Department of Energy & Climate Change

Research to Assess the Barriers and Drivers to Energy Efficiency in Small and Medium Sized Enterprises

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Contents

Executive Summary

The UK government's Energy Efficiency Strategy (DECC 2012) recognises the economic and environmental benefits that energy efficiency can deliver. It states that demand reduction is the first and most important action in making the transition to a low-carbon economy and it is committed to catalysing the adoption of energy-efficient business practices by developing a stronger understanding of the barriers and motivations encountered by individual firms, particularly small and medium-sized enterprises (SMEs).

DECC commissioned ENWORKS to undertake a small scale research programme, with qualitative and quantitative elements, to improve understanding of SMEs experiences of energy efficiency, focusing in particular on the later stage barriers and motivations.

Later Stage Barriers

Later stage barriers are defined as those barriers that occur after a business is made aware of the specific energy efficiency improvement actions it could make, including the potential cost savings and wider benefits of such actions. This study was able to focus on later stage barriers as the businesses involved had all received an ENWORKS Review, resulting in the identification of bespoke improvement actions with quantified implementation costs and projected annual savings.

Methodology

A workshop was held with business advisors to draw out their experience of what motivates or limits SMEs regarding the adoption of energy efficient business practices. A rapid evidence assessment was also carried out to supplement the workshop findings and to inform the design and delivery of the subsequent data gathering and analysis.

A set of interview questions was developed to identify and explore key themes associated with the implementation of energy efficiency improvements. Financial, technical and organisational barriers and drivers were considered, along with how differences between sectors and improvement types may influence uptake. 31 semi-structured interviews were undertaken providing qualitative evidence on SMEs experience of improving energy efficiency.

This was supplemented with quantitative data on energy efficiency from a much larger cohort of over 3,000 companies (including the interviewed businesses) from the ENWORKS Efficiency Toolkit. This enabled detailed analysis to support and challenge the key themes arising from the interviews. It also allowed for an investigation of the relationship between implementation rates and a range of different variables including cost savings, capital expenditure, payback period, sector and improvement type.

Findings and Conclusions

The research has identified a range of motivations and barriers, both financial and non-financial, that shape the ways in which SMEs engage with energy efficiency; in addition, differences between manufacturing and non-manufacturing SMEs were identified. The headline findings and conclusions are summarised below under each category, concluding with an overview of the estimated value of the missed opportunity.

Cost Savings

- All of the Interviewed Businesses cited cost savings as a motivation for implementing energy efficiency improvements. Furthermore, quantitative analysis of data from these businesses and the wider Toolkit shows a statistically significant positive correlation between implementation rates and the value of cost savings.
- Despite this correlation, implementation rates remain relatively low for opportunities with potentially significant cost savings (i.e. an implementation rate of just 25% for opportunities with cost savings over £10,000 per annum). This indicates that cost savings alone are not a sufficient catalyst to action and other barriers are interacting to limit uptake of energy efficiency measures.
- Challenges with quantifying and understanding financial savings emanating from energy efficiency improvements were reported in the interviews (even when the ENWORKS Review had contributed to reducing this information failure). This may lead or contribute to the undervaluing of energy efficiency and thus act as a later stage barrier to implementation. Improving access to metering and monitoring technology may help to counter this and therefore have the potential to increase implementation rates in SMEs.

Capital Cost

- The need for capital was commonly cited by the Interviewed Businesses as a barrier to implementation. However, the quantitative data from the larger Toolkit dataset shows that 30% of all identified improvements require zero capital expenditure. This indicates a potential misconception amongst SMEs that energy efficiency improvements require capital, and this may act as a barrier to engagement and uptake.
- Moreover, Toolkit analysis suggests that the value of capital investment has little effect upon implementation rates, suggesting that companies are equally willing to invest in high-cost improvements as they are in low-cost ones; this indicates the presence of other drivers and other later stage barriers beyond the requirement for capital.
- When no capital investment was required, analysis showed that implementation rates remained at 20%. Removing the requirement for capital investment, therefore, does not seem to be a sufficient catalyst for action on its own.

Payback Period

- The majority of Interviewed Businesses reported that energy efficiency improvements with a payback period of less than two years made business sense and would be likely to go ahead if finance was available; some extended this to five years. However, analysis of the wider Toolkit shows that the implementation rate for opportunities with a payback period less than two years is only 13% and shows no significant difference from the implementation rate for improvements with longer payback periods.
- This supports the contention that businesses operate within bounded rationality and did not follow simple ‘calculation – decision – implementation’ models; that is, they are influenced by wider business considerations and are subject to multiple limiting factors beyond financial measures.

Comparing Sectors

- A clear distinction is found to exist between manufacturing and non-manufacturing companies in both the qualitative and quantitative findings.
- Evidence shows manufacturing companies had a greater tendency to implement improvements (29% versus 18%) and regression analysis shows the value of cost

savings and payback period to be statistically significant for implementation rates amongst manufacturers.

- For non-manufacturing companies, none of the financial metrics (cost savings, capital cost or payback period) were shown by the regression analysis to be statistically significant for implementation rates, supporting the assertion made in the interviews that less tangible factors, such as ambience and customer experience, were likely to drive energy efficiency improvements in this sector.

Other Later Stage Barriers

- Interviewees that leased or rented their premises reported they were reluctant to invest in building improvements, particularly where the payback periods extended beyond their lease periods. Supporting landlords to improve the energy efficiency of their building stock may help to redress the misaligned incentives experienced by tenants.
- Interviewees also cited the risk of disrupting day-to-day operations as a barrier, but reported that this could be overcome by phasing the introduction of improvements and taking advantage of 'trigger points', such as wider upgrades, to create the opportunity for energy efficiency to be addressed. Helping companies to recognise and take advantage of trigger points may contribute to the removal of these barriers and lead to wider adoption of energy efficiency measures.
- Changing accepted practices, both in terms of internal operations and external customer expectations were noted as barriers. However, supply chain pressure was also reported to act as a driver in some instances, both from the private and public sectors. Influencing supply chains to value energy efficiency may therefore increase the levels of uptake among SMEs.

Other Drivers

- Some interviewees reported that they looked to what others were doing on energy efficiency to drive their own actions. Consequently, publishing positive and SME-relevant achievements may act as a motivation for others, normalising it as standard business practice.
- The internal business culture regarding energy efficiency was reported to be an influencing factor on its uptake. Analysis suggests a slight positive correlation between those SMEs reporting a positive energy culture and implementation rates; however, it is not possible to separate the influence of this intrinsic motivation from other drivers to establish a definite causality.

SMEs in Relation to Other Businesses

- Research indicates a tendency for SMEs to seek shorter leases to maximise flexibility. In addition, smaller firms have been found to be less likely to measure and keep performance records, owing to the presence of fewer technical and financial resources or less operational and management capacity.
- Many of the drivers and barriers discussed in this report are related to the size and capacity of a business and, whilst further research would be required to comment with certainty, it is possible they are experienced differently within larger firms. Understanding these differences will support the development of appropriate actions to catalyse the uptake of energy efficiency within SMEs.

Value of the Missed Opportunity

- The average value of the missed opportunity from energy efficiency for SMEs in the Toolkit database used in this research has been calculated to be between £5,800 and £12,200 per annum, or between 18% and 25% of their annual energy costs.

- These values do not represent the maximum theoretical value of energy efficiency savings for each company within the Toolkit, rather they are based on a pragmatic project intervention where the focus stretches across energy and other resource use; they could therefore be viewed as a conservative estimate of the potential savings that greater energy and resource efficiency could deliver to SMEs, although in some firms, technical constraints not identified at the point of recommendation may limit the take-up of measures. The capital costs associated with these savings are between £8,600 and £18,800 per SME, representing an average payback period of 1.5 years. It should be noted, however, that 37% of the savings would require zero capital investment.
- Were this level of missed opportunity to be representative of SMEs throughout the UK, the figures can be extrapolated using business population data to estimate that annual cost savings of between £1.26bn and £2.63bn are available for the SME community, and are currently being overlooked.
- The capital requirement to accrue these savings is estimated to be between £1.88bn and £4.1bn, noting again that 37% of the savings would require zero capital investment.
- If achieved, these cost savings are estimated to deliver associated CO_2e savings of between 8.7m and 17.6m tonnes per annum.

Glossary

Cohort A	Businesses that have had energy efficiency opportunities identified for them by ENWORKS, but have not taken up any further support to improve energy efficiency, i.e. have not implemented any improvement measures.
Cohort B	Businesses that have had energy efficiency opportunities identified for them by ENWORKS and have recently implemented improvement measures with support from ENWORKS.
Cohort C	Businesses that have had energy efficiency opportunities identified for them by ENWORKS and are intending to implement one or more of these improvement measures.
Energy Intensity	Two methods have been used to calculate energy intensity: I. Energy spend per employee; II. Energy spend as a percentage of turnover.
Identified Opportunities	All energy efficiency improvement measures that have been identified by ENWORKS within client businesses. This category represents the total savings value identified; i.e. opportunities at all statuses (see both Pipeline and Implemented Opportunities in this Glossary) are a subset of this category.
Implemented Opportunities	Energy efficiency improvement measures identified by ENWORKS in client businesses that have been fully installed, verified by the business, scrutinised by ENWORKS and recorded as 'Achieved' status on the Toolkit. Implemented Opportunities are a subset of Identified Opportunities.
Later Stage Barriers	Barriers to implementing energy efficiency improvements that are encountered once a business has become aware of the specific measures that are available to it, including their savings potential and cost implications.
Market Failure	Market failure refers to economic conditions in which an optimal allocation of resources, in a broad sense, is not attained. With social and environmental costs – commonly referred to as externalities – not minimised, some resources are wasted. In The Energy Efficiency Strategy (DECC 2012), DECC gives examples of factors that can intensify market failure. These include an embryonic market, the provision and status of information, misaligned financial incentives and behavioural barriers.

Opportunity	An individual energy efficiency improvement action or measure, identified for a business client by ENWORKS via conducting an on-site Resource Efficiency Review. Each opportunity contains both qualitative and quantitative data on the nature of the improvement action and the economic and environmental benefits associated with it. Each opportunity is assigned a status to indicate whether the action/measure has been implemented or not (see also Identified, Implemented and Pipeline Opportunities in this Glossary).
Payback Period	The period of time over which the cost savings generated by an energy efficiency improvement measure recoup the initial capital expenditure incurred in its installation.
Pipeline Opportunities	Energy efficiency improvement measures that have been identified by ENWORKS within client businesses but that have not yet been installed; i.e. are not Implemented Opportunities. The measures in this category are at various different stages of progress, including those which have not progressed from being identified to those which are at the final stages of approval before implementation. Pipeline Opportunities are a subset of Identified Opportunities.
Resource Efficiency Review (ENWORKS Review)	An on-site resource efficiency audit carried out by an ENWORKS advisor.
Small and Medium-sized Enterprise (SME)	The European Regional Development Fund definition of an SME: '*enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million'.*[1]
The Toolkit	ENWORKS Online Resource Efficiency Toolkit, 'the Toolkit', is a bespoke piece of online software that records all improvement actions identified for businesses relating to resource efficiency. It captures, collates and reports the potential and actual economic and environmental savings of individual improvement actions (opportunities).

[1] ERDF User Manual Chapter 2 – Eligibility Rules: Version 3, 3 August 2009

1. Introduction

The UK government's Energy Efficiency Strategy (DECC 2012) identifies four key benefits of energy efficiency: economic growth and employment; cost savings; reduced emissions; and improved energy security.

Energy efficiency, delivering either the same using less energy or more using the same level of energy, is the first and most important action in making the transition to a low-carbon economy.

Despite the notable potential for, and benefits of, energy efficiency in relation to the business community, this opportunity is not being realised. This 'energy efficiency gap' has been valued by other government research as an £11bn missed opportunity for business (Oakdene Hollins 2011).[2] There are market failures in place affecting this issue and, in the Energy Efficiency Strategy, four key types are identified: embryonic markets, information failure, misaligned incentives and undervaluing energy efficiency.

The Strategy points to existing government policies designed to combat these market failures and increase the uptake of energy-efficient business practice, but it recognises they are often focused on large businesses and therefore notes the significant further potential for commercial and industrial energy efficiency that is not covered by existing policy.

1.1 Small and Medium-sized Enterprises

Small and Medium-sized Enterprises (SMEs) are defined by the European Union as businesses that have fewer than 250 employees and either a turnover of less than or equal to €50million or a balance sheet total of less than or equal to €43million. At the start of 2013, SMEs accounted for 59% of employment in the UK private sector and 48% of its turnover; since 2000, SMEs have driven the increase in the overall UK business population (BIS 2013).

SMEs have particular characteristics that can present challenges for the adoption of energy efficiency. These relate not only to their size and turnover, although these are important factors, but also to their structure and culture. Small firms are less likely than larger ones to monitor performance, for example, and tend to have a more informal structure with roles less rigorously defined (EFILWC 2013). It is therefore important to understand the experiences of SMEs in order to catalyse action, rather than assume that a one-size-fits-all approach will be effective across the entire business community.

This research was commissioned to develop a stronger understanding of the barriers and motivations to energy efficiency encountered by individual firms, in particular those experienced by SMEs and those that are later stage barriers, i.e. those in play once a business has specific information about the energy efficiency opportunities appropriate to its operations.

[2] Page 6: low/no-cost energy saving opportunities £4bn, added to those with payback more than one year £7bn.

1.2 The Research

The research draws upon data contained in the ENWORKS Online Resource Efficiency Toolkit (‘the Toolkit’) for quantitative analysis and combines this with qualitative analysis of interviews undertaken with a sample of businesses contained within the Toolkit.

The interviews provided qualitative evidence on the later stage barriers to energy efficiency in SMEs and enabled exploration of how these barriers interrelate and the strategies that businesses adopt to overcome them. They also provided insights into the factors that motivate SMEs to engage in energy efficiency.

Quantitative analysis of the Toolkit explored the role of factors such as cost savings, capital cost and payback period on the implementation rates of opportunities and the extent to which business characteristics, such as turnover, energy intensity and number of employees, influence the propensity of those businesses to engage with energy efficiency.

1.3 This Report

The report starts with a summary of a rapid evidence assessment that contributed to the formation of the research. The methodology is then outlined, taking the reader through the available datasets and the stages of the research. Chapter 4 combines the qualitative and quantitative aspects of the research and is structured by themes arising from the interviews. Finally, Chapter 5 draws together the key threads of the research. The detail underpinning the methodology and analysis can be found in the annexes.

2. Context

At the outset of this research, a rapid evidence assessment was carried out to inform the subsequent data gathering and analysis.

2.1 Introduction

Recent comprehensive literature reviews in the field of barriers to non-domestic energy efficiency, in particular from the Centre for Sustainable Energy and Environmental Change Institute (2012), have highlighted the very large body of research available. Given the volume of material available, this particular task focused on specific areas that would address the aims and objectives of this study, rather than provide a comprehensive account of the evidence base, notably: definitions of the drivers and barriers; drivers of energy efficiency in business; and barriers experienced by businesses in implementing energy efficiency.

This piece of research is particularly concerned with later stage barriers to the implementation of energy efficiency, that is, those barriers that are encountered by a business once it has become aware of the specific measures that are available to it, including the savings potential and cost implications.

2.2 Understanding Drivers

Understanding why businesses engage in energy efficiency is key to developing policy that encourages and supports them in doing so. The Federation of Small Businesses (FSB) argues that it is also important to understand the experiences of SMEs in relation to energy, since regulations are often tailored to larger organisations and are therefore potentially counterproductive for smaller businesses (FSB 2012). Revell et al (2001) argue that the difficulty of engaging with small firms has often been attributed to a lack of awareness about the impacts of their business and with environmental legislation often targeting much larger companies.

The concept of ‘drivers’ is commonly found in discussions on energy efficiency, but resists rigid definition. Generally speaking, and for the purposes of this research, ‘driver’ is used as a term for ‘what is driving’ activity and is commonly used interchangeably with other terms such as motivation and rationale (Sherriff 2013). Eden (1996, quoted in North 2013) provides a useful categorisation comprising three broad types of drivers for businesses in engaging with sustainability: the bottom line (‘good for business’), regulatory compliance (‘you must do it or break the law’), and ethics (‘you should do it’). Revell et al (2010) divide drivers into ‘pull’, which reflect the potential benefits of attracting customers, good publicity, retaining staff and breaking into new markets, and ‘push’, which are responses to legislative control and fiscal incentives.

Research has highlighted a wide range of potential benefits to SMEs of improving energy efficiency including improved competitiveness, product quality, materials efficiency, and staff commitment as well as positive relations with the wider community, lower insurance premiums, lower finance rates and improved public profile.

Recent research has also indicated that businesses are concerned about energy costs and that this is experienced as a driver to energy efficiency. In a 2011 survey by the Federation of Small Businesses (Cave el al 2011), when asked about concerns relating to energy in their business, 81% of UK respondents mentioned concern for the rising cost of energy, 16% the reliability of energy supply and 13% pressure to increase energy efficiency.

2.3 Understanding Barriers

Barriers can be defined as 'man-made factors or attributes that operate in between actual and potential development or use' (Verbruggen et al. 2010, p852); they can be intentional or unintentional and can prevent or hinder action or impede progress towards realising potential. Reddy and Painuly (2004) provide a taxonomy of such barriers and this includes: lack of awareness and information, economic and financial constraints, technical risks, institutional and regulatory barriers, market barriers and market failures, and behavioural barriers.

Barriers are not only purely technical and economic, but also social and cultural: that is, expectations, conventions and decision-making processes will play roles alongside costs and practicalities (Sherriff 2013). In fact, the concept of barriers has been subject to criticism because it implies an expectation of rational behaviour, in which there is a simple causal relationship between the removal of barriers and a business implementing improvements. It is argued (see, for example, CSE and ECI 2012) that a socio-technical view offers a more nuanced understanding. In such a conceptualisation, barriers are located as part of a wider socio-technical landscape and the removal of barriers may have multiple, perhaps unanticipated, effects and will not in itself necessarily be enough to bring about change.

There is a need to understand the relationship between drivers and barriers and to appreciate the synergies and tensions between them. Revell et al. (2010) note, for example, that what appear to be drivers can actually be experienced as barriers. For example, whilst customer demand may be perceived as a potential driver, a lack of it, or a customer base that does not value energy-efficient products, can act as a barrier in that it does not provide businesses with legitimation and motivation for investment.

2.4 Barriers to Energy Efficiency in Business

In 2012, DECC published 'The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK', which sets out the future direction of Government policy in this area. The key consideration is how market failures and barriers can be addressed through the development of new policy. The Strategy describes four high-level barriers to energy efficiency:

Embryonic Markets: Energy efficiency has not yet achieved a mainstream status in the eyes of many consumer groups. This has led to a shortage of expertise in both the demand and supply sides and a lack of specific financial products to support energy efficiency.

Information: A lack of information exists about energy efficiency; in particular, for the consumer, energy performance information must be unbiased, trustworthy and specific to their particular circumstances. Another aspect of this barrier is the absence of accepted protocols for verification of energy performance, especially when the performance is affected by variables such as the ambient temperature, occupancy levels in an office, and capacity utilisation in a manufacturing business.

Misaligned Financial Incentives: The most commonly cited example of this barrier occurs in rented premises. Although the tenant pays the bills they will be very unlikely to make major investments to improve energy efficiency and the property owner has no incentive to invest in energy efficiency as the tenant incurs all the energy costs.

Undervaluing Energy Efficiency: In many organisations, energy is a relatively small proportion of the overall cost base and is not seen as strategically important. There may be significant 'hassle costs' associated with the disruption of implementing a new technology or practice and these will act as a major disincentive towards investment. When energy efficiency is undervalued, companies tend to opt for projects with short payback times and neglect other potential projects, even though they may be cost-effective in the long term.

As part of the development of the Energy Efficiency Strategy, DECC commissioned a literature review in the form of a 'Rapid Evidence Assessment' (CSE and ECI, 2012). This review drew on work by Sorrell et al. (2011) who developed a taxonomy of barriers relevant to industrial energy efficiency. In this, barriers were structured in six categories: the risk represented by energy efficiency investments; the difficulty of relying on imperfect information; hidden costs that are not anticipated, such as management time and disruptions to production; access to capital; split incentives, such as individual departments not being accountable for their energy costs; and bounded rationality, i.e. the tendency not to make decisions in the way often assumed in economic models (Sorrell et al. 2011). Sorrell et al. observe that barriers are, to a greater or lesser extent, interdependent; that several barriers will coexist within one organisation; and that they vary across technologies and organisations.

Other approaches to the categorisation of barriers exist. Cagno et al. (2013), for example, provide a more extensive framework in which barriers are divided by origin, as this is useful in determining appropriate policy responses. External barriers, they argue, are the market, government and politics, technology and services suppliers, designers and manufacturers, energy suppliers and capital suppliers. Internal barriers are economic, behavioural and organisational and those relating to competency and awareness (Cagno et al. 2013, p296).

It is also important to understand the temporal aspects of barriers, since the relative importance of a barrier may vary across the stages of decision-making and there may be different challenges later in the implementation process than earlier.

2.5 Barriers to Energy Efficiency in SMEs

Several studies have looked in more detail at the experiences of SMEs in engaging with energy efficiency. BMG Research (2009) undertook interviews with 2,001 businesses in the North West of England with the aim of understanding attitudes to resource efficiency. Only 2% of the participants had more than 100 employees, and the results are therefore likely to be highly relevant to SMEs. Energy efficiency was not the sole focus of this research (all aspects of resource use were covered); however, it did feature prominently. A total of 46% of interviewees mentioned barriers and the most prominent were 'a lack of capital/money' (15%), 'making change is expensive' (14%) and 'a lack of time to make the changes' (4%) (BMG Research 2009, p57).

Fleiter, Schleich and Ravivanpong (2012) undertook a web-based survey of 4,434 SMEs that had received subsidised energy audits from the German 'Sonderfonds Energieeffizienz in KMU' funding programme, with 542 companies responding. The three most important self-assessed barriers to the adoption of energy efficiency measures were high investment costs, low priority and lack of profitability. They add that technical barriers appear to be either unimportant or of average importance, but note that this may be due to most of the recommended measures being ancillary processes rather than core production processes.

These results are generally consistent with the BMG Research (2009), with financial barriers ranked most highly in both studies by a significant margin. Lack of time is also cited as a key barrier in both studies, but it appears more important in the BMG Research study. Using statistical regression techniques, the authors reached a number of additional conclusions. These included that access to capital is a crucial factor in adopting energy efficiency measures in SMEs, even if the measures can be expected to be profitable, and that the higher the proportion of energy in the overall cost structure of the business, the greater the likelihood of adopting energy efficiency measures. They also found that the company size had no effect upon adoption rates.

Crocker (2011) conducted a series of structured interviews with 12 SMEs in the Yorkshire and Humber region in order to explore attitudes to adopting low-carbon business practices and found that the recurrent themes in terms of internal barriers were cost and financial viability, access to capital and a lack of time.

A recent study of Italian SMEs by Trianni and Cagno (2011) interviewed 128 companies that had participated in subsidised energy audit schemes. The SMEs were drawn from a number of manufacturing sectors and, with their energy costs less than 2% of turnover, they were not considered energy-intensive. The financial barrier was ranked highest, followed by barriers related to a lack of information, even where the companies had received an energy audit. Lack of knowledge did not feature as a major barrier in the BMG Research study (cited by just 4% of respondents), which either reflects a low level of awareness, or a perception that their knowledge base was sufficient (71% of the companies had not previously sought external advice or support for resource efficiency).

Trianni and Cagno also explored how the size of the company influenced the relative importance of the barriers and segmented SMEs into small/medium enterprises (with fewer than 100 employees) and medium/large (with between 100 and 250 employees). Their analysis showed that, for the small/medium group, barriers relating to a lack of time, lack of internal technical skills and technical challenges associated with energy efficiency improvements were significantly greater compared to the medium/large group. In addition, the small/medium group had lower levels of awareness of energy efficiency.

Schleich and Gruber (2008) employed econometric techniques to analyse the results of interviews with over 2,848 public and private sector organisations in Germany, covering a wide variety of small commercial businesses (such as bakeries, butchers, car repairs, construction, laundries) and a range of public and private sector service organisations (such as banks, insurance, hospitals, hotels, schools). The businesses were generally small with an average of 37 employees for each sector. A total of 44% of the organisations in the study were judged to be active in energy efficiency on the basis that they had implemented measures recommended in energy audits.

Their analysis correlated the significance of each of the barriers to a number of company-specific factors such as specific energy consumption (generally kWh/employee), number of employees, availability of time and skilled resources, etc. The study concluded that the mix and significance of the barriers varied across sub-sectors. They also found that those businesses that occupied rented premises had the least knowledge about their energy consumption and the most barriers to investment. Those organisations in less energy-intensive sectors found lack of information a significant barrier whereas those with high energy use experienced the fewest barriers.

Finally, research by Muthulingam et al. (2011) focused on the adoption rates of energy efficiency measures recommended in audits. They used econometric research to follow up on audits carried out at 13,000 small and medium-sized firms under the Industrial Assessment Centers (IAC) Program of the US Department of Energy (DOE). They concluded that recommendations that appeared earlier in an evaluation report were more likely to be adopted than recommendations that appeared later on, and that there was no evidence of choice overload; that is, an increased number of measures did not decrease adoption rates. Subsequently, the recommendation was that business support organisations focus on measures that required the least managerial attention, or targeted support to reduce the required management input, to achieve the highest adoption rates.

3. Methodology

DECC commissioned ENWORKS[3] to undertake a research programme to improve understanding of the barriers and motivations to energy efficiency in SMEs.

3.1 Overview of the Research

The research programme took place in two stages:

1. Business Advisor Workshop – bringing together a group of 6 professionals with significant experience in business resource efficiency to discuss the barriers and motivations to energy efficiency in SMEs as experienced in the field.

   In January 2013, individuals from a number of different bodies took part in this workshop, including DECC, ENWORKS and organisations that have delivered business support through recent ENWORKS projects from the third and private sectors (both SMEs and large companies[4]). The workshop drew out a number of key themes, including that businesses generally reported being conscious that energy efficiency improvements would be beneficial to their operations, but, in the main, were not taking action. Explanations for this inactivity included a lack of internal expertise, resources and capital finance to take things forward.

