total costs to business of investing in energy efficiency measures.

The main objective of the research project was to quantify the non-capital[1] or 'hidden' costs associated with investment in energy efficiency and low carbon technology. As the scale of these costs is not well understood, it is unclear to what extent these costs may inhibit businesses from investing in energy efficiency measures. Additional aims of this research were to provide:

1. Quantitative estimates of the size and scale of non-capital costs compared to capital costs that businesses usually consider as part of their appraisal of energy efficiency and low carbon investments;

2. Better understanding, complete with estimates where possible, of businesses' approaches to project risk, including cost contingencies, discounting and payback periods; and

3. A greater understanding of the decision making process that firms go through and how energy efficiency investments are assessed to determine commercial viability.

The research focussed on investments in energy efficiency and low carbon technologies for industrial processes,[2] prioritising large scale investments where possible. This included a mixture of both non-energy intensive and energy intensive organisations, although by the very nature of industrial process, many participating organisations were classed as energy intensive. Face-to-face or telephone interviews were held with 30 organisation from these industrial sectors. Participants were drawn from an existing contact list and selected industries, such as the food & drink, automotive, chemicals and metals sectors. Alongside the interview, participants were also asked to share any business case data available relating to these investments.

[1] Any cost attributed to the project which is not incorporated into the capital component.

[2] Defined as process efficiency and process modification, new technological processes, energy input substitution (i.e. fuel switching, including renewable heat, waste heat, Combined Heat and Power (CHP) and Biomass), non-energy input substitution (e.g. clinker substitution in cement production); and Carbon Capture and Storage/Utilisation (CCS/CCU), excluding grid power sector, taking place within the industrial sector. IT does not include behavioural change. The industrial sector is defined as the DUKES definition at the SIC 2007 level, plus petroleum refineries, coke manufacture, blast furnaces and patent fuel manufacture, oil and gas extraction, and coal extraction.

Interpretation of Qualitative Data

This report shows the range of views and experiences among those interviewed. This is qualitative research with a sample size of 30 companies, 19 of whom provided business cases. Due to the sample size, the sample is not representative of the industry population as a whole. Therefore, where the prevalence of a viewpoint or practice has been quantified as a proportion or number, this should be considered illustrative of the sample, rather than statistically representative of the population. Additionally, as the research used semi-structured interviews, each participant was asked a set of bespoke questions based on an agreed topic guide. Therefore, in some instances specific questions were only asked of a selection of the sample.

Main Findings

This report has identified a wide variation in behaviour and approaches to energy efficiency measures.

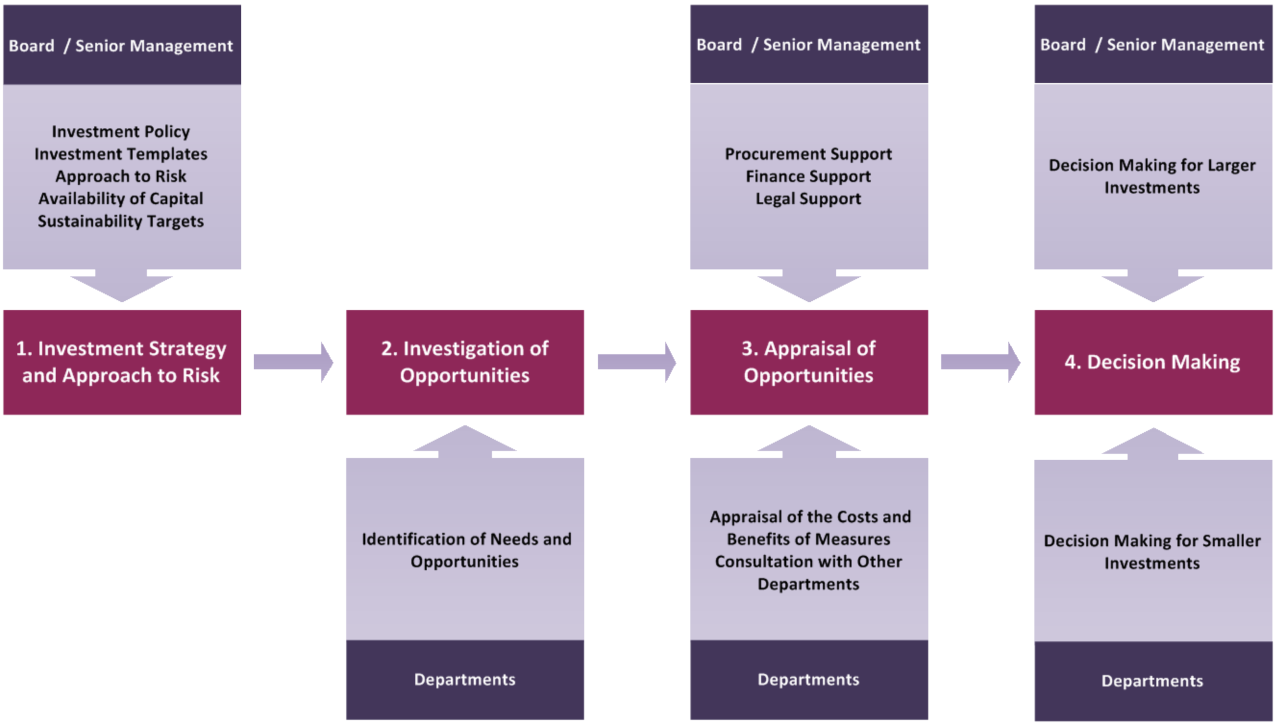
Investment Framework and Process

Attitudes relating to investment in energy efficiency measures varied across the 30 companies interviewed, according to their size and corporate structure. However, in many cases the investment process was simply characterised as a ‘request for capital’ based on approving expenditure associated with energy efficiency measures and providing a simple payback calculation.

Investment policy, approach to risk, availability of capital and sustainability targets were typically ‘top-down’ aspects of decision making, driven by the board or senior management. Energy efficiency considerations and project appraisals were typically ‘bottom-up’, initiated at a departmental level.

A consistent process to identify, appraise and approve energy efficiency measures exists. This comes with a set of common responsibilities, with boards and senior management taking on similar responsibilities within organisations. The typical roles and responsibilities are presented in Figure 1. While the individual steps associated with investments are unique in each company and are dependent on a range of factors (including risk, cost of the investment and timing), the four key steps (shown in Figure 1) were found to be consistent amongst all participants in the research.

Figure 1: Organisational Roles and Responsibilities



Investment Strategy and Approach to Risk

Nine of the 30 participants reported that corporate-led carbon and energy reduction targets helped drive the investigation of investment in energy efficiency and low carbon heating measures. However, more importantly, 17 out of 30 organisations reported that they were risk averse with regard to retrofitting energy efficiency measures, and their attitude to risk had a significant impact on investment decisions and processes.

Many participants financed energy efficiency and low carbon projects from their own capital, with three participants suggesting this enabled them to take advantage of tax ‘breaks’, such as Enhanced Capital Allowances (ECAs).[3] There were a small number of instances of participants using third party funding, but this was typically only for very large investments such as new combined heat and power plants and large-scale biomass boilers.

Seventeen of the 30 participants stated that investments were appraised using a simple payback calculation. Among the 23 participants that shared information relating to payback periods the thresholds of successful investments were relatively short, with less than five years cited by 21 participants.

In respect of technologies covered, organisations were typically technology agnostic, although amongst the majority of participants there was a strong preference for measures

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[3] As explained above, this study used qualitative research methods and therefore not all participants discussed the same topics or issues. Therefore, where the prevalence of a viewpoint or practice has been quantified as a proportion or number, this should be considered illustrative of the sample, rather than statistically representative of the population.

which would not interrupt production. Indeed, the greatest risk cited by participants was the potential for any detrimental impact of energy efficiency measures upon production or quality of products. Such costs, however, were not included in the business plans received. This suggests that projects which would impact production were screened out and did not make it to a full investment appraisal.

As a consequence, organisations typically installed energy efficiency or low carbon measures during scheduled maintenance or downtime windows to avoid any impacts to production and (indirectly) sales. There is also some evidence which suggests that some ‘intrusive’ measures, which are likely to result in loss of production, are not even appraised by organisations, with thirteen participants citing this as a reason for projects not proceeding.[4]

Investigation of Opportunities

The level of detail in the feasibility assessments and/or business cases prepared by participants varied significantly. As mentioned above, the primary appraisal method described by the majority of participants was an evaluation of the payback period for investment in a given project. Four of the 30 participants however, stated that their organisation appraised investments based on an internal rate of return (IRR), rather than a simple payback calculation.

All participants stated that business cases or capital requests were typically developed internally by the department in consultation with company stakeholders, such as the health and safety officer, operation or production managers, project engineers and using in-house expertise. Seven of the 30 participants suggested that they also gathered information by attending networking events, industry conferences and trade exhibitions and making use of trade literature.

Approach to Quantification

Definition of Capital and Non-Capital Costs

One of the aims of this research was to identify and quantify non-capital costs. As such, no pre-defined list of costs was offered to interviewees. Instead participants were asked to describe the types of costs included in their investment appraisals and the scale of such costs. These costs were then analysed by the research team and defined as non-capital or capital costs based on the description provided by participants. Typically, capital costs were considered to be any cost associated with the purchase and installation of specific plant and equipment whilst non-capital costs were defined as follows:

- General overhead costs of energy management;
- Costs involved in individual technology decisions; and

[4] The issue of downtime and undertaking installations during scheduled maintenance was not a specific question within the topic guide. This issue was raised independently by a number of participants but was not discussed with all interviewees.

- Loss of benefits in individual technology decisions

See Table 1 on page 38 for a detailed definition of non-capital costs.

The scale of capital costs associated with energy efficiency measures cited by participants ranged from £3,500 to over £50 million. In many cases the ‘capital costs’ described by participants included all costs with no differentiation between capital and non-capital costs. As such, capital costs accounted for between 50% and 100% of the total (capital and non-capital) project costs in the business cases provided. We were given access to 21 business cases from 19 individual organisations. In five cases, the estimates of capital costs were differentiated between ‘equipment and installation’ and the cost of ‘civil engineering works’, such as foundations, access roads etc. Equipment and installation costs ranged between 40% and 100% of total costs, whilst civil works ranged between 2% and 51% of total costs.

