Energy Cultures:
An Approach to Explore Workplace Energy Use at Multiple Scales

written and presented by

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy at the University of Central Lancashire

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STUDENT DECLARATION

1. Concurrent registration for two or more academic awards

I hereby declare that, while registered as a candidate for this research degree, I am not and have not been a registered candidate or enrolled student for another award at the University of Central Lancashire or any other academic or professional institution.

2. Material submitted for another award

I hereby declare that no material contained in this thesis has been used in any other submission for an academic award and is solely my own work.

3. Collaboration

This PhD is an EPSRC CASE award studentship in collaboration with BAE Systems. All research presented in the thesis has been designed and undertaken by the researcher. BAE Systems has provided access to its sites and employees for the purpose of data collection only. BAE Systems has also reviewed the thesis prior to submission to ensure no sensitive material that would breach security protocols is presented.

Signature of Candidate:

Type of Award: Doctor of Philosophy

School: School of Engineering

Abstract

Industry is attempting to meet its greenhouse gas emission targets by implementing energy efficiency measures. Technological solutions are often employed through the provision of on-site energy generation and improvements in heating and ventilation systems, despite Janda's (2000) observation that 'people use energy not buildings', with the role of employees often overlooked. Researchers have also tended to ignore the important role of employees when examining energy use in the workplace (Andrews and Johnson, 2016). The unique aspect of the thesis is its attempt to address this gap in research by developing the *workplace energy culture framework* to inform research on energy use in an industrial workplace.

In developing the workplace energy culture framework, the thesis argues that current approaches to examining energy use offer little opportunity for application in the workplace. The workplace energy culture framework provides a lens to examine and gain an understanding of the individual and organisational determinants of energy use. In the thesis, it has been operationalised through a mixed-methods case study approach consisting of surveys, interviews, focus groups and observations. Taken together, these provide both theoretical and methodological insights that could be deployed in other settings.

BAE Systems is the collaborative partner of this EPSRC CASE award research, and the workplace energy culture framework was initially applied to one of its UK manufacturing facilities before being deployed to inform research on two US sites. An examination of the energy culture at the UK site provides a rich empirical insight into employees' attitudes towards energy use on the site. It also highlights the various organisational determinants of energy use, such as the physical environment, wider organisational culture, sub-cultures and methods of communication. This thesis details how interventions seeking to improve energy efficiency – such as ISO 50001 – can target determinants of the framework, which can lead to improvements in energy efficiency and change the site energy culture. The study of various sites also provides insights into how energy cultures change with geography.

Table of contents

List of Tables

List of Figures

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I would not have reached the position of having a completed thesis without the support of the 'Brew Club', a time to escape the office, have a brew and talk non-PhD topics. A special thank you goes out to Sonia Griggs who, after the disbanding of the Energy and Power Management Centre, still kept in contact, catching up at lunch and providing lots of laughs and giggles. To Amine and David, thanks for keeping in touch, for the chippy dinners, giggles, strava/running and random chats. They really helped and improved my motivation.

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Abbreviations

AAG	Association of American Geographers
BAE	BAE Systems
BPSS	Baseline Personnel Security Standard
CEO	Chief Executive Officer
CASE	Cooperative Awards in Science & Technology
DEFRA	Department for Environment, Food and Rural Affairs
DECC	Department of Energy and Climate Change
EE	Energy and Environment
ECF	Energy Culture Framework
ESPRC	Engineering and Physical Sciences Research Council
FG	Focus Group
GHG	Green House Gas
HM	Her Majesty
HMG	Her Majesty's Government
IT	Information Technology
IBG	Institute of British Geographers
IPCC	Intergovernmental Panel on Climate Change
ITAR	International Traffic in Arms Regulations
LED	Light Emitting Diode
MAI	Military Air and Information
NEP	New Ecological Paradigm
PNS	Platforms and Services
PCA	Principle Component Analysis
SHE	Safety, Health and Environment
SIPRI	Stockholm International Peace Research Institute
TM1	Team Member 1
TM2	Team Member 2
TM3	Team Member 3
TPB	Theory of Planned Behaviour
UCLan	University of Central Lancashire
VBN	Value-Belief-Norm Theory

1 Introduction

This chapter provides an overview of this PhD thesis ('the thesis'). Setting the scene for the research that follows, it provides a summary of recent energy topics and highlights the many original aspects of the thesis. It proceeds to state the aim and objectives of this research ('the research'), before moving on to outline the structure of the remaining chapters, describing where each research objective is addressed. It also provides the reader with a broad overview of BAE Systems plc (BAE), which was the collaborator in this EPSRC CASE award PhD, and the Samlesbury BAE site, where the majority of research was conducted. It also highlights the role BAE played in this EPSRC CASE award research.

1.1 Overview

The last decade has seen a noticeable surge in research on topics concerning energy. This includes, but is not limited to, research on energy security (Correljé and van der Linde, 2006; Winzer, 2012; Brown *et al.*, 2014), fuel poverty (Walker, 2008; Moore, 2012; Bouzarovski and Petrova, 2015) and energy consumption and efficiency (Abadie *et al.*, 2012; Lutzenhiser, 2014; Boomsma *et al.*, 2016). Given this increased focus, it is somewhat surprising that only a limited amount of work has applied a social science perspective or human-centred approach to explore energy use (Sovacool, 2014; Schmidt and Weigt, 2015), with even less attention paid to the significance that culture might have upon energy use. In addition to this, the majority of energy-related human-centred approaches have traditionally concentrated on the domestic environment, a point reiterated by Lutzenhiser (1993), Carrico and Riemer (2011), Lo *et al.,* (2012), Lopes *et al.,* (2012), Andersson *et al.,* (2013) and Andrews and Johnson (2016). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) has also acknowledged this lack of human-centred research, stating:

> '… the potential [energy] reduction through non-technological options is rarely assessed and the potential leverage of polices over these is poorly understood.'
>
> (IPCC AR4 WG3, 2007:55)

The purpose of the thesis is to begin to address these research shortcomings by providing a detailed examination of energy cultures within an industrial workplace.

Why the Workplace?

The thesis details the findings from an EPSRC CASE award PhD in collaboration with BAE. In defining an industrial CASE award, EPSRC states that 'businesses take the lead in arranging projects' (EPSRC, 2016), hence the foundations of this PhD have provided opportunities to conduct energy research within an industrial organisational context. From an academic perspective, exploring the social (human-centred) side to energy use in the workplace has received little academic attention, a point reiterated by Dixon *et al.,* (2015) and Andrews and Johnson (2016), with the majority of research conducted in workplaces taking a technological approach. This is surprising, considering 'people use energy not buildings' (Janda, 2011) and businesses are major consumers of energy (Andrews and Johnson, 2016). Lutzenhiser (2014) also identified that energy in organisations should be an important priority for research. This highlights a need to examine workplace energy efficiency from a social perspective. Reiterating the important role of social research, Allcott and Mullainathan state, 'efficiency … depends on both the technology and the choice of the user' (Allcott and Mullainathan, 2010:1204).

The workplace is also an interesting environment to study as it is more complex than the domestic environment. These complexities involve a lack of financial impact to the individual from energy consumption (Carrico and Riemer, 2011; Lo *et al.*, 2012; Dixon *et al.*, 2014) and multiple employees using the same equipment (Carrico and Riemer, 2011). On an individual level, business decisions can directly shape their energy behaviour (Andrews and Johnson, 2016) such as an 'organisation's size, structure, goals, culture [and] market positions …' (Lo *et al.*, 2012:234). Finally, despite favourable economic outcomes, businesses may still not make energy efficiency a priority (Abdelaziz *et al.*, 2011). This list of complexities, which is expanded upon further in Chapter 2, has drawn attention to the interplay between the individual and the organisation (Andrews and Johnson, 2016). In seeking to explore this further, the research aims to apply an energy culture approach to examine energy use in BAE.

The thesis puts the employee at the centre of a framework for informing research on energy use in the industrial workplace. It seeks to explore both the individual and organisational elements that are intertwined to influence employees' energy use by applying an energy culture approach. The research uses the following definition for culture:

> 'how we learn to live, the languages we use to speak, our ideologies, and our ideas about things like love, religion and nature. Culture is not encoded in our genes, however, it is learned.'
>
> (Sovacool, 2014:18)

This definition is especially important for workplace settings. The individual will have their own culture, but will also be heavily influenced by the organisational culture. By using an energy culture approach, the research explores both these cultural elements.

UK Context: Why Is This Important?

Within the UK, there is continuing pressure from the Government to increase energy efficiency across all sectors, including industry (HM Government, 2013). This is driven by the Climate Change Act 2008, which commits the UK to reducing greenhouse gas (GHG) emissions by at least 80% below the base year (1999) amount by 2050. Coupled with this, the UK faces major energy challenges, with a need to decarbonise, provide a secure energy supply and meet emission targets during a period when there is increased international demand for energy resources (Department of Energy and Climate Change, 2012). Several approaches aimed at changing lifestyles and creating new technologies have been and are being developed to tackle these challenges. These include both social science and technological approaches, such as investing in renewable and low-carbon energy sources and improving energy efficiency (Foreign and Commonwealth Office, 2011). With this need, combined with legal requirements to increase energy efficiency, it is again surprising that little academic research has focused on the workplace.

1.2 Research Aim and Objectives

The research seeks to address this lack of human-centred workplace energy research, as identified above, with the following aim:

> apply an energy culture approach to examine energy use in an industrial workplace.

To address this, the following objectives will be met:

1. define a framework for informing research on energy cultures in the industrial workplace;
2. detail the evolving nature of organisational priorities and organisational cultures;
3. detail and review employees' attitudes towards energy use; and
4. examine the geographies of energy cultures.

In addressing these objectives, there are various elements of originality in this work. First, no other research has applied a cultural approach to investigate employees' energy use in the workplace. Second, the nature of national security associated with the defence industry means limited research is conducted within it and, consequently, no previous research has explored energy use focusing on the employee within this work environment. Third, and finally, in addressing Objective 1 of the research, the thesis builds on the work conducted by Stephenson *et al.,* (2010, 2015) and their energy culture framework by proposing a multi-scalar framework that demonstrates the various spatialities in which energy cultures can be observed in a workplace. This element of originality demonstrates the various systemic influences and characteristics of energy cultures in the workplace, as well as highlighting the variety of interactions between different energy cultures within a business. The revised Energy Culture Frameworks that are presented in the thesis demonstrate an evolution of Stephenson *et al,.* (2010, 2015) work.

Thesis Structure

In examining the above aim and objectives, careful consideration has been paid to the structure of the thesis. It consists of ten chapters, with each chapter addressing, or providing empirical material to address, a particular objective, as follows:

- **Chapter 1: Introduction** introduces the reader to the thesis. It presents an overview of the industrial case study workplace at BAE, where the research was conducted, and provides the foundation to begin to address Objective 1.
- **Chapter 2: The Workplace Energy Culture Framework** critically reviews existing literature, while further defining the originality of the research. It reviews some established theoretical frameworks and concludes by presenting the *workplace energy culture framework*. This framework, developed specifically for this project, directs the forthcoming research. The development and presentation of this framework directly addresses the research component of Objective 1.
- **Chapter 3: Methodology** first describes the philosophical background of the research, while also detailing how the objectives of the thesis are operationalised. In so doing, it describes the mixed-methods approach applied to conducting and analysing fieldwork, while also explaining some of the unique challenges and limitations associated with conducting research at BAE.
- **Chapter 4: Employees' Attitudes Towards Energy Use: Samlesbury Site** presents the results obtained from the methodology described in Chapter 3. This subsequently provides the foundations for addressing Objective 3.
- **Chapter 5: Spatiality of Energy Cultures** uses the survey results presented in Chapter 4, but explores them through a different geographical lens. It uses the analytical methods of principal component analysis and independent *t*-tests to examine differences between office and manufacturing areas on-site. It also uses qualitative data from interviews and focus groups to provide further detail on some of the differences in

energy cultures. Chapter 5, therefore, provides the foundation for addressing Objective 4.