   Advisors also reported that they commonly met businesses who stated if an improvement had a payback period of less than two years it would be implemented. The reality experienced on the ground, however, was that only improvements requiring no capital investment, or with a payback period of between six months and one year, had a realistic chance of implementation. Advisor experience also indicated that traditional business metrics, such as turnover and sector, had less impact on implementation rates than qualitative characteristics such as staff attitudes and management commitment. The findings from this workshop were used to inform the design and delivery of the SME research activity.

2. SME Research – the second stage, which is the focus of this report, involved gathering and analysing qualitative data on the barriers and motivations to energy efficiency from a small group of SMEs that had engaged with ENWORKS between 2010 and 2012. The study also analysed quantitative data on energy efficiency from these companies, and a larger cohort of companies that had engaged with ENWORKS over a longer period of time, to further explore the findings of the qualitative research.

   ENWORKS arranged for SMEs to participate in the survey element of the second stage and procured an academic partner to conduct the interviews and provide academic rigour to the

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[3] ENWORKS was established in 2001 and has supported over 12,500 businesses to improve their productivity, profitability, competitiveness and resilience through increasing their resource efficiency and reducing their exposure to environmental business risks. www.enworks.com

[4] This included SKM Enviros (now Jacobs), Newground CIC and Quantum Strategy and Technology Ltd.

analysis of both qualitative and quantitative data. Following a tender process, the University of Salford was chosen to undertake this part of the research project.[5]

3.2 The Interviewed Businesses

The Interviewed Businesses were initially divided into three cohorts (A, B & C) defined by DECC as follows:

- **Cohort A** – SMEs that had had energy efficiency opportunities identified for them by ENWORKS, but which had not taken up any further support, i.e. it was understood they had not implemented any energy efficiency improvements. It was intended that this group would provide insight into the barriers and hassle costs associated with energy efficiency upgrades.
- **Cohort B** – SMEs that had had energy efficiency opportunities identified for them by ENWORKS and had recently implemented improvements with support from ENWORKS. It was intended that this group would provide insight into the motivations for energy efficiency, the barriers faced and how they were overcome.
- **Cohort C** – SMEs that had had energy efficiency opportunities identified for them by ENWORKS and were about to implement an improvement. It was intended that this group would be followed through the implementation of the energy efficiency upgrades to provide a deeper understanding of the process, the barriers faced and how they were overcome.

Identification of suitable companies was carried out using a quota sampling approach. In all cases, the SMEs had to have at least four energy efficiency opportunities identified for them by ENWORKS between 2010 and 2012, with at least one of these requiring capital investment; further detail on this process is provided in Annex A. Between 10 to 15 SMEs were targeted for each cohort to provide an overall group of 30–45 companies for interview.

As part of this identification process, a Cohort Selection Framework (Annex A) was developed based on the business characteristics identified as relevant in the evidence assessment. These were: sector – broadly categorised as manufacturing and non-manufacturing; size – split into two bands of employee numbers: 10–49 and 50–249 employees; and energy intensity – categorised as low, medium or high for manufacturing companies only. A similar mix of businesses was sought in each cohort to allow for comparison. A total of 79 SMEs were identified as suitable and invited to take part; 38 SMEs agreed to be interviewed and 31 interviews were completed.

During the interviews, some Cohort A companies reported that they had implemented opportunities identified by ENWORKS under their own initiative; as a result, Cohort A membership could not be assumed to be a proxy for non-adoption. In response to this, the businesses were re-categorised to enable additional analysis as follows:

Adopters (the 22 companies that had implemented at least one opportunity) and

Non-adopters (the nine companies that had not implemented any measures).

[5] The Sustainable Housing and Urban Studies Unit (SHUSU) is a research and consultancy unit based within the College of Science and Technology at the University of Salford. www.salford.ac.uk/sustainable-housing-and-urban-studies-unit

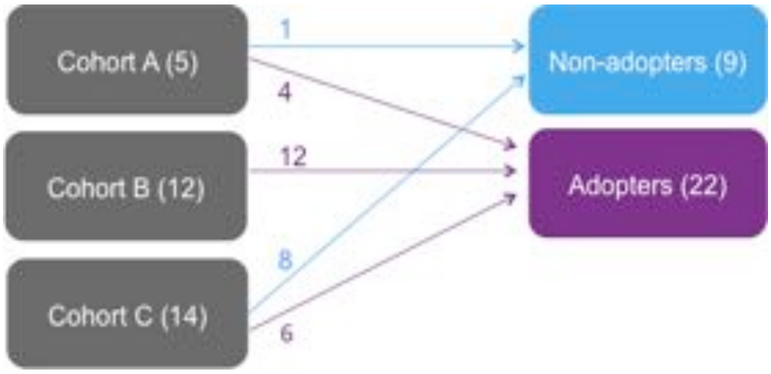

Figure 1. Relationship between the Original Cohorts and the Derived Adopters and Non-adopters

Figure 1 shows this completed transition. These two groups, rather than the three cohorts (A, B and C), informed the analysis and the presentation of the findings.

3.3 Qualitative Analysis

3.3.1 The Semi-structured Interviews

Drawing upon the findings of the evidence assessment, and guided by discussions between the three project partners, a topic guide was developed and used to deliver the semi-structured interviews (Annex B). It covered a range of issues including: the background of the business; key metrics such as energy spend and turnover; decision-making processes; experiences and views around implementing energy efficiency improvements; and the impacts of these measures, both perceived and actual.

Interviews were undertaken in November and December 2013, either face-to-face or over the telephone. In most cases they were with a director or other senior-level decision-maker in the business who was familiar with a range of relevant strategic and operational issues. The interviews lasted 30 to 60 minutes and were audio recorded and transcribed. The transcripts were treated anonymously.

3.3.2 Analysing the Interviews

The qualitative data generated in the interviews were coded and thematically analysed using QSR NVivo 10 software. Framework analysis was used to systematically engage with the data. This is an established technique within applied settings and provides a thorough approach for the development of themes and concepts grounded in the recorded data whilst maintaining an effective and transparent audit trail. The approach is effective for identifying emerging themes arising from within and between cases (i.e. the businesses). It also facilitates comparison of sectors and Adopters/Non-adopters, since these categories can be isolated in the analysis through the use of codes. The analysis categorised the data into 20 themes, as presented in Annex D.

3.4 Quantitative Analysis

3.4.1 The Interviewed Businesses

Data on resource efficiency improvements, covering both Implemented and Pipeline Opportunities, was gathered from the ENWORKS Toolkit (see Annex A for further information) and verified by the businesses during the interviews. To supplement this, data on annual turnover and employee numbers was collected during the interviews and verified via Companies House. Data on annual energy expenditure was also collected during interviews and, where available, was corroborated using data on the ENWORKS Toolkit.

The analysis of data from the Interviewed Businesses was limited by the relatively small sample size (i.e. 31 companies) and also by the skewed nature of the group, restricting the potential for statistical analysis. Therefore, the analysis carried out provides broad observations of the data and is indicative rather than statistically robust. As documented in Chapter 4, this analysis was carried out by summarising key characteristics and metrics in tables and histograms, and discussing trends visible in the data.

3.4.2 The ENWORKS Efficiency Toolkit and Other Quantitative Data

The Efficiency Toolkit contains data on company-specific resource efficiency improvements identified by ENWORKS (see Annex C) and a range of other support providers from across the UK. For this study, the data was filtered to identify only those companies that had been supported by ENWORKS and only SMEs (i.e. to eliminate large businesses). It also isolated only those that had energy efficiency improvements recorded (i.e. other resources and other types of improvement were excluded). This filtering provided a dataset of 3,272 SMEs with 14,471 individual improvement actions (opportunities) for analysis.

For each of these 14,471 opportunities, a large amount of data is captured as mandatory by the Toolkit, including: a narrative description of the improvement action (opportunity); date created/updated; resource type; status of action; capital requirement; cost saving and payback period. The Toolkit also captures data on a number of business characteristics, including: sector and SME status (mandatory, therefore available for all), plus turnover, employee numbers and annual energy expenditure (optional, therefore limited availability). This variation in the availability of data meant that four different subsets were created and lent themselves to different analysis. Table 1 gives an overview of these subsets.

Dataset	Businesses	Opportunities	Interview transcripts	Energy spend, turnover, employees	Classification by improvement type	Opportunities and associated savings
Wider Database	3,272	14,471				✓
Filtered Toolkit	2,970	10,961			✓	✓
With Information Businesses (WIB)	199	1,164		✓	✓	✓
Interviewed Businesses	31	334	✓	✓	✓	✓

Table 1. Description of Available Data for the Four Datasets Used in this Research

For each of the opportunities associated with businesses in the **Wider Database** the mandatory data described above is available alongside the sector of the business and its status as an SME. This research created a subset of this database, the **Filtered Toolkit**, where the researchers were able to apply a new classification to the improvement type by identifying keywords in the descriptions of the opportunities (Annex E), this enabled the implementation rates of specific energy efficiency actions to be explored. Within this, a small group of businesses had utilised the optional functions of the Toolkit (in addition to the above) and had recorded data on energy expenditure, turnover and employee numbers; these are referred to as **With Information Businesses (WIB)**, enabling investigation of the influence of these metrics on implementation rates. Finally, **Interviewed Businesses** are those that took part in the qualitative research via semi-structured interviews and had all data referred to above available for the research.

These datasets are further divided into two more categories:

Adopters and **Non-adopters** – Adopters are those businesses that have implemented one or more of the opportunities identified for them in the ENWORKS Review, whilst Non-adopters are those that have implemented none; and

Manufacturing and **Non-manufacturing** businesses – In some cases it was not possible to make such a sector classification with sufficient confidence; therefore, it was necessary to create a 'not classified' category. The split between these two sectors is given in Section 4.3.5.

3.4.3 Analysis

Where possible, Toolkit data was used to test the findings identified in the interviews. For this, the themes that emerged as either drivers or barriers to uptake in the surveys were examined using the datasets described above to explore the influence of different factors on the rate of uptake of energy efficiency improvements. For cost savings, capital cost and payback period (i.e. financial considerations), histograms were created that provided a visual representation of the relationship between implementation rate and these metrics. In order to complement this exploration with a more statistically robust approach, regression analysis was carried out using these financial factors.

The influence of business characteristics on implementation rates was also explored using regression analysis and comprised two tests. The first used employees, turnover, energy expenditure and energy intensity as the independent variables, with savings achieved as the dependent variable. The second used the Adopter/Non-adopter status of the business as a binary dependent variable. Since data on energy intensity and turnover were required for this test, the With Information Businesses dataset was utilised. For the purpose of the first test, the independent variables were converted using logarithms in order to make the non-normal distribution suitable for regression analysis. These tests were carried out for All Businesses and on the Manufacturing and Non-manufacturing subsets. Analysis by improvement type was also carried out.

A further stage of the quantitative analysis was the estimation of the potential cost savings for the Toolkit businesses and, in turn, the savings opportunity effectively missed by the businesses through non-adoption.

3.5 Limitations and Issues

It is important to consider the limitations and issues of this study when interpreting and contextualising the results:

- A non-random sampling method was used. All companies in the study (whether directly taking part in the interviews or indirectly contributing via their aggregated data from the Toolkit) had engaged with ENWORKS on resource efficiency.
- The sample of Interviewed Businesses was subject to selection bias; that is, companies chose whether or not to take part.
- The small sample size of the Interviewed Businesses was limiting and any differences between the groups were regarded as indicative rather than statistically significant.
- The length and depth of the interviews was influenced by the interviewee's availability. Any time limitations were made explicit at the outset allowing the focus to be tailored to the most relevant questions.
- The additional classification of opportunities (Annex E) contained an element of subjectivity and a complete validation of its accuracy was beyond the scope of this project.
- All the datasets derived from the Toolkit exhibit non-normal distributions, often with a large population of data points around the origin and a significant population of high-value outliers. These characteristics have militated the use of conventional parametric tests and restricted the level of statistical analysis that could be applied.

- With any quantitative analysis it is difficult to establish causality; it should be noted that evidence of a trend does not necessarily imply a specific cause. However, by enabling the integration of observations from qualitative interviews with quantitative analysis of the ENWORKS Toolkit, it is possible, to some extent, to overcome this limitation and to use qualitative data as a lens through which to view the quantitative.
- It has not been possible to investigate the time lag between the identification of an opportunity and its implementation in this study. This information is available for businesses that have received ongoing support from ENWORKS, and therefore analysis could be carried out, for example, to explore the influence of improvement type or sector on speed of uptake. For businesses not receiving ongoing support (e.g. where return on investment to ENWORKS was not sufficient), this data is not available in the Toolkit and cannot be investigated; it should be noted that in these cases, the assumption that implementation has not taken place may be incorrect, as the business may have taken action without notifying ENWORKS.

4. Findings

This chapter presents the key barriers and motivations to energy efficiency as articulated through the business interviews. It tests these findings against quantitative data from the ENWORKS Efficiency Toolkit wherever possible, exploring the significance of a range of factors on rates of uptake. Finally, it assesses the value of the missed opportunity for businesses that are not addressing energy efficiency.

4.1 A Note on Presentation

The results of the qualitative and quantitative aspects of this research are presented in different ways: the findings of the qualitative data analysis comprise a series of quotations within a commentary; whilst the quantitative elements lend themselves to numerical tables and charts with an analytical narrative. The level of precision that can be reported varies: the qualitative findings are expressed in terms of observed trends and patterns (e.g. 'many interviewed businesses expressed concern about Y' or 'the interviews suggest that businesses in the manufacturing sector were more likely to experience Z than those in the non-manufacturing sector'), whilst for the quantitative aspects, percentages and absolute values are provided, rounded to the nearest whole number (e.g. '73% of businesses demonstrate quality X'). Quotes from interviewees are followed in parentheses by information on their Adopter/Non-adopter status, their size in terms of number of employees, and whether they are in a manufacturing or non-manufacturing sector.

4.2 The Interviewed Businesses

As described in Chapter 3, the Interviewed Businesses consist of 31 companies: 22 Adopters and 9 Non-adopters. This is a relatively small dataset and observations from it are necessarily indicative rather than statistically robust.

A total of 20 of these businesses are in the manufacturing sector (13 Adopters and 7 Non-adopters) and 11 are in the non-manufacturing sector (9 Adopters and 2 Non-adopters).

Some 334 energy efficiency opportunities (improvement actions) have been identified by ENWORKS across these 31 companies, of which 87 had been implemented (representing a 26% implementation rate to date).

A number of business characteristics were identified for the Interviewed Businesses, including: turnover, number of employees, energy expenditure, energy intensity (energy spend expressed both as a percentage of turnover and by number of employees) and the number of energy efficiency opportunities recorded on the ENWORKS Toolkit (both identified and implemented).

Analysis of this data suggests no major differences between the characteristics of Adopters and Non-adopters, and so, for this small sample of SMEs, the characteristics listed cannot be shown to have affected the uptake of energy efficiency improvements. Within this statement, it should be noted that some variations across the sample were visible, although not significant; Adopters tended to have more opportunities identified for them and have a higher energy intensity (as a percentage of turnover) than Non-adopters. Further research would be required to investigate if these variations occur due to having a greater number of opportunities identified, or whether it was driven by having an ongoing relationship with ENWORKS and thus more time for additional improvement actions to be identified.

Business characteristics are explored further in later sections where additional factors are considered to determine their level of influence (Also see Annex F).

Figures 2 and 3 below show the distribution of Adopters and Non-adopters by the number of opportunities identified and by energy intensity (as a percentage of turnover).

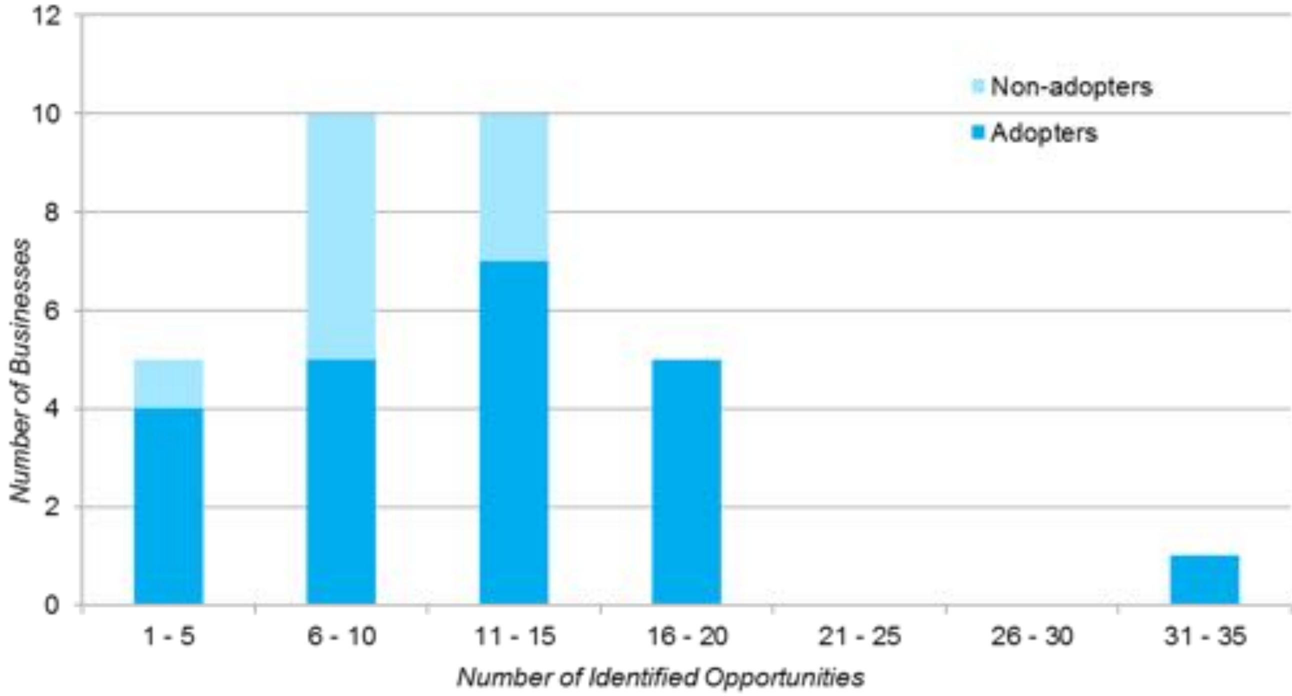

Figure 2. Interviewed Businesses (n=31): Number of Opportunities Identified, Adopters and Non-adopters

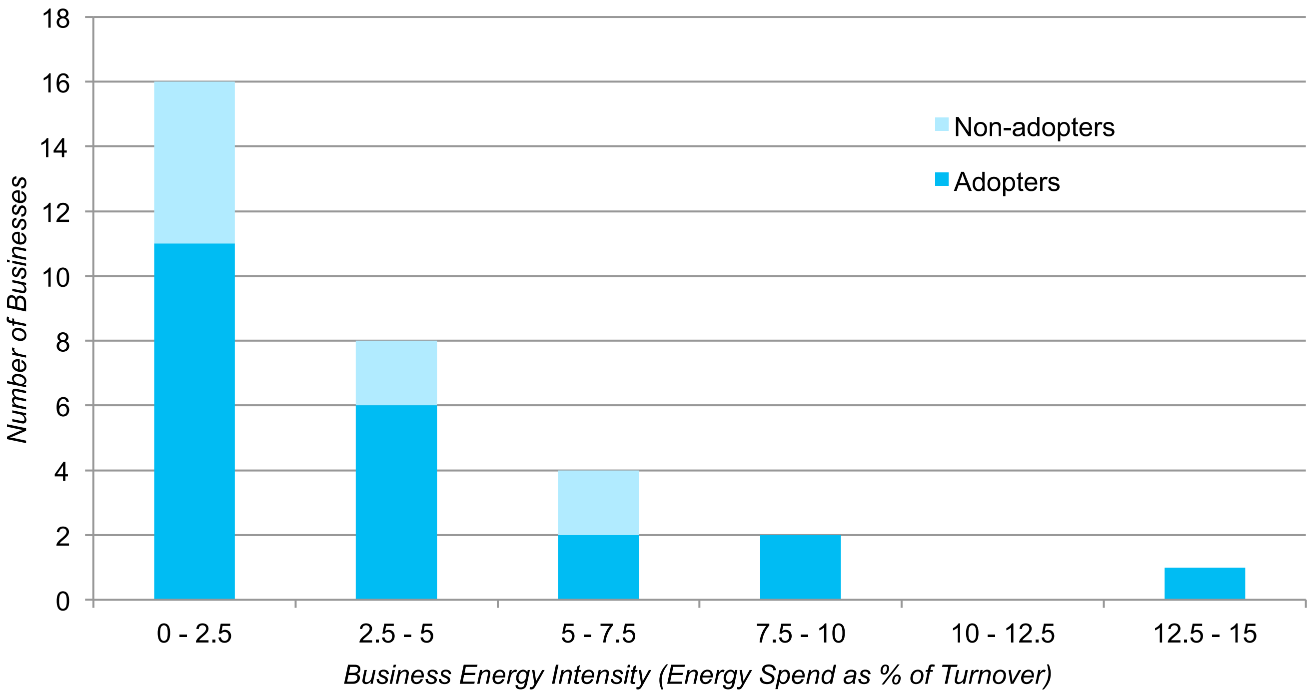

Figure 3. Interviewed Businesses (n=31): Energy Intensity, Adopters and Non-adopters

4.3 Cost Savings, Capital Expenditure and Payback

The economic components of implementing energy efficiency improvements featured prominently in the business interviews as both drivers and barriers to uptake. This section explores these factors in detail, using both qualitative material from the interviews and quantified data from the ENWORKS Efficiency Toolkit.

4.3.1 Cost Savings

Every business interviewed cited the potential to cut costs as being a driver for energy efficiency and many said the potential to take advantage of opportunities for cost savings was a reason for their initial engagement with ENWORKS.[6]

Manufacturing companies reported they were very aware of the energy cost component in their core manufacturing processes, resulting in the perception that 'money and energy [is] the same thing to us'. (Adopter, 10–49, Manufacturing)

> *I would say it's more an understanding of how the business is going and [costing]. The most important thing is that we get the costing of a metre of fabric correct. (Adopter, 50–249, Manufacturing)*

Aside from using energy in manufacturing processes, all businesses need to heat and light their offices, factory floors and storage areas and some, in the non-manufacturing sector, need to provide comfort for customers as well as employees. Interviewees tended to report that their energy use was particularly important in the context of rising energy bills as these additional operating costs could not necessarily be passed on to customers:

> *… in manufacturing it's become such a competitive market that you can't increase your prices. Our energy costs, and not consumption, have risen by maybe 10% or 12% but we can't put our prices up [by] 12%... that would leave us at a risk of losing our customers. (Adopter, 10–49, Manufacturing)*

Interviewees also described their awareness about the role of energy in business planning and the implication of rising costs in particular. Several expressed the view that even if it was impossible to keep energy costs stable, it should at least be possible to control energy use:

> *[What did you hope to get out of this process?] 'Stability in energy use... It's too much to hope for stability in energy prices.' (Adopter, 10–49, Non-manufacturing)*

In this respect, energy was reported to be viewed as an essential longer-term consideration, with the anticipated price increases acting as a driver to reduce or stabilise energy usage and therefore minimise the impact on operating costs.[7]

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[6] Research has suggested that SMEs tend to take a cost-cutting approach to finance, with many seeking funds internally or from family sources, since external finance can be difficult to obtain. (Price et al. 2013)

[7] North and Nurse (2014) observe that growing environmental awareness and the need to reduce costs in the context of increasing fossil fuel prices is now 'often seen by conventional business owners as an integral element of ensuring continued competitiveness'. (North and Nurse 2014, p35)

This finding was tested by analysing the quantitative data held in the ENWORKS Toolkit, both for the 31 Interviewed Businesses (Figure 4a) and the 2,970 businesses in the Filtered Toolkit dataset (Figure 4b).

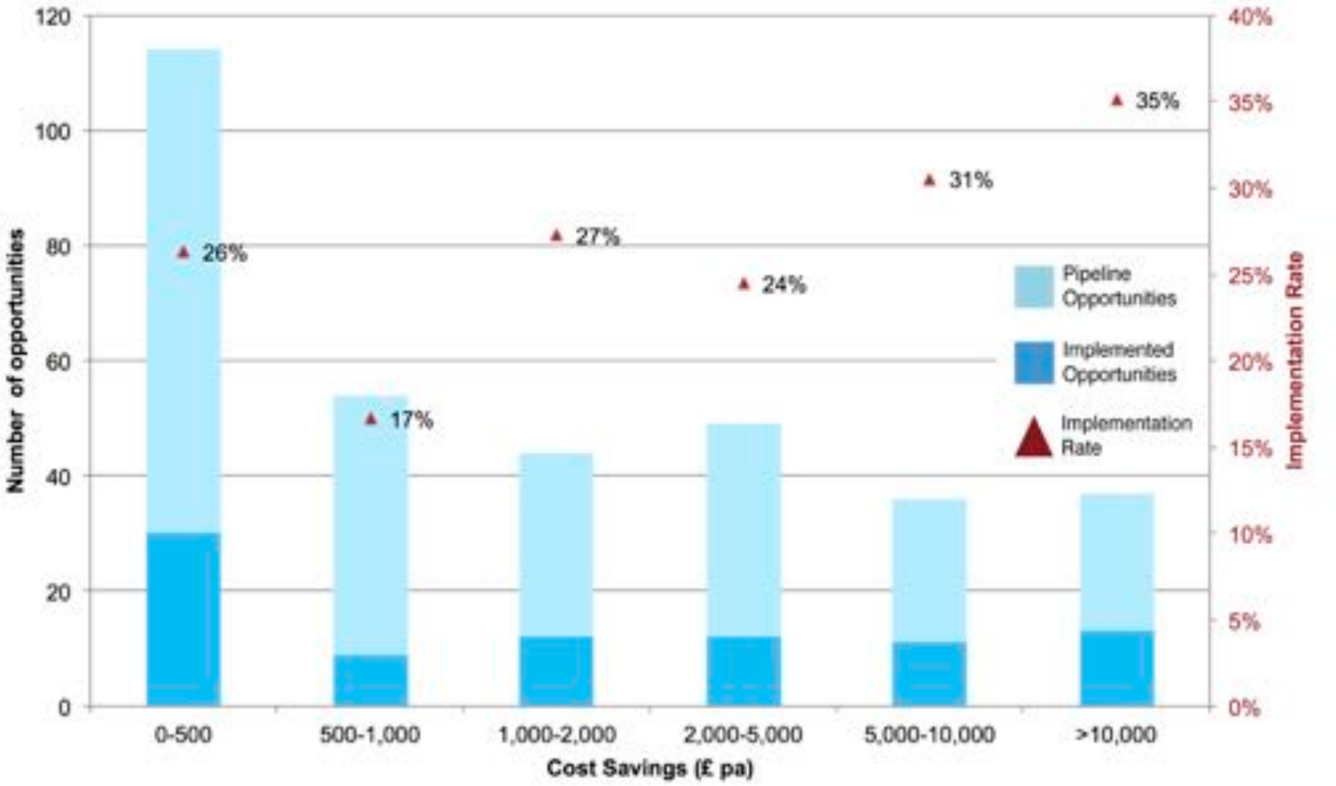

Figure 4a. Opportunities in Interviewed Businesses (n=334): Implementation Rate by Annual Cost Savings Value

The analysis looked at the relationship between cost savings and implementation rate and the figures below show these rates across different value bands of annual cost savings.