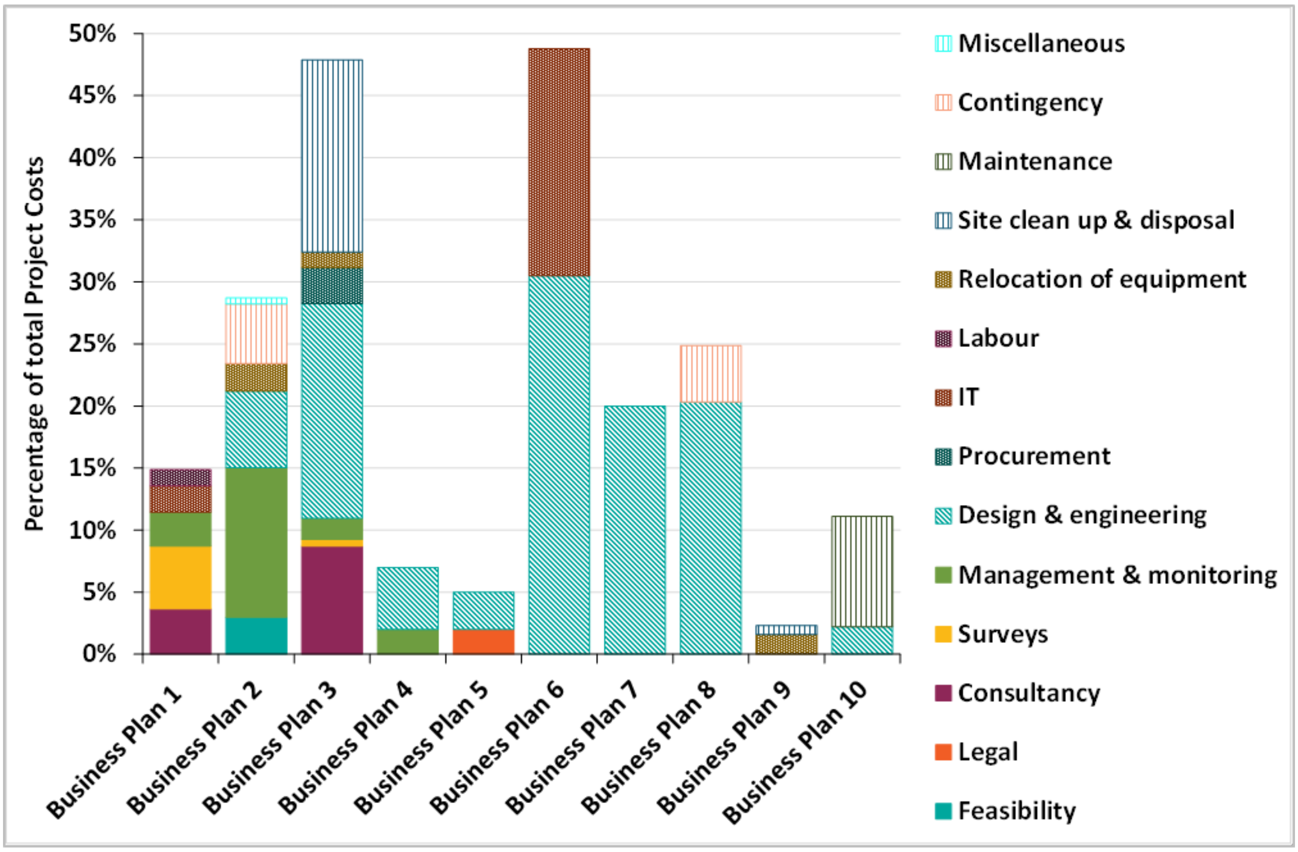
For the construction, vehicles, and paper, printing & publishing sectors the cost of equipment and plant accounted for 100% of the total costs of investment in the business plans provided as part of the research. This suggests that installation costs were wrapped up in the equipment costs and may have therefore been procured from a turnkey supplier. Business plans received from energy intensive organisations in the food, beverages & tobacco and chemicals sector most commonly included the cost of civil works. These were typically large investments which included, for example combined heat and power plant, turbine replacement and new evaporators.

In the business cases received, the equipment and plant costs made up a higher percentage of the total costs for smaller investment projects, such as voltage optimisation and compressed air plant. This may be because such projects are relatively straightforward and do not incur non-capital costs or because the low value of such projects did not warrant the time required to break down the costs for approval.

Non-capital costs did not carry the same importance in the investment appraisal process as capital costs as they only related to a small proportion of the total cost of the investment. Of the 21 organisations that discussed whether non-capital costs were prohibitive, 18 suggested that non-capital costs were not prohibitive to their organisation proceeding with an investment. The remaining three participants suggested such costs can be prohibitive depending upon the nature of the investment.

Within the business plans provided, over half (11 of the 21) did not identify any non-capital costs. In the remaining 10 business cases, non-capital costs accounted for between 2% and 50% of total project costs. The distribution of non-capital costs in each of these business plans is shown in Figure 2.

Figure 2: Distribution of Non-capital Costs in the Business Plans Provided

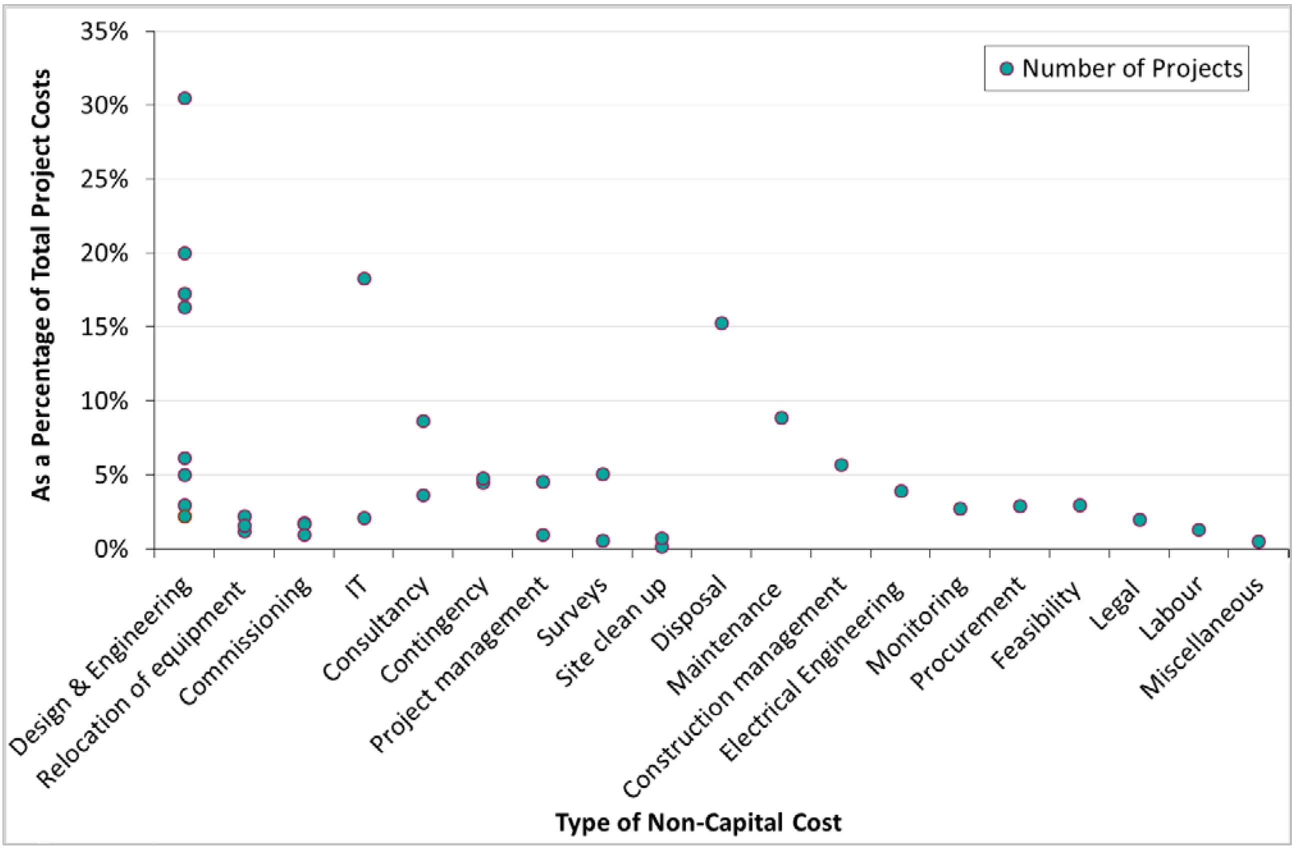


As shown in Figure 2, for specific projects, the highest non-capital costs contained in the business cases were those associated with 'design and engineering', IT and disposal of assets. Design and engineering were the only commonly cited non-capital costs in the business plans received.

Twenty-two of the 30 participants suggested that any 'internal' costs, such as those associated with feasibility or decision-making were not taken into consideration as these costs were usually considered as part of the overall operating cost of the business.

Figure 3 provides a breakdown of the frequency by which non-capital costs were identified within the business plans provided. Each dot represents the non-capital cost as a proportion of total project costs per project. Design and Engineering, for example, was identified in eight business cases with costs ranging from 2% to 30% of the total project costs.

Figure 3: Range of Non-capital Costs and the Frequency of Identification



With the exception of avoided energy costs and Climate Change Levy (CCL) savings, benefits were quantified on an ad-hoc basis. Project risks were also not typically monetised, although in some instances other methods, such as energy supply contracts, were used to guarantee cost levels. At least three participants from a range of sectors (mineral products, vehicles and printing) stated that risk was managed via such contracts with suppliers. These contracts provided guaranteed energy savings, which were used to reduce risk.

In the interviews, the majority of participants stated contingency was factored into their business cases or capital requests. Of the 24 participants that shared information relating to contingency, five said they did not factor in contingency, five participants applied a 5% contingency rate, one participant applied a 7% contingency rate and 13 participants said they factored in 10% contingency. Of these 24 participants, eight suggested that the contingency level varied depending upon the nature of the project and was impacted by the level of confidence an organisation has in the capital costs.

Whilst in the interviews 24 participants stated that contingency was factored into their investment appraisals, only two of the 19 business plans received included a contingency amount.

Key Messages

The key findings from the research are summarised below. It should be noted that these findings are not definitive and are based upon interviews with a small sample of organisations which have considered investments in industrial processes technology.

There is strong diversity across the 30 interviews in respect of attitudes to investment in energy efficiency measures. However, a consistent process to identify, appraise and approve energy efficiency measures exists. This comes with a set of common responsibilities, with boards and senior management taking on similar responsibilities within organisations.

Thirteen participants suggested that intrusive measures, which result in loss of production, are not usually appraised by their organisations. This is because they are considered to represent too much of a risk to the wider business. However, specific questions relating to downtime and intrusive measures were not asked. Therefore the evidence is not representative and this finding requires detailed follow-up research.

The templates used by organisations to appraise measures are typically simple pay-back calculations, with 17 of the 30 participants citing this method of appraisal. These templates are targeted at non-finance professionals and ensure that only key pieces of information are captured.

The extent of quantification of costs and benefits is controlled by the forms and the personnel completing them. The vast majority of these capture limited information, which focuses almost universally on capital costs.

Non-capital costs are not often captured, but when represented, they formed 2% to 50% of total estimated costs. The distribution of these costs varied from business plan to business plan, as shown in Figure 2. For specific projects, the highest non-capital costs contained in the business cases were those associated with ‘design and engineering’, IT and disposal of assets.

Twenty-four participants stated that they applied a contingency rate to their investment appraisals, with 5% to 10% cited by 19 participants.

Risk is not generally monetised in investment appraisals at departmental level, albeit this does appear to take place at board level.

Considerations for Policy Makers

Understanding the investment process and the associated roles and responsibilities is a key element of policy-making in this area. This research has identified a typical process that participants adopt, alongside a clear delineation of responsibilities throughout the process. Policies and programmes to promote the uptake of energy efficiency measures should consider the interaction of any related measures with this process.

The research has identified evidence that the majority of participants have adopted appraisal methods which typically favour the short term, over long term. This is particularly prevalent for retrofit measures where a simple payback calculation was the most common approach adopted. When appraising the uptake of measures therefore, it may be more appropriate for policy makers to model the impacts based on a simple payback calculation. This is particularly the case for retrofit and low cost technologies.

Almost all participants stated that it is standard practice to reduce the risk of retrofit projects by timetabling work to take place during scheduled maintenance windows. A smaller number of participants suggested that the perceived costs to the business associated with such intrusive measures was sufficient to deter participants from putting proposals forward. Therefore, although some investments appeared to offer significant benefits, they were unlikely to progress to appraisal unless they could be installed during a scheduled downtime. Further research is therefore recommended to provide understanding of the compatibility of suitable energy efficiency measures with scheduled maintenance windows in different industrial sectors.

Participants' quantification of non-capital costs is particularly variable and there is no clear pattern or consistency regarding the type and magnitude of such costs. There is some anecdotal evidence to suggest that the identification of non-capital costs appears to be influenced by participants' approach to risk; with the largest investments attracting the highest levels of non-capital costs.

Of the 21 organisations that discussed whether non-capital costs were prohibitive, 18 suggested that non-capital costs were not prohibitive to their organisation proceeding with an investment. The remaining three participants suggested that such costs can be prohibitive depending upon the investment. This gives some indication that when non-capital costs are monetised there are other factors which are more likely to influence the uptake of energy efficiency measures.