- **Chapter 6: Organisational Cultures and Priorities**: during site visits and data collection, it became apparent that a number of established cultures exist within BAE. This chapter focuses on a dominant subculture observed on site – the safety culture. It details how it is sustained in everyday activities and how it has evolved. It also details the organisational determinants of the workplace energy culture framework. In achieving this, Chapter 6 addresses Objective 2.
- **Chapter 7: Samlesbury Site Energy Culture**: using empirical material presented in Chapters 4 and 5, this chapter describes the energy culture of BAE's Samlesbury site. In this manner, it builds on the workplace energy culture framework defined in Chapter 2 and subsequently further addresses Objective 1. In achieving this, the chapter also details how empirical results from Chapter 4 address Objective 3, while also discussing early indications of how geography may affect energy culture.
- **Chapter 8: Geographies of Energy Culture: National Scale** details the energy culture of two BAE manufacturing sites in the USA and discusses the differences and similarities with the energy culture of the Samlesbury site (described in Chapter 7). It also provides empirical material to directly address Objective 4, as well as additional empirical material to address the other research objectives.
- **Chapter 9: Application of an Energy Culture Approach** discusses the workplace energy culture in the light of the research findings. By this means, it proposes modifications to an existing framework – the energy culture framework of Stephenson *et al*., (2010, 2015). It discusses how some of the research findings can be explained by numerous systemic influences, such as communication and legislation. By presenting a modified energy culture framework, this chapter also illustrates the interacting nature of energy cultures in a workplace. The thesis proposes that this framework could inform future work on energy use in the workplace.
- **Chapter 10: Conclusion** summarises the main findings of the research and details how the research aim and objectives have been addressed in the thesis. It also presents recommendations for BAE and other workplaces seeking to develop an energy-efficient culture. It concludes by acknowledging the limitations and challenges associated with the research, while also identifying areas for potential future research.

1.3 BAE

Before moving on to detail and review literature that has influenced the research, the remainder of this chapter provides an overview of BAE. BAE has played an important role in the research by shaping the methodology and providing fieldwork opportunities and access to employees across its multinational businesses, which also presented some unique fieldwork challenges and limitations (discussed in Chapter 3). To set the context for the research, and to provide the reader with foundation knowledge of BAE, an overview of the development of the strategic partnership with the University of Central Lancashire (UCLan) and the origins of this PhD is provided. Specific focus is placed on describing the Samlesbury site, where the majority of the research was conducted. The information presented here was obtained from a variety of sources, including the BAE Systems website, the employees involved in the research, and site visits.

BAE and the Strategic Partnership with UCLan

Between 2009 and 2014 BAE established a £1 million research strategic partnership with UCLan, which focused on three core research areas: intelligent management systems, distributed energy network hardware, and long endurance unmanned aerial systems. This strategic partnership created the *Centre of Energy and Power Management* (CEPM) and the following positions:

- two postdoctoral research assistants
- half a chair position
- a centre manager
- a personal assistant
- six PhD EPSRC CASE studentships.

Nigel Whitehead CBE, BAE Group Managing Director, Programmes and Support was the main driver for the research project from the BAE side, with Military Air and Information (MAI) being the key business involved in the partnership (see below for further details of these sub-businesses).

It is important to note that during the period of establishing this strategic partnership, energy was an important strategic priority for BAE; however, this changed through the course of the research. Chapter 6 provides further details on these priorities and the changing agenda of BAE.

1.3.1 Who Is BAE?

> ‘BAE Systems is an international defence, aerospace and security company with leading air, naval and cyber capabilities, supplying both defence and commercial customers.’
>
> (BAE Systems, 2014:6)

BAE employs 82,500 people in 40 countries, and had total sales worth £17.9 billion in 2015 (BAE Systems, 2015a). Formed from a merger of Marconi Electronic Systems and British Aerospace in

1999, BAE has become one of the largest defence contractors in the world (SIPRI, 2015). In achieving the multi-functions of defence, aerospace and security at an international scale, BAE acts as an organisational umbrella under which numerous businesses operate. Figure 1:1 provides an overview of these businesses and their specialities, and details the range of expertise and services that BAE offers its clients.

Applied Intelligence Expertise in four main areas: • cyber security, • financial crime, • communications intelligence, • digital transformation.	**Australia** A defence and security business in Australia, supporting the Australian Defence Force.	**Combat Vehicles (UK)** The UK's leading provider of combat, engineer and support vehicles, associated with the British army.
Electronic Systems Provides commercial and defence electronics for: • flight and engine control, • electronic warfare, • surveillance, • communications, • power and energy management.	**India** A defence and security business in India. BAE has a strategic vision to become a major and integral part of the country's domestic defence and security industry.	**Intelligence and Security** Provides real-time intelligence and analysis services to: • key intelligence professionals, • decision makers, • federal law enforcement officials, • military personal.
Maritime Involved in the design and manufacture of naval ships and submarines. Also involved in: • training solutions, • maintenance, • modernisation programmes.	**Military Air and Information** Involved in all aspects of the air section, including: • air and ground crew training, • aircraft and component manufacturing, maintenance and support, • systems development, • mission-critical information systems.	**Platforms and Services** Involved in combat vehicles, naval guns, surface ship combatants, commercial vessels, missile launchers, military ordnance and protective wear, and the design, support, maintenance and modernisation of this equipment.
Regional Aircraft A business focusing on commercial aircraft and the aviation market. Involved in all aspects of commercial aircraft, such as: • design, • support and maintenance, • modernisation and upgrades.	**Saudi Arabia** A defence and security business in Saudi Arabia.	**Shared Services** Primarily supports the UK operations of BAE. It has many capabilities to support the business, such as matters involving: • ICT delivery and support, • insurable risk, • research and technology.

Figure 1:1: Overview of the businesses within BAE (information from BAE Systems, 2015b)

In order to operate, BAE has a hierarchical business structure, with a Board of Directors and a Board of Executive Directors. The Board of Directors consists of a chair, three BAE employees and five members from outside the organisation (Figure 1:2).

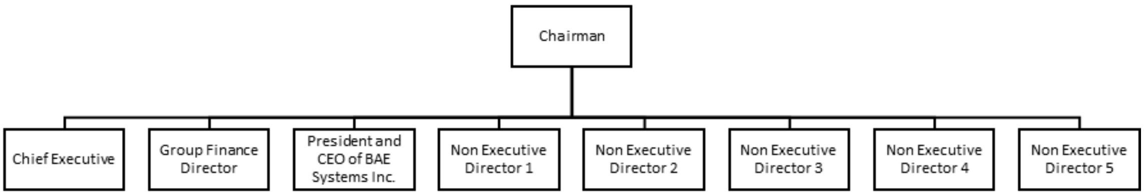


Figure 1:2: Board of Directors (BAE Systems, 2016b)

In addition to the Board of Directors, there is a Board of Executive Directors, which comprises heads of all the businesses within BAE (Figure 1:3). Each of these heads of business also has a business board of his/her own, fronted by their respective heads of departments in the associated business. All major investment decisions go to the associated board, to determine if they warrant a good return on investment. Decisions taken at board level are transferred through the hierarchical structure, to all employees. Chapter 6 provides an example of this process, and discusses the hierarchical structure further.

These structures have been presented in this introductory chapter to demonstrate the external (non-executive directors) and internal (all BAE employees) influences on all business decisions. They also demonstrate the traditional hierarchical organisational structure of BAE, which the thesis will argue has a strong influence on the energy culture of the site.

This PhD research has predominantly focused on the MAI business within BAE, as this was the main contact for the strategic partnership with UCLan. MAI has activities based at 21 sites across the UK. Specifically, the research predominantly involved the Samlesbury BAE site, located east of Preston in northwest England (Figure 1:4).

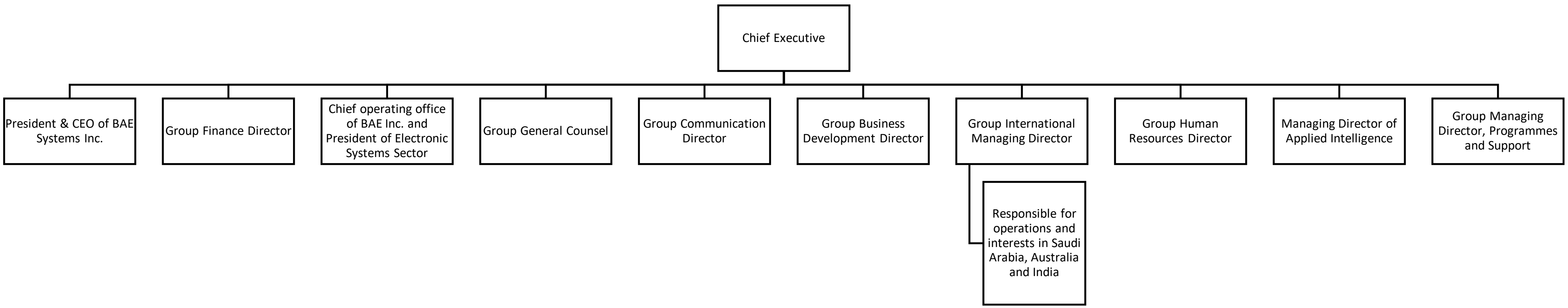


Figure 1:3: Board of Executive Directors of BAE Systems (BAE Systems, 2016b)

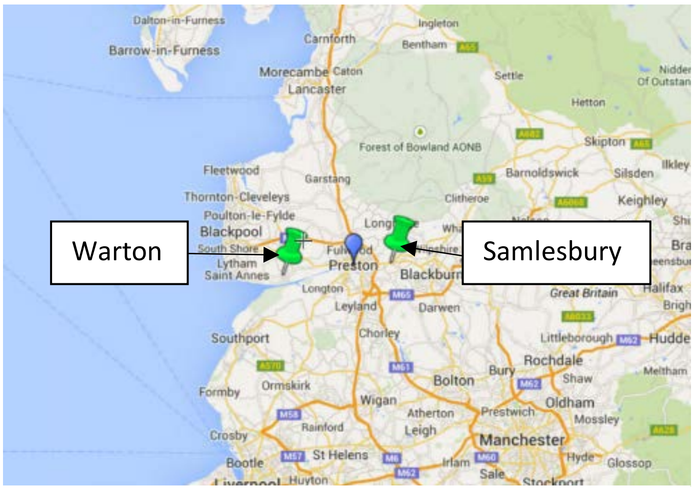


Figure 1:4: Location of Samlesbury and Warton BAE Systems sites

1.3.2 Samlesbury and Warton BAE Sites

The Samlesbury site is a large, multi-functional site with a mix of office and manufacturing facilities (Figure 1:5). The site manufactures parts and provides support for the F-35 Lightning II, Eurofighter Typhoon, Hawk, Tornado and Goshawk jets. The office-based staff are a mix of support staff for the site (e.g. safety, health and environment [SHE] function, finance, facilities management, human resources) and staff who provide support and guidance to the manufacturing processes.

Manufacturing on site has been taking place since 1939, and from this time the site has experienced a number of structural and business transformations, from the ownership of English Electric Company, which merged with several other businesses to create British Aircraft Corporate in 1960, becoming British Aerospace in 1977, to, more recently, the merger of British Aerospace and Marconi Electronic Systems in 1999. The site has continued to evolve during these periods through a range of construction phrases (Figure 1:6).

The Samlesbury site works closely with the BAE site at Warton located to the west of Preston (Figure 1:4). Both sites work closely in manufacturing and providing services for their customers. This PhD has links to the Warton site through the industrial supervisor, who is based at this site. Throughout the research several site visits to Warton took place; however, the majority of empirical material was collected at the Samlesbury site.