For the 31 Interviewed Businesses, 50% of the 334 opportunities identified have a cost savings value of less than £1,000 per annum. These measures had an average implementation rate of 23%. For opportunities with a savings value over £1,000 and up to £5,000 pa (these make up 28% of the opportunities), a slightly higher average implementation rate of 26% was observed.

For opportunities with a value above £5,000 and up to £10,000 pa, and for those opportunities saving over £10,000 pa, the implementation rates rose to 31% and 35% respectively. This indicates a general trend for rising implementation rates as the value of annual cost savings increases among the surveyed companies.

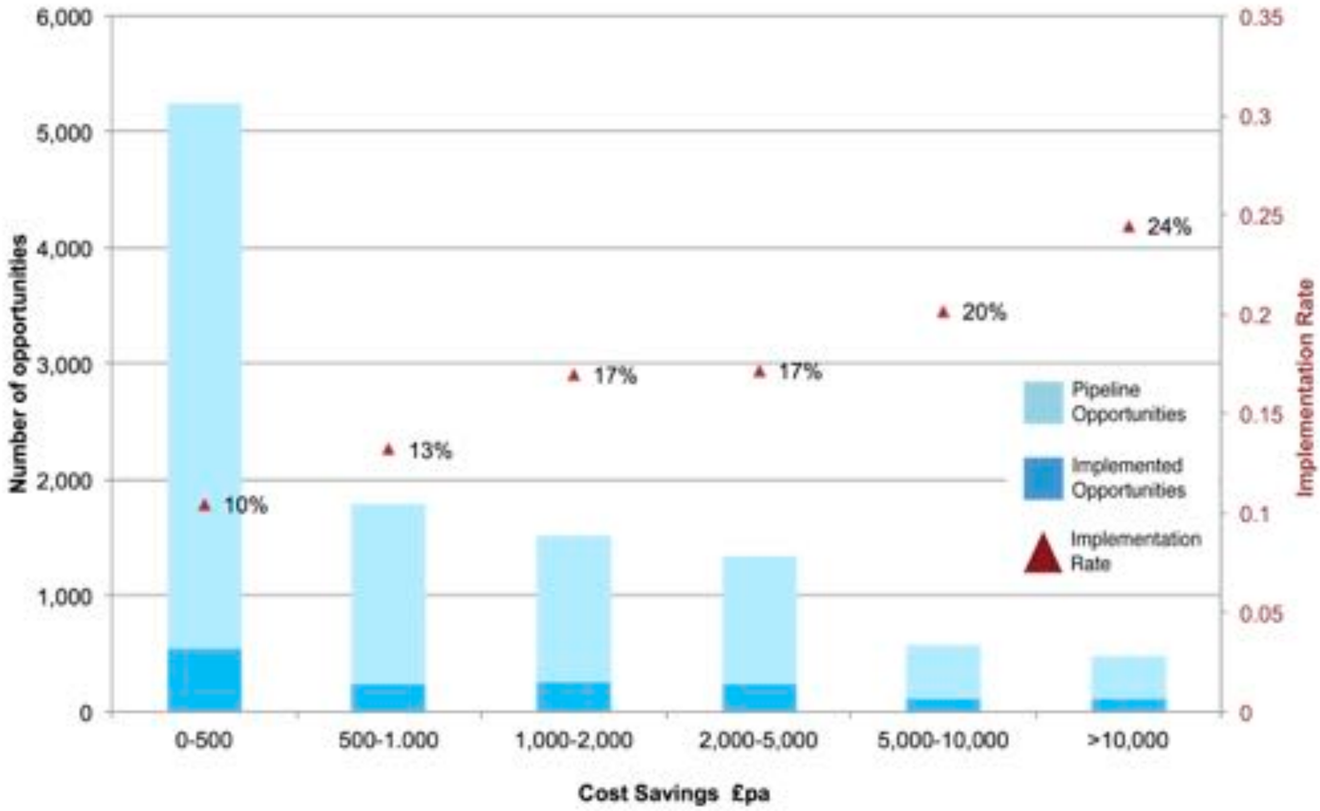

Figure 4b. Opportunities in Filtered Toolkit (n=10,961): Implementation Rate by Annual Cost Savings

A similar tendency can be seen across the 2,970 businesses and 10,961 opportunities in the Filtered Toolkit dataset, showing increasing implementation rates as the value of cost savings rises, reaching a maximum where savings are greater than £10,000 pa; although the implementation rates are lower overall, all below 25%.

Despite these trends, the data suggests that whilst SMEs commonly say that cost savings are a key driver, the reality is that even when specific information is provided to them regarding appropriate energy efficiency measures (i.e. early stage barriers are removed), the levels of uptake remain low, below a quarter of the potential available, indicating that other factors are in play and are limiting uptake.

4.3.2 Capital Cost

Many energy efficiency improvement measures require no capital expenditure, for example heating systems can be more closely controlled to prevent waste or the start-up and shut-down times of production machinery can be adjusted to prevent idle running.. Some 36% of the energy efficiency opportunities that have been identified for companies by ENWORKS require zero capital expenditure to implement and have the potential to generate £12.41m in savings pa. A total of 41% of the energy efficiency opportunities that have been implemented by companies supported by ENWORKS have required zero capital expenditure and are generating £2.88m savings pa.[8] However, the need for investment, and thus the need for appropriate

[8]Looking more broadly than just energy efficiency, to encompass other resource savings, 51% of all the opportunities that ENWORKS has identified for companies in the ENWORKS database require no capital expenditure to implement and have the potential to generate £79.24m of annual cost savings. Some 63% of the broader resource efficiency opportunities that have been implemented require zero capital expenditure and are generating £21.80m savings pa.

financial products or cash flow, has been commonly reported to affect the uptake of energy efficiency improvements (BMG 2009). This barrier came through as a key finding of the SME survey, as exemplified by the following extracts.

One company wanted to be able to update machinery but did not have the capital resources:

> *Some of the equipment we are using, we've had for a long time. It would be nice to say, right, we are just going to replace this section of the coating line. But, because of the way the market is we haven't necessarily got the capital available to invest. You kind of just make improvements where you can. I guess that would be a barrier. (Adopter, 10–49, Manufacturing)*

In some cases, the replacement of machinery was identified as being advantageous in energy terms but was not attractive to the business financially. For one business, replacement of motors was recommended but it was difficult to justify the expenditure when the machines did not need replacing:

> *You would have to replace lots and lots of bits of machine to be able to do that, unfortunately. It's not something we can really do. (Non-adopter, 50–249, Manufacturing)*

This was particularly relevant to newer companies where they had more recently invested in equipment:

> *We are only six years old, you see… It's not something that's already broken, or even becoming out of date. We would be replacing new things with new things. (Adopter, 10–49, Manufacturing)*

Some companies reported that they had been eligible to apply for public funds to support energy efficiency improvements and in some cases they reported problems with the bureaucracy of accessing these funds. This could be a particular difficulty for SMEs which are rarely able to dedicate the necessary resources to what can be time-consuming and complex application processes. For example, there was a perception in the interviewed companies that those responsible for coordinating these funds did not understand why SMEs were not more readily taking them up:

> *They are probably scratching their heads while the likes of our company keeps looking gift horses in the mouth. (Adopter, 10–49, Non-manufacturing)*
>
> *I think there were offers for interest-free loans. [For] the funds involved it wasn't really worth going through the hassle of demonstrating the things you had to do simply to get the money. (Non-adopter, 50–249, Manufacturing)*

One applicant was turned down for funding without receiving what they felt was an adequate explanation. They contested this and received funding in the end, but with a lot of difficulties:

> *I well remember having to supply 25 meg[abytes] of PDF attachments, because for every nut and bolt we used, we needed to provide a quotation and a purchase order, a delivery note and an invoice. (Non-adopter, 10–49, Manufacturing)*

Another had the grant rescinded after spending a great deal of time on paperwork and had to make alternative arrangements:

> *I'd literally filled in another sixty-page document and was about to submit it and then the day before I submitted, they cancelled all the funding. What we had to do was, we took a 50k loan from funding circle and effectively had to find it, we found a supplier who project managed it for us and we arranged to take some of the cost up front and we paid them an extra margin for paying back over a period of time. We basically had to sort it out ourselves. (Adopter, 10–49, Non-manufacturing)*

Another was pursuing funding via their local council and commented that the process had been slow, but attributed this to no specific reasons or experiences, just an impression of the bureaucracy and slowness of the operation of the council, which could have been the result of particular circumstances:

> *I think they had a problem with a member of staff being off sick and then their bureaucracy went very, very slow. (Non-adopter, 10–49, Non-manufacturing)*

The time and resources required to apply for financial support or public funding, whether real or perceived, can create barriers to the uptake of energy efficiency measures and these are commonly referred to as hassle costs.

As capital expenditure came through in the interviews as a key consideration, analysis was carried out on the quantified data for these companies (see Figure 5a) and for the larger Filtered Toolkit dataset (Figure 5b).

Figure 5a shows that 47% of the 334 opportunities identified for Interviewed Businesses require zero capital expenditure. These measures achieved a 24% implementation rate. A further 23% of the opportunities identified require less than £1,000 investment – these achieved an implementation rate of 30%. That is, 70% of the opportunities identified require no, or negligible, capital expenditure but only 25% of these were implemented.

Of the 87 opportunities that were successfully implemented by the Interviewed Businesses, 43% require zero capital expenditure, a further 44% require less than £5,000 and only 14% require more than £5,000.

Most Interviewed Businesses reported that their investments had been financed from their own funds and, given the relatively low values seen in Figure 5a, this seems plausible. It also indicates that, in practice, the investments are likely to have been absorbed into normal running costs and will have avoided the hassle costs described above, related to securing public subsidies, and will have had no requirement for any complex management decision-making (it should be noted that whilst the interview responses on this subject refer to public sector financial support, the same issues may also have been associated with securing finance from private sources).

So, even though 86% of the 524 improvements made by the Interviewed Businesses require either zero capital expenditure or less than £5,000 investment, the need for capital investment and the hassle costs associated with accessing finance and funding were still mentioned as barriers to the uptake of energy efficiency improvements.

This indicates that businesses may have perceived financial barriers which inhibited uptake of energy efficiency improvements even when they had the data available to show them that capital investment was not required and/or when they had first-hand experience of increasing energy efficiency without capital investment.

Analysis of the 10,961 identified opportunities in the Filtered Toolkit[9] shows that 30% required zero capital expenditure. These measures achieved an implementation rate of 20%. A further 40% of the identified opportunities require less than £1,000 investment – these achieved an implementation rate of 11%. That is, 70% of the opportunities identified require no, or negligible, capital expenditure but only 15% of these were implemented (lower than the Interviewed Businesses, which achieved 25% conversion).

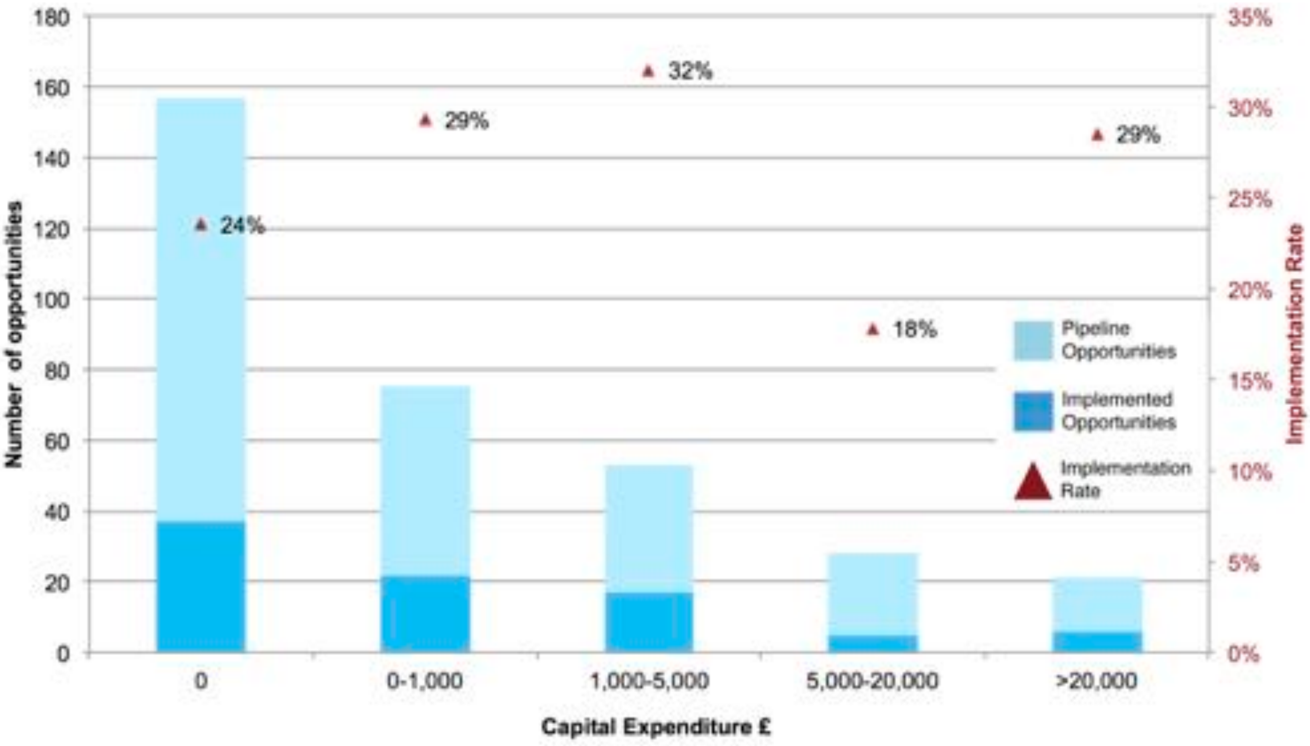

Figure 5a. Opportunities in Interviewed Businesses (n=334): Implementation Rate by Capital Expenditure Bands

Of the 1,412 opportunities that have been successfully implemented by businesses within the Filtered Toolkit dataset, 43% required no investment, a further 46% required less than £5,000 and just 12% required more than £5,000.

The distribution of Implemented Opportunities by the value of capital expenditure required is therefore largely the same across both the Filtered Toolkit and the Interviewed Businesses. This may reflect the focus that ENWORKS puts on identifying no-cost and low-cost opportunities for its clients, particularly in the first interaction, but is also a good indication that a significant amount of energy efficiency improvements can be made across the SME sector with little or minimal need for financial investment support. However, it is also the case that some measures do require capital expenditure over and above normal operating costs, and there is some evidence that there are both real and perceived hassle costs associated with finding and securing appropriate funding.

[9] The data derived from the Filtered Toolkit, which comprises 10,961 opportunities, contain unknowns for some of the financial metrics. Therefore, the actual number of opportunities used for analysis comprises 9,963 opportunities for capital expenditure and 10,877 for cost savings.

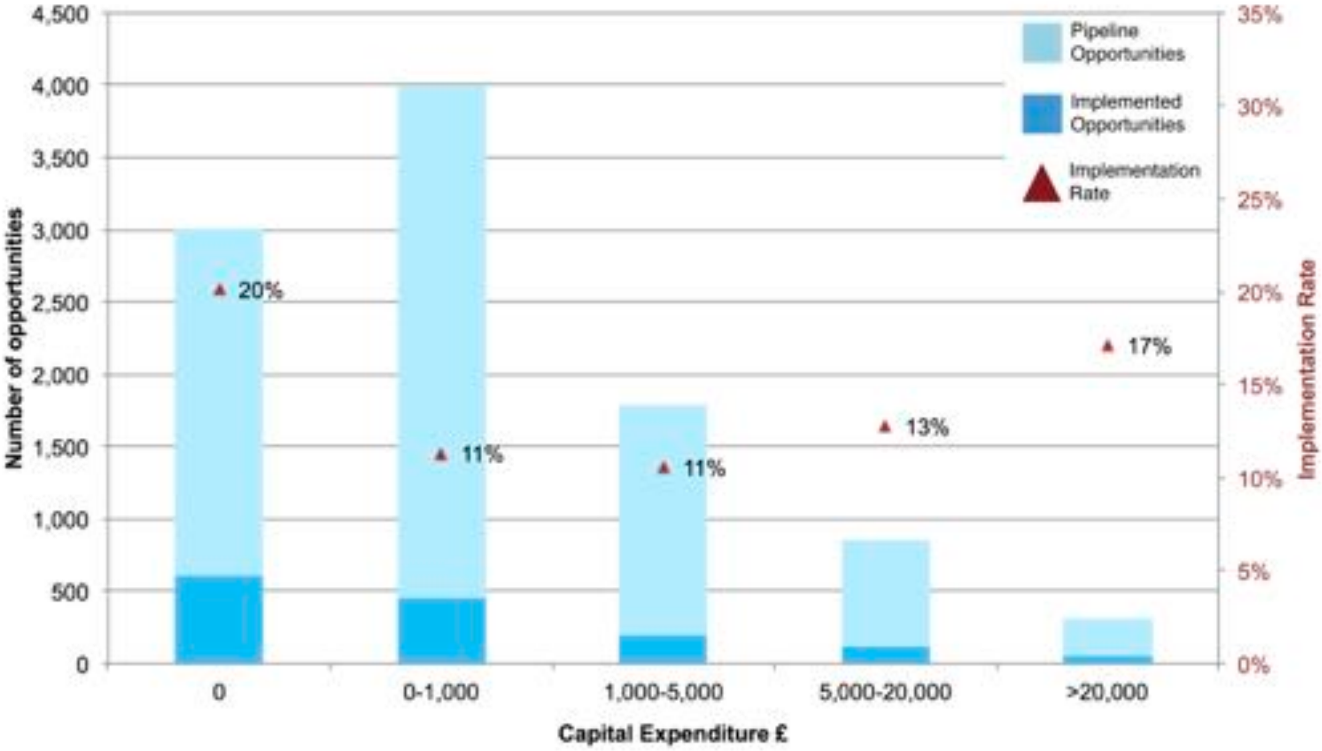

Figure 5b. Opportunities in Filtered Toolkit (n=10,961): Implementation Rate by Capital Expenditure Bands

4.3.3 Payback Period: Recouping the Investment

The payback period of an investment is intrinsically linked to both capital expenditure and cost savings[10]. Even when investment funds to make energy efficiency improvements can be found (as part of normal operating costs, internal budgets or external sources), it could be expected that the rate of return on that investment is an important consideration in deciding whether or not to proceed.

During the interviews, the majority of companies specifically mentioned payback period as an important consideration in the decision-making processes on implementing energy efficiency opportunities.

> *It's simple payback and cost. It's as simple and straightforward as that. (Non-adopter, 10–49, Manufacturing)*

Generally, two years was considered to be the maximum acceptable payback period, with a minority of companies reporting that they would consider projects with payback periods up to five years. With an attractive payback, it was reported that there was often 'no argument' against implementing an energy efficiency measure if its return on investment was within acceptable timescales.

This view is not entirely consistent with the quantitative data from the Interviewed Businesses, which show an implementation rate of around 25% for opportunities with payback periods of less than two years (see Figure 6a), and this figure is not markedly different from that for opportunities with longer payback periods.

[10] Payback period (p) is calculated in the Toolkit and derived from dividing the capital cost of an opportunity (x) by its annual cost saving (y), therefore giving the period of time over which cost savings outweigh the initial cost; p = x/y assuming prices do not change.

In cases where the payback period was longer than two years, interviewees reported that more extensive discussions around the business case were required and examples were given of measures being rejected due to the estimated payback period being too long – an opportunity to improve lighting offered a payback period of 3.1 years but was not implemented:

> *…the savings would have been okay, but a payback of 3.1 years is way too long for us. (Adopter, 10–49, Manufacturing)*

Some companies reported that it was difficult to calculate payback periods precisely, even when there was extensive sub-metering, as other 'noise' such as price rises and fluctuations in production clouded the issue:

> *I suppose the only major difficulty is working out what the payback is going to be [and] actually doing the calculations to see [if] it is worthwhile. (Non-adopter, 50–249, Manufacturing)*

Despite the importance of monitoring and anticipating impact, some businesses reported they were prepared to act without a detailed estimation of payback:

> *As time goes on, the domestic-style fittings start to get a little bit worn; they start to break. We took the view to replace them, on the principle that there should be a decent payback on them, but we aren't even going to be able to monitor it. (Adopter, 50–249, Manufacturing)*

In addition, it was reported that measures were sometimes cheaper to implement than first indicated, especially if businesses had their own established contractors or if other ways to reduce costs, such as a gradual rollout, were adopted:

> *The primary reason to do it incrementally was about it being less of an issue and a need for a big expenditure by doing it gradually. (Adopter, 50–249, Manufacturing)*

Whilst a simple calculation of payback period may have informed a decision, the benefits of a particular energy efficiency action may have been evident in a different part of the business from where the decision was made, or come under a different budget heading or a different manager's jurisdiction.

These factors can be difficult to integrate into up-front decision-making processes and indicate that businesses did not necessarily follow a simple 'calculation – decision – implementation' model when considering the payback period or broader investment rationale for energy efficiency improvements.

In the service and leisure sectors in particular, payback can be understood as a more general projection, whereby the benefits of measures were experienced in terms of sustained or increased levels of custom and income:

> *It's not so much a [direct] payback as hopefully generating more repeat business and income streams, but it's difficult…I don't do any upfront sort of spreadsheets of projections for that. One hopes that [with] a more attractive dining room we get more functions booked and one naturally hopes with better bathrooms we get…bookings and nice comments on TripAdvisor. (Adopter, 10–49, Non-manufacturing)*

This broader conceptualisation of 'payback' was most pervasive in the non-manufacturing sector, but there were equivalents in manufacturing: if, for example, buying/upgrading a particular production machine meant the difference between losing and keeping a customer, it was not the payback period of the machine that was the primary interest, but its ability to sustain the business:

> *It's very difficult to put payback on something like that because it's just a piece in our line of manufacturing that would increase the productivity to a specific customer. (Adopter, 10–49, Manufacturing)*

An individual measure may have been weak in terms of payback, but was understood to make an important contribution to the development of the business:

…The payback is important but it's taken in the wider scheme… where does it take the business longer-term as well. It's not as straightforward [as] if it doesn't pay back in three years we are not going to do it. (Adopter, 50–249, Manufacturing)

This was especially relevant when an investment was conceptualised more broadly as relating to improved or sustained business. It follows that, when businesses were required to place the customer in the centre of their business, customer-related improvements would take priority even in cases where conventional payback was too high or difficult to estimate:

For us, customer projects will always have a much higher priority. [If] it's improving the ambience of a room by redecorating or putting new furniture in, that would always have a higher priority than something that doesn't affect that customer. It then becomes about payback, and payback can be in terms of the physical money that we get back into the business or it might be about it being a defensive spend… that tends to be around customer-related stuff. (Adopter, 10–49, Non-manufacturing)

To test the findings from the interviews, the implementation rate of energy efficiency opportunities at different payback periods was analysed. The findings of this analysis are not entirely consistent with the views expressed.

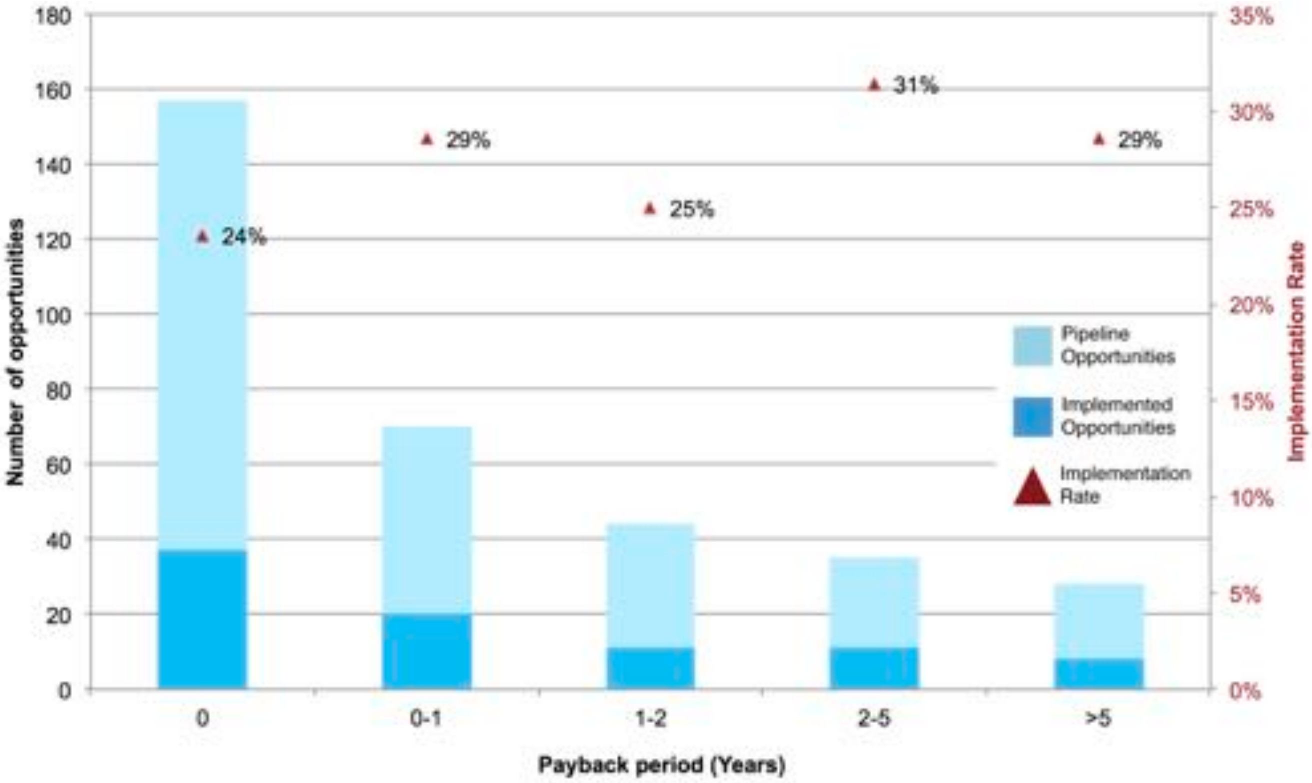

Figure 6a. Opportunities in Interviewed Businesses (n=334): Implementation Rate by Payback Period Bands

As we saw in Section 4.3.2, the data show that opportunities with a zero payback period, i.e. requiring zero capital expenditure, achieved an implementation rate of 24%. This indicates that factors other than availability of finance and return on investment were affecting take-up rates.