Introduction

Background

Eunomia Research & Consulting Ltd (Eunomia), in collaboration with Verco Advisory Services Ltd (Verco) and the Centre for Sustainable Energy (CSE), is pleased to present this report to the Department for Business, Energy and Industrial Strategy (BEIS) which investigates the total costs to business of investing in energy efficiency measures.

BEIS contributes to the UK government's efforts to combat climate change through energy efficiency policies that are effective and evidence based, while not unnecessarily burdening business or damaging the UK's competitiveness. BEIS assists the UK in meeting its environmental obligations, including through improved understanding of the incentives and costs that businesses face.

As businesses account for approximately a quarter of UK annual carbon emissions, they have an important role to play in the Committee on Climate Change's (CCC) five year carbon budgets.[5] The CCC has recommended that the UK government develop a series of decarbonisation roadmap reports for the most energy intensive industries. This work was commissioned by the former Department for Business, Innovation and Skills (BIS) and the former Department of Energy and Climate Change (DECC) (now merged to form BEIS), and published in March 2015.[6] In addition, the CCC recommended that the Government develops detailed plans, to ensure that mitigation action continues in the way intended by the roadmaps.

In order to effectively build on the work of the roadmaps, the Government requires detailed understanding of the costs and benefits which businesses consider prior to investing in energy efficiency measures. It seems reasonable that if businesses can make cost savings through greater efficiency, it makes good economic sense for them to do so. However several studies have recognised that companies do not always act this way, with 'hidden' or 'non-capital' costs being cited as the potential reason for this.[7] By failing to account for these additional costs, it is surmised in these studies that the net gains of energy efficiency to business are overestimated.[8] Currently, there is limited quantitative data regarding the full costs, including these non-capital costs that businesses face when making investment decisions. Examples of such costs include loss of production, additional training and associated costs of design or auditing.

BEIS commissioned this research to better understand non-capital costs. Alongside the identification of the costs, other areas of interest included the risks that businesses consider in appraising energy efficiency measures and how they are appraised by decision-makers within businesses. Existing evidence suggests that non-capital costs can

[5] www.theccc.org.uk/charts-data/ukemissions-by-sector/industry/
[6] www.gov.uk/government/publications/industrial-decarbonisation-and-energy-efficiency-roadmaps-to-2050
[7] www.gov.uk/government/uploads/system/uploads/attachment_data/file/65601/6925-what-are-the-factors-influencing-energy-behaviours.pdf
[8] www.sussex.ac.uk/Units/spru/publications/reports/barriers/final.html

be influential and can result in lower adoption of energy efficiency measures, which might otherwise have been considered attractive.[9]

Definition of Capital and Non-Capital Costs

One of the aims of this research was to identify and quantify non-capital costs. As such, no pre-defined list of costs was offered to interviewees, and instead participants were asked to describe the types of costs included in their investment appraisals and the scale of such costs. These costs were then analysed by the research team and defined as non-capital or capital costs based on the description provided by participants. Typically, capital costs were considered any cost associated with the purchase and installation of specific plant and equipment whilst non-capital costs were defined as follows:

- General overhead costs of energy management;
- Costs involved in individual technology decisions; and
- Loss of benefits in individual technology decisions.

Research Aims

The research aimed to quantify non-capital costs in a meaningful way and determine whether or not they had a prohibitive effect on a business' decision to invest in a particularly measure. The overarching aims of this research are to provide:

1. **Quantitative estimates of the size and scale of non-capital costs, compared to capital costs, that businesses usually consider as part of their appraisal of energy efficiency and low carbon investments;**

2. **Better understanding, complete with estimates where possible, of businesses' approaches to project risk, including cost contingencies, discounting and payback periods; and**

3. **A greater understanding of the decision making process that businesses undertake and how energy efficiency investments are assessed to determine commercial viability.**

The above aims were more clearly defined through subsequent research questions used to guide the study:

- How are hidden costs categorised by organisations and what is the scale of these costs?

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66566/7028-design-policies-efficiency-elec-edr.pdf

- At what stage of the decision making process are hidden costs taken into consideration?
- Do hidden costs prohibit organisations from proceeding with energy efficiency measures?
- What are the opportunity costs of investing in energy efficiency and how are these monetised?
- How do the opportunity costs compare against the investments in monetary terms?
- What is the discount rate, contingency level or pay-back period used by organisations?
- How do energy efficiency investment decisions interact with other investment frameworks?
- How does the investment process differ across the different types of organisation?

Methodology

This research comprised of both primary and secondary research techniques. We initially carried out a brief literature review of existing research on risks and costs to business associated with energy efficiency.

The primary research took the form of semi-structured qualitative interviews with 30 businesses. Where possible, these interviews took place face-to-face or, in some cases, via telephone and were carried out between April and June 2016. Interviews were conducted using an agreed topic guide and lasted around one hour. Alongside the interviews, participants were also encouraged to provide actual assessments and business cases containing their quantitative financial appraisals of potential energy efficiency investments. Further details on the methodology are shown in the technical annex.

Interpretation of Qualitative Data

This report shows the range of views and experiences among only those interviewed. This is qualitative research with a sample size of 30 organisations. **The sample is not representative of the industry population**. Therefore, where the prevalence of a viewpoint or practice has been quantified as a proportion or number, this should be considered illustrative of the sample, rather than statistically representative of the population. Additionally, as the research used semi-structured interviews each participant was asked a set of bespoke questions based on an agreed topic guide. Therefore in some instances some specific questions were only asked of a selection of the sample.

Interview quotations and case illustrations have been used where appropriate. Quotations have been attributed to participants using descriptive categories relevant to this research. Additional descriptive information has been included where this might help illuminate a finding and does not breach anonymity.

Challenges and Limitations

It is important to acknowledge the limitations of this research so readers can appraise the extent to which findings can be generalised and replicated.

Sampling Coverage

Even within organisations of the same size there can be significant variations in energy use and approaches to reducing it. For example, energy consumption and operational expenditure costs were much lower for a chemicals company compared to a steel manufacturer even though both can be considered industrial. Consequently different organisations will take different approaches to energy efficiency and low carbon measures.

The scope of the research was focussed on energy efficiency and low carbon technologies for industrial processes in the industrial sector. We prioritised large scale investments where possible. The organisations interviewed came largely from the food, beverages and tobacco, chemicals, vehicles and paper printing & publishing sectors.

The aim of the qualitative sampling process was not to be proportionally representative of the study population, but instead to ensure the sample represented the diversity within the industrial sector. A key element of the sampling was to interview both organisations who had begun an appraisal of energy efficiency measures but then decided not to go ahead, as well as those who did proceed.

Participant Recruitment

In total 89 organisations were invited to participate in the research, of which 30 agreed to interview (a response rate of 34%). There were a number of challenges in recruiting participants for the research. These included:

- gaining the participation of senior members of staff within organisations; and
- ensuring that commercially sensitive information was shared.

Regarding the second point, much of the information and data being gathered was commercially sensitive and therefore it has been necessary to ensure that businesses participating in the research cannot be identified. Where necessary, non-disclosure agreements (NDAs) have been signed with participants to protect the data from full disclosure. Therefore all data provided by participants has been anonymised and presented at an aggregated level.

There are three reasons why the sample and results may not be representative of the wider population; these stem from the recruitment process agreed. A necessary component of the definition of industrial processes, used here, is that the technology is installed in the industrial sector. This limited the companies who were asked to participate to the industrial sector. The sampling frame was also taken from a pre-existing list of contacts, rather than through random selection. Finally, participants self-selected based on the purpose of the study; the vast majority of those participating have gone ahead with investments, and the majority had business cases to share, as requested. A breakdown of the industries from which organisations were invited to participate, and the response rate is provided in Figure 4 and Figure 5 respectively.

A critical aim of this research was the analysis of business cases prepared by these organisations in relation to investments in energy efficiency measures and low carbon technologies. Consequently those that participated in the research were more likely to be organisations which prepared business cases than those who did not. This could not have been avoided, however, as obtaining and analysing business cases was a key element of the research.

Organisations who chose not to participate in the research were not asked to explain why they declined. One respondent, however, suggested research fatigue having already been involved in previous research projects.

Obtaining Business Cases

Participants that were successfully recruited generally spoke freely regarding investment decisions. However, in terms of helping us quantify non-capital costs, there was significant reluctance to share detailed financial information contained in business cases. This was despite assurances, including signed non-disclosure agreements. The reluctance was for a number of reasons, the most common being that the information was too commercially sensitive. In other cases, there was not a business case to provide. As confirmed in interviews, in many organisations the decision-making process did not include a detailed business case but instead used a simple capital request form. In these situations some participants did agree to share these but the level of detailed data was limited.

Of the 30 organisations who took part in the research, three organisations stated that they do not prepare business cases and eight did not provide a business case to us. Of the remaining 19, eight organisations provided a simple capital request form, a further eight undertook a basic business case and three organisations prepared a detailed business case. In total 21 business cases were received from 19 organisations.

Role of Participants

The research predominantly involved interviews with senior managers whose role included identifying and appraising energy efficiency measures. Many of the participants were also responsible for environmental management and sustainability within their respective organisation. As such their role included other responsibilities such as resource efficiency, utility procurement and environmental monitoring & reporting. At least one third of these individuals had an engineering background and therefore had a good understanding of their organisation's technical processes.

A small number of senior management and finance managers also participated in the research. These individuals were typically responsible for reviewing and approving investment proposals.

A small number of participants were responsible for, or had access to, a departmental budget (not always specifically dedicated to energy efficiency investments) which was used to make investment decisions. The majority of participants, however stated that requests for investment in energy efficiency measures needed to be submitted to senior management or board level for approval, due to the lack of a specific departmental budget dedicated to investment in energy efficient measures. The ability for participants to approve energy efficiency measures appeared to be influenced by factors such as the level of capital available to the organisation, its specific investment framework and the organisation's corporate structure, as discussed in more detail in the following sections.

Report Structure

The report has been structured as follows:

- **Background to the Organisations** – this section describes the organisations that took part in the research and the importance they place on energy costs;
- **Investment Framework and Process** – this section captures views on the approach to investments and framework used by participants;
- **Investment Strategy and Approach to Risk** – this section includes approaches to risk, company policies and strategies, availability of finance and investment policies and templates;
- **Investigation of Opportunities** – this section considers contents of appraisal and technologies considered;
- **Approach to Quantification** – this section captures quantitative estimates of the scale of non-capital costs relative to capital costs for energy efficiency projects that either received or did not receive funding. It also captures views on risk and whether it is monetized, and the use of contingency; and
- **Key Findings** – this section summarises the key findings of the research.