Figure 1:5: Area photograph of the Samlesbury site with an added red site boundary line

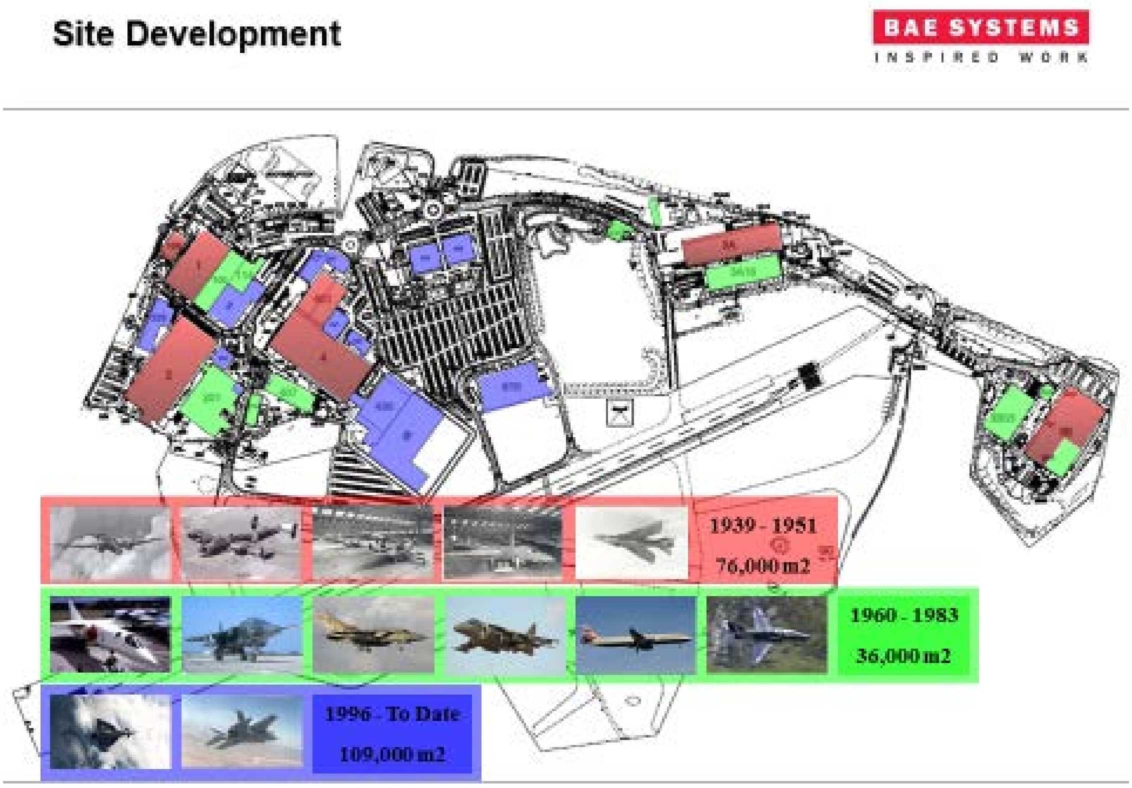


Figure 1:6: Samlesbury site layout. The map also provides an indication of the three main phrases of building construction on site, along with the total footprint of those buildings

1.3.3 Role of BAE in the Research

Prior to the appointment of any research positions from the strategic partnership, all advertisements were co-written by UCLan and BAE. This PhD research focuses on the social side of energy use, in contrast to the other research of the CEPM, which takes a more technical approach. The research interest for this PhD came from a joint interest between UCLan and a key BAE member in the strategic partnership (TM1). TM1 is an engineer based at the Warton site, who was heavily involved in the strategic partnership with UCLan. BAE was interested in how to engage employees in sustainability topics, and the strategic partnership provided an opportunity to explore this topic within a BAE context.

Readers' note: The names of the core team members have been anonymised and are represented by TM1, TM2 and TM3.

BAE Core Team

One of the key challenges for conducting research with BAE was access to the site and employees. In order to assist with this, a core BAE team was appointed to the research. First, TM1 was appointed as the industrial supervisor of this EPSRC CASE award. During the course of the research she acted as the main gatekeeper, providing contacts within MAI. She was also involved with reviewing the thesis to ensure its suitability for publication against BAE security protocol. In order to assist the researcher in gaining an understanding of the structure of BAE and the day-to-day culture on site, TM1 and UCLan decided that a placement in a team at BAE would be useful. During the first six months of the research, several meetings were held with TM1 and representatives of different departments at both the Samlesbury and Warton sites (e.g. Human Factors, SHE, Engineering, Sustainability) to determine whether any existing projects could be incorporated into the research. However, no suitable BAE project was identified. During this time research enquiries continually developed, and a focus on energy use within manufacturing workplaces developed. The research direction prompted TM1 to get in contact with TM2, based at the Samlesbury site, to see if the research could be of interest to them.

TM2 was a member of the SHE function and had work duties specifically focusing on environmental themes. TM2 then contacted TM3, a sustainability engineer at the Samlesbury site, who had worked closely with TM2 on other projects aimed at reducing site energy use. These three people then formed the core industrial team for the PhD research (Figure 1:7).

Team Member 1 (TM1): The industrial supervisor assigned to this PhD CASE award when it started in April 2012. TM1 co-wrote the research advertisement and was involved in the interview and recruitment process. This employee is based at the Warton site.
Team Member 2 (TM2): A member of the SHE function based at the Samlesbury site. This employee was recruited by TM1 when the research developed and the research area had been defined (November 2012). This employee traditionally focuses on environmental issues in the SHE function.
Team Member 3 (TM3): A sustainability engineer and part of an investment and infrastructure team at the Samlesbury site. This employee was recruited by TM2 as they had worked together on previous site projects focusing on reducing energy use.

Figure 1:7: Overview of core industrial team associated with the PhD research

1.3.4 Access to Site

The nature of the industry BAE is involved in presented some boundaries for the research. The initial aim of the research, to be involved in a project conducted by another team within BAE, required regular access to the site. In order to obtain this, the researcher was required to apply for Her Majesty's Government (HMG) Baseline Personnel Security Standard (BPSS). Details of the application process are provided in Figure 1:8. Once this was granted, the researcher was allowed a *contractors pass*, which permitted unescorted site access. Gaining building access, however, required further consents from personnel in the relevant buildings.

During the course of this PhD, HMG updated the BPSS (HM Government, 2014), which had implications for gaining site access. The update required the core team to book the researcher on site via site reception and security prior to site visits. It also required the researcher to be escorted around site at all times. This led to the researcher requiring assistance from one of the core team members during data collection.

HMG Baseline Personnel Security Standard process

Completion of:

- Nationality and Immigration Status Form
- Signing of the Official Secrets Acts 1911–1989
- Identification verification
- Employment history verification
- Criminal record declaration
- Criminal Record Certificate (Disclosure Scotland)
- Baseline Personnel Security Standard Verification Record

Figure 1:8: Outline of the Baseline Personnel Security Standard process

As the researcher was not involved in any BAE established projects, she was an outsider to the organisation. This posed site access constraints and methodological challenges, which are detailed in Chapter 3. BAE also administers a strict no photograph, video or recording equipment policy on site, unless permission has been applied for and granted. Recording of interviews can occur in certain areas on site. The granting of permission is a complex process, which requires one of the core team to apply on behalf of the researcher. The application is then submitted to a security department, which requires details of the research and why a photograph or recording of the site is needed. It subsequently reviews any audio or visual data post-collection. As a result of this time-consuming process, the majority of visual aids used in the thesis were obtained from documents in the public domain.

1.4 Personal Motivation: Reflective Section

Before moving on to examine the wider academic field (Chapter 2), the personal motivation of the researcher is described here. Chapter 3 draws on some of this information by detailing the philosophical groundings of the research, and some of the ethical dilemmas faced during it.

The motivation for conducting the research stemmed from a personal interest in trying to address a need to reduce the carbon footprint of the UK. Industry is a significant user of energy (electricity and gas) in the UK (Department of Energy and Climate Change, 2015) and it became apparent within the first few months of this PhD research that industry has not been the focus of much academic work. Initially the research was interested in comparing workplace and domestic energy behaviours and the 'spillover' (Thøgersen and Crompton, 2009) of behaviours to different environments. However, it soon became apparent this was an unachievable task for a novice researcher who needed to develop relationships with gatekeepers to gain access to participants before any research could be conducted.

Bringing the focus back to industry, the researcher was inspired by the research papers of Hargreaves and colleagues (Hargreaves *et al.*, 2010, 2013), which explored the interaction of households with smart meters. They identified that on many occasions householders became disengaged with the smart meters, which then blended into the background of everyday activities. With the government launching a smart meter roll-out to all householders (Department of Energy and Climate Change, 2009), the researcher was interested in such research enquiries as, for example, how these were going to help with reducing energy use, while also leading to sustained behavioural change. These enquiries developed into further questions: If these smart meters were launched into industry, how would people interact with them? How could they be incorporated into everyday activities to lead to a reduction in energy?

In considering these questions, the researcher decided to explore models and theories of behaviour change, and during this time the research of Stephenson *et al.,* (2010), and their *energy culture framework*, was identified. This framework could help identify and understand key areas that could be targeted to change energy behaviour, leading to sustained behaviour change. This prompted further research enquiries into whether frameworks similar to that of Stephenson *et al.,.* (2010) could be developed and applied to a workplace environment. The outcome of these enquiries is this thesis.

Role of Geography

> 'Geographers have long asked research questions that require investigating multiple data sources, intersecting human and physical phenomena, and processes that operate at multiple spatial scales … '
>
> (Elwood, 2010:100)

The researcher has an academic background in geography, and this has played an important role in the development, approach, analysis and writing up of the research. The extract above demonstrates the ability of geographers to analyse data from a variety of sources, and explore links between the physical environment and the social world, while also acknowledging dimensions of space, place and time. Chapters 8 and 9 explore the 'Geographies of energy cultures', and demonstrate the ability of geographers to explore topics at a variety of spatialities (Elwood, 2010; Pasqualetti and Brown, 2014). During the course of this PhD, the researcher was immersed in the geographical academic world, through academic networks such as the Royal Geographical Society (with IBG) Postgraduate Forum and Energy Geography Research Group. The researcher also attended a number of conferences associated with the Royal Geographical Society and the Association of American Geographers. These experiences and events shaped the researcher and, consequently, shaped this PhD research.

2 The Workplace Energy Culture Framework

This chapter directly addresses Objective 1:

Define a framework for informing research on energy cultures in the industrial workplace.

2.1 Overview

The previous chapter introduced the relationship and role of BAE with the research, and detailed the academic background of the researcher. In doing this it began to explain the development of the research. This chapter builds on this information by detailing how the wider academic literature has assisted in the development of the research. It begins to address the research aim 'apply an energy culture approach to examine energy use in an industrial workplace' by detailing how a framework titled the *workplace energy culture framework* has been developed. In so doing, it begins to address the first research objective: 'define a framework for informing research on energy cultures in the industrial workplace'. This framework is the outcome of a literature review focusing on topics of energy, pro-environmental behaviour and the workplace, which are themes associated with the research. The previous chapter detailed how energy topics focusing on the workplace environment have received little academic attention; as a consequence, the literature review incorporates wider pro-environmental research topics, such as recycling and waste management. This chapter argues that current research approaches and frameworks applied to examining energy use provide limited opportunities for applications in a workplace. In addressing this limitation, this chapter argues that a cultural approach is needed to examine energy use in the workplace.

Throughout this chapter, references are made to energy efficiency and conservation. These terms, as explained by Owen (2000), are very different, but are often used interchangeably. Energy efficiency definitions often take a 'supply side approach' (Faghihi *et al.*, 2015:401), which can include building and infrastructure modifications. These can broadly be defined as improvements that will reduce energy use without direct modifications in behaviour. Energy conservation focuses on the 'demand side of sustainability … reducing consumption by modifying user behaviour' *(*Faghihi *et al.*, 2015:2014*).* The thesis acknowledges these different definitions, and in this chapter the term used by the authors whose work is cited will be used.