For opportunities with a payback period of less than two years (excluding those with zero capital expenditure), the average implementation rate was 27%; for those where payback period was between two and five years the implementation rate was 31% and for those with a payback period over five years the rate was 29% (see Figure 6a). That is, there was no marked difference in the implementation rates for different payback periods, as could be expected to be seen solely based on the interviews, indicating that payback period alone was not in itself a sufficient driver or barrier to the uptake of energy efficiency improvements.

However, the volume of opportunities implemented did reflect the preferences expressed in the interviews, as 36% of the opportunities implemented by these businesses have a payback period of less than two years (if zero payback opportunities are included, this rises to 78%).

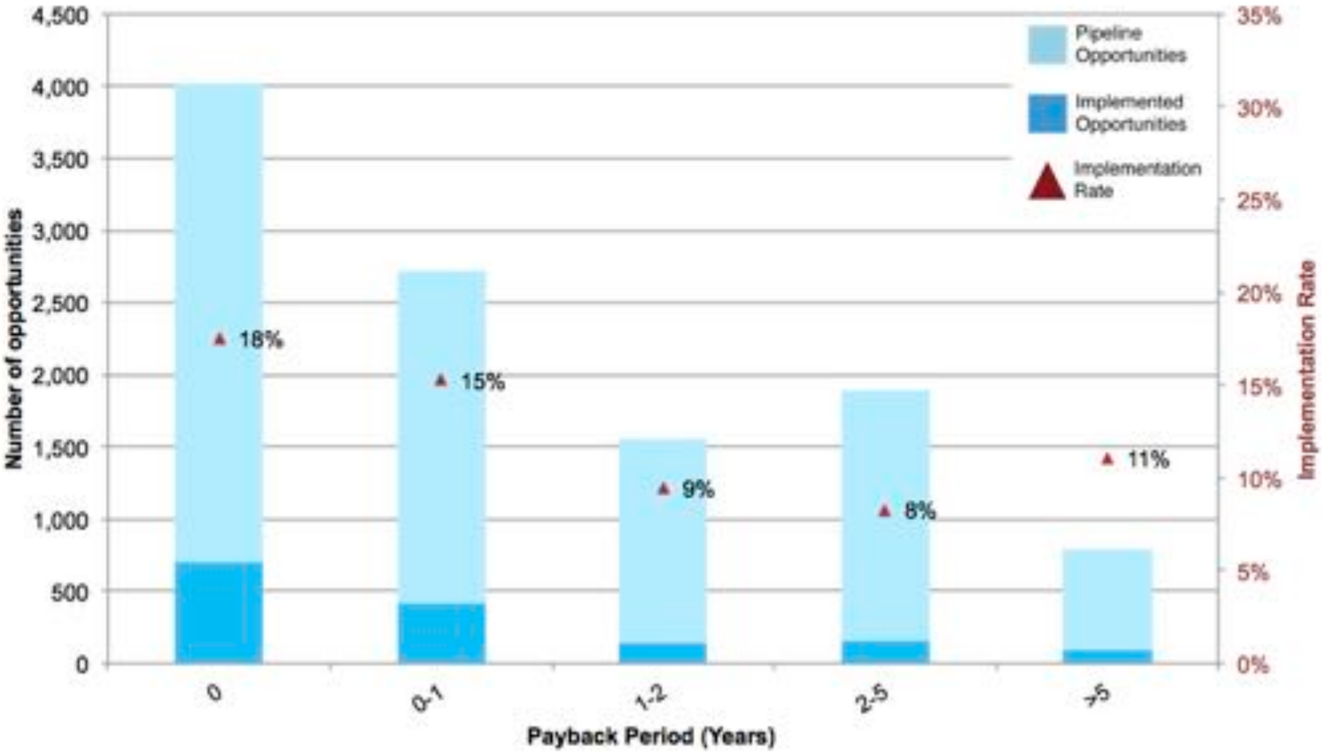

Figure 6b. Opportunities in Filtered Toolkit (n=10,961): Implementation Rate by Payback Period Bands

Analysis of the larger Filtered Toolkit dataset, presented in Figure 6b, shows that for opportunities with a payback period of less than two years (excluding those with zero capital expenditure), the average implementation rate was 13%; for those where payback period was between two and five years this was 8% and for those with a payback period over five years the rate was 11%. Again, whilst the conversion rates were lower than for the Interviewed Businesses, there was no marked difference in the implementation rates across different payback periods. This suggests that, all things being equal, companies in the Filtered Toolkit appeared equally willing to invest in opportunities with short and longer-term returns on investment.

Looking at the volume of opportunities implemented by this larger dataset, we see the same tendency for improvements with short/quick payback period (i.e. less than two years) to be implemented more often, as in the Interviewed Businesses; here, these made up 37% of implemented opportunities (if zero payback opportunities are included, this rises to 84%).

These findings could be a reflection of the ENWORKS model, which aims for the business benefits of energy efficiency to be proven through the prioritisation of no-cost and low-cost actions (i.e. low-risk measures) in the early stages of engagement before progressing to improvements where capital expenditure or longer payback periods are needed. Further analysis of the datasets, focusing on the timelines of opportunity identification to implementation, would be needed to explore whether this is the case. However, if viewed in conjunction with the low uptake rates for opportunities with short payback periods, they could also indicate that payback did not operate alone as an influencing factor and that other elements were acting as barriers or disincentives to the implementation of energy efficiency measures.

4.3.4 Significance of cost savings, capital cost and payback period on implementation rates

As these three factors featured so highly in the interview responses, and as detailed data is available on all three from the Filtered Toolkit dataset (i.e. for 2,970 SMEs)the research tested the statistical significance of each of these factors on the implementation rates of energy efficiency measures using logistic regression.

The dependent variable, i.e. the outcome being tested, is whether or not each opportunity was implemented; it is therefore a binary variable with 'implemented' and 'not implemented' as its outcomes.

As shown in Table 2, the opportunities in the Filtered Toolkit[11] are split into 13 subsets:

- three relating to business sector (1: opportunities in all sectors, 2: opportunities in the manufacturing sector and 3: opportunities in the non-manufacturing sector), and
- ten relating to improvement type (the improvement types chosen account for 93% of opportunities across the Filtered Database – see Section 4.3.6).

In terms of statistical significance, a 1% significance level ($p<0.01$) is taken to be highly significant and a 5% significance level ($p<0.05$) as significant. Table 2 presents mean levels for the three predictor variables entered into the logistic regression, with ** used to denote highly significant and * used to denote significant (associated significance levels are provided in Table G1, Annex G).

[11] For this dataset, and subsets, there are a sufficient number of energy efficiency opportunities to perform the analysis. Although the data are skewed – that is, the subsets do not approximate normal distributions – this is less of a concern for logistic regression than other forms of regression.

Dataset	Opportunities	Cost Saving	Capital Cost	Payback (yrs)
All opportunities	10,961	****£2,470**	£3,910	1.97
Opportunities in the manufacturing sector	3,384	****£3,199**	£4,843	***1.36**
Opportunities in the non-manufacturing sector	3,740	£2,571	£3,830	2.48
Compressed air	731	***£3,728**	***£867**	***0.39**
Process energy	173	£7,266	£9,137	2.94
Behaviour change	1,626	£2,357	£535	0.16
Space Heating	853	£2,551	£5,213	2.84
Fuel Switch	512	£2,883	***£8,369**	4.57
Steam Heat	273	£6,405	£22,580	3.44
Motors	135	***£4,699**	£7,740	3.97
Control Systems	1,883	£1,926	£2,328	2.51
Lighting	3,698	***£1,169**	£1,771	1.84
Power Quality	267	***£8,942**	£14,668	2.78

Table 2. Mean values for Cost Saving, Capital Cost and Payback with significance indicated by regression analysis (indicates p<0.01 and * indicates p<0.05)**

For ‘all opportunities across all sectors’, cost savings are the only significant factor and, at p=0.005, they are highly significant. This relationship is shown in Figure 4b. For manufacturing businesses, cost savings continue to be highly significant, but here payback also features as significant. This relationship is shown in Figures 7a and 9a. This indicates that the two factors may have been considered in the decision-making process by manufacturing SMEs. For opportunities in non-manufacturing businesses, the picture is less clear, with none of the three factors demonstrating statistically significant effects (although, comparative to each other, cost savings are still the most influential variable). This may reflect the findings of the interviews, which suggested that SMEs in the service sector were less calculative about payback and cost savings and more likely to consider less tangible factors such as ambience and customer experience.

When looking at improvement types, the analysis suggests that the three variables had different levels of influence depending on the particular energy efficiency improvements in question. Cost savings are either the only significant factor, or are the most influential factor of the three where none are statistically significant, in five of the ten improvement types, with payback period and capital expenditure being the most influential factor for two types each. Compressed air is different from the other nine improvement types as all three variables are shown to be significant.[12]

[12] This could be a reflection of the ENWORKS delivery model where compressed air leak detection surveys have been included as a standard component of the service for many years. Among the reasons for this are: the leak detection equipment is relatively inexpensive; it requires minimal technical training for advisors; surveys can be carried out with minimal disruption to business operations in a short period of time; findings are immediately obvious; cost savings are quick to calculate easy to communicate; the capital expenditure required to fix leaks is

The influence of sector and improvement type is further explored in the following two sections.

4.3.5 Comparing Sectors

Whilst there may be some commonality between manufacturing and non-manufacturing sectors in terms of their approaches to energy efficiency, the interviews have suggested that, in some cases, they were experienced or addressed differently.

Table 3 provides a summary of the opportunities in the Filtered Toolkit, split by sector. Some 63% of the SMEs in the Filtered Toolkit dataset, i.e. 1,870 businesses, are able to be classified as either manufacturing or non-manufacturing; where this is not possible due to uncertainty or ambiguity, the businesses are retained in a ‘not classified’ category.

Of the 2,970 SMEs in the Filtered Toolkit, 680 are classified as Adopters as they had implemented at least one energy efficiency opportunity (this equates to 23% overall). Looking at this ratio by sector subset, there was a greater tendency for those classified as manufacturing companies to implement improvements (29% Adopters) compared to those classified as non-manufacturing (18% Adopters). The manufacturers also had a higher implementation rate, both in terms of the number of opportunities (17% vs 11%) as well as the value of savings (21% vs 14%). Manufacturers also delivered a greater return per opportunity (i.e. 17% of the opportunities generated 21% of the cost savings) and overall (i.e. manufacturers delivered 40% of the cost savings value but made up only 29% of businesses).

	Businesses		No of Opportunities			Annual Savings Value		
	Total	Adopters (% of Total)	Total	Imple-mented	Implement-ation rate	Imple-mented	Implement-ation rate	% of Total
Manufacturing	845	247 (29%)	3,384	559	17%	£2,217,328	21%	40%
Non-manufacturing	1,025	186 (18%)	3,740	428	11%	£866,740	14%	16%
Not classified	1,100	247 (23%)	3,837	524	14%	£2,473,417	25%	44%
All Filtered Toolkit	2,970	680 (23%)	10,961	1,511	14%	£5,557,485	21%	100%

Table 3. Summary of Opportunities in the Filtered Toolkit Split by Sector

Earlier analysis looking at implementation rates by bands of cost savings value was repeated using these manufacturing and non-manufacturing subsets of the Filtered Toolkit. Results are shown in Figures 7a and 7b. These show the same general trend as the larger population did, that is, implementation rates increased as the value of cost savings increased. For manufacturing companies, the implementation rate ranged between 12 and 26%, whereas for non-manufacturing companies it was lower, ranging between 10 and 18%.

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usually zero or minimal; the return on investment is quick (e.g. staff time may be required even if there is no capital investment needed); complex management decisions are not usually required to authorise action; and maintenance of compressed air systems is usually already part of an employee’s responsibilities.

This suite of ‘influencing factors’ means that compressed air improvements are frequently supported in the early stages of ENWORKS engagement to help provide evidence of the business benefits of improving energy efficiency, i.e. it is attractive in terms of the three economic variables examined here, but also meets many of the less tangible factors explored later in the report. Further exploration of this balance of influencing factors may be beneficial to increasing uptake of energy efficiency measures.

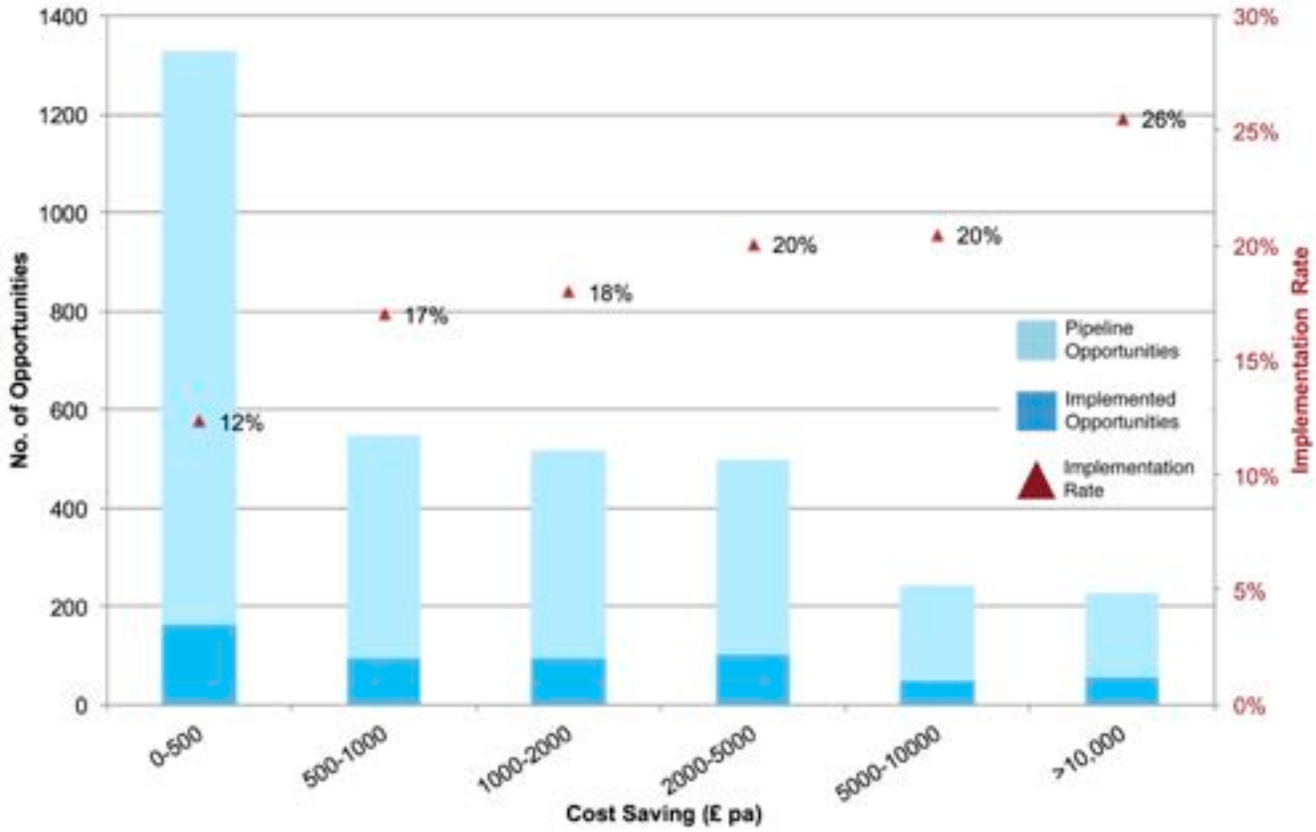

Figure 7a. Opportunities in Manufacturing Businesses in the Filtered Toolkit (n=3,384): Implementation Rates by Cost Savings Bands

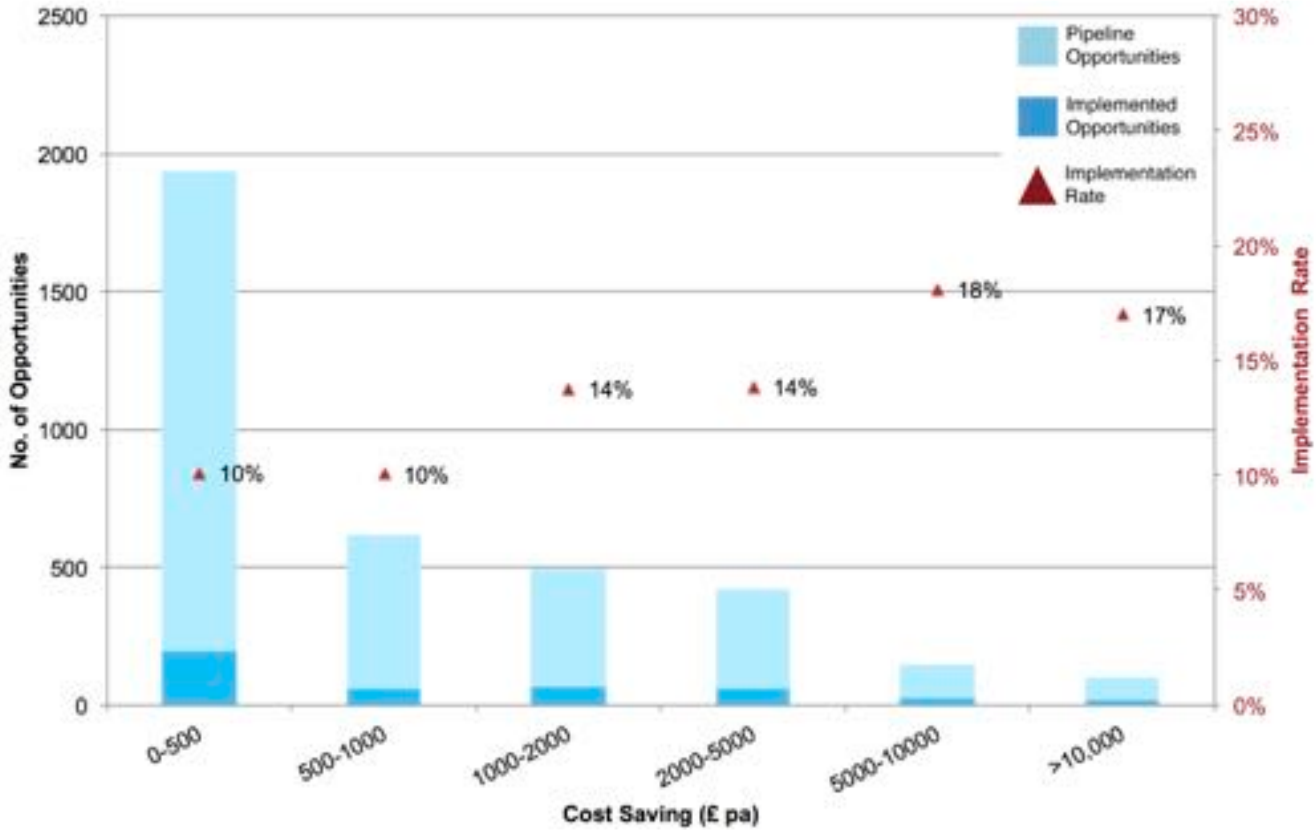

Figure 7b. Opportunities in Non-manufacturing Businesses in the Filtered Toolkit (n=3,740): Implementation Rates by Cost Savings Bands

This analysis was then repeated looking at implementation rates by bands of capital expenditure using the manufacturing and non-manufacturing subsets of the Filtered Toolkit (Figures 8a and 8b). For both subsets, as with the overall Filtered Toolkit dataset, the overall trend is that implementation rates did not differ significantly by capital requirement.

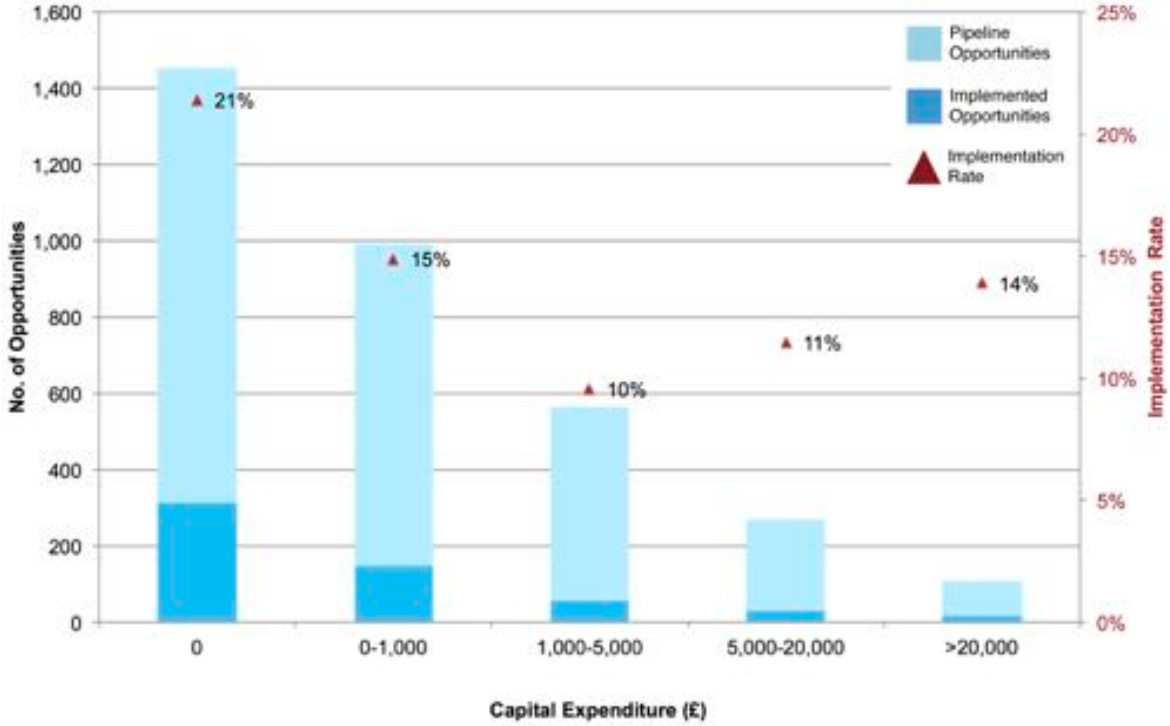

Figure 8a. Opportunities in Manufacturing Businesses in the Filtered Toolkit (n=3,384): Implementation Rates by Capital Expenditure Bands

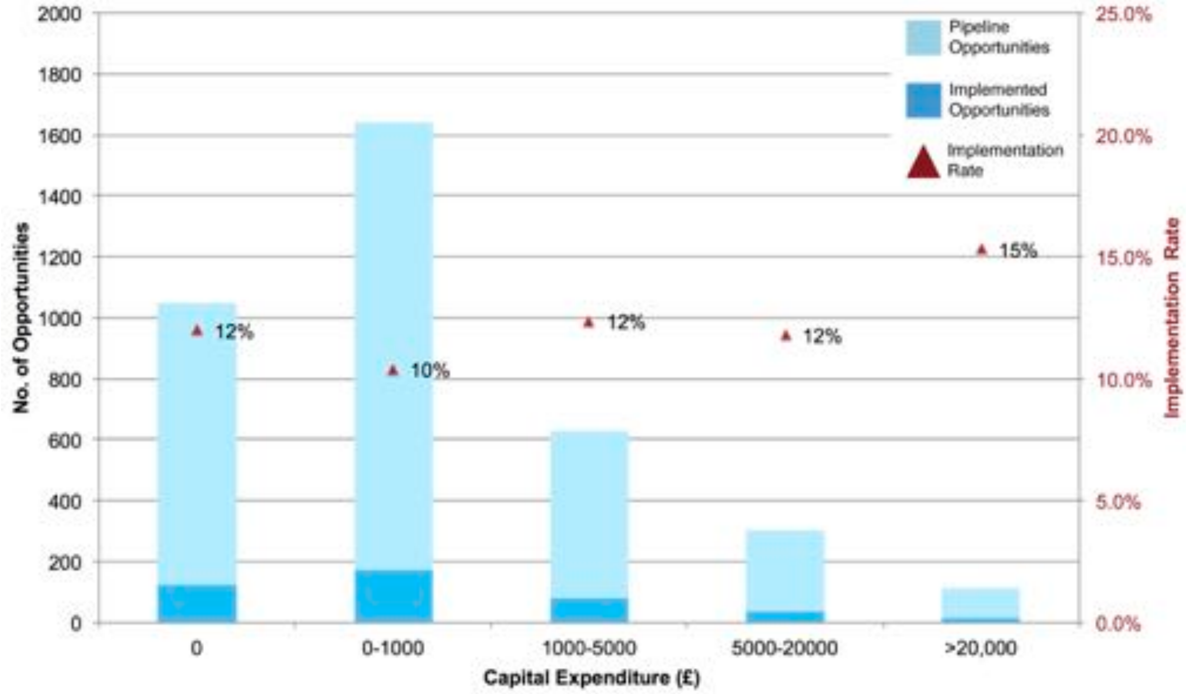

Figure 8b. Opportunities in Non-manufacturing Businesses in the Filtered Toolkit (n=3,740): Implementation Rates by Capital Expenditure Bands

For manufacturing companies, the implementation rate was 19% for opportunities requiring £1,000 or less. For non-manufacturing companies there was a similar but less distinctive trend, starting at 11%.

Both sectors display a slight upward trend of implementation rate for the high capital expenditure bands, which may reflect a tendency for these opportunities to have been more carefully researched and tailored to the business; i.e. a reviewer may have been less likely to recommend such expensive options unless they were well suited to the business.