Background to the Organisations

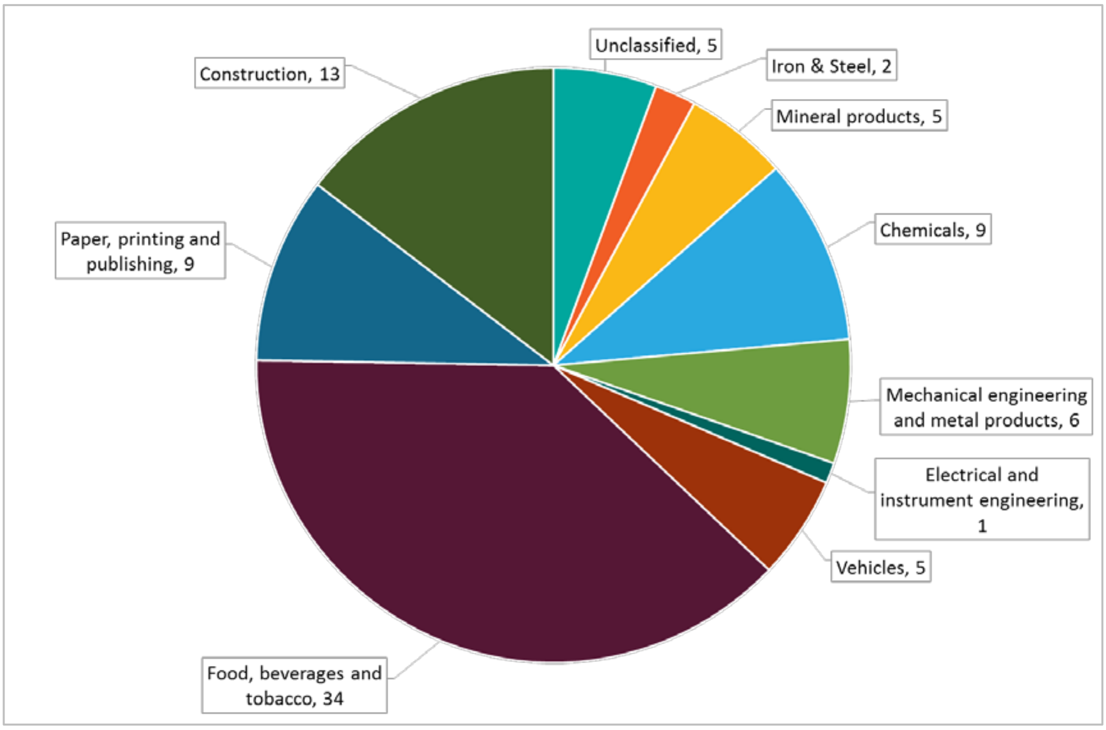
Types of Organisations

The research focussed on investment relating to energy efficiency and low carbon technologies for industrial processes in the industrial sector.[10] This included:

- Process efficiency and process modification;
- New technological processes;
- Energy input substitution (i.e. fuel switching, including renewable heat, waste heat, CHP and Biomass);
- Non-energy input substitution (e.g. clinker substitution in cement production); and
- Carbon Capture and Storage/Utilisation (CCS/CCU), excluding grid power sector.

Within this scope, 89 organisations were approached to participate in the study, as shown in Figure 4. Of these, 30 organisations agreed to participate in the research, as shown in Figure 5.

Figure 4: Industries Invited to Participate in the Research by Sector



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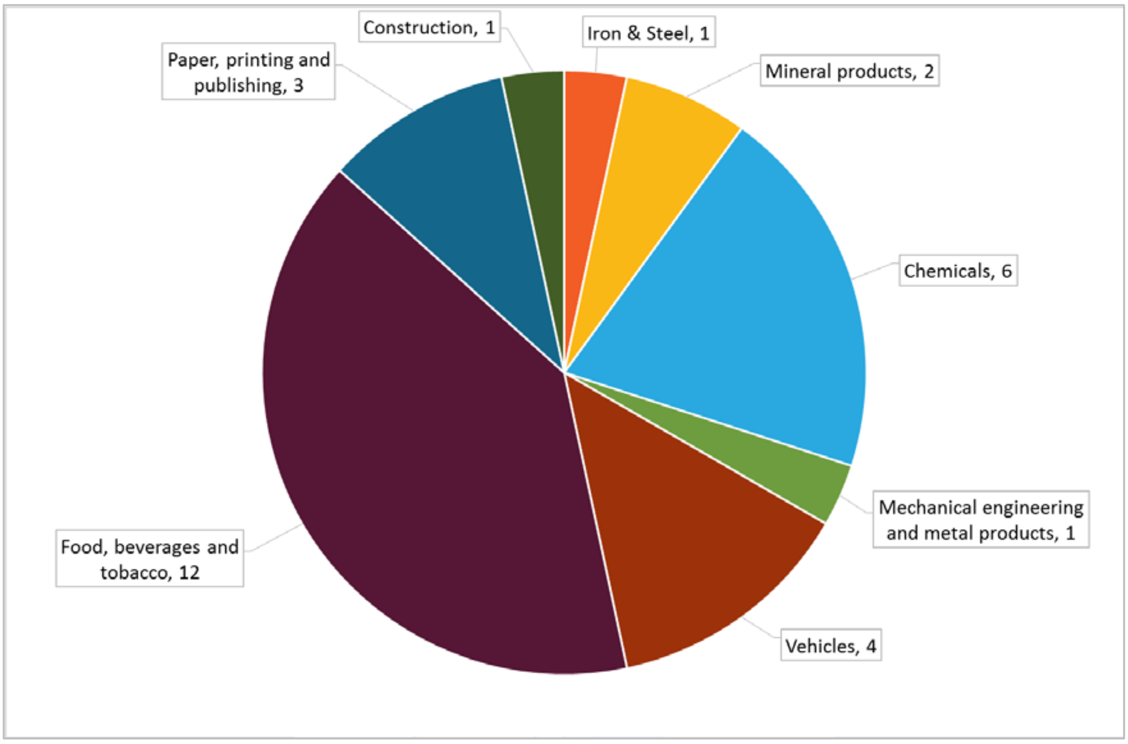
[10] As defined by the Carbon Budget and the SIC 2007 Classifications.

Figure 5: Industries Participating in the Research by Sector



Overall, the organisations participating in the research were predominantly large organisations (employing over 250 employees), although a small number of SMEs also participated in the research. Just under half of the participants employed over 1,000 employees. The majority of organisations operated across the UK, with 21 of these also operating in Europe and further afield. Furthermore, 22 organisations identified themselves as ‘energy intensive’.[11]

Importance of Energy Costs

Of the 30 participants, 22 suggested that their organisation placed a high level of importance on energy costs, particularly those organisations who described themselves as energy intensive. The most prominent uses of energy related to the generation of heat for process heating (typically via gas).

For the 22 organisations identifying themselves as energy intensive, participants suggested that energy costs were a significant proportion of their organisation’s operating costs and so there was an incentive to reduce energy costs through energy efficiency and low carbon generation. Many of these organisations identified energy costs as one of the key costs that could be actively managed. A small number of participants also specifically identified that reducing energy costs would maintain, or increase, their competitiveness.

Nine of the 30 participants stated that the cost of energy had always been an important issue; particularly for the energy intensive organisations. Meanwhile eight participants

[11] Whereby ‘energy intensive’ is defined as having energy costs that must be 3% or more of production costs.

reported that the level of importance placed on energy costs by their organisation had increased due to factors such as increased competition in their sector or better awareness of energy issues and the cost savings available.

There were different perceptions from participants relating to how changes in energy prices had affected the level of importance their organisation placed on energy costs over time. Two of the 30 participants suggested that there had been less importance placed on energy due to recent reductions in the wholesale price of energy (most likely gas). Two participants however, suggested that rising energy costs (possibly due to increasing non-commodity costs, such as network charges and policy costs) had led to greater importance being placed on energy within their organisation.

> **“[Energy is] Very important, energy is 13% of operating costs and the third largest cost, below raw materials and staff.”**
>
> *Metal manufacturer*

Investment Framework and Process

Summary of Key Findings

- Investment policy, approach to risk, availability of capital and sustainability targets were typically 'top-down' aspects of decision making, driven by the board or senior management;
- Energy efficiency considerations and project appraisals were typically 'bottom-up', initiated at a departmental level; and
- The investment process for at least nine of the 30 organisations was simply characterised as a 'request for capital' based on approving expenditure associated with energy efficiency measures and providing a simple payback calculation.

Approach to Investments

The particular approach to investments in energy efficiency measures varied among participants depending upon their size and corporate structure. Smaller organisations appeared to have ill-defined and flexible investment processes, with an emphasis on quick and efficient decision making. Investments in energy efficiency measures often utilised a simple capital request to senior management. A not too dissimilar approach was taken by large, family owned organisations, which prioritised quick and efficient decision making over detailed examination and analysis. By comparison, larger corporate entities tended to have a more rigorous investment framework in place, with a larger number of staff members involved in the decision-making process.

From discussions with participants it was apparent that there was in many cases an informal, two stage approach to investment appraisals taken by energy managers. The initial stage comprised a basic, 'common sense' check of factors such as, for example, the impact on production required for installation and/or likely payback periods. This check was not necessarily written down or recorded but was used to determine whether it was worth spending the time and resources investigating a measure in detail. If a measure made it through this informal screening process then it would go to a formal appraisal.

Interaction with Wider Investment Processes

All participants suggested that energy efficiency and low carbon heating investments were subject to the same process as other investment decisions within their organisation. This was typically based on an assessment of payback and business priorities at the time of decision-making. This approach allowed organisations to prioritise investments across the entire business. Consequently, participants suggested that investment proposals for energy efficiency measures often had to compete for capital with other investment proposals within the business – especially where there was no ring-fenced budget.

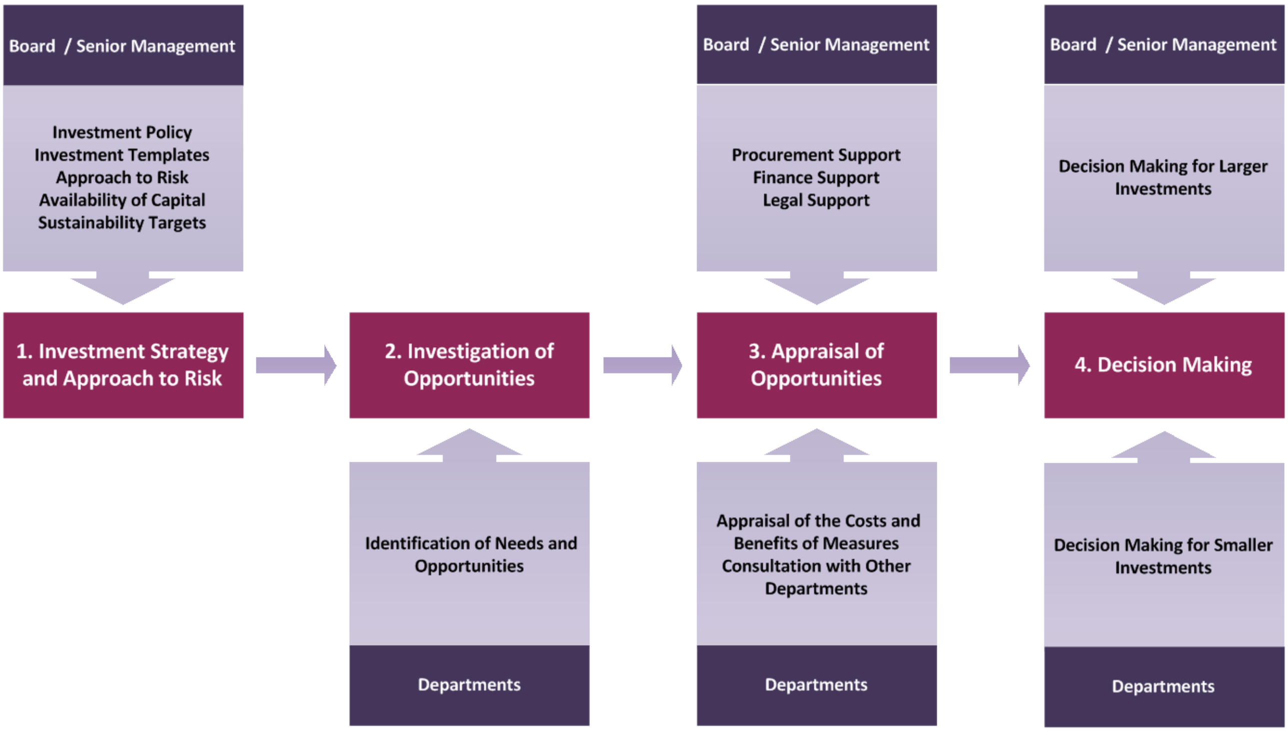
Roles and Responsibilities

All participants reported that organisations allocated different roles and responsibilities across their hierarchy associated with energy efficiency investments.