Chapter Structure

This chapter is structured into the following sections:

- **Why is the research needed?** This section builds on the information presented in the introductory chapter and details why research on energy use in the workplace is needed.
- **Wider energy use research.** Three main bodies of literature are presented in this section. The first is barrier literature, detailing research that has examined the barriers to adopting energy efficient or pro-environmental behaviours. Second, this section discusses the link between socio-demographics and pro-environmental and energy use behaviours. Last, this section details research focusing on intervention strategies, which are methods of changing the ways in which people use energy or conduct pro-environmental behaviours. Where appropriate, in this section a distinction is made between research focusing on the home environment and that focusing on the workplace. This chapter addresses these bodies of literature as they all assist in gaining an understanding of how energy is used, and the influences on energy use. They also receive a lot of academic attention.
- **Understanding the workplace.** In addressing the aim of the research, this section focuses on the workplace. It highlights the specific influences on and challenges to energy efficiency, such as the role of managers, supervisors and building operators,that are unique to work environments. It also discusses research on greening organisations, which applies cultural approaches to examine how organisations can improve their environmental performance. This section also acknowledges wider organisational research that does not focus specifically on topics of energy or pro-environmental behaviour. In doing this it details research exploring knowledge transfer in organisations, the various influences on energy use, and how emotions and attitudes can influence the way tasks are conducted.
- **Approaches to examining energy use.** The academic literature presents a range of approaches to examining energy use. This section provides a review of three socio-psychological theories: the *theory of planned behaviour* (TPH; Ajzen, 1991), the *new ecological paradigm* (NEP scale; Dunlap *et al.*, 2000) and the *value-belief-norm* (VBN) theory (Stern *et al.*, 1999), which have been applied by many researchers to examine energy use and pro-environmental behaviour. This section then moves on to discuss other approaches and analytical frameworks that have been applied, to a lesser extent, to examine energy use. In doing so, this section acknowledges the dualism of structure and agency, and some theories that seek to bridge the gap between these dualisms. It

concludes by detailing why each of these frameworks and theories provides limited opportunities for application in the work environment.

- **Cultural approaches.** This section argues that a cultural approach is needed to examine energy use in the workplace. It defines what a cultural approach is, while also detailing research that has applied a cultural approach to examine energy topics. In so doing, this chapter details the originality of the research while also demonstrating how the *workplace energy culture framework* builds on previous energy cultures research.
- **PhD conceptual framework.** This section presents a framework developed to inform research on energy cultures in the industrial workplace. The schematic in Figure 2:1 demonstrates how the key sections of this chapter are interrelated and contribute to the development of the workplace energy culture framework. This section also explains why a new framework is needed, and how it builds on previous research.

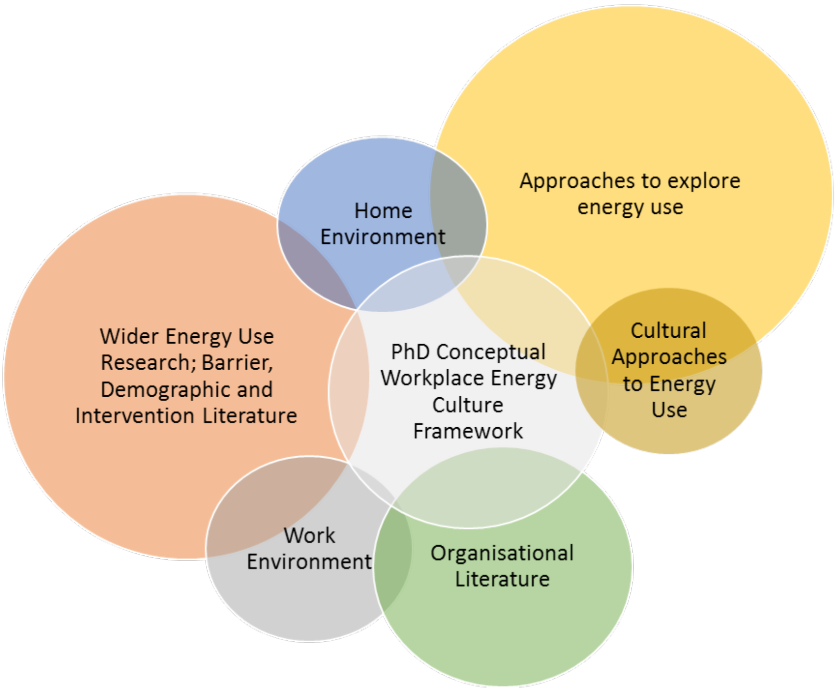


Figure 2:1: Schematic of literature review

2.2 Why Is the Research Needed?

The introduction of the thesis highlighted the energy challenges the UK faces in the coming decades, with the need to decarbonise while also providing secure supply (Department of Energy and Climate Change, 2012). Coupled with these challenges, the UK government has identified that to achieve an 80% reduction in greenhouse gas (GHG) emissions there needs to be an increase in energy efficiency across all sectors (HM Government, 2013). The UK industrial sector accounts for 23% of GHG emissions and a quarter of UK energy demand (HM Government, 2013:59). This makes industry an important sector for research attention. The DECC Carbon Plan includes a large section on improving energy efficiency and reducing GHG emissions in industry; however, its predominant focus is on technological solutions to improving efficiency, such as changing fuel sources and improving carbon capture and storage (HM Government, 2013). An overlooked opportunity to improve efficiency concerns the role of the end-user in industry – the employee. This opportunity is identified by authors such as Janda (2011), who highlights the important role end-users play by stating, 'people use energy not buildings'*.* Allcott and Mullainathan have also highlighted the important interplay people have with technology by stating energy 'efficiency … depends on both the technology and the choice of the user*'* (Allcott and Mullainathan, 2010:1204).

The DECC Carbon Plan does consider the end-user when discussing approaches to improving energy efficiency in the domestic environment. Here the report states that every household in the UK will have a smart meter (energy monitoring device) by 2019, which aims to help users understand their energy use (HM Government, 2013) and subsequently lead to a reduction in that use. However, research on smart meters has identified that users often become disengaged with them, which then blend into the background of the household environment after a short period of time (Hargreaves *et al.*, 2013). Hargreaves *et al.,* (2013) also state there is a need to gain an understanding of end-users, as they are the ones required to interact with the meters and who ultimately determine their success. These comments highlight a growing need to gain an understanding of the end-user, a point reiterated by Lutzenhiser:

> 'the role of human social behaviour has been largely overlooked in energy analysis, despite the fact that it significantly amplifies and dampens the effects of technology-based efficiency improvements.'
>
> (Lutzenhiser, 1993:248)

During the literature search for the research, it was noted that energy research focusing on the end-user in the workplace has received little academic attention, with the majority of such research concentrating on the household environment, a point reiterated by Lo *et al.,* (2012), Andersson *et al.,* (2013) and Zhang *et al.,* (2013). This PhD research begins to address this gap in the literature, with the development of the workplace energy culture framework in Section 2.7, which can be applied to gain an understanding of the determinants of end-user energy use.

2.3 Wider Energy Use Research

This chapter proceeds to detail three main energy research categories: research exploring (a) barriers to adopting energy efficiency measures, (b) correlations or links to demographics, and

(c) various intervention methods to change energy use. These categorises are discussed as they have influenced the development of the forthcoming framework, and have received a lot of academic attention. Where appropriate, distinctions are made between workplace and household literature.

2.3.1 Barrier Literature

Often people and businesses see the potential for adopting energy efficiency measures but do not implement them. Many authors describe this as an 'energy efficiency gap' (Weber, 1997; DeCanio, 1998; Sorrell *et al.*, 2000; Brown, 2001; De Groot *et al.*, 2001; Schleich and Gruber, 2008; Thollander *et al.*, 2010; Csutora, 2012; Endrejat *et al.*, 2015). In attempting to find ways to address this energy efficiency gap, one approach is to focus attention on the barriers to adopting energy efficiency technologies and actions.

From a broad environmental perspective, Lorenzoni *et al.,* (2007) examine the barriers members of the public face when engaging in climate change issues. They find barriers include a lack of knowledge about causes, impacts and solutions to climate change, a barrier also identified by Steg (2008) in research on energy use in households. Additional barriers include issues of distrust, the need to change lifestyle, a lack of political action through potential policy changes and a lack of resources to assist members of the public in taking action (Lorenzoni *et al.*, 2007). This research highlights the variety of interplaying factors, such as knowledge, tasks, politics and resources, that influence pro-environmental decision making, and consequent energy-use decisions. Some authors have categorised barriers into 'technological system(s), technological regime(s) and … socio-technical regime(s)' (Thollander *et al.*, 2010:49) and in so doing have identified additional barriers concerning lack of appropriate incentives, potential hidden costs, access to capital and a lack of information from a credible or trustworthy source (Thollander *et al.*, 2010). The research cited here highlights how both social and technical approaches that target improving energy efficiency can also present challenges.

Workplace

Within the workplace there are numerous approaches to exploring barriers to adopting energy efficiency. Some research focuses on specific work environments, while some concentrates on specific behaviours. A detailed review of barriers in workplaces is provided by Sorrell *et al.,* (2000), who provide a discussion on what constitutes a barrier and detail the economic, behavioural and organisational barriers to energy efficiency. An extension to this work is provided by Cagno *et al.,* (2013), who provide an alternative taxonomy of barriers to energy efficiency based on categories of external and internal barriers. This research acknowledges these findings but seeks to draw the reader's attention to additional research that is not covered in these reviews.

Hasanbeigi *et al.*'s (2010) findings suggest 'management concern about production' and 'management concerns about investment costs of energy efficiency measures' were key barriers to adopting energy efficiency techniques, while main drivers to improve energy efficiency were 'reducing energy costs' and 'reducing the final product cost' (Hasanbeigi *et al.*, 2010:33). Both the drivers and barriers in this example appear to be financially focused. Exploring this financial link further, Hasanbeigi *et al*., considered a hypothetical question, asking participants about what would happen if energy became more expensive. The results revealed workplaces would introduce 'energy efficiency technologies' or 'shift to alternative (cheaper) sources of energy' (Hasanbeigi *et al.*, 2010:33). In addition to the financial link, these research findings also demonstrate that environmental concern was not a main driver towards energy efficiency, ranking fifth or sixth out of the top answers cited. When environmental concern was cited it appeared to be related to company environmental targets or corporate environmental strategies rather than being customer driven. It appears from Hasanbeigi *et al*.'s (2010) findings that financial viability is an important consideration for businesses. These points highlight some of the differences between individuals based in domestic environments and industry, such as cost of the final product being a consideration in energy discussions, which indicate that firms do not behave like individuals (DeCanio, 1993).

Schleich (2004) identified barriers of lack of time, lack of information about energy consumption patterns, lack of information about measures, investment priorities, uncertainty about future energy costs, and the landlord/tenant dilemma when analysing interviews conducted in German commercial and service sectors. They also explored whether organisational size, energy intensity and energy audits affect these barriers. Their findings suggest energy-intensive organisations see 'lack of time' as a lesser barrier than non-energy-intensive organisations. Larger organisations appear to be less affected by barriers of lack of information about energy consumption patterns, information about energy measures, energy uncertainty and the landlord/tenant dilemma than smaller organisations. Schleich and Gruber (2008) built on this work by exploring the similarities and differences in work environments across 19 subsectors. They found that 'barriers to energy efficiency vary considerably across sub-sectors' (Schleich and Gruber, 2008:458), which supports the findings of Hasanbeigi *et al.,* (2010), who reported differences in barriers between three sectors in Thailand. Schleich and Gruber (2008:458) also found that a lack of information about energy consumption was a major barrier.

A more recent study has categorised barriers to energy efficiency into workplace structural barriers, regulatory (national policy) barriers, contextual barriers and workplace cultural barriers

(Liu, 2012). These findings highlight how structural barriers such as the turnover of managerial staff can affect the success of energy-efficiency strategies. Liu argues that energy-efficiency plans often take several years to be successfully implemented but with a high turnover of managerial staff, this often means they are not successfully completed. When detailing cultural barriers, Liu identified conflict between administrative and operations sectors in the workplace, with the operations staff being sceptical of new initiatives from administrative departments (Liu, 2012). These findings suggest that organisational structures and procedures can strongly influence energy use in work environments (Andrews and Johnson, 2016).