Finally, the analysis looked at implementation rates by payback period using the manufacturing and non-manufacturing subsets of the Filtered Toolkit (Figures 9a and 9b). Notwithstanding the potential limitations of the low number of data points available for the higher payback bands, it is possible to observe the trend in the charts to understand the relationship between payback and implementation. The data show a much higher implementation rate for opportunities with a payback period of less than one year amongst manufacturers (19%) than amongst non-manufacturers (14%).

For non-manufacturing companies, the implementation rate remains more constant across payback periods; similarly to manufacturing, it starts off higher for payback periods less than one year and then levels off around 10% (within a degree of variation in the trend). This suggests that the ‘two-year hurdle’ raised in the interviews (see Section 4.3.3) may have been less of an issue for non-manufacturing companies and adds credence to the idea of non-manufacturing businesses seeing payback in a more holistic, less calculative, way.

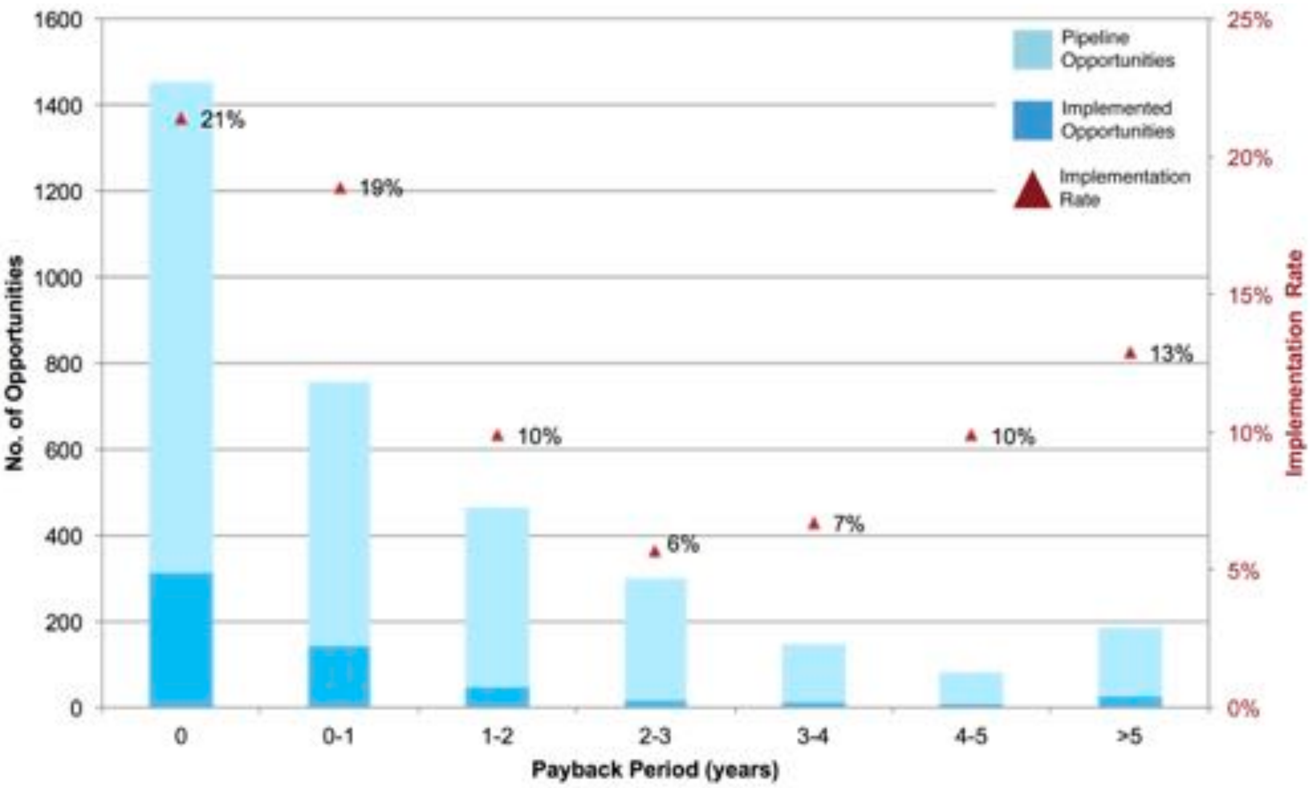

Figure 9a. Opportunities in Manufacturing Businesses in the Filtered Toolkit (n=3,384): Implementation Rates by Payback Period[13]

[13] As noted in Table 3, 37% of businesses cannot be classified as manufacturing or non-manufacturing. This may affect the ability of the analysis to distinguish between manufacturing and non-manufacturing.

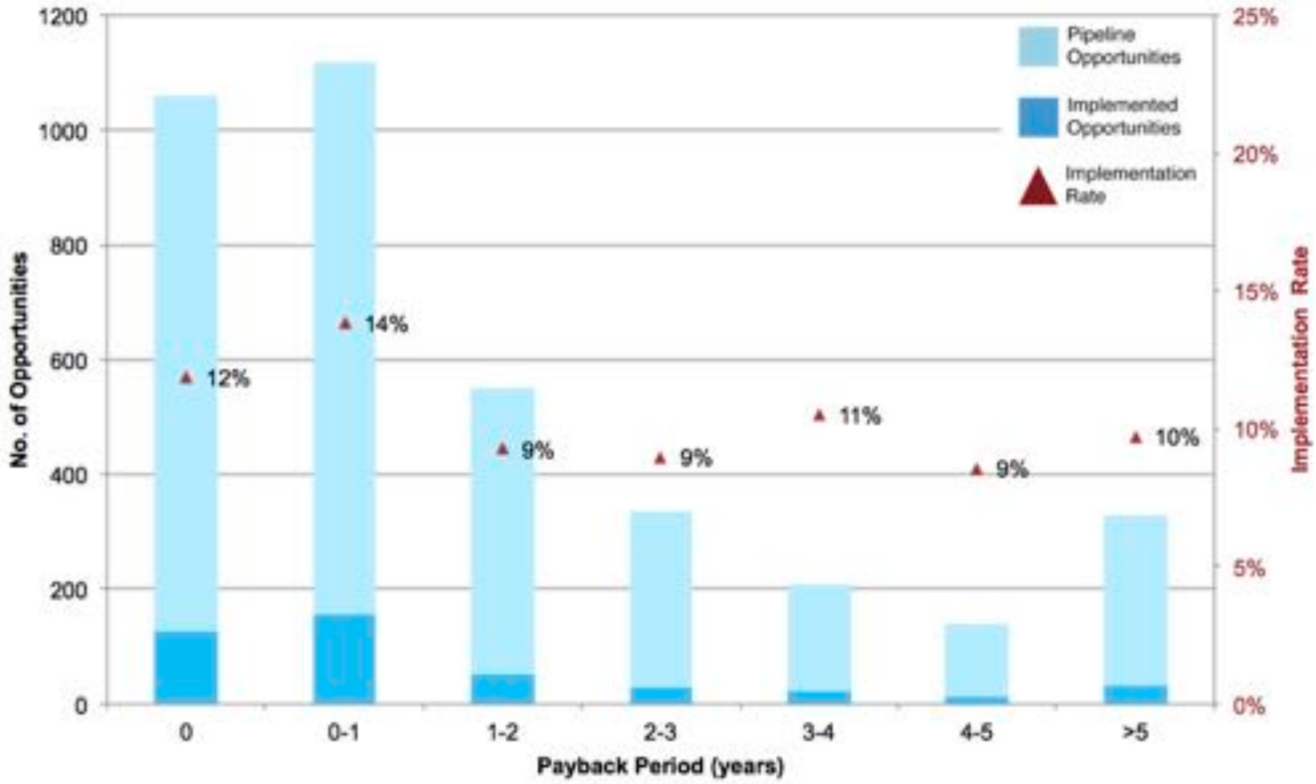

Figure 9b. Opportunities in Non-manufacturing Businesses in the Filtered Toolkit (n=3,740): Implementation Rates by Payback Period

4.3.6 Comparing Improvement Types

Building on the findings of Section 4.3.4 – that cost savings, capital expenditure and payback period may have influenced decision-making and implementation rates differently depending on the improvement type – further analysis was carried out on the Filtered Toolkit opportunities to identify whether any useful correlations could be detected at this level. Table 4 presents the full list of improvement types into which opportunities were reclassified for this exercise (76% of the 14,471 opportunities were reclassified in this research; this is described in Annex E) alongside data on implementation rates and savings.

Improvement Type	Opportunities: Pipeline	Opportunities: Implemented	Opportunities: Implemen-tation rate	Annual Savings: Implemented (£ pa) to nearest £k	Annual Savings: Implemen-tation rate	% Zero capital expenditure
Compressed Air	484	247	33.8%	1,270,000	47.2%	69.2%
Pollution Control	13	6	31.6%	37,000	30.0%	63.2%
Process Energy	134	39	22.5%	614,000	52.1%	38.7%
Behavioural Change	1,337	289	17.8%	849,000	23.1%	84.6%
Space Heating	723	130	15.2%	280,000	12.5%	31.8%
Fuel Switching	437	76	14.8%	191,000	13.2%	21.1%
Steam/Heat generation	234	39	14.3%	518,000	23.3%	19.0%
Motors and Drives	116	19	14.1%	228,000	36.1%	22.2%
IT Equipment/Appls	251	37	12.8%	41,000	17.9%	53.5%
Control Systems	1,658	225	11.9%	471,000	13.0%	28.1%
ACV	52	6	10.3%	42,000	21.2%	36.2%
Lighting	3,346	352	9.5%	603,000	14.0%	20.6%
Insulation of Buildings	380	34	8.2%	39,000	5.0%	18.6%
Power Quality	256	11	4.1%	374,000	15.7%	14.6%
CHP	29	1	3.3%	1,000	0.1%	13.3%
All Improvement Types	**9,450**	**1,511**	**13.8%**	**5,558,000**	**21%**	**36.5%**

Table 4.Implementation Rates by Improvement Type (n=10,961)

What the data shows is that implementation rates vary greatly across different improvement types (from 3% to 34% by number of opportunities); this indicates that different energy efficiency measures may have additional characteristics which act in combination with other factors, influencing the decision-making process and impacting on rates of uptake. For example, Process Energy improvements have the potential to deliver wider business benefits such as increased productivity or product quality, alongside energy savings, which could increase the likelihood of their adoption if these benefits are considered core to business performance (in the Filtered Toolkit, 22.5% of this type of opportunity are implemented). By contrast, for example, Lighting improvements may be viewed as ancillary to core business practices and therefore not prioritised as highly within decision-making processes (in the Filtered Toolkit, 9.5% of these opportunities are implemented).

Within 10 of the 15 improvement types listed above, the percentage of savings implemented is greater than the percentage of opportunities implemented. This reflects the significance placed on cost savings when businesses are prioritising which measures to implement. However, the data also presents instances where cost savings may not have been the primary driver, or were being considered alongside a suite of other factors; as reflected in the themes arising from the interviews. For example, for both Space Heating and Insulation of Buildings, the percentage of opportunities implemented is higher than the percentage of savings achieved; in these cases the comfort of staff or customers could have provided an additional driver to implementation above and beyond the financial considerations.

This part of the research highlights the complexity of a business's decision-making process associated with the implementation of energy efficiency opportunities, in that different improvement types, energy efficiency measures and technologies can present unique sets of motivations and challenges that will act in combination with other more generic considerations.

4.4 Business Characteristics

Alongside the three key economic factors influencing uptake of energy efficiency improvements, the interviews also highlighted a range of other barriers and drivers that are explored in the following sections. Because these factors are often less tangible than the economic factors analysed earlier, they are difficult to quantify or categorise and, in the majority of cases, quantitative data are not available, either directly or via relevant proxies within the Filtered Toolkit, to further test these findings.

4.4.1 Business Premises

Business premises could have been a physically limiting factor in the implementation of some energy efficiency improvements. In some instances, this may not have been obvious from the start, that is, some improvements could have appeared feasible at an initial stage of assessing options, but became unfeasible once a detailed investigation had taken place. In these cases, the building could be classed as a later stage barrier as not all energy efficiency improvements will have been appropriate for all business premises – i.e. the combination of improvement type and particular premises became a limiting factor/barrier.

In one long-established factory, the interviewee noted that the nature of the corridor network, with many small segments, twists and turns, raised safety concerns with respect to the installation of sensors for lighting:

> *It's like a rabbit warren… If it was a long passage and you could put one there and one there, fine… Well we could put one there looking down there and one up on the landing and one there and when we miss someone and they fall down the stairs and break their legs, where are we? It's all right putting these things, but they are not always practical. (Adopter, 50–249, Manufacturing)*

Similarly, a business with a very large warehouse space found that adding light sensors to this would be difficult and costly and this had been the source of some disagreement:

> *I thought that would probably be the best way to do it… the complicating factor was… the warehouse is quite big… how best to locate the sensors. (Adopter, 10–49, Non-manufacturing)*

One business was recommended to investigate roof-mounted radiant heaters, but in order to be effective, they needed to be installed higher than their roof space would allow, so this was not practical. Instead they used more efficient models of the heaters they already had.

Listed building status could also provide challenges to improving energy efficiency. One of the interviewees noted their premises had limitations on the changes that could be made to its physical structure, although they did report a solution had been found:

> *We can't suddenly rip all the walls out for insulation materials and the same with the roof. It's very much a shell that we have to work with… Externally on the building we can't suddenly clad it or put thermal panels visible on the walls…The agreement we've reached… is that if we were to put solar panels on the roof where they are not visible from street level then they [English Heritage] would be comfortable with that. (Non-adopter, 10–49, Non-manufacturing)*

Availability of space was also reported to be a challenge to the uptake of energy efficiency improvements.

> *With it being very susceptible to dampness or anything like that, we have to have very specific storage, silos. (Adopter, 10–49, Manufacturing)*

In addition to the building type, the status of ownership of the business premises could have a relationship with the uptake of energy efficiency improvements. Nine out of the 31 companies interviewed reported that they rented or leased their premises and suggested that this could act as a barrier to the implementation of certain measures relating to the energy efficiency of the building or premises. This reflected misaligned financial incentives; for example where a landlord would bear the cost of improvements to a building and potentially benefit from increased rents in the future, but saw no incentive to reduce the energy bills, which were paid by the tenant.[14]

One business reported it had to install a piece of production-related equipment on the outside of their premises, at greater expense than an internal fixture, because the landlord had not allowed it to be installed inside. Another was reluctant to invest in making improvements to the lighting system as the benefit would go to the landlord by improving the standard of the building. The factory had an approximately £5,000 a month fixed electricity bill attributable, in the main, to the old fluorescent lighting system, but it seemed counterintuitive to upgrade it:

> *There seems to be no way other than horse-trading with the landlord to get past… completely renewing the lighting for the building is actually making the property more valuable and therefore why as a tenant should I do it…? We could go for a wind turbine but why would you when you are in year seven of a ten-year lease? (Non-adopter, 10–49, Manufacturing)*

Tenancy arrangements could also interact with other barriers. For example, a payback period could be seen to be artificially capped by the length of tenancy agreement remaining, so that an investment that would normally be implemented, e.g. within a two-year payback period, would not take place if the remaining tenancy period was less than this. No interviewees from businesses that owned their buildings raised equivalent issues.

Data collected during the interviews on building ownership are not sufficient to conduct meaningful analysis of the tenant–landlord barriers to energy efficiency. Within the Toolkit, only ten opportunities for building fabric improvements are identified for Interviewed Businesses and nine of these opportunities have a capital cost of less than £1,500; this implies that they are unlikely to entail major strategic investment decisions but this was not explored during the survey. Information on building ownership is not available for the wider Toolkit dataset and there are no suitable proxies for further testing of this issue.

4.4.2 Competition and Benchmarking

Many of the businesses interviewed reported that they looked to what other businesses were doing on energy efficiency to drive their own actions. Increasing energy efficiency can provide a comparative advantage through reducing operating costs or strengthening customer relationships, and the fear of missing out on these benefits and losing market share to competitors was identified by interviewees as a motivation for engaging with ENWORKS and implementing energy efficiency measures:

> *There was a cost element, but also just are we doing things sensibly? Are we just missing obvious opportunities? (Adopter, 50–249, Non-manufacturing)*
>
> *To a certain degree it's just getting an idea and understanding across the board where you actually fit. It is trying to benchmark myself against other companies, but unfortunately you can't benchmark, you can only benchmark yourself… (Adopter, 10–49, Manufacturing)*

In another example, the environmental credentials associated with energy efficiency improvements were identified as a way for a business to distinguish themselves within a competitive market.

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[14] The issue arose at a Guardian seminar late in 2013 at which Allen Creedy, environment, water and energy chair for the Federation of Small Businesses, argued the importance of persuading landlords and those who own building stock to invest in energy efficiency (Jenkin 2014).

To be honest, because there are a lot of companies that have got the ISO 14001, that is what influenced us as well. Obviously, we want our customers to see that we are actually improving the environment. It will show customers and other companies what we can do… It's more for the customers I think, to show that we are helping the environment. (Adopter, 10–49, Manufacturing)

For some businesses, benchmarking their energy performance against competitors was cited as a motivation for engaging with ENWORKS. However, difficulties in accessing relevant information from others meant that it was sometimes more practical to replace benchmarking with internal monitoring and tracking of usage over time:

One of the pieces of equipment they were monitoring shows that we were getting abnormal usage and [sometimes] very high usage… some of the motors weren't as efficient as they should have been and one of the control panels… was seriously not working right. (Adopter, 50–249, Manufacturing)

In terms of quantifying the impact of this theme on the uptake of energy efficiency improvements, there are no sensible proxies either within the Interviewed Businesses or the wider Toolkit dataset to allow for this analysis. As with many of these issues, further analysis might indicate that experiences differed between different sectors or supply chains of the business community.

4.4.3 Avoiding Disruption and Sustaining Production

In some cases, interviewees reported that it was their day-to-day operations that limited, or were perceived to limit, the scope for implementing energy efficiency measures. In general terms, manufacturing businesses tended to have very specific requirements for energy use in industrial processes, meaning that the specific ways in which energy was used to achieve specific outputs could present limitations to the scope for energy efficiency.[15]

In the review of one business, a change from gas to an electric furnace was recommended, but there were concerns about the capability of electric heating*:*

There is an element of the gas burner design that produces… good gloss finish to the production process of a gradient nature. (Adopter, 50–249, Manufacturing)

The business changed to a more efficient gas burner instead, so an energy efficiency improvement was achieved within the production requirements relevant to that company, but it may not have been the most optimal solution available.

One business tried reducing the pressure in their compressed air units, but found they were not able to reduce by as much as planned due to process requirements. Another explained that they required specific process temperatures, which they felt required specific amounts of energy input, concluding that there were absolute limitations on their energy reductions dictated by their processes:

There is very little scope for energy efficiency on them other than making sure that you are using them properly and turn them off when you are not using them. (Adopter, 50–249, Manufacturing)

The risk of disruption to manufacturing processes was also cited as a barrier to implementing energy efficiency improvements. In the review of one business, it was suggested that they could reduce the opening hours of the plant to more closely match production, but:

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[15] A study of small to medium-sized manufacturing businesses in the USA, for example, found that concerns over safety, production throughput and product quality were paramount and that any measures that might interfere with these could be viewed with suspicion (Trombley 2014).

The way that we operate, our customer requirements make that a very challenging thing indeed. (Adopter, 10–49, Manufacturing)

Interruptions to the operations of a business were potentially costly in terms of lost production and could therefore have acted as a barrier to the uptake of energy efficiency improvements:

I think loss of production is the biggest thing… we have to plan – it's either loss of production and then we try to weigh it up… or do we have enough buffer built in our planning process to accommodate such a breakdown or shall we pay overtime and extra hours and then get it done in a weekend or [move] major day jobs [to] weekends. (Adopter, 50–249, Manufacturing)

In terms of overcoming these barriers, the Interviewed Businesses reported a number of ways in which they had mitigated or avoided potential disruption. For example, one company had two key pieces of production equipment and was therefore able to upgrade one without interrupting their processes entirely. Another had closed part of its business over the quietest time of year to implement improvements. Rolling out measures gradually was also found to be a way to overcome barriers, as it proved easier in terms of decision-making. This meant that opportunities could be implemented with minimised disturbance to ongoing work and processes.

Waiting until multiple improvements were needed, i.e. combining disruptions was another way that barriers were overcome. For example, one business waited until other retrofit measures were planned before upgrading its water tank and boiler. Trigger points were also identified as an opportunity to overcome barriers to energy efficiency, often becoming a driver for improvements. Trigger points were activities that created an opportunity to adapt practices and infrastructure[16] and included moving premises, changing staff, decorating or modifying product lines.

Interviewed Businesses reported the following examples: one had found that moving into a new building and onto an hourly-metered supply was a trigger to look at electricity bills; one took the opportunity of the creation of a new building to install environmental features, including straw buildings and heating from a ground source heat pump; and another took the opportunity to install solar water heating at the time of building new premises. Finally, one business had been conducting a general review of business performance and felt that including energy use at the same time would be beneficial.

The natural end of life of a product could also create a trigger for energy efficiency improvements; one interviewee had to replace their lighting system as, due to its age, it was becoming difficult and expensive to maintain, and at that point they had ensured that the energy efficiency of the different options was considered as part of the decision-making process.

If I was to purchase anything… i.e. a lighting system or a heating system the efficiency of it would be very high up in the criteria list. (Adopter, 10–49, Manufacturing)

4.4.4 Building Relationships with Customers and the Supply Chain

The SMEs interviewed in this study represent a mixture of business-to-business (B2B) companies and business-to-consumer (B2C) companies. The former provide products and services to other businesses in a supply chain; the latter deal directly with the end users or consumers. It should be noted that this distinction is not necessarily clear-cut: one of the theatres involved in this study described issues relating to its audiences and bar visitors (consumers) and those relating to touring theatre companies which were, in effect, the business

[16] See Energy Saving Trust (2011).

with the end-user interaction, i.e. this business has both B2B and B2C relationships. Some issues within this theme may therefore cut across both categories.

In the interviews, requests from customers (whether these were other businesses further up the supply chain or the end user of the product/service) were identified as a driver for having the ENWORKS Review and so could broadly be described as a driver for improved environmental performance and increased energy efficiency. In a couple of instances, there was a recognition that customer requirements in relation to reporting environmental performance might change in the medium term, with requirements for low-carbon credentials (including energy efficiency specifically) increasing from the supply chain and the end user. Therefore, some of the interviewees noted there was value in demonstrating commitment to energy efficiency improvements now, and this was reported to be the main motivation in a minority of cases.

> *…the motivation for those electric cars is about demonstrating [sustainability] to our customers. (Adopter, 50–249, Non-manufacturing)*
>
> *…we want to show to our customers that we are green and we are efficient. We have had customers come and I've literally shown them round the heat recovery, because they are interested to see what we had done. (Adopter, 10–49, Non-manufacturing)*[17]

Business-to-Consumer

For businesses dealing directly with consumers, the message coming from the interviews was that there was little customer pressure per se, but there was commercial value in presenting your company as environmentally aware. As part of this, there was a sense that appearing to be environmentally conscious was good for customer relationships.

Customer satisfaction, rather than customer pressure, appeared to be a key driver for all improvements in non-manufacturing companies; this could affect energy efficiency improvements both positively and negatively. Whilst one business, for example, had positive reviews on TripAdvisor regarding their environmental policy, but generally comments and complaints from customers related to other issues:

> *You've got to understand that as [someone who] is now owning and running a hotel looking after people who come with complaints about the towels not in their room... Also, the compliments that they really enjoyed the steak and they really enjoyed the swimming pool or whatever it is. The energy aspect of it is a different thing altogether. (Non-adopter, 10–49, Non-manufacturing)*

Customer expectations were not identified as a driver for implementing energy efficiency improvements; however, they were identified as a means of differentiating from the competition, with one interviewee becoming enthused about environmental issues, having seen the way they had helped to raise their profile, including being on local radio. Ongoing feedback from customers became a driver for further measures to embrace green issues in a broader sense, including ceasing to buy bottled water:

> *I was basically looking at a flat planet and they were saying to me, no, you need to look at things in a different way, because that will be different in the future. The future is on its way to you, but also the effect on your business, profit-wise, is immense. Now, the future part of it is beginning to come of benefit to us without us realising… (Non-adopter, 10–49, Non-manufacturing)*

[17] In this example 'customers' refers to client businesses.

This response gave a sense of energy efficiency and customer satisfaction being synergistic. These observations suggest that experiences differed between SMEs depending on their relationship with other businesses and consumers.[18]

Interviewees reported that customer expectations had also created barriers to energy efficiency. In one case, regular customers had complained (via the retailer) about the use of reused cardboard packing as an alternative to polystyrene chippings:

> *They were complaining that we were basically sending them our rubbish by putting pieces of cardboard in the void filler. (Adopter, 10–49, Non-manufacturing)*

To rectify this, the company invested in a machine to make air pockets from plastic, which, while not as resource-efficient as the reused cardboard packaging, provided an improvement on the original polystyrene chippings and satisfied customer expectations.

Some businesses reported features that they wanted to preserve for the sake of customer experience, and this became a limiting factor for energy efficiency. For example, one reported it had a chandelier with 138 bulbs and wanted to retain this feature as part of the décor. Although they had found an energy-efficient bulb, they were experiencing problems with them causing short circuits and it was becoming expensive. Similarly, another business had an exhibition space and felt it was important for the new LED lighting to give the right colour for the feel of the area, which placed specific demands on the process of LED selection and highlighted the extent to which the availability of technology could be limiting:

> *The exhibition hall itself isn't really kitted out with LED… It's very pastel. We've got to keep that for the customers coming in. It's a very difficult thing to get with LED fittings. That is the area we struggle in. (Adopter, 10–49, Non-manufacturing)*

Another reported that, after upgrading their hotel and including underfloor heating, it had made the beds too warm, which directly affected their customers' perception of their service. This was not a barrier for the hotel interviewed but something that they would warn others of:

> *If we did it again, we would not put it under the beds. You get too hot in bed. (Adopter, 50–249, Non-manufacturing)*

These examples show that SMEs were concerned about customer reactions and their potential to have a detrimental effect on the economic viability of their business, which could lead to both barriers and motivations to improved energy efficiency. They also highlight the more direct nature of this relationship for companies in the non-manufacturing sector.