Universally, the management of risk, budget allocation, investment processes, and sustainability targets were all led by senior management and boards. By contrast, investigations and appraisal of energy efficiency measures were broadly a ‘bottom-up’ approach; with participants suggesting that departmental staff, rather than senior management led these tasks and reverted to board and senior management for approval.

The typical roles and responsibilities associated with energy efficiency decision making within organisations are shown in Figure 6. Whilst the individual steps associated with investments are unique in each organisation and are dependent on a range of factors (including approach to risk, cost of the investment and timing of investments), the four key steps (shown in Figure 6) were found to be consistent amongst participants in the research.

Figure 6: Organisational Roles and Responsibilities



Considerations for Policy Makers

Understanding the investment process and the associated roles and responsibilities is a key element of policy-making in this area. This research has identified a typical process that participants adopt, alongside a clear delineation of responsibilities throughout the process. Policies such as the Energy Savings Opportunity Scheme (ESOS) appear to have been designed to align with stages two and three of the investment cycle. Although ESOS includes an obligation for one or more board level directors to review the findings of the assessment, the obligations stop short of requiring the implementation of cost-effective energy savings measures in stage four. The Electricity Demand Reduction Pilot (EDR) has been set up as another possible way to support the decision making process. The participants who secure funding via the EDR pilot auction are expected to see the financial viability of their energy saving project improve. However pilot design, including strict deadlines to register interest and apply to participate in the pilot may have delayed or reduced overall pilot participation. A full evaluation of the pilot is underway and findings will be reported to parliament at the conclusion of the pilot. This highlights the importance of ensuring policies and programmes to promote the uptake of energy efficiency measures consider the interaction of all related measures with investment appraisal processes.

Investment Strategy and Approach to Risk

Summary of Key Findings

- The majority of participants stated that investments were appraised using a simple payback calculation;
- Of the 23 participants that shared their payback thresholds, 21 cited relatively short payback periods of less than five years. The remaining two participants suggested a much longer payback threshold of nine and ten years;
- Of the 30 participants, over half stated that corporate led carbon and energy reduction targets helped drive investment in energy efficiency and low carbon heating measures;
- At least half of the 30 organisations participating in the study typically financed energy efficiency and low carbon projects using their own capital, often taking advantage of tax 'breaks' such as Enhanced Capital Allowances;
- Organisations were typically risk averse in respect of retrofitting energy efficiency measures and the organisations' attitude to risk had a significant impact on investment decisions and processes; and
- All participating organisations were technology agnostic, although there was a strong preference for approving measures which would not interrupt production.

Company Policies and Targets as Drivers

At least half of the 30 participants suggested that their organisation had targets and policies in place relating to energy performance and carbon reduction. These included ISO 14001 and ISO 15001, with at least seven participants stating that they had an Energy Management System (EMS) in place.[12] Participants from at least nine organisations (all of which had 500 employees or more) stated that their company had either site-specific or corporate carbon or energy reduction targets in place. These participants suggested that these targets helped to drive investment in energy efficiency and low carbon heating although they were not the main driver. The overall impact of these policies on energy efficiency investments appeared limited, however, as only a very small number of organisations cited these as a key driver for investment in energy efficiency measures.

[12] ISO 14001 is the International Standard for Environmental Management Systems and ISO 15001 is the International Standard for Energy Management Systems.

Alongside organisations' own policies and targets, it was noted by three participants (particularly from the food manufacturing sector), that their customers (typically retailers) promoted investment in energy efficiency measures. Therefore in these instances, there were external commercial drivers, in addition to internal drivers.

> **"Corporate Sustainability Strategy guiding 5% energy/CO_2 reduction at a business and site level, based on a 2015 baseline. Corporate energy reduction strategy guides investment decisions, and also aligned to EMS"**
>
> *Food and Drink Manufacturer*

The Energy Savings Opportunity Scheme (ESOS) was cited by several participants as an example of a legal requirement to consider their energy use. Although participants were not asked specifically about the impact of ESOS on their energy efficiency projects, at least eleven participants suggested that they already had detailed knowledge of their energy use (for example via sub-metering) prior to the introduction of the scheme and therefore it did not act as a significant driver.

Five of the 30 participants, mainly those in smaller organisations, stated that the organisation had no environmental policy in place to stimulate investment in energy efficiency and low carbon heating technologies.

Approach to Risk

Seventeen of the 30 participants identified their organisations as being risk averse and this impacted the approach towards retrofitting energy efficiency measures. All of these participants expressed the view that their organisation was not unique in this regard and that this approach to risk was consistent across their sector.

Participants were not specifically asked to categorise the risk considered by their organisations however the key risks commonly cited by participants included (in order of prevalence):

- **Operational risk** relating to the loss of production or adverse impact to the quality of products during the installation of energy efficiency measures. This was identified by at least 16 participants;
- **Economic risk** relating to uncertainty in particular sectors affected by global market forces, such as food and drink manufacturing and iron and steel. Participants also cited economic risks relating to energy price volatility which, in some cases, can make it difficult to confidently estimate potential savings and payback;
- **Technical risk** relating to the credibility and proveness of energy efficiency and low carbon technologies; and
- **Safety risk** relating to the potential impacts to site safety as a result of technologies being installed incorrectly or impacting production processes.

A large proportion of participants reported that their organisation's approach to risk was led by top-down policies, but it was also recognised by a smaller number of participants that some risk aversion also prevailed amongst individuals working in departments. It was noted that some members of staff were measured on the success of energy efficiency measures and therefore opted to identify lower risk measures, so to increase the chances of success.

Attitude to risk had a significant impact on investment decisions and processes. Risk appeared to be factored in to:

- **The financial appraisal assumptions**. At least twelve participants aimed to reduce risk by ensuring that payback thresholds favoured measures that were forecast to deliver large returns on investment (i.e. only investing in measures with short pay-back periods);

- **The types of measures considered**. At least ten participants reported the requirement to invest only in measures that have been proven to be successfully deployed in their industrial sector;

- **The oversight and decision-making strategy deployed by boards and senior management**. At least five participants reported that larger scale and complex investments typically attracted greater scrutiny; and

- **Procurement of energy services**. At least three participants from a range of sectors (mineral products, vehicles and printing) stated that risk was managed via contracts with suppliers. These contracts provided guaranteed energy savings, which were used to reduce risk.

Eleven of the 30 participants suggested that the appetite for risk in their organisations depended upon the nature of the investment; typically this related to the magnitude and timing of the investment. For example, those energy efficiency measures which did not impact production would be classified as lower risk investments as there was no impact to production or sales. In contrast, new product development, which would impact production and sales, would be considered higher risk. Ten participants, however, took a contrasting view and suggested that the appetite for risk is the same across all projects in the organisation regardless of their characteristics.

> **"We seek to minimise risk wherever possible. Any downtime [to upgrade a plant] is estimated to cost £1 million per day in lost revenue. Therefore integrating energy efficiency measures into this type of plant is considered to be extremely high risk and requires a back-up**."
>
> *Mineral Producer*

To minimise risk, a small number of particularly risk averse participants from organisations which operated across multiple sites suggested that their projects were more likely to get approved if a similar project had been successfully implemented on another of their sites.

More widely, a larger number of organisations reported to utilise a centralised energy/ sustainability/ green team, who helped to share ‘success stories’ within each organisation.

Almost all participants stated that it is standard practice to reduce the risk of retrofit projects by timetabling work to take place during scheduled maintenance windows. A smaller number of participants suggested that the perceived costs to the business associated with such ‘intrusive’ measures was sufficient to deter participants from putting proposals forward. Therefore, although some investments appeared to offer significant benefits, they were unlikely to progress to appraisal unless they could be installed during a scheduled downtime.[13]

This particular issue was followed up with participants via an email exchange after interviews. The following questions were asked of participants:

What is the monetary value of the potential energy efficiency investments which were not appraised due to concerns about stoppages to (or reductions in) production outside of scheduled maintenance or ‘downtime’ periods:

In the last year?

In the last 5 years?

Which specific energy efficiency technologies does your answer to the question above cover?

What is the monetary value of potential energy efficiency investments which were appraised in some form, even if they were later rejected?

In the last year?

In the last 5 years?

What proportion (in monetary terms) of total potential energy efficiency investments were ruled out on this basis:

During the last year?

During the last 5 years?

The response to the additional request was limited (nine participants replied), but seven of the nine participants suggested that all of the energy efficiency measures they considered can be installed within regular maintenance schedules. It is unclear, however, whether this can be interpreted that any measure can be installed in regular maintenance schedules because they are of sufficient duration, or whether only certain measures which could be installed in regular maintenance schedules are considered.

[13] The issue of downtime and undertaking installations during scheduled maintenance was not a specific question within the topic guide. This issue was raised by independently by a number of participants but was not discussed with all interviewees.

> **"Stoppages typically occur for a maximum of 20 hours per year. Any project that needs a longer stoppage is hugely costly, so is unlikely to be viable outside of the scheduled stoppage window. Additionally, if an energy efficiency project extends the stoppage, it could render the whole project unviable."**
>
> *Chemicals Manufacturer*

Further research is recommended so to understand the compatibility between scheduled maintenance windows and technical requirements of suitable energy efficiency measures.

Investment Policies and Templates

Twenty-one of the 30 participants reported that their organisations imposed different thresholds and processes on different types of investments. This is in keeping with other studies, whereby how a project is categorized influences the assessment method and profitability requirements for financing.[14] These were often dependent on the nature and magnitude of investments required. Three participants stated that there were no differences in the thresholds in place for different types of investments. The majority of participants reported that templates for investment were typically provided by finance departments.

Capital and/or payback thresholds for passing decision-making to senior or board management varied across organisations. Some participants suggesting that anything over £1,000 had to go to senior management whilst other participants suggested a limit of £25,000. This variation did not appear to be based on the size of the organisation or its sector but more upon how 'cash-rich' the organisation was, or whether energy efficiency measures could draw on departmental budgets. Three of the 30 participants suggested that the thresholds within their organisation had changed over to time to reflect the company's financial standing.

For larger businesses, the investment framework typically included at least two levels of decision-making. The first was at the department or site management level. If approved at this level (and above a certain capital/payback threshold) the investment proposal would then be progressed to the board. For international companies, investment decisions were typically reviewed by the site management, the UK management team and then, if above a certain threshold, the Group board.

Larger organisations, particularly energy intensive businesses, were much more likely to work from a defined annual or quarterly budget. In a small number of cases, capital was specifically set aside for energy efficiency investments. Even for some of these larger organisations, however, measures which would require an interruption to production were, in almost all cases, appraised against the needs of the business rather than an investment appraisal. As described above, the perceived costs of loss of production were such that many managers were unlikely to investigate measures that would interrupt production,

[14] Cooremans, C. (2012) Investment in energy efficiency: do the characteristics of investments matter?, Energy Efficiency, Vol.5, No.4, pp.497-518

unless the equipment was being replaced anyway due to the other operational needs of the business or installation could be performed during scheduled downtime.

In respect of the timing of investments, 14 of the 30 participants stated that investment decisions were made on an annual cycle to coincide with the allocation of budgets. Others, meanwhile, stated that there was a rolling approval process with investment decisions made throughout the year. This was more common among smaller organisations which tended to make investment decisions based on an assessment of need, with capital made available as and when required.

Availability of Finance

At least half of the 30 organisations participating in the study typically financed energy efficiency and low carbon projects using their own capital. There were a small number of instances of participants using third-party funding, but this was typically only for very large investments such as new combined heat and power plants and large-scale biomass boilers. The remaining participants could not confirm how their organisations financed investments.

The participants' rationale for using their own funds was that their organisations had capital available and it was more cost effective to use this than to use third-party finance. The 'opportunity cost' of using their own capital, which might otherwise have been used for other investments within the business did not appear to be considered by many participating organisations who raised this issue.