2.3.2 Socio-demographics

In addition to research examining the different barriers to adopting energy efficiency, there is a body of work that explores the relationships between demographic variables, barriers and energy use. Within the domestic environment, research has found links between the demographics of gender, marital status, education and city locations with barriers such as environmental beliefs and cost (Pelenur and Cruickshank, 2012). Reiterating these links, Abrahamse and Steg (2009) found the socio-demographic variables of household income and size were positively correlated with energy use, but other socio-demographic variables did not appear to influence energy savings. However, energy saving did appear to correlate with psychological factors (e.g. attitudes and values; Abrahamse and Steg, 2009). Levels of education, income and ethnicity have also been found to correlate with recycling rates and hybrid car ownership (Laidley, 2013).

Research has found families with younger children are more likely to adopt energy efficiency technology and conservation practices, while families with more elderly persons often have lower levels of technology adoption (Mills and Schleich, 2012). The research also found that higher education levels positively correlated with adoption of energy efficiency technology and energy conservation practices (Mills and Schleich, 2012). Urban and Scasny (2012) also found a positive correlation between university education and environmental concern. A review paper by Zelezny *et al.,* (2000) provides further details of links between demographics and pro-environmental behaviours and attitudes by exploring the link between gender and environmentalism. They found 'women report stronger environmental attitudes and behaviours than men' (Zelezny *et al.*, 2000) and argue that future models exploring environment behaviours should incorporate gender as a determinant of attitudes.

2.3.3 Intervention Techniques

Closely linked with research on barriers to adopting energy use and the correlations between energy use and socio-demographics is a body of work examining, and developing, interventions aimed at changing behaviour. Intervention techniques vary, as highlighted by De Young when discussing techniques of prompting, incentives, social pressure and disincentives, and commitment (De Young, 1993). The analysis by De Young (1993) is very broad, focuses on pro-environmental behaviour and does not detail specifics on data collection; however, it does demonstrate the variety of success rates of interventions. A well-documented explanation of interventions aimed at changing environmental behaviour is provided by Steg and Vlek (2009). This PhD research acknowledges this work, along with other research that explores pro-environmental behaviour interventions (Lee *et al.*, 1995; Staats *et al.*, 2004; Dietz *et al.*, 2009), but proceeds to discuss research focusing on energy topics.

Home

The home environment has been the subject of intervention techniques aimed at general energy use (Abrahamse *et al.*, 2007) and specific energy practices such as electrical cooking (Wood and Newborough, 2003). Recent years have seen a surge in research on smart meters as an intervention feedback method (Wood and Newborough, 2007; Burgess and Nye, 2008; Hargreaves *et al.*, 2010; Hargreaves, 2012; Schleich *et al.*, 2012). One purpose of smart meters is to address the barriers associated with users' lack of knowledge of current behaviours (Schleich, 2004; Lorenzoni *et al.*, 2007; Schleich and Gruber, 2008; McKerracher and Torriti, 2013). They provide the user with an understanding of existing energy usage with the aim of changing energy activities, and they 'make energy visible' (Hargreaves *et al.*, 2010). However, research has shown people often become disengaged with the smart meters over a period of time (Hargreaves *et al.*, 2013).

Other intervention studies include Lutzenhiser (1993), which reviews techniques of mass information, direct information (involving feedback) and financial incentives. It found incentives that provide feedback appear to be the most successful, while financial incentives failed to sustain behaviour change once the financial benefit had stopped. Abrahamse *et al.,* (2005) provides a more comprehensive review of household intervention studies published between 1977 and 2004. In a similar way to De Young (1993), Abrahamse *et al.,* (2005) evaluate studies according to the success of behavioural change. They focus on the levels of change and energy reduction of an intervention, and also whether the new behaviour or effects of the intervention were sustained over time. In addition to these evaluations, they also explore the extent to which effects could be attributed to the intervention, and whether the underlying behavioural determinants were examined in the intervention study. Both Lutzenhiser (1993) and Abrahamse *et al.,* (2005, 2007) argue that interventions which tailor information to particular groups or individuals are needed to sustain behaviour change. As Abrahamse *et al.,* write:

> 'a problem diagnosis is necessary in examining which behaviours and which behavioural tenants should be targeted by the intervention.'
>
> (Abrahamse *et al.*, 2005:283)

When researching intervention studies, it was noted that many authors explore how interventions affect attitudes and behaviours (Dietz *et al.*, 2009; Steg and Vlek, 2009). Dietz *et al.,* found that knowledge can be changed through mass media and information programmes, but that knowledge does not lead to behaviour change (Dietz *et al.*, 2009). During this work, they also found that inventions that combine several policy tools, use social marketing or address multiple targets were the most successful at changing behaviour. Steg found that psychological factors such as attitudes, perceptions and motivations need to be considered along with structural considerations (for example, changing environments to make it easier for a behaviour to take place) when approaching household energy conservation (Steg, 2008). These are important findings for developing a framework to examine energy use in the workplace, and are discussed further in Section 2.7.

All the research reviewed here suggests there is not one intervention method that is highly successful in all scenarios. However, it does suggest that one of the more effective methods is tailoring information (Abrahamse *et al.*, 2005; Steg, 2008). In order to tailor information, and in agreement with Abrahamse *et al.,* (2005), there is a need to understand the target population to determine on which behaviours to focus and which interventions to implement.

Workplace

Intervention research focusing on the workplace reiterates the findings cited above, that tailoring information is one of the more successful intervention methods (Daamen *et al.*, 2001; Carrico and Riemer, 2011; Lo *et al.*, 2012). Other intervention research conducted in the workplace includes the use of comparative techniques, where one group receives information about another group's energy use (Siero *et al.*, 1996). In this research both groups also received tailored information, and their energy efficiency improved, which supports previous findings that tailored feedback changes behaviour (Siero *et al.*, 1996). However, the group that received comparative feedback was more successful at improving energy efficiency compared with the group that received no comparative feedback. These results are promising for the use of competitive feedback as an intervention technique to reduce energy use. However, limitations of this work include the small sample size (two groups) and the fact that the groups showed positive ‘energy related cognitions’ (Siero *et al.*, 1996:245). This suggests the two units were receptive to information regarding energy, which may have led to the positive response to energy intervention.

Dixon *et al.,* (2014) builds on Siero *et al.*’s (1996) research by investigating the effectiveness of comparative feedback over a longer period of time (three years) and with a larger sample (six buildings). They found that electricity usage in the buildings whose occupants received comparative feedback was reduced more than in other areas. They also found that individuals in the buildings that received comparative feedback perceived that their peers/colleagues were engaging in energy conservation behaviours more than those in buildings that received no comparative feedback. However, they did not find a change of respondents’ attitudes and behavioural intentions between the comparison and non-comparison feedback areas, and attitudes and behavioural intentions did not appear to change between the pre- and post-surveys.

The intervention research in both the domestic and the workplace environments shows that comparative and tailored feedback have been successful on the behaviours in question, but the question of whether these interventions lead to sustained behavioural change (De Young, 1993; Abrahamse *et al.*, 2005) remains largely unanswered. Dixon *et al.,* (2014) found that a year after an energy campaign based on comparative feedback had finished, there was an increase in electricity consumption. Hargreaves *et al.,* (2013) found a similar result from interviews held with participants involved in gaining feedback from smart meter trial. This research found smart meters become ‘backgrounded’ within normal household routines’ (Hargreaves *et al.*, 2013:132).

2.4 Understanding the Workplace

This section discusses research that assists in gaining an understanding of the workplace and its unique characteristics and challenges, when compared with the domestic environment, and a body of research that examines the greening of organisations. Such research concentrates on themes of energy and wider decision making within organisations.

Research has largely ignored discussions on how to promote energy efficiency within the workplace (Andersson *et al.*, 2013; Zhang *et al.*, 2013, 2014; Moezzi and Janda, 2014; Dixon *et al.*, 2015), despite, as previously stated, industry being a major consumer in the UK energy sector. Abdelaziz *et al.,* (2011) provide a review of energy-saving strategies in the industrial sector, but fail to mention the potential energy savings by the end-user, the employee. They structure their work by themes of energy savings by management, technology, policy and regulations. Within the 'energy saving by management' section there is a short paragraph on energy-efficiency courses and training, but their approach focuses on management training rather than training programs for end-users. Their review concentrates on technology and policy/regulation strategies, which also reflects the approach taken by many industries in their approaches to improve energy efficiency. Often industries apply technological changes as their first approaches to improving energy efficiency (Dietz *et al.*, 2009). However, end-users need to be considered in the energy use of organisations, as they shape the energy consumption of buildings and organisations through the choices they make (Aune *et al.*, 2009). They can also determine the success of any technological approaches to improving energy efficiency. Research has found technological systems can often be victims of 'creative adaption' or 'sabotage of systems' by building users (Aune *et al.*, 2009:45), which prevents them operating successfully. This demonstrates the important role the end-user has in energy efficiency and illustrates that 'people use energy not buildings' (Janda, 2011).

In the UK the average full-time employee (37.5 hours per week) spends around a quarter of the week in work, during which time they have various interactions with equipment that uses energy. There are many differences between the workplace and the home environment. Employees' energy use does not usually have a direct financial consequence. Employees typically do not see energy bills (Dixon *et al.*, 2014), nor are they in a position to make decisions on energy-related subjects. The workplace is also much more complex than the household environment, and has a variety of additional determinants of decision making. The organisation structure and environment can influence employees' way of working (Bock *et al.*, 2005), with supervisors, managers and boards of directors all playing important roles (Ramus and Steger, 2000; Johansson *et al.*, 2011; Robertson and Barling, 2012; Walls and Hoffman, 2012). Another dimension that adds complexity when exploring energy use is employees' privacy concerns associated with energy monitoring. These concerns can affect energy efficiency and could, in some instances, be seen as a barrier to implementing energy monitoring technology (Bolderdijk *et al.*, 2013). In addition to these, there are further complexities with the design of workplace buildings and how end-users interact with them. Aune *et al.,* (2009) discussed this by exploring the difficulties architects and engineers have when designing buildings without understanding the end-user, and also how they hand over buildings to clients often without having direct contact with end-users.

Furthering the discussion on challenges between construction and energy use, Aune *et al.,* (2009) point out that building operators may be good candidates for providing a link between technology, the system and the user. Aune *et al.,* (2009) describe the variety in building operators' roles by defining four categories: the teacher, the housekeeper, the manager, and the juggler. Using this analogy of the four different roles highlights job variety, from the more 'hands on' operator who interacts regularly with the end-user, to the operator who sees users 'as customers' and may be involved in more administrative tasks (Aune *et al.*, 2009). The study does not look at personality traits of building operators, and nor does it look directly at operators' views on approaches to reducing energy use. This research demonstrates the different roles individual employees can have in directing energy usage in the workplace. It also demonstrates how all workplaces are different and that a 'one-size-fits-all' approach is not appropriate (Christoffersen *et al.*, 2006:516).

Johansson *et al.,* (2011) explore energy efficiency in industry from a manager's perspective and highlight the importance of non-technological approaches. They conclude that the interaction between culture, will, and acceptance and recognition create conditions in an organisation, department, and group that a leader must manage when improving energy efficiency (Johansson *et al.*, 2011). The roles of senior management, supervisors and middle management have been explored by other researchers, such as Lo *et al.,* (2012), who find that the involvement of middle management, along with the physical facilitation of an intervention, is important in succeeding in changes in pro-environment behaviour. They also found 'communication about energy management is more effective if the message is adapted to the relevant management level and style' (Lo *et al.*, 2012:516). This extract reiterates the findings from the intervention research examined in Section 2.3.3, which revealed that tailored information is more effective than non-tailored techniques. It also indicates that tailored messages need not be made available to all employees, but can be applied at a managerial level. Another example exploring the role of managers in the workplace is research by Ramus and Steger (2000), which found that strong organisational encouragement and supervisory support were positively correlated with the development of pro-environmental creative ideas by employees. Similar research focusing on managerial attitudes towards pro-environment and/or energy behaviour has occurred in the hotel industry (Kasim, 2009), across public and private corporations in Poland, Australia and Ukraine (Leszczynska, 2010) and in the US and Canada (Robertson and Barling, 2012). The general findings from all the research cited here suggests that the pro-environmental attitudes and actions of managers, supervisors and leaders in the workplace affects the pro-environmental behaviour of employees (Ramus and Steger, 2000; Johansson *et al.*, 2011; Robertson and Barling, 2012).