Business-to-Business

Businesses interviewed reported little customer pressure about energy efficiency:

> *[Pressure from customers is received] very rarely; some customers that do ask… what sort of standards we had in place and things like that. I would say it's very rare. (Adopter, 10–49, Manufacturing)*

However, they recognised that being able to demonstrate some environmental practices or improvements, or the presence of an environmental policy, could be helpful in supply chains.

> *People like to see you are environmentally aware. (Adopter, 50–249, Manufacturing)*

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[18] Klewitz and Hansen (2013 p16) agree, arguing that 'there should be a stronger differentiation of SMEs operating in business-to-business versus business-to-consumer markets'.

With the ability to sustain supplier-client relationships often vital to the survival of SMEs, there was some evidence that some companies were experiencing pressure via their supply chains. Several businesses mentioned the need to demonstrate environmental improvements in order to win contracts. One SME felt negatively about this, reporting that supermarkets were passing responsibility for sustainability onto the smaller businesses in the chain, therefore adding a cost to doing business:[19]

> *You've got [several supermarkets] who we have just stopped doing business with… As corporate entities they are on a sustainability journey and… big business turns to small business and says, 'I'm now going to give you all of my health and safety issues. I'm going to make you accredit yourself'… you have to have a licence that says, I'm allowed to step inside the bubble… SMEs like us are picking up all the costs… (Adopter, 10–49, Non-manufacturing)*

One of the reasons this company engaged with the ENWORKS Review was to help demonstrate to corporate customers that they were on a 'sustainability journey' and should retain their position in a valued supply chain. This was also reported to apply in public sector supply chains, with government bodies requiring high standards of sustainability to be demonstrated within their tendering process:

> *…they expect us to behave in an environmentally conscious way… put pressure on us… to do things even if it is a much longer… payback. We do energy reports now to the Arts Council about CO_2 emissions. They want to see them coming down… regardless of cost or cost savings… (Adopter, 10–49, Non-manufacturing)*

Other challenges created in the B2B chain were also cited in the interviews: for theatres, particularly those with visiting touring productions, i.e. business customers on-site that required rapid set-up and malleable configurations, difficulties had been experienced in sourcing LEDs that could respond to the range and subtleties required without creating delays and complications:

> *[Energy-efficient] stage lights are nowhere near [what we need]... Some existing companies use LED lights to provide lighting at the back of the stage. But even they have problems with colour matching… With being a theatre there is an expectation that you are going to have this type of light… Once you change that into all the LED lighting then all their lighting bulbs go up the chute. The colour temperatures are different. The gels are different. The dimming time is different… 99% of touring companies don't want to know. (Non-adopter, 10–49, Non-manufacturing)*

Notwithstanding these challenges, there was also some evidence that businesses looked to customers to request or push for change, without which action would not be taken. One business mentioned this with regard to its decision not to put an EMS in place:

> *We have an environmental manual and there are lots of things we do, but we haven't gone for official certification yet, just because really again it's another thing, it's the cost and customers aren't pushing for it yet. (Non-adopter, 50–249, Manufacturing)*

In this case a lack of pressure from customers was perceived to be a barrier, but care must be taken not to infer that customers were somehow to blame for lack of attention to efficiency.

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[19] Pederson and Anderson (2008) argue that conduct, i.e. the amount of effort companies are putting into various improvements, can be unevenly split across the supply chain. With the goodwill associated with being socially responsible often associated with a brand, one company will likely receive the full benefits and the rest of the supply chain can expect only indirect benefits.

In terms of quantifying the impact of this theme on the uptake or implementation rates of energy efficiency improvements, there are no sensible proxies either within the Interviewed Businesses data or the Filtered Toolkit to allow for this analysis.

4.4.5 Changing Behaviour

Changing the way things were done was often key to increasing energy efficiency and was generally an integral component of successful improvement measures. For example, reducing the energy consumption of a particular production line might have involved upgrading the motors and drives, which was a technological solution, but could also have required revised start-up and shut-down times to be implemented, which involved people adjusting the way they operated, i.e. behaviour change. There were many more examples of this integrated relationship but, for the purposes of this study, the academics defined behaviour change solely as the actions of individuals not connected to core products or services. That is, the focus was on simple, non-business-critical actions like switching off lights.

On this subject, whilst one company was optimistic, estimating that they had achieved a 10% decrease in resource use through speaking to staff about not leaving equipment turned on, this was an exception as most reported behaviour change as something they had found difficult to carry out, and to evaluate. Challenges included winning over, or getting buy-in from, colleagues:

> *It's more difficult to sort of get your head round, because you are not just changing one person's mind, it's you are changing 18–20 people. (Adopter, 10–49, Manufacturing)*

A related issue was the capacity and willingness of staff to engage with this agenda. In some cases this could be considered the main barrier:

> *It's not the process or the recommendations that have been the barrier. It's the lack of time and resource to actually implement… that's been the barrier. (Non-adopter, 10–49, Manufacturing)*

Another had pre-emptively decided not to explain what they were doing on energy efficiency to shop floor staff to avoid potential complications:

> *If we went to the shop floor at the moment and tried to get them to understand why we are doing some of the things that we were doing, we would probably struggle. But we also recognise that none of these things are ever delivered unless they buy into it… (Adopter, 10–49, Non-manufacturing)*

One business had taken the effort to move light switches to places where staff would find them easier to operate and had had some success with this but still found it challenging to convince staff to switch them off when not in use, an experience not atypical among the businesses:

> *The main one is setting the reduction target and then monitoring it on a monthly basis through meter readings and also setting rules for the staff from the point of view of usage or equipment and turning stuff off at night… when they are not in use. We've actually spent money on moving light switches so that staff have easier access to switch lights off in areas of the warehouse… That has been quite successful, although I still have to chase them sometimes, because they forget to switch lights off. (Adopter, 10–49, Non-manufacturing)*

Behaviour change aimed at customers visiting the business premises presented additional challenges as these transitory populations could be difficult to engage with meaningfully.

Behaviour change could be understood as an 'approach' to energy efficiency, rather than a direct barrier or driver. In this respect, it was comparable with the improvement type categories, such as lighting and heating, which have been addressed earlier. Despite this, behaviour change has been afforded its own section alongside the other key themes here because it was distinctive among the approaches in having a significant human element and as a cross-cutting theme: many other approaches required elements of participation or compliance.

4.4.6 Environmental Ethos

In some cases the motivation for energy efficiency measures was reported to have been more intrinsic, rather than solely a response to business concerns.[20] One interviewee recounted that, although they did not experience pressure from customers on these issues, they saw themselves as an environmental organisation and wanted to try to improve their carbon footprint. In another, a senior member of staff was enthusiastic about environmental issues and positioned himself as a 'green champion' in the business, appearing from the interview to have significant support and buy-in from the Director:

> *We have our… who is a senior part of the management team and also a senior part in giving me sort of feedback as and when something isn't a good idea or is a good idea… (Adopter, 50–249, Non-manufacturing)*

One interviewee, from a tourist attraction strongly tied to a popular conservationist figure, saw environmental issues as being important to them and to their visitors, describing themselves as

> *'Following in [their] footsteps' and that the environment has 'got to be part of what we do'. (Adopter, 10–49, Non-manufacturing)*

Whilst these statements appeared to reflect intrinsic motivation, it is noted that they often sat alongside more conventional business benefits, such as cost savings and creating a 'green' business image, which in turn generated sales; it was therefore difficult to separate the two.

One company, for example, explained that environmentalism and cost savings through energy efficiency have been synergistic:

> *I don't want to go all green and fluffy on you, but doing my best to keep energy usage as low as possible for the planet... Actually linked that to saving money as well, and that's where the big messages I used to shout about when I was heavily involved with the [local] Green Business Forum, that there are plenty of things that a lot of people didn't realise you could invest and actually see the payback in a few years… Money and sustainability. (Adopter, 10–49, Non-manufacturing)*

In terms of testing the relationship between environmental ethos and implementation rates, three interviewees expressed this type of ethos and they were all Adopters. As this is a small number, it is not possible to draw any firm conclusions on this relationship, especially as it is plausible that businesses with an environmental ethos may have faced other barriers to implementation that could have interacted in different ways with their environmental approach.

In terms of quantifying the impact of this theme on the uptake or implementation rates of energy efficiency improvements in the Filtered Toolkit dataset, there are no sensible proxies to allow for this analysis.

4.4.7 Organisational Energy Culture

The energy culture of an organisation could be understood as the extent to which considerations of energy are embedded in the organisation's practices and processes, particularly those relating to decision-making. In order to understand something about the energy culture of the Interviewed Businesses, interviewees were asked whether the business had staff directly allocated to overseeing energy use, targets for energy use reductions, or an

[20] Whilst evidence of commitment to reducing environmental impact is encouraging, it should be noted that research has indicated that there tends to be an 'attitude–practice gap' whereby level of performance rarely exceed compliance or satisfying basic efficiency measures. (Williamson et al, 2013 p4)

environmental management system (EMS); a range of responses were received. One business provided a good example of integration between environmental management and overall business planning:

> *We have targets that are set… every year…That again will form part of the management review, how we have done… whether it's underachieved…whether it's done better… (Adopter, 10–49, Non-manufacturing)*

There were also examples of more informal systems:

> *We have a fairly loose environmental management system although it is a written policy. We also have a less formal energy policy. (Adopter, 50–249, Non-manufacturing)*

Some businesses reported that they took a more general approach to reducing energy consumption without formal policies, systems or staff; others that they had taken a broader approach through a 'sustainability' policy to encourage the adoption of more efficient behaviours across resources; or that they had built energy use into the business's Key Performance Indicators (KPIs) to help drive change. Others preferred to address energy with a series of ongoing, ad hoc activities rather than via a dedicated strategy; some of these companies saw an increased likelihood of needing an EMS in future.

There were also examples of companies with no targets, policies or management systems; one felt that their energy use was insufficiently high to justify a dedicated policy, whilst another preferred to:

> *Just take things as they come up and deal with them. (Adopter, 10–49, Manufacturing)*

External drivers to formalise energy monitoring and targeting were reported to be in place in some instances, for example where external funding or regulation stipulated annual reporting on energy use.

Comparing the responses of the Interviewed Businesses, there is an indication that some elements of a positive energy culture (e.g. having efficiency targets, an EMS or a member of staff with responsibility for energy) are more likely to be evidenced in Adopters than Non-adopters.

Suitable data to investigate this trend are not available in the Filtered Toolkit and so further research would be required to explore any statistical analysis of the correlation between, for example, an EMS and increased uptake of energy efficiency measures.

4.4.8 Monitoring Impacts

Generally speaking, it could be difficult to establish accurate monitoring of energy savings for a number of reasons, including: where extensive sub-metering was not in place, where measures were linked to production processes and production rates varied regularly, and where numerous measures were implemented concurrently. The Interviewed Businesses reflected this in their interviews, reporting they had found the quantification of savings challenging. This is interesting to note as all recommendations made by ENWORKS have both economic and environmental savings quantified at the outset and again at implementation by qualified environmental auditors – when measures are implemented, these savings are reviewed with the business, including the calculations made, and are signed off by the business. The fact that interviewees still reported challenges in this area indicates the existence of broader challenges around quantifying, understanding and integrating energy efficiency savings into normal business information flows.

Most businesses reported only having one or two meters on-site, limiting their potential to identify how much individual machines, technologies or practices were consuming, either before or after efficiency measures were implemented.

Attitudes to monitoring also varied, from those who saw it as having a role in the efficient running of the business and therefore being, in itself, an efficiency measure:

> *We are just installing some more electricity meters and we can monitor different sections a bit better because we haven't really got full visibility on where all the power usage is in the factory. (Adopter, 50–249, Manufacturing)*

To those who felt it was a drain on their resources:

> *Given that I've only just spent twenty grand on getting the electricity circuit boards up to code… Having to spend another five grand to do a monitoring and targeting is not number one or not even number ten on my list at the minute. (Non-adopter, 10–49, Manufacturing)*

In many cases, businesses considered the measures recommended in the ENWORKS Review but decided not to implement them because they did not perceive the benefits to be significant enough. This could reflect the fact that the reviewer was external to the company and could not, in the time available for the Review, necessarily understand all the nuances of the company's operations; or that recommendations made by an impartial advisor would not always have been aligned to the current priorities of the client business. Alternatively, it could support the contention that energy efficiency was undervalued and therefore not seen as a significant contributor to business success. There is no indication from the interview data that Adopters had fewer difficulties with monitoring than Non-adopters.

In terms of quantifying the impact of this theme on the uptake or implementation rates of energy efficiency improvements, there are no sensible proxies either among the Interviewed Businesses or the Filtered Toolkit dataset to allow for this analysis.

4.4.9 The Influence of Business Characteristics on Implementation Rates

Building on the analysis carried out on the Interviewed Businesses (section 4.2), the Filtered Toolkit was mined to identify a set of companies for which the following data are available: number of employees, turnover, energy expenditure (energy intensity was calculated using these three elements) and sector (assigned as either manufacturing or non-manufacturing). This exercise created the 'With Business Information' dataset containing 199 SMEs with 1,164 opportunities and enabled a further exploration of the extent to which these particular business characteristics could be seen to have influenced the uptake of energy efficiency improvements.

Firstly, regression analysis was performed with the business characteristics used as independent variables and the status of the business, as either Adopter or Non-adopter, as a binary dependent variable.

One limitation of this dataset is that once it is divided into manufacturing and non-manufacturing subsets, the latter subset has only 33 businesses, thus limiting confidence in the analysis (in addition, 11 businesses cannot be categorised by sector). Another is the extent to which the independent variables correlate, with a strong correlation between variables potentially distorting the regression analysis. To overcome this, where initial analysis showed a correlation between variables, the significance tests were repeated with these variables removed. These tests did not result in different relative levels of significance between the predictor variables, implying that correlation between variables is not a major issue.

Table 5 presents mean values for the five business characteristics and cost savings, i.e. the six predictor variables, with ** used to denote highly significant and * used to denote significant. The significance levels for the regression analysis are presented in Table G2.

The analysis indicates that within the 'all businesses' dataset (all 199 companies), the value of cost savings had a highly significant ($p<0.01$) influence on whether a business was an Adopter. This is also true of the manufacturing sector taken on its own which accounted for 74% of the sample. This variable is less significant for non-manufacturing businesses and, whilst caution is required due to the small sample size, this would support the interview responses of non-manufacturing businesses regarding the presence of other drivers of energy efficiency such as customer satisfaction.

Energy intensity (expressed as % of turnover) also showed as significant ($p<0.05$) for ‘all businesses’ and for ‘manufacturing businesses’, but was indeterminate for the non-manufacturing businesses.

Dataset	Cases	Employees	Turnover (£m)	Energy Spend (£)	Energy Intensity (turnover, £/yr)	Energy Intensity (employees, £/yr)	Cost Savings Identified (% energy spend)
All businesses	199	51	5.85	76,642	***76,642**	****1,419**	****22%**
Manufacturing businesses	148	62	7.52	120,789	***120,790**	1,928	****26%**
Non-manufacturing businesses	33	33	3.75	83,039	83,039	1,837	18%

Table 5. Mean values for business characteristics with significance indicated by regression analysis (indicates $p<0.01$ and * indicates $p<0.05$)**

A second test used linear regression analysis to determine the extent of implementation as a dependent variable, expressed as a percentage of identified savings (implemented cost savings/identified cost savings). To make this analysis possible, the Non-adopters were removed from the dataset, further reducing the size of the sector subsets. The highly skewed nature of the data is problematic for regression analysis. To accommodate this, the data were transformed using a logarithmic scale (base ten), and this partially addressed the issue of non-normality in the distribution.

Table 6 presents mean values for the six predictor variables, with ** used to denote highly significant and * used to denote significant (the significance levels from the regression analysis are presented in Table G3). Across all sections of this analysis, the value of savings is the only variable that is significantly correlated with the implementation rate, and the p values indicate that it was highly significant. For the other variables tested, no significant correlation was identified. The analysis was repeated, with those variables that could be strongly correlated with each other removed, and the relative significance levels did not change, confirming that the value of cost savings is the only significant factor.

Dataset	Cases	Employees	Turnover (£m)	Energy Spend (£)	Energy Intensity (turnover, £/yr)	Energy Intensity (employees, £/yr)	Cost Savings Identified (% energyspend)
All businesses	68	80	7.68	163,497	4%	****1,934**	36%
Manufacturing businesses	50	87	8.74	177,402	3%	****1,742**	39%
Non-manufacturing businesses	12	81	6,62	174,474	7%	****2,494**	22%

Table 6. Mean values for business characteristics with significance indicated by regression analysis (indicates $p<0.01$ and * indicates $p<0.05$)**

4.5 Missed Savings Opportunity

This section explores the value of the missed opportunity for businesses not adopting energy efficiency measures. It takes a number of different approaches to estimate this value for the businesses in the Filtered Toolkit and also extrapolates these findings up to a national UK level. Wherever the data allows, the same methods are applied to estimate the capital cost and CO_2equivalent (CO_2e) savings associated with the missed opportunity.

4.5.1 Simple Approach

The Filtered Toolkit data shows £27.07m of annual energy efficiency cost savings have been identified for 2,970 SMEs; this is an average potential saving of £9,116 pa per SME. Of these, £5.56m pa of savings have been implemented, equivalent to an average actual saving of £1,871 pa per SME.

A simple assessment of the value of the missed opportunity for the SMEs in the Filtered Toolkit is therefore £21.51m pa, i.e. the gap between the identified and implemented savings figures, which gives an average missed opportunity saving of £7,245 pa per SME.

Applying the same method to CO_2e, that is, using the data from the Filtered Toolkit which calculates CO_2e savings for each unit of energy saved using UK government conversion factors[21], shows that 181,207 tonnes are associated with the £27.07m cost savings (an average of 61t per SME pa[22]), of which 34,791 tonnes have been implemented (an average of 12t per SME pa), giving a missed opportunity of 146,416 tonnes pa (an average of 49t pa per SME).

Capital cost is approached in the same way, with all the data summarised in Table 7 below. It should however be noted that £7.97m of the £21.51m missed opportunity (37%) requires no capital investment.

Table 7 shows: the Cost Savings pa, the Capital Cost required and the CO_2e savings pa for the total Filtered Toolkit, and as an average per SME, for both Identified and Implemented Opportunities – the difference between the two representing the Missed Opportunity for the businesses in this dataset. It also highlights the value of cost and CO_2e savings that are associated with opportunities requiring zero capital expenditure (no cost opportunities) in the Filtered Toolkit.

		Cost Savings (pa) (no cost opportunities)	Capital Cost	CO_2e Savings (t/pa) (no cost opportunities)
Total	Identified	£27.07m (£8.35m)	£38.95m	181,207 (13,683)
	Implemented	£5.56m (£0.38m)	£6.30m	34,791(2,408)
Average per SME	Identified	£9,116	£13,115	61.01
	Implemented	£1,871	£2,112	11.71
Missed Opportunity	Total	£21.51m (£7.97m)	£32.65m	146,416 (11,275)
	Average per SME	£7,245	£11,003	49.30

Table 7. Missed Opportunity for SMEs in the Filtered Toolkit using the simple approach (n=2,970)

[21] CO_2e conversion factors in the Efficiency Toolkit are the 'Government conversion factors for company reporting' issued by Defra, the Greenhouse Gas Conversion Factor Repository is available at: http://www.ukconversionfactorscarbonsmart.co.uk/ These conversion factors are embedded into the Efficiency Toolkit.

[22] CO_2e savings have been rounded to the nearest whole number

4.5.2 Adopter/Non-adopter Approach

If the Filtered Toolkit data are interrogated for the Adopter and Non-adopter subsets (Table 8), they show that Adopters have different levels of potential and implemented savings from Non-adopters, and therefore have different values of missed opportunity.

For example, Adopters have average identified annual savings of £20,281 (plus 132t of CO_2e savings), with an associated capital cost of £28,105. Having implemented an average of £8,173 savings pa (plus 51t of CO_2e savings) at a capital cost of £9,267, the average missed opportunity value is £12,109 savings pa (with 81t of CO_2e savings missed) that would require capital investment of £18,838 to implement.

Non-adopters by definition have not implemented any improvements and so the value of their identified savings is the same as their missed opportunity; in this case it is an average of £5,801 savings pa per SME (plus 40t of CO_2e savings pa) with a capital investment requirement of £8,663.

		Adopters	Non-adopters	All Businesses
No. of SMEs		680	2,290	2.970
Total identified	Cost savings (£m pa)	13.79	13.28	27.07
	CO_2e savings (t pa)	89,953	91,254	181,207
	Capital Cost (£m)	19.11	19.84	38.95
Mean Identified per Business	Cost savings (£ pa)	20,281	5,801	9,116
	CO_2e savings (t pa)	132.28	39.85	61
	Capital Cost (£)	28,105	8,663	13,115
Mean Implemented per Business	Cost savings (£ pa)	8,173	0	1,871
	CO_2e savings (t pa)	51.17	0	12
	Capital Cost (£)	9,267	0	2,112
Mean Missed Opportunity	Cost savings (£ pa)	12,109	5,801	7,245
	CO_2e savings (t pa)	81.11	39.85	49
	Capital Cost (£)	18,838	8,663	11,003

Table 8. Value of Missed Opportunity by Adopter and Non-adopter Subsets of the Filtered Toolkit

Combining the simple approach and Adopter/Non-adopter approach gives a range for the average missed opportunity values per SME of:

- £5,801 to £12,109 pa cost savings
- 40 to 81 tonnes of CO_2e pa
- requiring a capital investment of between £8,663 and £18,838 for implementation

4.5.3 A Scenario Approach: Pessimistic and Optimistic

In order to develop a more nuanced estimate of the average missed opportunity per SME within the range established above, a scenario-based approach was developed (see Annex H). In this, implementation rates are increased to different levels for Adopters and Non-adopters within two scenarios: pessimistic and optimistic.

As implementation rates are increased, the value of the missed opportunity decreases, as the sum of the two is restricted so as not to exceed the £27.07m upper limit of savings potential identified in the Filtered Toolkit.

Within the pessimistic scenario, the change in implementation rates results in the missed opportunity value reducing from £21.52m pa to £16.01m pa. The optimistic scenario further lowers the value of the missed opportunity to £14.00m pa.

4.5.4 Total Identified Savings and Maximum Theoretical Savings

It should be noted that, whilst the savings in the Filtered Toolkit represent a tailored set of energy efficiency measures bespoke to each business, they do not represent the maximum theoretical savings possible through energy efficiency for each business. This means that the total identified savings figures used in the calculations in this section (e.g. £27.07m and 181,207t CO_2e), and consequently the average savings per SME and the missed opportunity savings figures, do not necessarily reflect the full potential available for these companies and could be deemed to be conservative estimates.

Similarly, whilst all savings have been identified by expert auditors, it is possible that some of the improvements may not be feasible in practice, thus reducing the potential savings available and affecting the value of the missed opportunity.

Further research would be required to understand the difference between the maximum theoretical savings possible for each business and the value identified in the Filtered Toolkit, in order to refine these figures.

4.5.5 Savings as a Proportion of Energy Spend

Another approach to calculating the value of the missed opportunity is to use the With Information Businesses dataset to establish savings potential as a percentage of energy expenditure. These data are summarised in Table 9. Again, Adopters and Non-adopters are treated as separate subsets to allow the assumption that these businesses have different characteristics to be explored.

With Information Businesses	Adopters	Non-adopters	All Businesses
No. of Businesses	68	131	199
Mean energy spend per business (pa)	£163,497	£76,149	£105,997
Mean energy Savings Identified per business (pa)	£58,712	£14,011	£25,863
Mean energy Savings Identified as % of Energy Spend	36%	18%	24%

Table 10. Levels of Savings Identified and Achieved across the With Information Businesses

While it cannot be assumed that energy spend and identified savings in the With Information Businesses are representative of the Filtered Toolkit (e.g. the average savings identified are higher than in the previous approaches), if it is assumed that the ratio of energy savings identified to total energy spend is a suitable approximation, then it is possible to estimate the total energy spend of the Filtered Toolkit businesses.[23]

For Adopter businesses, where there are £13.79m of annual energy savings identified (Table 9), their energy spend can be calculated to be £38.42m pa (i.e. £13.79m/36%). Applying the same logic to Non-adopter businesses, their energy spend can be estimated to be £72.17m pa (£13.28m/18%). Adding together the totals for Adopters and Non-adopters gives an estimated total energy expenditure for all Filtered Toolkit businesses of £110.59m pa (Table 11). From this, the actual value of savings identified (£27.07m) and implemented (£5.56m) can be converted into percentage savings of total energy spend. These are also shown in Table11.

[23] It has not been possible to apply this method to CO_2e savings as the breakdown of energy usage by fuel type is not known.

Filtered Toolkit	Adopters	Non-adopters	All Businesses
Total energy spend (pa)	£38.42m	£72.17m	£110.59m
Energy savings Identified (pa)	£13.79m	£13.28m	£27.07m
Energy savings implemented (pa)	£5.56m	-	£5.56m
Energy savings Identified as % of Energy Spend	36%	18%	24%
Energy savings implemented as % of Energy Spend	14%	-	5%
Missed opportunity as % of Energy Spend	21%	18%	19%

Table 11. Savings as a Percentage of Total Energy Spend

These figures can then be used to estimate the value of the missed opportunity savings beyond the datasets in this study.

4.5.6 Extrapolating to UK SMEs

A range of estimates has now been established for the value of the missed savings opportunity for the Filtered Toolkit companies. Using this information, it is possible to extrapolate the calculations to a national level. It should be noted that the companies in the Filtered Toolkit dataset may not be representative of the UK business population, hence this information should be regarded as a broad indication of the savings available; See Annex C for further details of the Filtered Toolkit businesses.

Firstly, the average savings per SME can be applied. Figures from the Department of Business, Innovation and Skills (2013) show that there are 217,430 businesses in the UK with between 10 and 250 employees (this is a strong proxy for the SME definition used to allocate companies to the Filtered Toolkit dataset).