It was also suggested that capital investment could result in tax benefits and therefore it was more beneficial to reinvest funds back into the business. Several participants highlighted the use of the Enhanced Capital Allowances (ECA) scheme. The ECA scheme provides an incentive for businesses to invest in energy-saving plant and machinery by allowing businesses to offset the entire investment against taxable profit in the same year as the investment is made. For investments outside of the ECA scheme, the standard capital allowance rate per year is a maximum of 25% on the reducing balance.

The majority of projects were therefore either financed using departmental budgets that were already set aside or by accessing a central reserve of internal capital. As a consequence of this, however, as mentioned above, some participants suggested that their projects had to compete internally for finance with other projects.

> **"We do not borrow. The main rationale is that the company tends to have cash and that spending reduces tax obligations."**
>
> *Food and Drink Manufacturer*

Investigation of Opportunities

Summary of Key Findings

- The level of detail in the feasibility assessments and/or business cases prepared by participants varied significantly across all of the organisations;
- All participants stated that business cases or capital requests were typically developed internally by the department in consultation with company stakeholders and using in-house expertise; and
- Whilst all 30 participants appeared technology 'agnostic', as mentioned above, the perceived impact on production required for the installation of some energy efficiency measures was a common barrier cited by participants.

Considerations for Policy Makers

Almost all participants stated that it is standard practice to reduce the risk of retrofit projects by timetabling work to take place during scheduled maintenance windows. A smaller number of participants suggested that the perceived costs to the business associated with such intrusive measures was sufficient to deter participants from putting proposals forward. Therefore, although some investments appeared to offer significant benefits, they were unlikely to progress to appraisal unless they could be installed during a scheduled downtime. Further research is therefore recommended to provide understanding of the compatibility of suitable energy efficiency measures with scheduled maintenance windows in different industrial sectors.

Appraisal Methods

In the majority of cases investment decisions appeared to be driven by an appraisal of the cost of the project against the energy savings it was estimated to deliver, rather than from an investment opportunity perspective.[15] A small number of participants from smaller organisations suggested that investment decisions were primarily driven by an appraisal of the necessity of the investment, i.e. it was only made if the equipment that needed replacing was critical to enabling the business to continue to operate.

The primary appraisal method described by the majority of participants was an evaluation of the payback period for investment in a given project. A very small number of participants stated that their organisation appraised investments based on an internal rate of return (IRR), rather than a simple payback calculation.[16] There was one instance where appraisals were based on the cost per unit rather than a total return on investment or payback period.

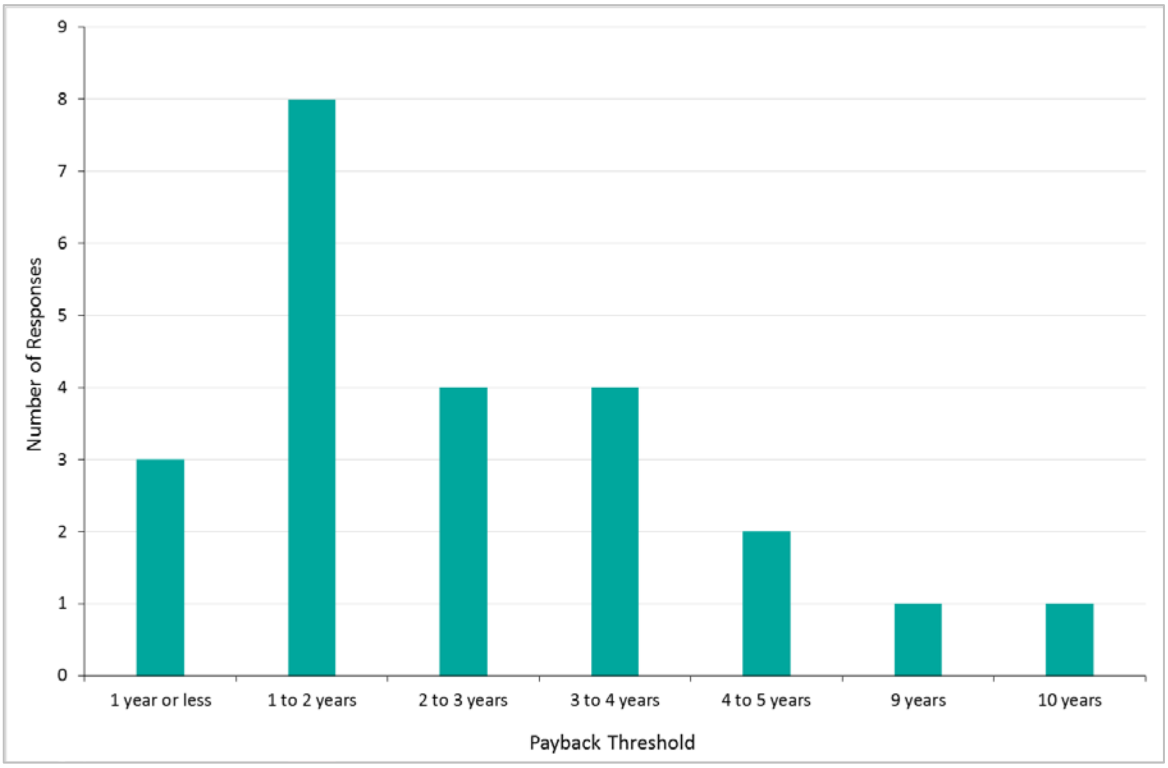
Lifetime costs or 'total cost of ownership' were mentioned by a limited number of participants as way of identifying the best energy efficiency products. This involved reviewing how long a piece of equipment was expected to last, comparing this to other products and using this as the basis for an investment decision. This approach was typically seen by participants as more appropriate for appraising new measures rather than replacement equipment.

Payback Thresholds

Payback thresholds stated by participants ranged from ten months to ten years, however, one to less than five years was typical among the majority of participants as shown in Figure 7. Seven participants did not provide information relating to their payback thresholds.

[15] Appraisals were based upon cost savings potential rather than the opportunity for reinvestment and wider company benefits as a result of such savings.
[16] IRR is a metric which can be used in investment appraisals to measure the profitability of potential investments.

Figure 7: Number of Responses for Number of Years of Payback Threshold



Participants did not explain the reason behind these relatively short payback periods, but they may be for a number of reasons, such as:

- Organisations are risk averse and therefore have a preference for established technology that is well demonstrated, carries a low 'technical' risk and requires a low investment; and/or

- The inherent insecurity within these industrial sectors is such that organisations are reluctant to pursue long term investments. This insecurity stems from sites regularly being closed or relocated and/or a high number of mergers or acquisitions within these industries on a global basis. Organisations may be reluctant to invest on a long term basis as assets may become stranded.

For projects which exceeded the organisation's payback thresholds, some participants suggested there needed to be a strong reason to proceed, for example if the project is considered a strategic infrastructure investment, or else some form of external grant funding or support can be obtained.

Nine of the 30 participants stated that their payback thresholds were consistent throughout the organisation, even where they suggested that energy efficiency projects were often considered lower risk compared to other projects.

> **“Payback period threshold is less than 2 years. 2 to 3 years may be acceptable depending on capital availability. Greater than 3 years is probably not acceptable, unless it was a strategic investment e.g. long term infrastructure project.”**
>
> *Food and Drink Manufacturer*

Internal Rate of Return and Discounting

Four of the 30 participants stated that their organisation appraised investments based on an IRR. Hurdle rates for the IRR ranged between 9% and 40% and in most cases this was converted into simple payback terms.

Where a discounted cash flow (DCF) analysis was used, this typically appeared to be undertaken by finance departments using the information contained in a document or form completed by the energy manager.[17] Consequently many participants had limited understanding of this method of appraisal and were either not aware whether a DCF analysis was undertaken, or what discount rate was applied. Where discount rates were known, rates stated by participants ranged from 7% to 10%.

Appraisal Contents

The level of detail in the feasibility assessments and/or business cases prepared by participants varied significantly across all the organisations, regardless of their size or sector.

At least 22 of the 30 participants stated that the assessments focused solely on capital costs of the plant or equipment and associated payback. Three participants, however, suggested a greater level of scrutiny was required. These participants suggested that this could comprise of a number of different factors, but would typically include an appraisal of the measure’s alignment with the organisation’s strategic plan, assessment of risks, operational impacts and energy price forecasts.

All participants stated that business cases or capital requests were typically developed internally by the department in consultation with company stakeholders, such as the health and safety officer, operation or production managers, project engineers and using in-house expertise. Seven of the 30 participants suggested that they also gathered information by attending networking events, industry conferences and trade exhibitions and making use of trade literature.

The level of external support in identifying opportunities appeared to vary across and within participants’ sectors. Where necessary, some participants supplemented their investigations with evidence/quotes from third-party suppliers. However, several participants expressed some scepticism over whether third parties could deliver value for money (due to their lack of detailed knowledge of specific equipment and plant

[17] A ‘discounted cash flow’ is a valuation method used to estimate the attractiveness of an investment opportunity using the concept of the time value of money.

configuration). Participants from the food and drink industry suggested that they regularly made use of external consultants. This was because the industrial processes in this sector were varied and complex and the organisations did not have the in-house expertise to appraise these. In the metal and engineering sectors however, the energy managers typically had an engineering background and understood their industrial process well. These individuals therefore had limited need for external support, beyond supplier specifications and quotes.

Seven of the 30 participants mentioned that they had undertaken energy audits which had helped to identify some opportunities for energy efficiency measures. One participant suggested that these had not been taken up however because the payback was too long (greater than two years) whilst another stated that such audits had little value as those undertaking them had little knowledge of their organisation's specific industrial processes.

Technologies Considered

Participants expressed an interest in all types of energy efficient and low carbon heating technologies. These ranged from small equipment such as motors, variable speed drives and compressors through to large plant such as biomass boilers, CHP and heat pumps. Whilst participants appeared technology 'agnostic', however, the perceived impact on production required for the installation of some energy efficiency measures was a commonly cited barrier.

Considerations for Policy Makers

The research has identified evidence that the majority of participants have adopted appraisal methods which typically favour the short term, over long term. This is particularly prevalent for retrofit of measures where a simple payback calculation was the most common approach adopted. When appraising the uptake of measures, policy makers might wish to consider modelling these simple assessment techniques for more simple technology investments.

Approach to Quantification

Summary of Key Findings

- In many cases the ‘capital costs’ described by participants included all costs, with no differentiation between capital and non-capital costs;

- Capital costs accounted for between 50% and 100% of the total costs in the business cases provided. Equipment and installation costs ranged between 40% and 100% of total costs, whilst civil works ranged between 2% and 51% of total costs;

- Non-capital costs did not carry the same importance in the investment appraisal as the capital costs as they only related to a small proportion of the total cost of the investment;

- Within the business plans provided, non-capital costs accounted for between 0% and 50% of total project costs. The distribution of these costs varied from business plan to business plan, as shown in Figure 8. For specific projects, the highest non-capital costs contained in the business cases were those associated with ‘design and engineering’, IT and disposal of assets;

- Non-capital costs were not considered prohibitive to organisations proceeding with an investment. Some participants did suggest that the cost of production downtime may be prohibitive, however measures that impacted upon production were often screened out at an early stage and did not make it to a full business appraisal. As such these costs were not typically captured;

- ‘Internal’ costs, such as those associated with feasibility or decision-making costs were not taken into consideration in investment appraisal;

- With the exception of (avoided) energy costs and Climate Change Levy (CCL) savings, financial benefits were quantified only on an ad-hoc basis;

- Project risks were not typically monetised, however in some instances other methods, such as energy supply contracts, were used to guarantee costs and savings; and

- A contingency rate for capital costs of between 5% and 10% was commonly used by participants.