In addition to managerial attitudes, another workplace-specific influence on employee pro-environment decision making is the role of the board of directors (Cole, 2004; Mullins, 2007; Brooks, 2009). The environmental experience of a board of directors, along with the network of each member of the board, plays a critical role in allowing organisations to have pro-environmental behaviours within the workplace (Walls and Hoffman, 2012). Walls and Hoffman (2012:267) use this argument as a reason why some organisations adopt 'above-and-beyond environmental practices and others do not'. Organisational studies often explore the role of decision making at board level and the influence this has on employees. However, as stated by Walls and Hoffman (2012), much of this research does not explore pro-environmental decision making.

Within the organisational literature there is a lot of research on knowledge transfer, such as the special issue of *Organizational Behavior and Human Decision Processes* (volume 82, issue 1, 2000). However, this literature does not often focus on topics of energy use. The intervention literature cited earlier notes how communication and efficient transfer of energy knowledge need to occur if workplaces seek to improve energy efficiency. Consequently, some knowledge transfer literature is explored in the thesis.

Knowledge transfer can occur in several ways, including via formal and informal networks and through basic elements such as members, tools and tasks (McGrath and Argote, 2008). Knowledge transfer can also occur through subnetworks and group identities (Argote and Ingram, 2000). Relating to the research, Bock *et al.,* (2005) describe factors relating to knowledge transfer through the development of a framework that incorporates themes of national culture, organisational climate, subjective norms, self-worth, extrinsic rewards, reciprocal relationships and attitude to sharing knowledge. They argue their framework can assist with understanding the range of influences on knowledge transfer at an individual level in an organisation. Their research also demonstrates that when exploring workplace behaviours, there is a need to explore the individual and the organisational influences (Bock *et al.*, 2005). This theme is incorporated into the design of the workplace energy culture framework presented in Section 2.7. Research focusing on the individual has found that attitudes and emotions, such as enthusiasm and excitement, can be positively associated with daily pro-environmental tasks (Bissing-Olson *et al.*, 2012). Furthermore, research examining energy topics in the wider workplace has detailed the importance of exploring how information is shared and received in workplaces through groups and networks, and the wider organisational rules, norms and structures (Andrews and Johnson, 2016).

2.4.1 Greening Organisations

Another body of work that seeks to understand the added complexities workplaces experience, when compared with the domestic environment, is often labelled 'greening organisations' research. It spans management, business and organisational disciplines. A common theme in greening organisations literature is the application of a cultural approach to the analysis (Shrivastava, 1995; Stead and Stead, 2015; Welford, 2016), which makes this body of work particularly interesting for the development of a framework for the PhD research. This discussion seeks to focus on some of the key debates and findings from the greening organisations literature and to demonstrate how it can contribute to developing a framework for the research.

Similar to the majority of the research previously cited in this chapter, the greening organisations research developed from an increased interest in environmental concerns, and the examination of how organisations can move towards sustainability (Fineman, 2000; Harris and Crane, 2002). Organisations undertake greening for a variety of reasons. These include, but are not limited to, a belief that greening an organisation, and promoting this to customers, will provide them with an advantage over non-green competitors in the marketplace (Saxena and Khandelwal, 2012), in response to increased pressure from environmental groups, where organisations seek not to be branded negatively and to avoid adverse publicity (Fineman, 2000), or to comply with legislation and avoid fines and other penalties (Fineman, 1997).

From reviewing the organisational greening literature, it can be seen that there are many different research avenues, including research into the greening of infrastructure (Guy, 2000), management (Fineman, 1997), specific sectors (Schaefer and Harvey, 2000) and the supply chain (Green *et al.*, 2000; Zhu and Sarkis, 2006). All of these examples focus on specific parts of an organisation. Other authors have taken a similar view when researching the greening of organisations by examining them as consumers. Green *et al.,* (2000) examined organisational greening through the lens of the consumer by asking questions such as: Who is the consumer? and What does the consumer do? This work is interesting as it acknowledges the variety of consumers in an organisation, such as the individual who is the consumer of organisational goods, and the organisation as a customer that consumes goods and services from other organisations. All the work cited previously identifies the complexity of organisations and the multiple perspective, and multiple scales, at which greening of organisations can be viewed.

The greening organisations literature often reports that for organisations to be 'green', they need to incorporate technical, engineered solutions while also embracing more social solutions such as responsible values, beliefs and behaviours (Shrivastava, 1995; Harris and Crane, 2002; Stead and Stead, 2015), which echoes some of the earlier discussions in this chapter. However, the research already cited in this section only examines organisations from a singular view point. In seeking to find greening organisations literature that incorporates a variety of themes of organisational greening, the work of Harris and Crane was found. They argue that there is 'not a simple uni-dimensional concept' (Harris and Crane, 2002:221) for organisational greening.

They identify seven factors, which they argue account for organisational greening (Figure 2:2). In this figure they also incorporate the themes of degree, diffusion and depth to discuss the extent of organisational greening. They define these terms as follows:

- 'Depth of cultural greening pertains to how deeply managers perceived greening to be valued by various organizational members and factions,
- Degree of cultural greening refers to the extent to which managers felt that green values and sensibilities were manifested in organisational creations and artefacts,
- Diffusion of cultural greening applies to how widely managers believed these feelings and behaviors to be exhibited throughout the organisation'

(Harris and Crane, 2000:222)

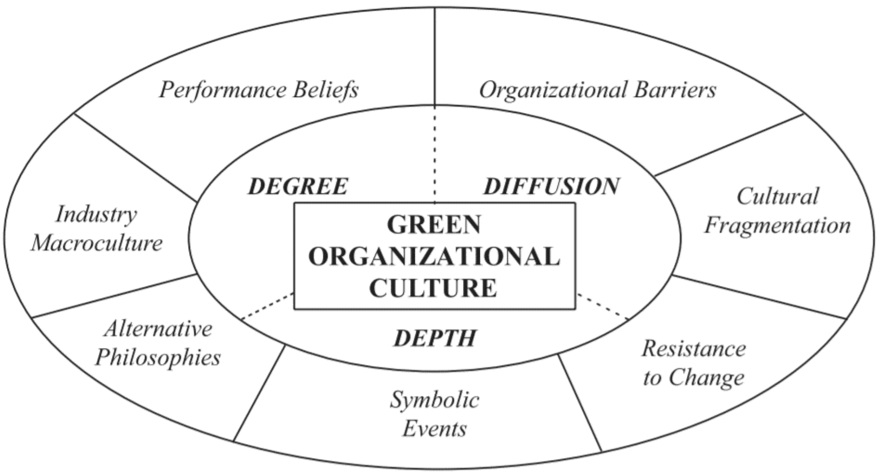


Figure 2:2: Depth, degree and diffusion of organizational greening (Harris and Crane, 2000:222)

By examining a green organisational culture, Harris and Crane (2002) identify how greening can be found and examined at a variety of macro and micro levels in an organisation. They also identify that a genuine belief in green issues may be limited to a single department (Harris and Crane, 2002:229). This work is particularly interesting for the research as it approaches organisational greening through a cultural lens and it describes how organisational greening can be established through the seven themes inFigure 2:2. Of particular interest to the research is the cultural fragmentation theme; here Harris and Crane (2002) acknowledge the wider cultural mosaic of an organisation (Morgan, 1986). As discussed in later chapters, BAE acknowledges many cultures within its businesses; for example, the safety culture (for more details, see Chapter 5).

The work by Harris and Crane (2002) is useful for the research as it identifies a number of factors that could be included in a framework to address research on energy cultures in an industrial workplace, while also acknowledging the variety of scales of greening and the wider cultures of an organisation. However, a limitation of this work is that themes are derived through interviews with managerial staff of an organisation. The research methodology solely focuses on interviewing management and does not incorporate wider organisational views, such as those from other employees. Harris and Crane (2002) acknowledge this limitation and call for 'further research [to] usefully approach culture by addressing far larger samples of organizational members' (Harris and Crane, 2002:231). The PhD research and framework seek to address this call.

All the research cited here has demonstrated that workplace presents an environment where there are many more determinants of individual energy use when compared with the household environment. Prior to considering how these factors have been incorporated into a framework that can examine energy use in the workplace, a review of established approaches to explore energy use through models, frameworks and theories is provided.

2.5 Approaches to Examining Energy Use

The purpose of reviewing approaches that have been applied to explore energy use is to determine whether any are appropriate for encompassing the wide range of determinants of energy use in the work environment. This section also seeks to identify further determinants that should be considered when exploring energy use in the workplace. This review acknowledges the breadth of approaches, models and frameworks; for example, norm-activation model (Schwartz, 1977), social marketing (McKenzie-Mohr *et al.*, 1995; McKenzie-Mohr, 2000) and social cognitive theory (Bandura, 1989) have been used to explore and change behaviour. However, space constraints limit this review to approaches that have become widely applied, particularly those that focus on energy use in the domestic or workplace environment. This section starts with a review of psychological theories: the theory of planned behaviour (TPB; Ajzen, 1991), the new ecological paradigm (Dunlap *et al.*, 2000) and value-belief norm theory (Stern, 2000). These have all been reviewed as they can assist with exploring workplace energy use from an employee perspective. Finally, an overview of additional analytical frameworks is provided to show why a new framework to address energy use in the workplace is needed.

Theory of Planned Behaviour

The TPB is a well-documented social psychological theory that has been applied in much pro-environmental and energy research (Ajzen, 1991). Applications include research on environmental concerns (Bamberg, 2003), travel behaviour and choices (Bamberg and Schmidt, 2003; Staats *et al.*, 2004), energy saving behaviours and conservation (Gadenne *et al.*, 2011), influences on household energy use (Abrahamse and Steg, 2009), understanding recycling habits (Nigbur *et al.*, 2010) and general pro-environmental behaviour (Kaiser and Wilson, 2004). More recently, applications targeting the workplace include research by Greaves *et al.,* (2013), Chen and Knight (2014), Zhang *et al,.* (2014) and Endrejat *et al.,* (2015), who have found correlations between elements of the TPB and behaviour. The aim of the TPB is to explain and to assist with predicting human behaviour. It argues that human behaviour is a function of four themes, which interact to create a behaviour. These are the attitudes towards a behaviour, subjective norms (i.e. the perceived social pressure to perform or not to perform), the perceived behavioural control (i.e. the perceived ease or difficulty of performing the behaviour) and the intention to perform the behaviour (defined as the willingness/effort to do something). These are presented in the TPB framework illustrated in Figure 2:3. Detailed discussions about how the TPB was created are presented in Ajzen (1991, 2005). Figure 2:4 provides example of how various authors have operationalised each theme of the TPB.

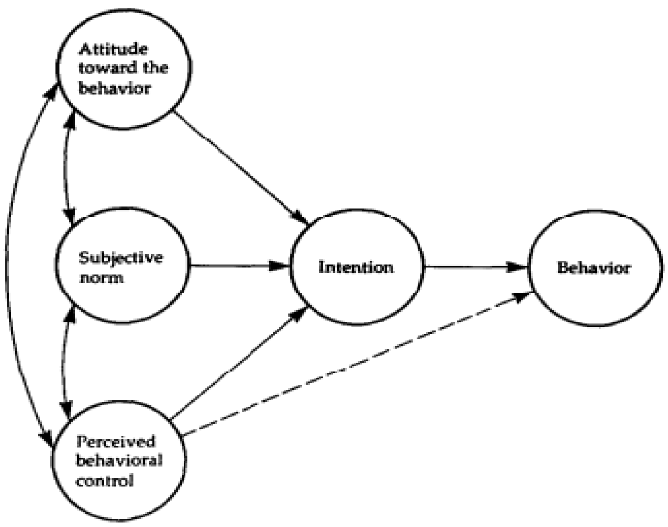


Figure 2:3: Theory of planned behaviour (from Ajzen, 1991:182)

Figure 2:4 presents examples of how the core elements of the TPB have been articulated in research using survey methods. It demonstrates how applying the TPB is up to user interpretation as there are no predefined questions, unlike other theories, such as the NEP scale by Dunlap *et al.,* (2000). Bock *et al.,* (2005), who applied a previous version of the TPB called the theory of reasoned action (Ajzen and Fishbein, 1980) to explore factors influencing employees' knowledge-sharing intentions, state:

> 'in a mature field of study where the beliefs that underlie a focal behaviour are well specified, prior literature is usually a sufficient source for identifying the relevant beliefs.'
>
> (Bock *et al.*, 2005)

However, the field exploring energy use in the workplace is not well established, so any use of the TPB will draw on wider literature such as pro-environmental literature, along with the work of Greaves *et al.,* (2013) and Chen and Knight (2014).