From the simple and scenario approaches, the estimated value of the missed opportunity for UK SMEs, on the assumption that the ENWORKS results are representative is estimated to be between between £1.26bn and £2.63bn pa, with associated CO_2e savings of between 8.66m and 17.64m tonnes pa:

- £1.26bn and 8.66mt CO_2e pa (using the lowest average missed opportunity value of £5,801 and 39t pa per SME – the mean missed savings opportunity for Non-adopters)
- £1.58bn and 10.72mt CO_2e pa (using the average missed opportunity value of £7,245pa and 49t per SME – the mean missed savings opportunity across all businesses)
- £1.98bn and 13.27mt CO_2e pa (using the average potential savings value of £9,116 and 61t pa per SME- the mean potential saving for SMEs across all businesses)
- £2.63bn and 17.64mt CO_2e pa (using the highest average missed opportunity value of £12,109 and 81t pa per SME – the mean missed opportunity for Adopters)

It should be noted that for some SMEs in the UK business population, the higher range of between £20,281 and £58,712 average annual savings potential, identified for Adopters, could be used as the value of their missed opportunity. That is, some companies will have significant potential to save and will not yet have implemented any energy efficiency measures. These values would increase the estimate of maximum savings potential to between £4.4bn and £12.7bn per annum; however, this has not been done in this study as the number of SMEs that may meet these criteria is not known.

Secondly, the cost savings as a percentage of energy spend can be applied. Figures from DECC (2013) show annual non-domestic electricity and natural gas consumption to total £22.45bn; this includes SMEs, large companies and the public sector. In order to estimate the

SME contribution to this figure, the total energy spend pa of the businesses in the Filtered Toolkit derived from the With Information Businesses, i.e. £110.59m, is divided by the number of businesses in this sample (2,970) to produce an average energy spend of £37,236 pa per business. If this is multiplied by the number of UK SMEs used above (217,430), the estimated SME expenditure on energy is £8.10bn pa.

Using the percentages established above, the value of the missed opportunity for UK SMEs can be estimated as between £1.49bn and £1.98bn pa:

- £1.49bn pa (using the lowest missed opportunity percentage of 18% - the missed opportunity as a percentage of energy spend for non-adopters)
- £1.58bn pa (using the average missed opportunity percentage of 19% - the missed opportunity as a percentage of energy spend for all businesses)
- £1.73bn pa (using the highest missed opportunity percentage of 21% - the missed opportunity as a percentage of energy spend for Adopters)
- £1.98bn pa (using the average potential savings percentage of 24% - energy savings identified as % of energy spend for all businesses)

It should be noted that, as with the average savings per SME method above, some SMEs will have a greater potential to save (i.e. they are closer aligned to the Adopters in this study). For these companies, the 36% savings potential figure could be used as the value of their missed opportunity. This value would increase the maximum savings potential to beyond £2.9bn per annum; however, this has not been done in this study as the number of SMEs that may meet these criteria is not known.

In summary, the two approaches produce a conservative estimate of the value of the missed opportunity for savings from energy efficiency across UK SMEs of between £1.26bn and £2.63bn pa, with associated CO_2e savings of between of between 8.66m and 17.61m tonnes of CO_2e pa; an estimated 37% of which could be achieved with no capital cost required.

5. Conclusions

This research has addressed two core aims:

- To provide qualitative and quantitative evidence of the motivations and barriers to energy efficiency as experienced by SMEs, with a particular focus on later stage barriers wherever possible.
- To calculate the value of the missed opportunity for SMEs not improving their energy efficiency.

This has been achieved by combining evidence gathered from business interviews with appropriate testing against quantitative data from the ENWORKS Efficiency Toolkit.

Cost Savings

The 31 SMEs interviewed in this study all cited cost savings as an influencing factor for implementing energy efficiency improvements; this supports the findings of previous research (e.g. FSB 2012; Trombley 2014), that businesses are concerned about the cost of energy and therefore they see it, along with the potential for it to deliver cost savings, as a driver to increasing energy efficiency.

Quantitative analysis of the wider database reinforces this assertion, showing a statistically significant correlation between implementation rates and the value of associated cost savings; i.e. as the reward increases, so does the likelihood of adoption.

Despite this correlation, the Toolkit data also highlights that implementation rates remain low in general, at below 25%, even for those improvements with potential cost savings exceeding £10,000 pa and even after the ENWORKS review has sought to address information failures. This suggests that a broader set of barriers are acting to limit implementation and that cost savings alone are not a sufficient driver to catalyse action, even though SMEs may perceive them to be an important motivating factor. In addition, it suggests that energy efficiency improvements that deliver low levels of cost saving are less likely to be implemented. Given the potential for wide-scale uptake of low-value actions to contribute incrementally to large-scale reductions of carbon emissions at a national level, this is a concern.

The interviews provided some insight into the factors that could be limiting uptake in SMEs, including the challenges in quantifying, understanding and integrating energy efficiency savings into normal business information flows, making it difficult for the value of any potential or actual improvement to be calculated and therefore recognised in the same way that other business improvements are. This may result in energy efficiency being undervalued, which in turn acts as a limiting factor to its widespread uptake. Improving access to metering and monitoring technology may help to counter this and therefore could have the potential to increase implementation rates amongst SMEs.

Capital Cost

The need for capital investment, and the difficulties in accessing finance, were also commonly cited by the Interviewed Businesses as key barriers to the implementation of energy efficiency improvements; this again reflects the findings of previous research (BMG 2009; Fleiter, Schleich and Ravivanpong 2012). However, the quantitative data on the relationship between levels of capital expenditure and implementation rates from wider database indicates that there is no clear relationship between these variables, supporting the contention that capital investment is unlikely to be the only barrier.

Firstly, the data shows that 30% of the improvements identified for SMEs in the wider database require zero capital expenditure, yet only 20% have been implemented. The fact that interviewees perceive there to be capital costs associated with energy efficiency may, therefore, indicate a misconception as there are evidently opportunities available that do not require capital cost.

Secondly, analysis suggests that the value of capital expenditure required has little effect upon implementation rates, with levels remaining below 20% for the large cohort of businesses in the Toolkit, irrespective of the size of investment needed; this figure also applies to improvements requiring no capital investment, indicating that the absence of a need for capital is not a strong enough driver alone to catalyse action. This suggests that companies are equally willing to invest in high-cost opportunities as they are in low-cost opportunities, indicating the presence of other drivers and other later stage barriers beyond the requirement (or not) for capital.

With regard to accessing finance, in the majority of cases where capital investment had been made (by both the Interviewed Businesses and the wider Toolkit database), less than £5,000 had been needed. This level of investment can usually be absorbed into normal running costs, i.e. it does not require external funding support – either from the public or private sector. Despite this, the perception from some interviewees was that accessing finance was an important stage in implementing energy efficiency and that it had associated hassle costs which could outweigh the benefits likely to be accrued; therefore suggesting that this perception may be acting as a limiting factor.

Payback Period

While payback period is inherently connected to capital expenditure and, therefore, may be affected by similar drivers and barriers, it differs in that it is a measure of return on investment over time rather than affordability and availability of funds; it therefore presents additional motivations or challenges to the uptake of energy efficiency.

The significance of payback period on the decision-making process for implementing energy efficiency improvements was clearly reflected in the interviews, with the majority of SMEs reporting that the case for improvements with a payback period of up to two years (and occasionally up to five years) made business sense and would likely go ahead if finance was available. This aligns to common business practice for other investments and improvements.

However, analysis of the wider database shows that the implementation rate for opportunities with a payback of two years or less was only 13%, which shows no significant difference from the implementation rate of opportunities with longer payback periods; for example, improvements with a 5+ year payback period have an 11% implementation rate.

This is further evidence that businesses operate within bounded rationality (Sorrell et al. 2011). That is, they do not appear to operate on simple 'calculation – decision – implementation' models based on payback period and other financial measures alone, but are influenced by wider business considerations and subject to multiple limiting factors.

Comparing the Sectors

At the outset of this study, a distinction was made between manufacturing and non-manufacturing businesses to allow for a comparison of how barriers and motivations are experienced between these two broad sector categorisations. All of the Interviewed Businesses were able to be categorised, along with 63% of the 2,970 businesses in the Filtered Toolkit.

A clear distinction is shown to exist in both the qualitative and quantitative findings. The quantitative evidence gathered from the Filtered Toolkit shows that there is a greater tendency for manufacturing companies to implement improvements (29% are Adopters) compared to those in non-manufacturing companies (18% are Adopters). As a possible explanation, the interviews indicated that manufacturing companies are more likely to conceptualise energy as an operational cost, linked to production levels, and therefore view anticipated price increases as a motivation for stabilising or reducing energy consumption.

Findings from the logistical regression analysis further highlight the distinction between the sectors. For manufacturing businesses, the value of cost savings is shown to be highly statistically significant, with payback also being statistically significant, to the implementation rates of energy efficiency improvements. However, for non-manufacturing businesses, none of the financial metrics (cost savings, capital cost or payback period) were statistically significant. This difference supports the assertions made in interview responses that less tangible factors, such as improving ambience and customer experience, are more likely to drive, and constrain, energy efficiency improvements in service sector/non-manufacturing SMEs.

These findings support those of previous research (Schleich and Gruber 2008), indicating that different sectors of the business community may respond to different drivers for energy efficiency and benefit from tailored approaches to overcoming their particular barriers.

Other Later Stage Barriers

Interviewees that leased or rented their premises reported that this presented a barrier to the implementation of energy efficiency improvements as they were reluctant to invest in building improvements, particularly where payback periods extended beyond lease periods. Support for landlords may help to redress these misaligned incentives and increase the uptake of energy efficiency improvements in business premises.

The risk of disruption to day-to-day operations and the perception that particular business processes limited the scope for energy efficiency were cited as barriers to implementing improvements, particularly by those in the manufacturing sector. A number of interviewees provided examples of how these issues had been overcome, including phasing changes to limit disruption and taking advantage of trigger points, such as wider upgrades to business processes, to create the opportunity for energy efficiency to be addressed. Supporting companies to recognise and take advantage of such trigger points may help to remove barriers and increase the uptake of energy efficiency.

Diverting from accepted practice, both in terms of internal operations and external customer expectations, was also noted as a barrier to energy efficiency. However, supply chain pressure was also reported to act as a driver in some instances, both from the public and private sectors. Influencing supply chains may therefore have the potential to impact the uptake of energy efficiency among SMEs.

Other Drivers

Some businesses reported that their actions were driven by what others were doing on energy efficiency, therefore publicising relevant positive achievements may normalise the adoption of energy efficient practices and catalyse wider uptake in SMEs.

Finally, the culture towards energy efficiency within a business was reported to be an influencing factor on its uptake. Analysis suggests a slight correlation between those reporting a positive culture and higher implementation rates; however, it was not possible in this research to separate the influence of this intrinsic motivation from other drivers to establish definite causality.

SMEs in Relation to Other Businesses

Many of the barriers discussed in this report are related to the size and capacity of a business and, whilst further research would be required to comment with certainty, it is possible that they are experienced differently within larger firms. For example, non-SMEs are more likely to own their premises and are therefore less likely to be subject to the misaligned financial incentives of the landlord–tenant relationship. Recent research also indicates a tendency for SMEs to seek shorter leases to maximise flexibility (Crosby et al. 2006 and EFILWC 2013) which may inhibit investment in building improvements (Pett and Ramsay, 2003). In addition, smaller firms have been found to be less likely to measure and keep performance records (EFILWC 2013), owing to fewer technical and financial resources or less operational capacity, thus maintaining the undervaluation of energy efficiency and limiting uptake of improvements. An understanding of these differences should support the development of appropriate solutions to increase uptake within SMEs.

Value of the Missed Opportunity

Energy efficiency represents a substantial economic opportunity that is not being realised to its full potential by UK SMEs. The size of this missed opportunity has been estimated in this report to be between £1.26bn and £2.63bn pa. If realised, this could deliver between 8.66m and 17.61m tonnes of annual CO_2e savings.

At an individual business level, on average, this equates to annual missed savings of between £5,801 and £12,109, or between 18% and 24% of their annual energy costs. The capital cost associated with delivering these savings is between £8,663 and £18,838, with an average payback period of 1.5 years; however, it should be noted that £37% of the savings could be achieved with zero capital investment.

The study also developed evidence to show that, in some cases, this could rise to £20,281 average annual savings per SME, or 36% of annual energy expenditure.

It should be noted that the basis of these figures – energy efficiency improvements identified by an ENWORKS Review – does not represent the maximum theoretical value of savings possible in these SMEs and therefore the figures may be higher in practice for some companies.

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Annex A – Cohort Selection Process

Introduction

The source for the cohort sample selection was the ENWORKS Online Resource Efficiency Toolkit. The full dataset was progressively filtered to identify suitable targets for the interviews. This began by identifying those businesses that had received a Resource Efficiency Review from ENWORKS; this provided a starting cohort of 5,274 companies, 3,969 of which are SMEs (75%).

Further analysis identified just those that had had energy efficiency opportunities identified for them since 1st January 2010 (i.e. older interactions and opportunities involving other resource types were excluded).

This set was then further refined to include only those SMEs with more than three improvement actions on record, and then finally to isolate those with which ENWORKS was in contact at the time of the study. This process delivered 79 SMEs which were then categorised as Cohort A, B or C (27 met the definition of a Cohort A business, 27 for Cohort B and 25 for Cohort C). This process is outlined in Figure A1 below:

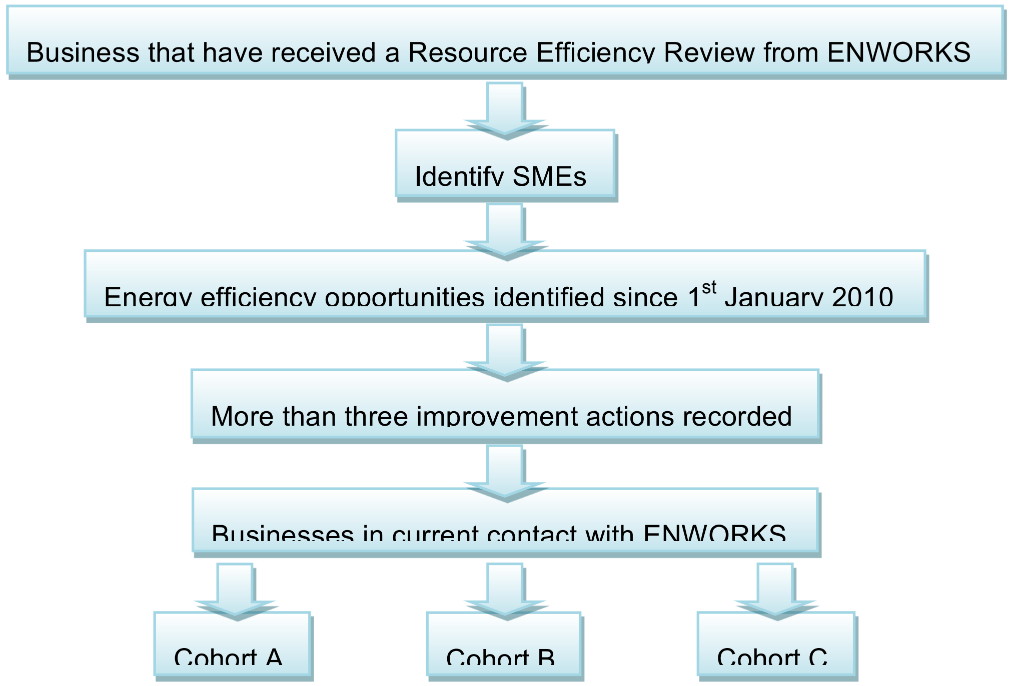

Figure A1. Sample Selection Process

Cohort Selection Framework

In order to achieve an appropriate mix of businesses, a Cohort Selection Framework was developed to ensure the desired spread of business characteristics was achieved; characteristics identified as pertinent during the evidence assessment were size, sector and energy intensity. Table A1 shows the spread of businesses targeted for inclusion in each cohort by these business characteristics. Some 10–15 companies were targeted for each cohort.

The 79 businesses identified as suitable for the survey were then aligned to the Selection Framework and targeted to achieve the desired mix across each of the three Cohorts. This resulted in 38 companies agreeing to participate in the interviews: 12 in Cohort A, 14 in Cohort B and 12 in Cohort C with good alignment to the Framework.

	Manufacturing Sector			Service Sector
No. of Employees	Low energy intensity	Mid energy intensity	High energy intensity	
11 – 49	1	1	1	2
50 - 249	2	2	2	1

Table A1. Cohort Selection Framework

Following the transition from the Cohort categorisation to the Adopter/Non-adopter categorisation (section 3.2), the make-up of the Interviewed Businesses is displayed in Table A2.

	Manufacturing Sector		Service Sector	
No. of Employees	<49	50 - 249	< 49	50 – 249
Adopters	6	7	5	3
Non Adopters	3	4	2	0

Table A2. Characteristics of the Interviewed Businesses following re-categorisation

The Cohort Selection Framework was informed by analysis into the sector breakdown of businesses in the UK[24] and those recorded on the ENWORKS Toolkit. A comparison of the two is shown in Table A3[25]; it shows that manufacturing companies are overrepresented and the service sector is underrepresented in the Toolkit. Therefore, the prominence of manufacturing companies within the Selection Framework represents the make-up of the businesses in the Toolkit, but is not representative of the sectorial split of businesses at a national level.

[24] https://www.gov.uk/government/publications/bis-business-population-estimates

[25] This comparison has to be treated with some caution; since the National Statistics classification is a self-declaration according to SIC code, ENWORKS has used a subjective assessment of company activity (driven by the former Regional Economic Strategy).

BIS Business Population Estimates 2012		ENWORKS Wider Database	
Mining and Quarrying; Energy, Water Supply; Sewerage, Waste Management etc	1%	Recycling and waste Energy Renewable energy Environmental Technology	2%
Manufacturing	7%	Aerospace Biotechnology Food and Drink Manufacturing/Engineering Chemicals Textiles Automotive	37%
Construction	12%	Construction	10%
Wholesale and Retail; Repair of Motor Vehicles	19%	n/a	
Transportation and Storage	3%	Warehousing/distribution	2%
Accommodation and Food Service Activities	10%	Leisure and Tourism	15%
Financial and Insurance Activities	2%	Financial and Professional Services	6%
Real Estate Activities	3%	n/a	
Professional, Scientific and Technical Activities	13%	n/a	
Administrative and Support Service Activities	8%	n/a	
Education	1%	Health and Education	8%
Human Health and Social Work Activities	5%		
Arts, Entertainment and Recreation	2%	Creative and digital	8%
Information and Communication	5%		
Other Service Activities	5%		n/a
Agriculture, Forestry and Fishing	4%		n/a
n/a		Maritime	1%
n/a		Sport	4%
n/a		Other	7%

Table A3. Sector Comparison between BIS and Toolkit Classifications

Annex B – Interview Topic Guide

What do we want to know?	What are the questions? (with prompts if applicable)
1. A checklist of key identifying information about the business	In a table the following will be confirmed – much of this will be pre-completed by the interviewer: a) Company name b) Interviewee name c) Job title and job function d) Sector (INSERT PRE-EXISTING CATEGORIES FROM ENWORKS LIST) e) No. of employees in business f) Site/premises ownership – owned or rented? g) Are you able to give an approximate cost per annum for energy (gas, electricity and other fuels separately as far as possible £ pa) h) Are you able to give an approximate value for turnover for the business per annum? (£ pa) i) Their role in the review and subsequent measures identified by ENWORKS (INSERT DATE/PERIOD) NOTE TO INTERVIEWER: When providing thank you email after interview follow up with any uncertainties and lack of information in the email to complete these sections where appropriate.
2. What the approach of the business currently is towards investment	Can you tell me about any capital investment projects you've made in the last 12 months? a) If these have had any energy efficiency, resource use or other sustainability (which could include water, transport, diversion from landfill) components (i.e. lighting, new equipment, insulation etc.)? b) Once a capital investment opportunity has been identified can you just tell me about the sort of decision-making process that takes place? Prompt for: - Who makes the final decision? (seek to understand the decision-making process) - How do others find out about and/or input into these decisions? - Is this a board decision? - Differences in terms of size of investment/nature of opportunity? - How does the payback period influence decisions? - What helps?

	- What hinders? - Are there particular metrics or tools that are used in decision-making? c) How are investments typically funded in the business? Prompt for: - Own funds? - Loan? - Whether it depends according to different kinds of investments
3. What is the broad canvas upon which energy is conceptualised in the business?	a) Is there a member of staff with responsibility for looking into issues of energy use in the business? If yes prompt for: - Who is it? - What sort of role do they have? - Is this information shared with amongst the workforce? - Who do they report to in the organisation? If no prompt for is there any particular reason why not? b) Do you have any targets for reducing energy consumption in the business? If yes, prompt for: - What are these? - Are they part of an EMS (Environmental Management System e.g. ISO 14001)? - Did these targets exist prior to the intervention from ENWORKS? - Are targets/performance reported externally (e.g. on company website)? - What would you say is the track record in meeting these targets? c) Can you tell me when the last time the business checked the rates from your utility suppliers? Prompt for: - If one took place who prompted a check? - Did you switch? If not, why not? d) Do any of your buildings have EPCs (Energy Performance Certificates) or DECs (Display Energy Certificates)? e) Other than energy efficiency, has the business undertaken any measures to improve resource efficiency (e.g. water, waste reduction or recycling)?
4. Understanding the initial motivations for undertaking a review	a) Can you tell me why it was decided that the business should have a Resource Efficiency Review? Prompt: cost savings, customer pressure, general CSR commitment. (also non-business prompts: e.g. it was free, the sales pitch was convincing, boss said we should) b) Had you had previous reviews into efficiency and sustainability?

	c) What did you hope to achieve from the review? d) Why did you agree to the review?
5. Understanding the view of the business with respect to the review process	Can you tell me a little bit about the review process? Prompt for: a) How did you find the process of the review? b) Did the consultant cover the sorts of things you expected? c) Was there anything unexpected about how the review was conducted? d) What were your thoughts on the sorts of opportunities identified as a result of the review? e) How did it measure up to your expectations?
6. What are the motivations for engaging with some opportunities whilst not taking up others?	FOR COHORT B (ADOPTERS) - We understand you adopted a number of measures [interviewer refer respondent to list provided by ENWORKS]. a) Can you tell me a little bit about why you adopted the opportunities you did? Prompt for: - Payback period - Part of natural upgrade - Ease of implementation - Support within business - Low cost/cost savings - Enhanced reputation - Supply chain pressure - Legislative compliance b) We're interested in the daily experiences in taking up opportunities and integrating them in the business, can you tell me about any successes and challenges you faced when adopting these opportunities? Prompt for: - Management buy-in - Time - Expertise - Cost - Difficulty level - Lack of integration with existing systems/infrastructure c) Can you tell me why you decided not to implement the other opportunities identified [interviewer to refer respondent to list provided by ENWORKS]? Prompt for: - Payback period - Part of natural upgrade - Ease of implementation

	- Support within business - Cost - Time - Other priorities - Lack of detail - Lack of expertise - Not a priority - Not part of core business - Tenant/landlord issues - Other physical constraints d) Do you plan to revisit any opportunities identified at a later date? If yes prompt for: - Which? - Why later? e) Did you address any other issues relating to energy efficiency but not through ENWORKS? Prompt for: - What were these? - What happened? - Why later?
7. What is their assessment of the process they went through?	a) Can you tell me about any energy savings you have observed as a result of the measures? Have these energy savings been measured and/or quantified? Prompt for: - More or less than anticipated - Impact on business b) Have there been any additional benefits other than energy savings? c) Have there been any negative impacts of the project(s) that have been implemented? d) Would you be happy to recommend carrying out energy efficiency measures to other businesses? Prompt for why? e) Would you undertake additional reviews in the future? Why/why not?

Annex C – ENWORKS and the Online Resource Efficiency Toolkit

This Annex provides information on ENWORKS and its Online Resource Efficiency Toolkit. The text draws from a summary created for the benefit of current and potential Toolkit users and does not form part of the academic research.

ENWORKS

Since 2001, ENWORKS has been providing advice and support with the aim of improving the economic and environmental performance of businesses across the North West of England and therefore helping the UK to make the transition to a low-carbon economy. To date, over 12,500 businesses have been engaged with ENWORKS support services, which include: on-site business reviews to identify and quantify the potential for resource efficiency improvements; ongoing practical support with implementing efficiency improvements; workshops to transfer the knowledge and skills required to increase the adoption and success rates of efficiency improvements; identification and management of environmental business risks to increase resilience and competitiveness; and the provision of tailored information services and tools to manage change. ENWORKS arranges for all projects to be independently evaluated and for all the reported achievements to have a fully verified and transparent audit trail. Further information and documentation relating to ongoing monitoring and evaluation is available at www.enworks.com and www.enworksinabox.com.

The ENWORKS Online Resource Efficiency Toolkit

Introduction

The ENWORKS Online Resource Efficiency Toolkit ('the Toolkit') is a bespoke piece of web-based software, developed to capture and report the economic and environmental outcomes of resource efficiency activity, for example in individual businesses or via business support projects.

It has been used by ENWORKS since 2004 and has been taken up by others across the UK, including the London Development Agency, the South East England Development Agency, the national Envirowise programme, the Welsh Assembly Government and a number of commercial enterprises.

Currently, there are over 10,000 businesses registered on the Toolkit, with over 40,000 individual resource efficiency improvements being tracked.

The Toolkit is hosted on a secure site, with multiple access/security levels enabling it to be used by the beneficiaries of support, support providers, programme managers and other stakeholders, whilst protecting commercial confidentiality.

The Toolkit enables all relevant parties to log, manage, quantify and report in real time the cost savings and resource savings associated with improvements made in resource efficiency.

No special software is required as the Toolkit is accessed via all commonly used web browsers and minimal training is required for new users.

Application of the Toolkit

The Toolkit has a straightforward ‘family tree’ structure which is flexible enough to work for a diverse range of delivery mechanisms, project structures or business models, whilst ensuring data security and confidentiality.

The Toolkit logs individual improvement actions (Opportunities) that have been identified, for example through an audit or site review, as having the potential to increase resource efficiency, reduce waste to landfill or improve sustainable procurement practices.

It then tracks these improvements through to completion. As such, it can be used by any project that delivers resource efficiency improvements or carbon savings to business, or by any individual businesses doing the same.

Data Capture and Applications of the Toolkit

Each Opportunity (improvement action) is recorded using both qualitative information (e.g. a description of the improvement) and quantitative information (e.g. the Capital Cost associated with the improvement).

Each Opportunity is assigned a Status to describe the progress that has been made by the business on that improvement action (from Initial Scope, to Investigation... to Implementation, to Achieved).

Each Opportunity is broken down into its component parts. These parts are the quantified cost and resource savings (multiple resources can be saved by one improvement action).

Savings are categorised as either Resource Reduction – using less of a particular resource; Waste Diverted from Landfill – changing the way waste is managed; or Substitution – changing the nature of a resource used.