Definition of Capital and Non-Capital Costs

One of the aims of this research was to identify and quantify non-capital costs. As such, no pre-defined list of costs was offered to interviewees, instead participants were asked to describe the types of costs included in their investment appraisals and the scale of such costs. These costs were then analysed by the research team and grouped accordingly.

Typically, capital costs were considered any cost as associated with the purchase and installation of specific plant and equipment whilst non-capital costs were defined as per Table 1.

Table 1: Definition of Non-Capital Costs

Theme	Examples
General overhead costs of energy management	Costs of employing specialist personnel (e.g. energy manager) Costs of energy information systems (including: gathering of energy consumption data; maintaining sub-metering systems; analysing data and correcting for influencing factors; identifying faults etc.) Cost of energy auditing
Costs involved in individual technology decisions	Cost of (i) identifying opportunities (ii) detailed investigation and design (iii) formal investment appraisal Cost of formal procedures for seeking approval of capital expenditures Cost of specification and tendering for capital works to manufacturers and contractors Cost of disruptions and inconvenience Additional staff costs for maintenance Costs for replacement, early retirement of retraining staff
Loss of benefits in individual technology decisions	Problems with safety, noise, working conditions, extra maintenance, reliability, service quality etc. (e.g. lighting levels)

Scope and Magnitude of Capital Costs

The scope and magnitude of the capital costs typically included within energy efficiency investments was identified via analysis of the business plans provided by participants. Of the 30 organisations that took part in the study, 19 shared business plans with us. Of these, eight organisations provided a simple capital request form, a further eight undertook a basic business case and three organisations prepared a detailed business case. Consequently these findings are based upon a subset of data from a small sample of organisations and are therefore not representative of the wider population.

All participants suggested that capital costs tended to include cost of the plant and equipment (new or reconfigured) and civil engineering costs for supporting infrastructure, such as grid access, foundations, grid connection. Some participants suggested they use turnkey service providers and, as such, have a single capital cost.

The scale of capital costs associated with energy efficiency measures cited by participants ranged from £3,500 to over £50 million. In many cases the ‘capital costs’ described by participants included all costs with no differentiation between capital and non-capital costs. In the 21 business cases provided capital costs accounted for between 50% and 100% of the total project costs. In five of the 21 cases, the estimates of capital costs were differentiated between equipment & installation and civil works costs. Equipment and installation costs ranged between 40% and 100% of total costs, whilst civil works ranged between 2% and 51% of total costs.

> **"There was no differentiation between capital and non-capital costs - production losses were not included as the project was timed to coincide with plant shutdown. "**
>
> *Chemical Producer*

For the construction, vehicles, and paper, printing & publishing sectors the cost of equipment and plant accounted for 100% of the total costs of investment in the business plans provided as part of the research. This suggests that installation costs were wrapped up in the equipment costs and may have therefore been procured from a turnkey supplier. Business plans received from energy intensive organisations in the food, beverages & tobacco and chemicals sector most commonly included the cost of civil works. These were typically large investments which included, for example combined heat and power plant, turbine replacement and new evaporators.

In the majority of the business cases received, the equipment and plant costs made up a higher percentage of the total costs for smaller investment projects, such as voltage optimisation and compressed air plant. This may be because such projects are relatively straightforward and do not incur non-capital costs or because the low value of such projects did not warrant the time required to breakdown the costs for approval.

Scope and Magnitude of Non-Capital Costs

As stated in the previous section, the scope and magnitude of the capital costs typically included within energy efficiency investments was identified via analysis of the business plans provided by participants. Consequently these findings are based upon a subset of data from a small sample of organisations and are therefore not representative of the wider population.

There was an inconsistent approach taken to non-capital costs by participants. Such costs appeared to be identified on an ad-hoc basis and varied depending on the energy efficiency measure being considered.

In general, participants stated that non-capital costs did not carry the same importance in the investment appraisal as capital costs as they only related to a small proportion of the total cost of the investment. Where they were identified, non-capital costs cited by participants **in the interviews** were wide ranging and included:

- Project management;
- Foreign exchange risk;
- Plant-downtime;

- Engineering costs;
- Automation costs;
- Maintenance and labour;
- Training;
- Planning; and
- Legal and commissioning costs.

The calculation of non-capital costs was derived from a range of sources with participants citing past experience, rule of thumb estimates, and quotes from external consultants and suppliers. Twenty-two of the 30 participants suggested that any ‘internal’ costs, such as those associated with feasibility or decision-making were not taken into consideration as these costs were usually considered as part of the overall operating cost of the business. Three participants stated that such costs were quantified but were rolled into the capital cost of the project.

> **“The non-capital costs are covered by site and group overheads, so don't affect individual projects from going forward.”**
>
> *Food and Drink Manufacturer*

Within the business plans provided, over half (11 of the 21) business cases did not identify any non-capital costs. In the remaining ten business cases, non-capital costs accounted for between 2% and 50% of total project costs. The distribution of non-capital costs in each of these business plans is shown in Figure 8. As shown in Figure 8, for specific projects, the highest non-capital costs contained in the business cases were those associated with ‘design and engineering’, IT and disposal of assets.

Figure 9 provides a breakdown of the frequency by which non-capital costs were identified within the **business plans** provided. Each dot represents the non-capital cost as a proportion of total project costs per project. Design and Engineering, for example, was identified in eight business cases with costs ranging from 2% to 30% of the total project costs.

Figure 8: Distribution of Non-capital Costs in the Business Plans Provided

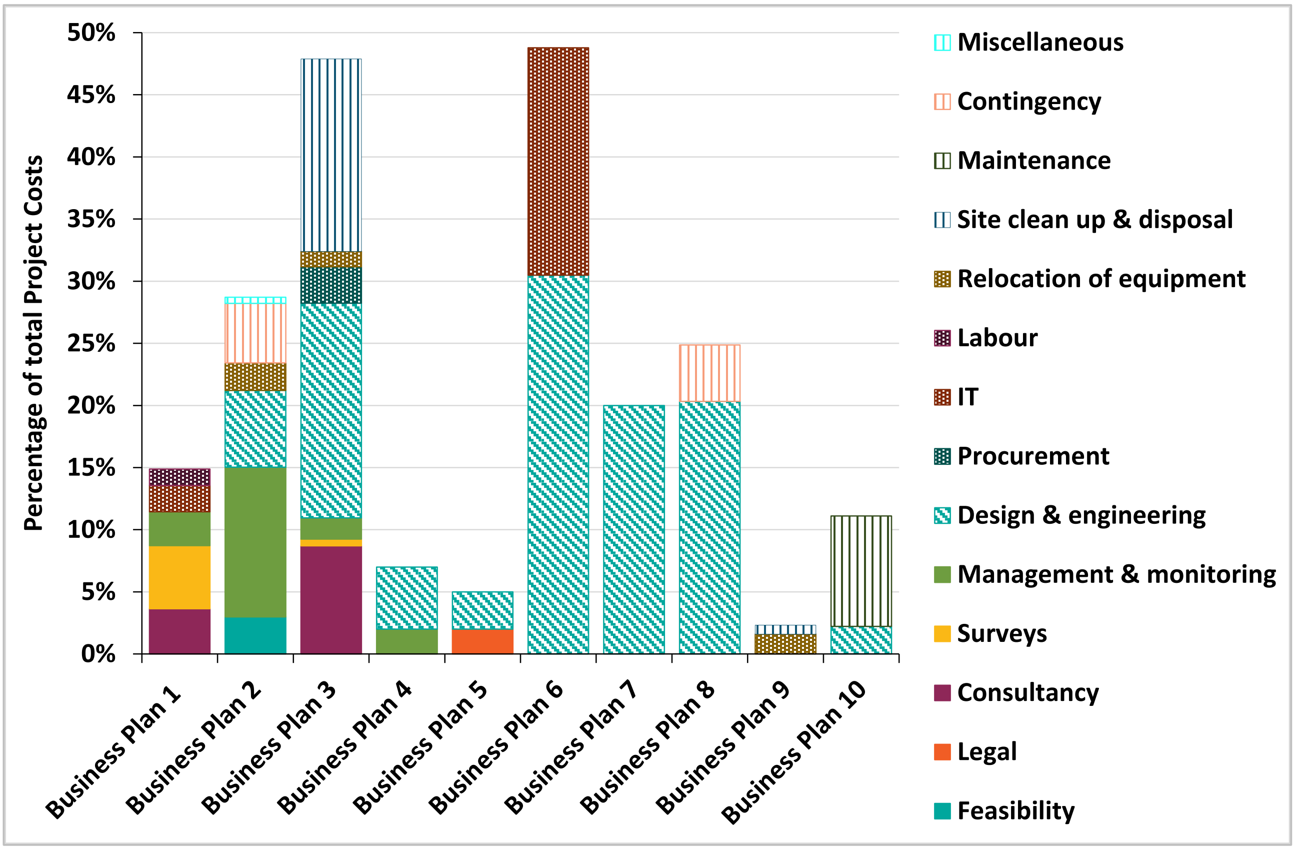
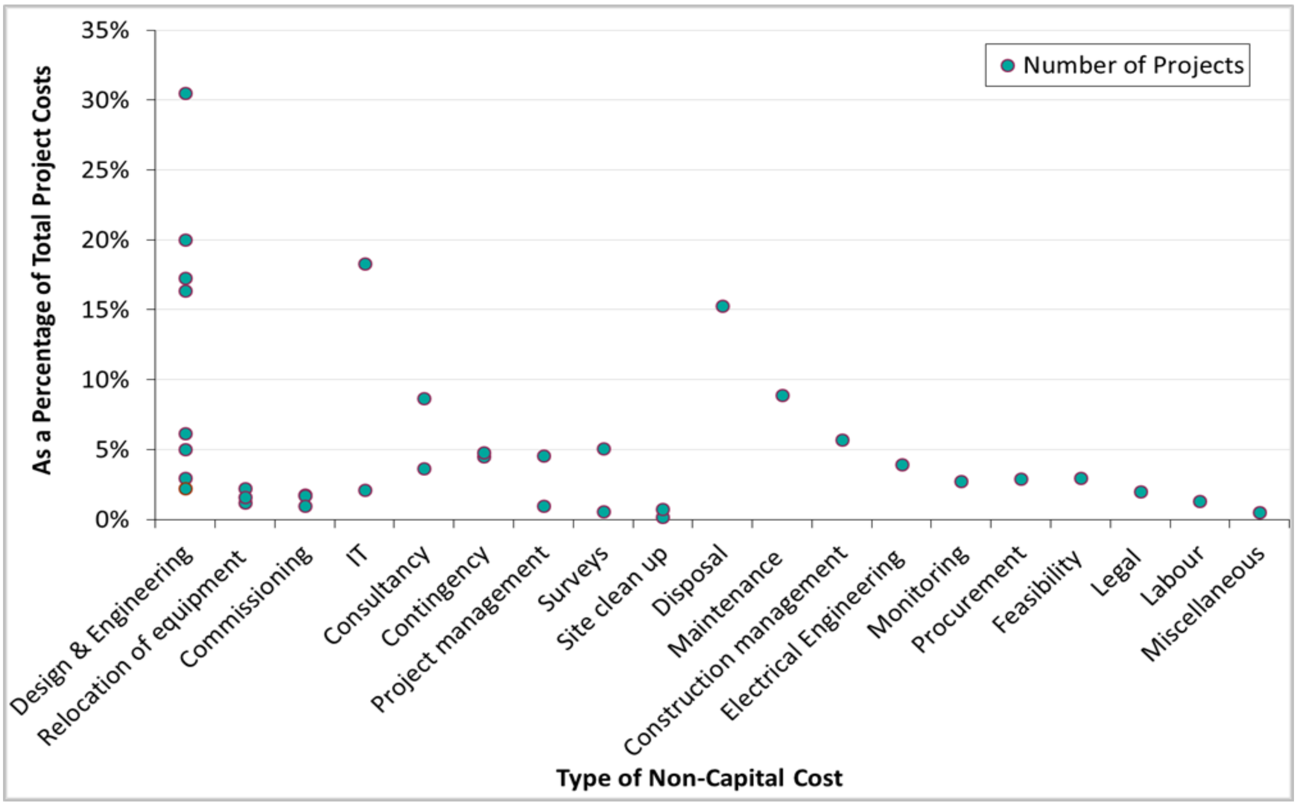


Figure 9: Range of Non-capital Costs and the Frequency of Identification



In total, the respondents identified 19 different categories of non-capital costs. Apart from commissioning, mentioned three times, all other costs were mentioned twice or less. In one instance, IT made up 18% of total costs, and in another disposal made up 15% of total costs. Despite being cited by participants in the interviews, non-capital costs such as the cost of financing, training and downtime did not feature in many of the business cases provided. Please see the Definition Matrix in the Appendices for a further breakdown of non-capital costs.