Critics of the TPB argue that the model assumes that rational, logical decisions are made by people (Bamberg and Schmidt, 2003; Gadenne *et al.*, 2011) and that it does not include wider structural and industrial influences (Blake, 1999) such as organisational culture and norms.

Attitudes

Chen and Knight (2014:24) use a 'person's subjective judgement about the positive and negative evaluation of the act of energy use' as a definition of attitudes in their study. They used the following statements: 'Energy conservation is too much of a hassle; energy conservation means I have to live less comfortably; it wastes my time to conserve energy; my personal need to coolness is high; I would conserve energy only if I could not afford the cost'(2014:28).

Bamberg and Schmidt (2003) explored attitudes to using the car by asking participants to answer two questions based on a 5-step bipolar scale of whether the journey would be good/bad and pleasant/unpleasant.

Dixon *et al*., (2015:124) use the following statements: 'lowering energy use at work is a good thing; my work habits contribute to Cornell's overall energy use; reducing my energy use at work would help the university save money; reducing energy use at work would be good for the environment', and assess them through a 5-point Likert scale.

Subjective Norms

Chen and Knight (2014) focus on injunctive norms, which refer to the 'perceived approval or disapproval of behaviours to others' (Chen and Knight 2014:24). They explore the influence of close colleagues on energy behaviours by using the following statements: 'the majority of my co-workers approve: recycling papers, cans and bottles is important; saving electricity is important; reusing things is important; protecting the environment is important'.

Bamberg and Schmidt (2003:271) use the following statements: 'When I use the car for university routes next time, most people who are important to me would support this; and most of the people who are important to me think that I should use the car for university routes next time'. These were both assessed in a bipolar scale from likely to unlikely.

Dixon *et al.*, (2015:123) use the following statements: 'most people who are important to me at work would think it is a good idea to conserve energy; I am expected to conserve energy at Cornell; I feel responsible for conserving energy at work' to explore injunctive norms. They use the following statements: 'the people I work with, whose opinions I value, are concerned about their energy use; most people I work with, who are important to me, try to pay attention to their energy use; many people I work with are trying to reduce their energy use' to examine subjective norms.

Perceived Behavioural Control

Chen and Knight (2014:28) ask the following agree or disagree statements: 'I know how I can save energy at work; I can reduce my energy use at work quite easily even if my manager did not ask me to do so; I can reduce my energy at work quite easily even if my colleagues did not want to do so'.

Bamberg and Schmidt (2003:271) use the following statements: 'Using the car for university routes next time would be (easy/difficult) for me; my autonomy to use the car for university routes next time is (large/small)'.

Dixon *et al*., (2015:124) use the following statements: 'Reducing my energy consumption at work would be simple; if I wanted to, I could reduce my energy use at work, and the amount of energy I consume at work is mostly up to me'.

Figure 2:4: Examples of how TPB attitudes, subjective norms and perceived behavioural control have been explored in surveys

The New Ecological Paradigm

The NEP scale is a set of questions on the balance of nature, limits to growth, anti-anthropocentrism, human exceptionalism and eco-crisis. The questions are designed to 'measure endorsement of an ecological worldview' (Dunlap *et al.*, 2000:438), or – as others have phrased it – to assess the level of environmental concern of groups and individuals (Anderson, 2012). The NEP scale consists of fifteen statements, twelve based on the present or future relationship between humans and nature and three on the rights of humans in relation to the environment.

The NEP scale has been widely applied in academic research as a measure of environmentalism or concern for the environment (Zelezny *et al.*, 2000; Stephenson *et al.*, 2010) and is one of the most frequently used measurements of public environmental concern (Stern *et al.*, 1995). For an overview of studies using the NEP scale, refer to Hawcroft and Milfont (2010), who review 69 studies that have applied the NEP scale. Relating to energy use, Urban and Scasny found that people with 'higher environmental concern were on average more likely to perform energy saving [actions]' (Urban and Scasny, 2012:9) and were more likely to install energy-efficiency retrofits in households. This research, along with that of the previously cited authors, demonstrates that there is a link between environmental concern and the intention to perform pro-environmental actions.

Value-Belief-Norm Theory

VBN, developed by Stern *et al.,* (1999), incorporates the NEP scale into its theoretical model. It also incorporates the norm-activation model (Schwartz, 1977) and value theory. It argues that individual choices or decisions can be explained by the VBN model, which consists of five variables that Stern considers to determine pro-environmental action. These are personal values, NEP, awareness of adverse consequences, ascription of responsibility to self and personal norms (Stern, 2000) (Figure 2:5).

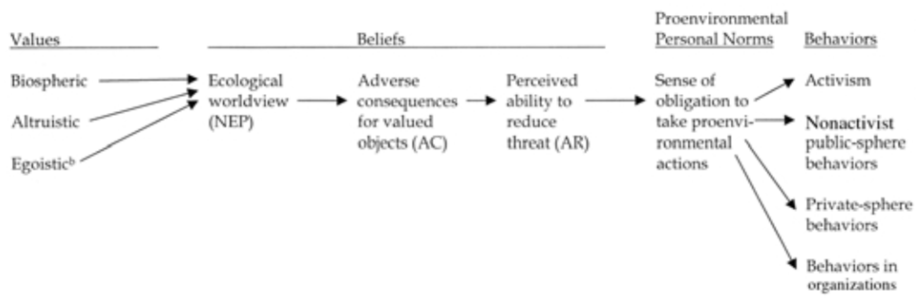


Figure 2:5: Visualisation of VBN scale (from Stern, 2000:413)

Scherbaum *et al.,* (2008) apply the VBN theory to explore factors relating to employee energy conservation in work, finding that environmental personal norms and behavioural intentions predicted employee energy efficiency. They also found that NEP was a predictor of environmental personal norms, demonstrating the individual determinants of energy use. Applications of VBN in a workplace environment include the work by Scherbaum *et al.,*(2008), Chen (2015) and Endrejat *et al.,* (2015). One limitation of these theories is that they present no opportunities to consider the wider environmental factors influencing energy use. This chapter has already highlighted the added complexity the work environment places on behaviours.

2.5.1 Other Analytical Frameworks and Approaches

The core principles of the TPB and VBN theory have been incorporated into other research, such as the work by Endrejat *et al.,* (2015), who provide an overview of individual psychological factors they argue should be considered when designing interventions for non-residential buildings. Throughout their research, the organisational culture, informal communication channels, the creation of subjective norms through social interaction with colleagues, data security and lack of direct feedback on energy use are highlighted as unique workplace influences on energy use (Endrejat *et al.*, 2015). Barr (2007) also incorporates elements of TPB and VBN theory by developing a framework for exploring factors influencing environmental attitudes and behaviours relating to household waste actions in the UK. In Barr's framework environmental values, behavioural intentions, situational variables and psychological variables all influence environmental behaviour (Barr, 2007).

Drawing on the various determinants of energy use detailed in this chapter, and the wider energy use research, it appears that there are two important elements that need consideration when exploring influences on energy use in the workplace: the organisation/workplace and the individual (Andrews and Johnson, 2016). However, there is limited research that appears to bring together these two elements, a point reiterated by Lo *et al.,* (2012). There are a few exceptions, most notably the work by Lee *et al.,* (1995), Tudor *et al.,* (2008), Unsworth *et al.,* (2013) and Ucci *et al.,* (2014), which is discussed below.

Unsworth *et al.,* (2013) developed a model to explore how to create pro-environmental behavioural change in the workplace. The model (Figure 2:6) identifies a range of influences on employee pro-environmental decision making, such as goal conflict, attractiveness and efficacy of the task, while also incorporating 'the existing values and identities of the employees' (Unsworth *et al.*, 2013:222). The research findings also suggest that in order to provide a suitable environment for pro-environmental behaviours, the workplace should 'include more environmentally related cues' (Unsworth *et al.*, 2013:224). This demonstrates the importance of the physical environment when exploring employee behaviours.

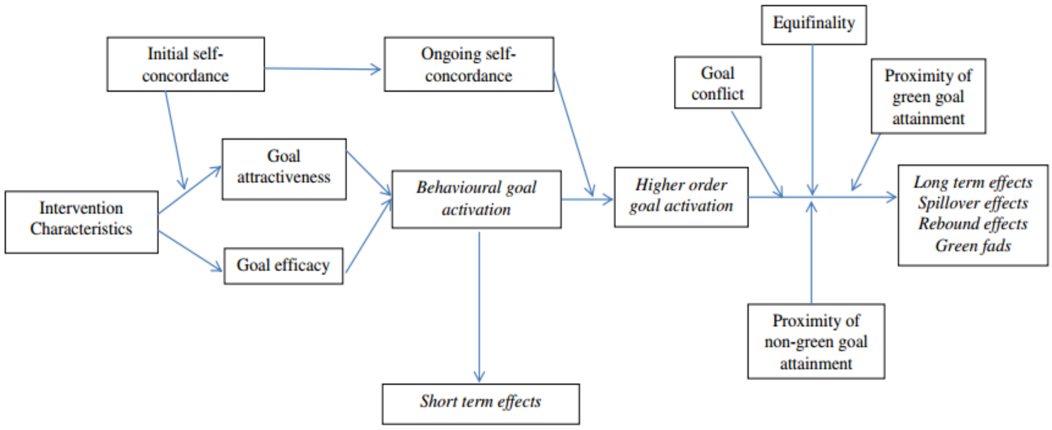


Figure 2:6: The psychological conditions underlying pro-environmental behaviour change (from Unsworth et al., 2012:214)

Lee *et al.,* (1995) explored influences of prior experience with recycling, organisational commitment, individual commitment, economic motivation, convenience of recycling, and intrinsic satisfaction, and whether they influenced individual recycling. They found that prior experience of recycling had an impact on recycling behaviours at work and also that organisational commitment to recycling appeared to increase recycling behaviours in the office (Lee *et al*., 1995). The theme of prior experience of a particular behaviour is closely linked to research exploring the 'spill-over effect' (Whitmarsh and O'Neill, 2010; Austin *et al.*, 2011) sometimes named 'catalyst behaviours' (Department for Environment, Food and Rural Affairs, 2008). The spill-over effect is the potential or ability of a behaviour to 'spill-over' or be transferred into other environments. Refer to Whitmarsh and O'Neill (2010) and DEFRA (2008) for a more in-depth discussion of the spill-over effect.

Drawing on research in the building services discipline, Ucci *et al*., explore employee attitudes, perceptions, awareness, supervision and energy-saving behaviours (Ucci *et al.*, 2014). Their theoretical framework of mechanisms affecting pro-environmental behaviours (Figure 2.6) draws on several of the themes already mentioned in this review, and involves both organisational and individual determinants of energy use.