Resource Types for each saving are logged from a list of 26 covering different energy types, water sources and Defra priority materials. The Method by which a saving is being made is also recorded from a list of 22 options.

The Toolkit has a number of different reports, the content of which can be determined by selecting criteria from up to 15 filters. These filters allow the reports to be tailored for different uses, thus enabling both simple status reporting and more complex comparative analysis to take place.

Where the reports contain information on outcomes, such as cost savings or resource savings, these are reported as both Cumulative savings to date (daily accrual of savings taking into account any capital investment required) and as Annualised or One-Off savings.

CO_2e savings are also reported wherever there is a nationally approved (UK Defra) GHG conversion factor – all factors are fully visible so there is complete transparency in any reporting.

Benefits of the Toolkit

The Toolkit can assist with removing barriers to engagement in resource efficiency and waste management improvements – these commonly include a lack of time, resources and expertise, and the difficulties of managing seemingly large amounts of complex data across multiple improvement projects.

The Toolkit helps to overcome these by providing a flexible yet robust management tool that the majority of users do not have the financial resources or the expertise to develop alone. It can be updated and report status very quickly and it captures and manipulates complicated datasets for the user.

The Toolkit helps to create a knowledge bank within organisations that is not vulnerable to staff changes, and assists with knowledge transfer and information management.

The Toolkit can also assist in resolving common difficulties associated with managing the delivery of resource efficiency projects/support – these may include the absence of commonly agreed metrics and reporting systems; the need to collate and analyse complex data in different ways for different audiences at different times; and the verification and objective assessment of outcomes.

The Toolkit provides a standardised management and recording system for outcomes that is capable of reporting in real time with a good degree of flexibility in report content and focus. It also provides the framework for ensuring that savings are verified by the beneficiary and/or can be externally evaluated.

To support the continual improvement of activity and the future development of policies, the Toolkit allows comparative analysis of projects/outcomes to take place in real time, and in a range of data combinations.

This enables best practice to be identified and shared, and the improvement programme course to be corrected if necessary. It allows a comparative analysis of activity and a clear and transparent evaluation of ‘environmental support’ or ‘resource efficiency projects’ to take place on an ongoing basis.

The Toolkit can provide an evidence base for future policy and programme development by quantifying the impact of interventions over time. It has been used as such in research undertaken by UK government departments including Defra, BIS and DECC, and the European Commission.

Annex D – Analysis and Quality Assurance

Analysing the Interviews

The University of Salford developed themes and concepts from the interviews and shared these with their wider research team in an analytical workshop, in which the initial analysis was subject to scrutiny. Within this workshop, cross-cutting themes were developed and key findings for each theme were discussed. These cross-cutting themes were used to further develop the analysis and ultimately to structure the findings and conclusions in this report. For each cross-cutting theme, key arguments and findings were established and these were associated with interview quotations that provided illustration and substantiation of the points being made. It should be noted that all qualitative research embraces interpretation and subjectivity. However, Framework Analysis reduces the risk of partiality by involving multiple researchers in the process and using the systematic approach to guide the discussion from interview transcripts, through to codes and themes, and into the report structure.

1	processes of decision making
2	factors considered in decision-making
3	energy policies and targets in the business
4	the allocation (if any) of responsibility for energy in the business
5	the relationship between the business and their utility providers
6	drivers of and motivations for energy efficiency
7	reasons for embarking on the ENWORKS Review
8	experiences of the ENWORKS Review
9	opportunities that were implemented
10	why opportunities were implemented
11	why measures were not adopted
12	challenges experienced in relation to technical issues
13	challenges experienced in relation to regulations
14	challenges experienced in relation to building premises
15	challenges experienced in relation to supply chain and customers
16	challenges experienced in relation to expertise
17	challenges experienced in relation to finances and funding
18	challenges experienced in relation to staff and operations
19	relevant future plans of the business
20	impacts of implemented opportunities and issues relating to monitoring

Table D1. Themes around which the Framework Analysis was structured.

Quality Assurance

Quality Assurance by the academic partner took five forms:

1. A systematic and clearly documented research methodology, as outlined in this section of the report, was utilised following recognised protocols.
2. Regular project review meetings were held (internally and with the commissioners) to ensure consistency of project vision and alignment of objectives.
3. The datasets (both quantitative and qualitative) were reviewed by two team members with the appropriate skills and experience to ensure accuracy prior to analysis.
4. The analysis (both quantitative and qualitative) has been subject to internal peer review and ongoing advice by suitably qualified experts, who are internal to the University but outside the core team, subsequent to drafting by core team members.
5. Regular spot checks have been undertaken by core team members to ensure the accuracy of the analysis during the study.

For the qualitative analysis these checks comprised:

- Internal peer review of drafts of the analysis and the framework matrix to assess the interpretation of the qualitative material and the use of the framework methodology;
- An internal workshop to review the framework matrix, identify themes arising from it and review the interpretation of quotes.

For the quantitative analysis these checks comprised:

- A second team member repeating and checking calculations and analysis performed by another;
- The involvement of an expert in statistics as an additional team member at strategic points in the development of the quantitative analysis to advise on appropriate tests and check calculations and interpretations.

Annex E – Categorisation by Improvement Type

The Toolkit contains information on 14,471 energy improvement opportunities for SMEs that have been identified by ENWORKS. For each of these opportunities recorded since 2010, the method by which the improvement has been or will be implemented has been recorded. There are 12 'methods' of relevance to energy efficiency and analysis showed the majority of opportunities were recorded under the 'Environmental Technologies' or 'Premises Improvement' method, as shown in Table E1.

METHOD	No. of Opportunities	Comment
Behaviour change	1,235	Monitoring and targeting, switch off campaigns, awareness some compressed air leak reduction
CHP	3	2 CHP; 1 biomass
Eco Design	42	PV, lighting controls and heat recovery
Environmental Technologies	2,604	All energy efficiency and renewable technologies
Green tariff	10	Fuel switching; Green electricity tariff
On-site energy recovery	6	Heat recovery, heat pumps, PV
On-site renewables	132	All renewable technology
Process improvement	651	Mainly process related but some lighting and monitoring and targeting
Premises improvement	2,373	Mainly lighting and heating projects
Procurement Change	46	5 tariff project remainder mainly lighting
Switch to biofuel/biomass	9	All biomass
Blank entry	7,363	Opportunity entered before 'method' function added and made mandatory
Total	**14,471**	

Table E1. Breakdown of Method by which Opportunities Are to Be Implemented in the Toolkit

Table E1 highlights two issues that needed to be addressed to support this research. First the 7,363 opportunities that were captured prior to 2010, i.e. before the 'method' was introduced to the software, where no detail is recorded; these represent 51% of the energy opportunities in the Toolkit; and second to address the fact that methods do not disaggregate energy efficiency opportunities from others (for example, within the Environmental Technologies method, both energy efficiency and renewable energy opportunities are included).

To overcome these issues, the University of Salford developed a list of 15 'improvement types' to further categorise the data (it should be noted that these new categories are not strictly defined by technology types, but apply a broader definition of the means by which opportunities would be implemented). These new categories are shown in Table E2 along with the definitions applied to each one.

Technology	Definition / Description
Behavioural Change	Awareness and educational campaigns for employees where it is assumed they will result in general energy saving activities without the need for investment. Initiatives that enhance the quality of information concerning energy use, e.g. installation of meters or an energy monitoring and targeting system.
Lighting	Investments in the lighting technology involving the installation of more energy efficient lighting systems, e.g. replacing fluorescent lighting with LEDs
Space Heating	Investments in the space heating technology for buildings, e.g. new boilers or alternative heating systems.
Air Conditioning & Ventilation (ACV)	Investments in the air conditioning and ventilation of buildings involving the installation of more energy efficient systems.
Insulation of building fabric	Improvements to building fabric to reduce heat losses, e.g. wall insulation, installation of double glazing.
IT equipment and appliances	Investment in more energy efficient small appliances such as refrigerators and IT equipment (PCs and printers).
Steam/heat generation	Improved efficiency of the generation of steam, hot water or thermal for process use. This will involve investment or modification to boiler plant.
Process energy	Improved efficiency for manufacturing process plant and machinery.
Pollution abatement	Improved efficiency in pollution control equipment, e.g. dust extraction, thermal oxidisers, water treatment plant.
Compressed air	Improvements to the delivery of compressed air service e.g. leak reduction, low energy drying, pressure reduction.
Motors and Drives	Installation of energy efficient drives, VSDs and power optimisers.
Power Quality	Power factor correction, voltage optimisation.
Combined Heat and Power	Simultaneous heat and power production from a prime mover such as an internal combustion engine or gas turbine.
Renewable Energy	PV, solar thermal, wind power, heat pumps.
Control Systems	Devices or systems that control the operation of energy consuming appliances plant or equipment, e.g. automatic switching systems for lighting, thermostats for heating, building energy management systems (BEMS).

Table E2. 'Technology Type' Descriptions Developed to Further Categorise Toolkit Data

Given the large number of opportunities, a 'manual' reclassification of the opportunities according to the definitions was not possible and a word search methodology was developed; the titles of the opportunities were searched for specific keywords associated with each of the improvement types. These are shown in Table E3.

Technology	Search Terms
Lighting	T9; T5; lighting; lighting; LED; blank; illumination; SON; halide; high bay ; high-bay; Lighting; T12; T8; bulb; bulbs; lights; light fittings; Light fittings; light switches; luminaires; luminaire; fluorescents; fluorescent; Lighting; Fluorescent; fluorescent
Space Heating	space heating; space; heating; heaters; domestic hot water; destratification; LTHW; gas radiant heater
ACV	air-conditioning; air conditioning; ventilation; condenser; condenser; evaporator; evaporator; VRF; Air Conditioning; Chiller; chiller; Air conditioning
Insulation of building fabric	double-glazing; double glazing; double-glazing; Insulation ; cavity; building fabric ; insulate; Insulate; windows; Windows
IT equipment and appliances	PC; freezer; fridge; refrigerator; beer chiller; chiller cabinet ; printer ; PCs; PC; office equipment; coffee machine; appliances; dishwasher; dish washer ; Computers; computers
Steam/heat generation	; boiler; Steam/heat generation; condensate ; burner; combustion; economiser; steam; blank; flash steam; steam trap; lagging; Boiler
Process Energy	furnace; oven; mill; roller; crusher; blender; mixer; milling; boring; Rework ; reheat; re-heat; heat treatment; cutting; printing; moulding; litho; lithographic; filtration; rework ; blast chiller; Conveyor; conveyor; Heat treatment; tank insulation; Refrigeration plant
Pollution Abatement	thermal oxidiser; cyclone; filter; water treatment plant; aeration; effluent; compactor;
Compressed air	Compressed air ; leak ; leak detection; air pressure; psi; bar ; leak survey; solenoid ; compressed air ; compressor; air loss; Compressed; Airline; air line ; Compressor
Motors and Drives	Motors and Drives; electric motor; soft start; invertor; inverter; VSD; variable speed drive; energy efficient motor ; EEF; Variable Speed Drive; Variable speed drive; Variable Speed Drives; variable speed drives; High efficiency motors; high efficiency motors; motor optimisers; optimisers
Power Quality	power quality; Power Factor; voltage optimisation; voltage optimization; transformer; 3 phase; 11kV; 11KV; 11Kv; three phase; voltage; Voltage ; power factor
CHP	CHP; combined heat and power; cogeneration; gas engine; gas turbine ; IC engine; IC engine; internal combustion
Renewables	renewables; PV; Photovoltaic; photo-voltaic; Wind ; biomass; heat pump; ground source; air source; GSHP; ASHP; solar; Solar; pv; wind turbine; Renewables; Renewable; renewable ; water wheel; hydro; photovoltaic; Air Source Heat Pump
Behavioural Change	Behavioural Change ; motivation; awareness; meter; meters; Targeting; target; targets; targeting; monitor ; Management ; M&T; m&t; energy management; degree days; Management ; Educate; monitor; educate; management; Energy Management; staff awareness; Maintenance; benchmark; Monitor
Fuel Switching	coal; oil; wood
Control systems	Control ; control; thermostatic; TRV; Passive ; PIR; sensor; senser; PLC; BEMS; BEM; correctly set; temperature settings; TRVs; timer; Timer; thermostatic radiator; thermostats; Thermostatic; Occupany; occupancy

Table E3. Terms Used in Word Search Methodology

As the number of keywords in the lexicon was expanded, the number of opportunities that were captured and classified increased. With the list of words in Table E3, 10,961 of the opportunities were allocated a new 'improvement type' classification. For those opportunities allocated to multiple technology types by the word search, a hierarchy of types was applied with generic methods (Behavioural Change and Control Systems) taking precedence over the narrower definitions such as lighting, compressed air, motors and drives. Note that the misspelling of words in the keyword lists was a tactic employed to pick up inevitable errors resulting from manual data entry.

Although it was found that the addition of further words beyond those listed in Table E3 increased the number of classified improvement types, it also increased the number of opportunities that were classified under multiple improvement types, and the list developed in Table E3 was judged to be optimum within the constraints of the project. Given additional resources, more sophisticated approaches to automated classification could be developed, for example those based upon 'fuzzy logic' approaches.

The distribution of opportunities (in terms of number of improvement actions) across these new classifications is shown in Table E4, including whether it had been implemented or was still in the pipeline.

Technology Type	No. of Opportunities (able to be re-categorised)			Implementation Rate
	Implemented	Pipeline	Total	
Lighting	352	3,346	3,698	10%
Behavioural Change	289	1,337	1,626	18%
Compressed Air	247	484	731	34%
Control systems	225	1,658	1,883	12%
Space Heating	130	723	853	15%
Fuel Switching	76	437	513	15%
Steam/heat generation	39	234	273	14%
Process Energy	39	134	173	23%
IT Equipment & Appls	37	251	288	13%
Insulation of Buildings	34	380	414	8%
Motors and Drives	19	116	135	14%
Power Quality	11	256	267	4%
ACV	6	52	58	10%
Pollution Control	6	13	19	32%
CHP	1	29	30	3%
Grand Total	**1,511**	**9,450**	**10,961**	**14%**

Table E4. Distribution of Toolkit Opportunities by Number

In Figure E1, the distribution of implementation rates across improvement types is shown.

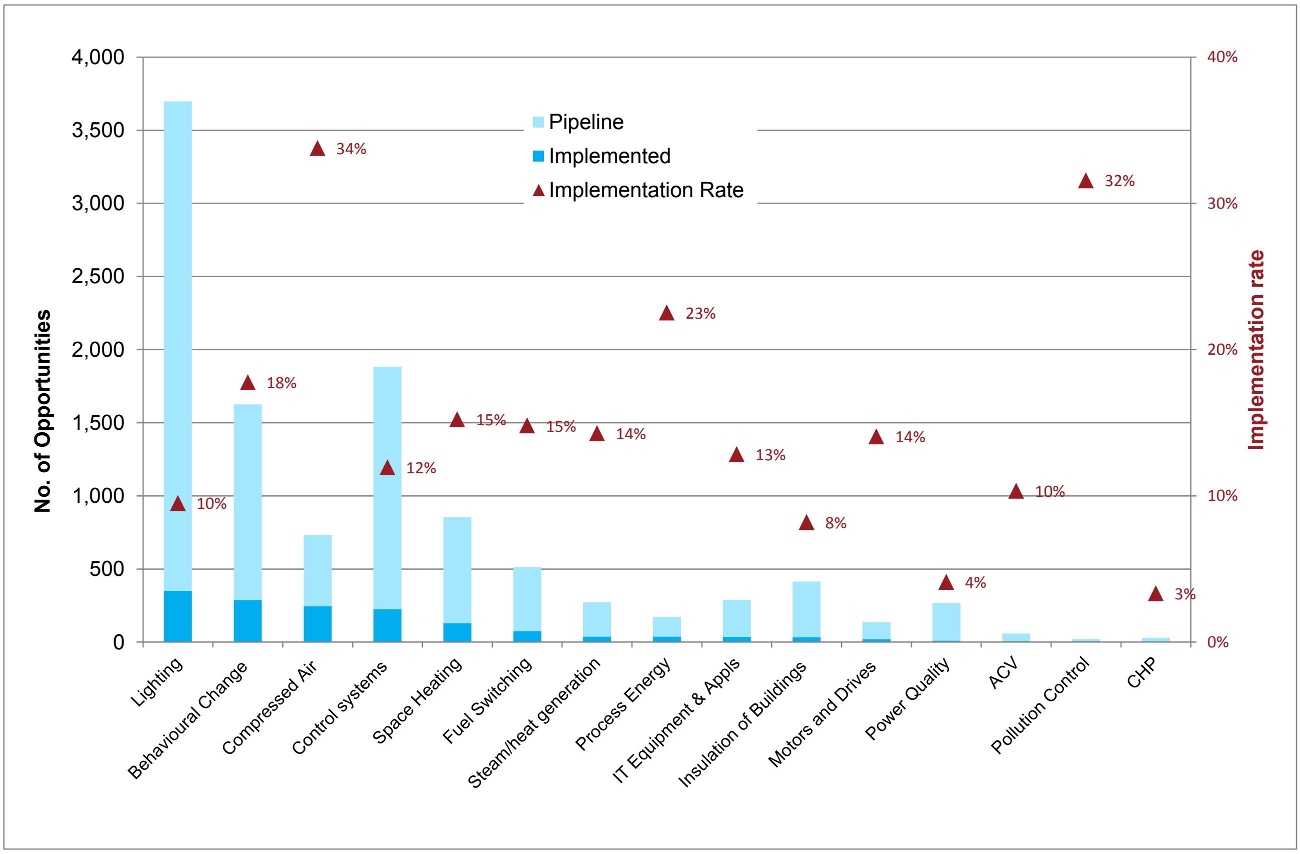

Figure E1. Implementation Rate by 'Technology Type'

Annex F – Characteristics of Interviewed Businesses

			All interviewed businesses	Adopters	Non-adopters
Payback Period (Implemented Opportunities)	years	Min Mean Median Max	0.0 2.6 0.3 79.7	0.0 2.6 0.3 79.7	
Payback Period (Pipeline Opportunities)	years	Min Mean Median Max	0.0 1.5 0.2 23.7	0.0 1.8 0.7 23.7	0.0 0.7 0.0 21.4
Cost Savings (Implemented Opportunities)	£pa	Min Mean Median Max	£3 £5,199 £1,149 £62,530	£3 £5,199 £1149 £62,530	
Cost Savings (Pipeline Opportunities)	£pa	Min Mean Median Max	£15 £3,967 £910 £87,991	£15 £4,188 £682 £87,991	£27 £3,539 £990 £49,320
Capital Expenditure (Implemented Opportunities)	£	Min Mean Median Max	£0 £4,805 £150 £90,000	£0 £4,805 £150 £90,000	
Capital Expenditure (Pipeline Opportunities)	£	Min Mean Median Max	£0 £7,890 £50 £282,0612	£7,890 £11,152 £175 £282,061	£0 £1,561 £0 £25,000

Table F1. Characteristics of Opportunities Identified for the Interviewed Businesses

Annex G – Statistical Analysis and Significance Tests

Dataset	Opportunities	Cost Saving	Capital Cost	Payback	R^2
All opportunities	10,961	****0.005**	0.119	0.408	0.004
Opportunities in the manufacturing sector	3,384	****0.005**	0.082	***0.029**	**0.008**
Opportunities in the non-manufacturing sector	3,740	0.131	0.639	0.872	0.001
Compressed air	731	***0.029**	***0.033**	***0.010**	**0.042**
Process energy	173	0.058	0.602	0.234	0.073
Behaviour change	1,626	0.087	0.593	0.772	0.003
Space Heating	853	0.369	0.470	0.263	0.006
Fuel Switch	512	0.117	***0.038**	0.319	0.021
Steam Heat	273	0.161	0.072	0.058	0.061
Motors	135	***0.014**	0.395	1.000	0.194
Control Systems	1,883	0.108	0.105	0.843	0.004
Lighting	3,698	***0.014**	0.436	0.081	0.010
Power Quality	267	***0.046**	0.414	0.848	0.065

Table G1. Significance Levels of the Predictor Variables within the Sector and Improvement Type Subsets (indicates $p<0.01$ and * indicates $p<0.05$). R^2 value is Nagelkerke.**

Dataset	Cases	Employees	Turnover	Energy Spend	Energy Intensity (Turnover)	Energy Intensity (Employees)	Savings Identified	R^2
All businesses	199	0.213	0.722	0.100	***0.044**	****0.008**	****0.000**	**0.317**
Manufacturing businesses	148	0.624	0.628	0.051	***0.039**	0.068	****0.000**	**0.355**
Non-manufacturing businesses	33	0.504	0.989	0.805	0.769	0.983	0.426	0.194

Table G2. Significance Levels of Business Characteristics on Adopter Status (indicates $p<0.01$ and * indicates $p<0.05$). R^2 value is Nagelkerke.**

Dataset	Cases	Employees	Turnover	Energy Spend	Energy Intensity (Turnover)	Energy Intensity (Employees)	Savings Identified	R^2
All businesses	68	0.647	0.433	0.620	0.615	0.274	**0.000**	**0.398**
Manufacturing businesses	50	0.895	0.317	0.893	0.904	0.138	**0.000**	**0.322**
Non-manufacturing businesses	12	0.399	0.879	0.322	0.391	0.394	**0.002**	**0.891**

Table G3. Significance Levels of Adopter Characteristics on Implementation Rates (indicates $p<0.01$ and * indicates $p<0.05$). R^2 value is Nagelkerke.**

Annex H – The Scenario Approach to the Value of Missed Savings

The scenarios used in section 4.5.3 are:

- **Baseline** – The current situation recorded in the Filtered Toolkit at the time of this study.
- **Pessimistic** –For the Adopters, the median implementation rate of opportunities (expressed as a percentage of identified cost savings) is considered the minimum level of performance: i.e. all those businesses that achieve below the median in the baseline improve their performance to the median value. For the Non-adopters (who implement no measures in the baseline) it is assumed that the implementation rate of their pipeline opportunities is equal to that of the Adopters in the baseline.
- **Optimistic** –For the Adopters, the upper quartile implementation rate of opportunities (by value of the cost savings) is considered the minimum level of performance: i.e. all those businesses that achieve below the upper quartile in the baseline scenario improve their performance to the upper quartile value. For the Non–adopters it is assumed that their implementation rate (expressed as a percentage of identified cost savings) is the same as that achieved by the Adopters in the Pessimistic scenario.
- **All Scenario** – In this scenario, both Adopters and Non-adopters implement all the identified opportunities.

Table H1 summarises the potential cost savings from each of the scenarios outlined. It provides the implementation rates for Adopters and Non-adopters for each of the scenarios in order to show the relationship between them; for example, the implementation rate for Non-adopters under the Pessimistic scenario is the same as the implementation rate for Adopters under the Baseline.

	Adopters Savings		Non-adoptersSavings		All Businesses Savings	
Scenario	Savings (pa)	Implementation rate	Savings (pa)	Implementation rate	Savings (pa)	Implementation rate
Baseline	£5.56m	40.3%	--	0.0%	£5.56m	20.5%
Pessimistic	£5.72m	41.5%	£5.35m	40.3%	£11.07m	40.9%
Optimistic	£7.57m	54.9%	£5.51m	41.5%	£13.08m	48.3%
All	£13.79m	100%	£13.28m	100%	£27.07m	100%

Table H1. Total savings across the Filtered Toolkit using the scenario approach, together with implementation rates (as % of cost savings achieved).

Table H2 presents the cost savings in Table H1 as missed opportunities. These are conceptualised in two ways 'Relative to Baseline' and 'Relative to All', as outlined in the following paragraphs and visually represented in Figure H1.

	Adopters Missed Opportunity		Non-adopters Missed Opportunity		All Businesses Missed Opportunity	
Scenario	**Relative to Baseline**	**Relative to Maximum**	**Relative to Baseline**	**Relative to Maximum**	**Relative to Baseline**	**Relative to Maximum**
Baseline	£0m	£8.23m	£0m	£13.28m	£0m	£21.52m
Pessimistic	£0.16m	£8.07m	£5.35m	£7.93m	£5.51m	£16.01m
Optimistic	£2.01m	£6.22m	£5.51m	£7.77m	£7.52m	£14.00m
All	£8.23m	£0m	£13.28m	£0m	£21.52m	£0m

Table H2. Missed savings opportunities under the scenario approaches, relative to the baseline and the All.

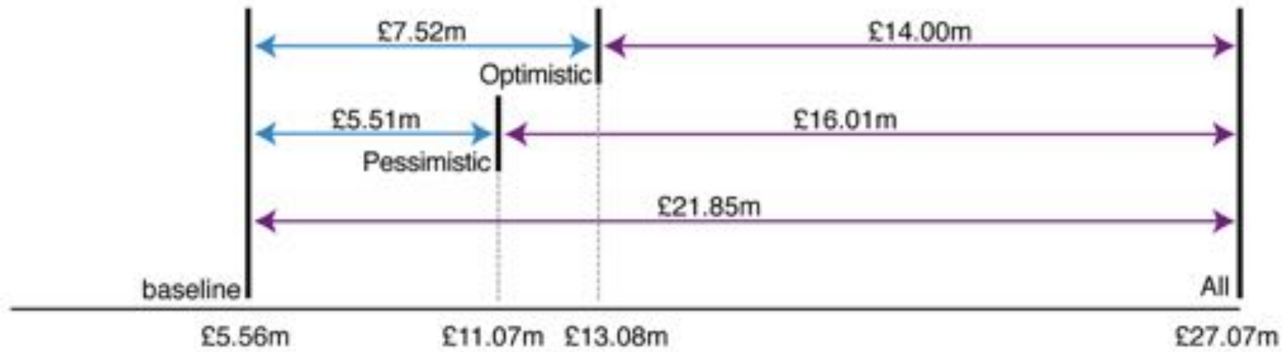

Figure H1. The range of missed savings opportunity under the scenario approach.

On the one hand, understood relative to the baseline, if the Pessimistic scenario is assumed to be achievable, then businesses in the Toolkit are currently missing out on at least £5.51m. On the other hand, understood relative to the All scenario, even if the pessimistic scenario is achieved, the savings achieved by the businesses would continue to fall short of the All scenario by £16.00m. Similarly, if the Optimistic scenario is assumed to be achievable, then businesses in the Toolkit are currently missing out on £7.52m, but these savings fall short of the All scenario by a further £14.00m.

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.gov.uk/decc
URN 14D/452