Prohibitive Costs

At least 18 of the 30 organisations suggested that non-capital costs were not prohibitive to their organisation proceeding with an investment. In 'marginal' cases in relation to the investment thresholds, at least two participants stated that non-capital costs could be used to tip the balance either way, and therefore their inclusion varied on a case-by-case basis, depending upon the desired goals of that participant or department.

The cost of loss of production was cited by a number of participants as being prohibitive to organisations proceeding with an investment. As described above, therefore, measures that could not be undertaken within scheduled maintenance periods were unlikely to be progressed to be formally assessed. As a consequence, the non-capital costs associated with loss of production due to the installation of energy efficiency or low carbon heating measures were rarely quantified.

Scope and Magnitude of Benefits

Benefits cited by participants following the decision to install the technology included:

- Increased competitiveness and market share;
- Efficiency gains;
- Energy cost savings;
- CCL savings;
- Reduced operating and maintenance costs;
- Improved operational performance; and
- Progress towards corporate environmental targets.

With the exception of (avoided) energy costs and CCL savings, however, these benefits were quantified on an ad-hoc basis, if at all. A small number of participants suggested that in some cases assumptions were adjusted to ensure meeting relevant payback thresholds.

The approach to calculating (avoided) energy costs varied among participants. Some suggested that they used their current unit costs and did not inflate these over the lifetime of the project, whereas others indexed their existing energy prices. One participant stated that they applied a 30% to 50% sensitivity on energy prices over the appraisal period.

Monetisation of Risk

Risks associated with energy projects cited by participants included the following:

- Technical risk related to equipment;
- Economic risk related to energy price volatility;
- Supply chain risk related to the reliability of the installer; and
- Operational risk related to loss of production.

The majority of participants stated that some form of risk appraisal or assessment was undertaken as part of the business case, but in most cases this was not monetised. A small number of participants suggested that risk was monetised, but only for specific costs, for example energy costs or production downtime, but that this was not typically aggregated for the project as a whole. Some participants suggested that the monetisation of risk may happen further up the decision-making chain, but this was not made explicitly available to them. In addition, it was suggested by some participants that where risk was monetised, this was usually only for larger projects.

As described above, short payback periods were the primary method of investment appraisal. Whilst not explicitly stated by participants, this could be perceived as another means by which organisations monetised risk. By setting short payback thresholds organisations encouraged a high rate of return, insuring against economic risks, such as changes in energy costs and expenditure. In addition, proven technologies were most likely to deliver the expected payback and therefore this approach may have helped to insure against technical and supply chain risk.

In respect of operational risk, as described above, this was a significant barrier to investment and energy managers were unlikely to propose particular measures if their installation would impact upon production. Therefore, whilst this was a significant risk, it was rarely monetised as such measures were unlikely to make it to the business plan stage. Instead energy managers typically overcame this by only recommending such measures where installation could be undertaken during scheduled production downtime.

> **“For turnkey providers we have requested savings to be guaranteed by contractors as part of the contractual obligations.”**
>
> *Chemical Producer*

Contingency

In the interviews, the majority of participants stated contingency was factored into their business cases or capital requests. The level of contingency suggested by these participants ranged from 5% to 10% of the capital costs. Of the 24 participants that shared information relating to contingency, five said they did not factor in contingency, five applied a 5% contingency, one participant applied a 7% contingency and thirteen said they factored in 10% contingency. Of these 24, eight suggested that the contingency level varied depending upon the nature of the project and was impacted by the level of confidence an organisation has in the capital costs.

A very small number of participants stated that contingency was not factored into their business cases or capital request. The majority of these participants did not confirm why a contingency rate was not used although a single participant suggested that this made investments look unattractive and was therefore excluded.

Whilst in the interviews the majority of participants stated that contingency was factored into their investment appraisals, only two of the business plans received included a contingency amount. This may suggest that contingency had been applied externally to the business plans, however, it is not possible to state this with any certainty. This is because the interview questions did not specifically ask participants whether they factored contingency into their business plans, more so their investment appraisals as a whole. It may be the case that contingency is not explicitly stated in the business plans, but factored into capital costs.

Considerations for Policy Makers

Participants' quantification of non-capital costs is particularly variable and there is no clear pattern of consistency regarding the type and magnitude of the costs. There is some anecdotal evidence to suggest that the identification of non-capital costs appears to be influenced by participants' approach to risk; with the largest investments attracting the greatest identification.

Of the 21 organisations that discussed whether non-capital costs were prohibitive, 18 suggested that non-capital costs were not prohibitive to their organisation proceeding with an investment. This gives some indication that when the non-capital costs are monetised there are other factors which are more likely to influence the uptake of energy efficiency measures.

Key Messages

The key findings from the research are summarised below. It should be noted that these findings are not definitive and are based upon interviews with a small sample of organisations in the industrial processes sector.

There is strong diversity across the 30 interviews in respect of attitudes to investment in energy efficiency measures. However, a consistent process to identify, appraise and approve energy efficiency measures exists. This comes with a set of common responsibilities, with boards and senior management taking on similar responsibilities within organisations.

Organisations are typically risk averse – this pervades all the mechanisms and approaches to investigating energy efficiency measures and ensures that there is investment in low risk measures only.

There is limited evidence which suggests that intrusive measures, which result in loss of production, are not usually appraised by organisations. This is because they are considered to represent too much of a risk to the wider business. However, specific questions relating to downtime and intrusive measures were not asked. Therefore the evidence is weak and this finding requires detailed follow-up research.

The templates used by organisations to appraise measures are typically pay-back calculations. They are targeted at non-finance professionals and ensure that only key pieces of information are captured.

Risk is not generally monetised in investment appraisals at departmental level, albeit this does appear to take place at board level.

The quantification of costs and benefits are controlled by the forms and the personnel completing them. The vast majority of these capture limited information, which focuses almost universally on capital costs.

Non-capital costs are not often captured separately within business plans, but when represented, they typically form 2% to 50% of total estimated costs.

Considerations for Policy Makers

Understanding the investment process and the associated roles and responsibilities is a key element of policy-making in this area. This research has identified a typical process that participants adopt, alongside a clear delineation of responsibilities throughout the process. Policies and programmes to promote the uptake of energy efficiency measures should consider the interaction of any related measures with this process.

The research has identified evidence that the majority of participants have adopted appraisal methods which typically favour the short term, over long term. This is particularly prevalent for retrofit of measures where a simple payback calculation was the most common approach adopted. When appraising the uptake of measures, policy makers might wish to consider modelling these simple assessment techniques for more simple technology investments.

Almost all participants stated that it is standard practice to reduce the risk of retrofit projects by timetabling work to take place during scheduled maintenance windows. A smaller number of participants suggested that the perceived costs to the business associated with such intrusive measures was sufficient to deter participants from putting proposals forward. Therefore, although some investments appeared to offer significant benefits, they were unlikely to progress to appraisal unless they could be installed during a scheduled downtime. Further research is therefore recommended to provide understanding of the compatibility of suitable energy efficiency measures with scheduled maintenance windows in different industrial sectors.

Participants' quantification of non-capital costs is particularly variable and there is no clear pattern or consistency regarding the type and magnitude of such costs. There is some anecdotal evidence to suggest that the identification of non-capital costs appears to be influenced by participants' approach to risk; with the largest investments attracting the highest levels of such costs. Policy makers might consider, therefore, that assumptions relating to the level of non-capital costs may vary according to the size of investment and associated risk.

Of the 21 organisations that discussed whether non-capital costs were prohibitive, 18 suggested that non-capital costs were not prohibitive to their organisation proceeding with an investment. This gives some indication that when such costs are monetised there are other factors which are more likely to influence the uptake of energy efficiency measures.

Appendices

Cost Definition Matrix

The cost definition matrix contains data aggregated from the business cases made available by participants in this research. This is available as a separate spreadsheet.

Overview of Participants

Sector	No. of UK Employees	Energy Intensive	Type of Investment	Scale of Investment	Investment Progressed
Chemicals	250 and above	Yes	A new plant	£5,000,000	Yes
Food, beverages and tobacco	Not stated	Yes	Evaporator	£100,000	Unconfirmed
Food, beverages and tobacco	250 and above	Yes	Various examples incl. heat exchangers, thermal compressors, steam trapping, insulation, boiler controls, variable speed drives	Costs varied	N/A
Mineral products	250 and above	Yes	Connection to mains gas	£5,000,000	Yes
Chemicals	250 and above	Yes	Biomass CHP plant	Not Stated	Yes
Vehicles	250 and above	Yes	Various examples incl. biomass boilers, LEDs, light sensors and timers, energy efficient hand driers, voltage optimisation	Costs varied	Unconfirmed
Food, beverages and tobacco	Not stated	Yes	CHP plant	£2,000,000	Yes
Construction	250 and above	No	Voltage optimisation	£3,617	Yes

Sector	No. of UK Employees	Energy Intensive	Type of Investment	Scale of Investment	Investment Progressed
Mechanical engineering and metal products	250 and above	Yes	Refurbishment of gas furnaces	£1,500,000	Yes
Food, beverages and tobacco	250 and above	Yes	Multiple large solar PV projects	Costs varied	Unconfirmed
Food, beverages and tobacco	250 and above	Yes	Various examples incl. heat pumps, biomass, CHP, micro nuclear, geothermal, lighting, variable speed drives, and refrigeration plant	Costs varied	N/A
Food, beverages and tobacco	250 and above	Yes	Efficient pumping equipment	£82,000	Unconfirmed
Food, beverages and tobacco	250 and above	Yes	Review of compressed air systems	£6,900	Unconfirmed
Food, beverages and tobacco	250 and above	Yes	VSD, cooling tower, heat recovery and SCADA upgrade	£1,699,058	Yes
Chemicals	Not stated	No	Fuel saving systems	£193,816	Yes
Food, beverages and tobacco	250 and above	Yes	Various examples incl. variable speed drives, lighting, heat recovery, ammonia refrigeration, water source heat pumps	Costs varied	N/A
Food, beverages and tobacco	Not stated	No	Various energy efficiency measures	£3,600,000	Yes
Chemicals	250 and above	Yes	Various examples incl. variable speed drives, steam reduction, boiler replacement	£200,000 to £10,000,000	Yes

Sector	No. of UK Employees	Energy Intensive	Type of Investment	Scale of Investment	Investment Progressed
Chemicals	250 and above	Yes	Replacement of turbines and super heaters	£79,167,000	Yes
Chemicals	250 and above	Yes	Steam turbine for CHP	£5,500,000	Yes
Vehicles	250 and above	Yes	Lighting replacement with presence detection, daylight detection and reflective casings	£238,000	Yes
Paper, printing and publishing	250 and above	Yes	Intellair device in stock products	£9,000	Yes
Paper, printing and publishing	10 - 249	No	No example provided	N/A	N/A

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