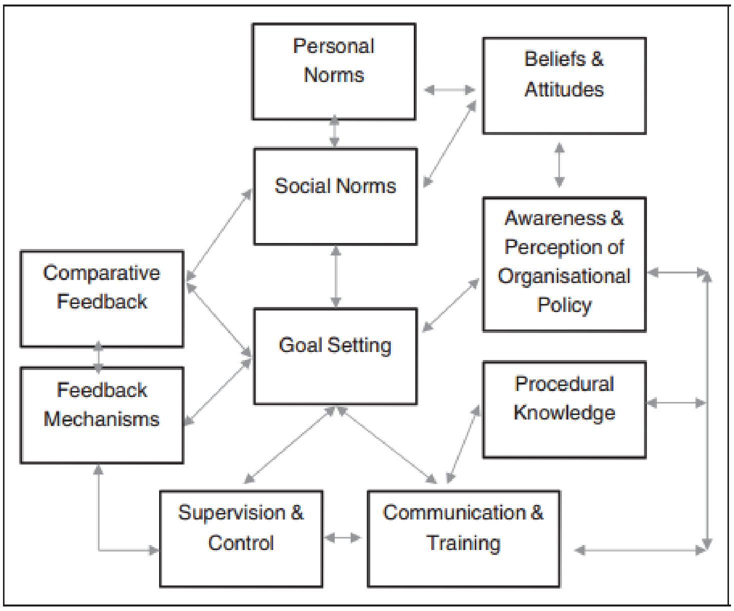


Figure 2:7: Theoretical framework of the mechanisms affecting pro-environmental behaviours (Ucci et al., 2014:40)

The final study incorporating both individual and organisational elements is the research by Tudor *et al.,* (2008), who examine the determinants of pro-environmental behaviour. They acknowledge a number of the socio-psychological theories already discussed in this chapter, but argue that they alone do not serve as predictors for sustainable waste behaviour. In developing a 'dynamic, holistic, intrarelated, and interrelated conceptual framework' (Figure 2:8), Tudor *et al.,* (2008:426) identify the key influences of attitudes, organisational structure, culture and policy, and show that the size and type of site/department where the behaviours take place affect behaviour. This demonstrates a vast array of determinants of pro-environmental behaviour.

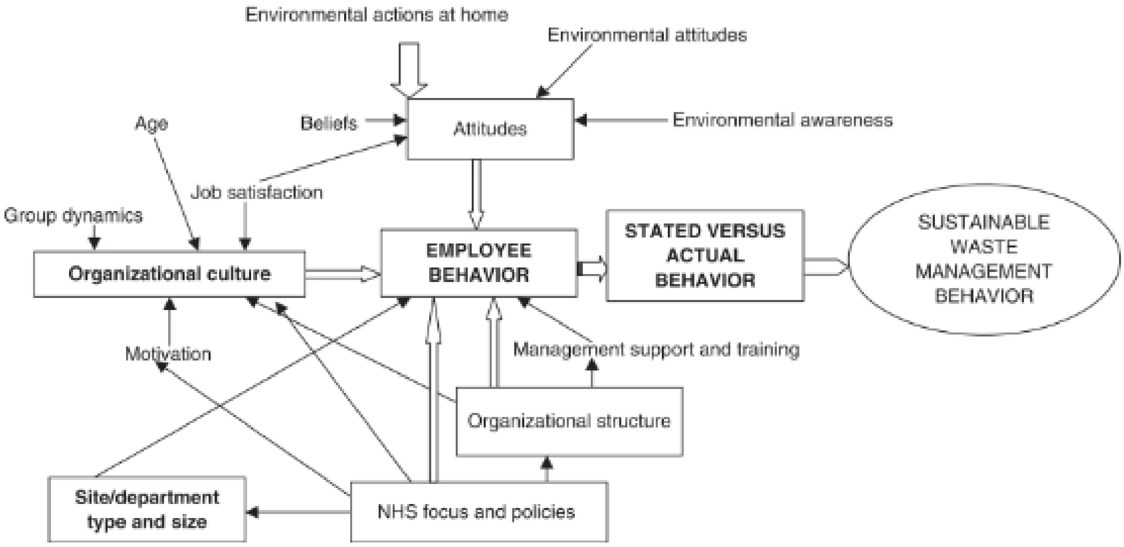


Figure 2:8: Influences on sustainable waste management behaviour in the Cornwall NHS (Tudor et al., 2008:445)

All four frameworks and approaches detailed here (Lee *et al.*, 1995; Tudor *et al.*, 2008; Unsworth *et al.*, 2013; Ucci *et al.*, 2014) succeed in incorporating aspects of individual and organisational influences when examining environmental behaviour. However, there are some limitations in these approaches. First, both Tudor *et al.,* (2008) and Lee *et al.,* (1995) focus on pro-environmental behaviours rather than on energy use. Andrews and Johnson (2016) urge caution when applying pro-environmental frameworks to explore energy use in the workplace, and argue that energy topics need to be explored as a separate research target. One major difference between energy and pro-environment behaviour is that energy is invisible (Hargreaves *et al.*, 2010). It is a component of a specific task being completed, and it is difficult to determine how much is being consumed, unless aids such as smart meters are installed. Second, the framework by Ucci *et al.,* (2014) was developed to assist in the creation of a survey that could be used as a benchmarking tool to determine behavioural change potential. It does not provide an opportunity to examine wider organisational influences on energy use such as energy teams or business structure. Lastly, the primary focus of the research by Lee *et al*., (1995) and Unsworth *et al.,* (2013) is the individual. The approaches they use are agency focused (a discussion on structure and agency follows). They both address aspects of the organisation, but do not provide equal weight in opportunities to explore both individual and organisational influences on behaviour, and the integration of wider social structures on behaviours.

2.5.2 Structure, Agency and Practice Theory

As discussed above, a number of the frameworks take a predominantly agency view and do not allow integration of the intertwined nature of structure and agency. Structure and agency dualism is central to many debates in the social sciences and human geography (Sewell, 1992; Chouinard, 1997; Calhoun, 2002; Gregory *et al.*, 2009). The *Dictionary of the Social Sciences* (Calhoun, 2002) offers the following definitions:

> 'Agency commonly refers to the ability of actors to operate independently of the determining constraints of social structure … Agency raises the questions about the importance of human intentions, the nature and social construction of free will, moral choice, and political capacity. In common usage, agency places the individual at the centre of analysis.
>
> Social Structure [is] the most basic, enduring and determinative patterns in social life. [The study of social structure is] oriented by the goal of understanding systematic relationships and regularities among social phenomena.'
>
> (Calhoun, 2002:7–8, 251)

The debates around structure and agency focus on whether people are free agents, acting as they choose, or whether they act in a particular way because of the overarching structures that govern society. The energy use and pro-environmental behaviour literatures already cited in this chapter demonstrate some clear distinctions between structure and agency accounts of thinking. For example, Schliech (2004) researched barriers to adopting energy efficiency techniques in organisations. The findings take a predominantly structural point of view, identifying landlord-tenant dilemmas, investment priorities and uncertainty about future energy costs. Other examples include Ramus and Steger (2000), Johansson *et al.,* (2011), Robertson and Barling (2012) and Walls and Hoffman (2012), all of whom identify how supervisors, managers and boards of directors can influence employee energy use. Taking a more agentive stand-point is the NEP scale developed by Dunlap *et al*., (2000). The authors argue that environmental orientation can be determined by their 15-point scale, which is based on individual attitudes, and that the scale can be used as an indicator to explain behaviours. These examples suggest that research can be easily categorised into having a structure or agency approach.

However, it is not that simplistic. Sewell (1992) argues that structure and agency are intertwined and have a dynamic relationship. Structures can 'empower and constrain social action and … tend to be reproduced by that social action' (Sewell, 1992:19). Consequently, many scholars attempt to bridge the gap between structure and agency approaches by integrating them. This is something the PhD research seeks to do.

Before moving on to discuss how an energy culture approach incorporates both structure and agency, this chapter briefly discusses another approach to bridging this dichotomous gap – social practice theories (SPT). Applications of SPT in energy research have increased in popularity in recent years, as is outlined below. In discussing SPT, the research acknowledges an alternative approach for the integration of structure and agency, while also explaining why this approach is not well suited to the research.

Social Practice Theory

SPT is different to much of the research previously cited in this chapter because it focuses on practices, not practitioners (Nicolini, 2012). This means that, instead of considering why an individual behaves in a particular way, or the barriers to a particular way of behaving, social practice theorists analyse the practice being conducted, and how that practice is constructed. A widely cited definition sees practice as:

> 'a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, knowhow, states of emotion and motivational knowledge.'
>
> (Reckwitz, 2002:249)

While Nicolini describes practices as 'configurations of actions which carry a specific meaning' (Nicolini, 2012:10), Schatzki describes practices as 'embodied, materially mediated arrays of human activity centrally organized around shared practical understanding' (Schatzki, 2001:11). As will become apparent in this discussion, there is not one unified SPT (Schatzki, 2001):

> 'Practice theories constitute … a rather broad family of theoretical approaches connected by a web of historical and conceptual similarities.'
>
> (Nicolini, 2012:1)

Each theory has slightly different definitions of what constitute practices. However, as Schatzki states, 'practices are arrays of human activity' (Schatzki, 2001:11). An example of an SPT approach would be examining car driving, where car driving would be the unit of analysis, rather than the individual or the environment. Shove *et al.,* (2012) explain that by focusing on the practice of driving, which is the 'doing of driving, narrowly defined as controlling and navigating a car' (Shove *et al*., 2012:26), an appreciation of the various elements that define the practice can be obtained; for example, an acknowledgement that 'elements of driving pre-date the arrival of the car' (Shove *et al.,* 2012:26) such as the introduction of gasoline engines (for more information on this example, see Shove *et al.,* 2012:26–29).

By focusing on practices, SPT is different to many other approaches that address topics of structure and agency (Nicolini, 2012). SPT provides opportunity to examine the intertwined nature of structure and agency, and the interaction of these dualisms, rather than taking a structure or agency view point. Anthony Giddens is a key theorist often cited in SPT texts. Giddens' (1984) structuration theory bridges the gap between structure and agency by detailing how individual actors continually interact with social structures, with each being shaped by the other. Nicolini's review of Giddens' structuration theory, states:

> 'Giddens' structuration theory revolves around the conclusion that human activity, and the social structures which shape it, are recursively related. That is, activities are shaped and enabled by structures of rules and meaning, and these structures are, at the same time, reproduced in the flow of human action. This flow is neither the conscious, voluntary purpose of human actors, nor the determining force of giving social structures'
>
> (Nicolini, 2012:3)

This extract demonstrates the intertwined nature of structure and agency in Giddens' structuration theory. Even though there is not one unified SPT (Nicolini, 2012) several of the more recent SPTs, such as those put forward by Theodor Schatzki (1996, 2010) and Elizabeth Shove (Shove, 2003; Shove and Pantzar, 2005; Shove *et al.*, 2012), build on the work of Anthony Giddens (1984, 2013) and his view of the dualisms of structure and agency. Their work demonstrates that SPT provides opportunity to move away from debates of structure and agency, and instead focus on practices and how they are constructed.

Within the workplace and organisational settings, SPT has been used as an approach to examine workplace practices (e.g. the work by Østerlund and Carlile, 2005; Scapens, 2006; Ahrens and Chapman, 2007; Ahrens and Mollona, 2007; Baxter and Chua, 2008; Hargreaves, 2011; Caldwell, 2012). SPT provides the opportunity to examine all the components of practices, such as:

> 'phenomena such as knowledge, meaning, human activity, science power, language, social institutions and human transformations [that] occur within, and are aspects, or components of the fields of practices.'
>
> (Schatzki, 2001:11)

Recently, SPT has become increasingly popular with energy research scholars. This can be seen in articles published in the journal *Energy Research and Social Science* (e.g. Walker *et al.*, 2014; Galvin and Gubernat, 2016; Horta *et al.*, 2016; Palm and Reindl, 2016). In addition to these examples, a key social theorist applying and developing social practice theory to examine energy use is Elizabeth Shove (Guy and Shove, 2000; Shove, 2003).

Suitability of SPT for the Research

Practice theorists argue that their approaches can be applied beyond the micro-scale (individual) and explore practices as a 'field of practise' (Schatzki, 2001:15). In doing this, Schatzki argues that one can explore reproduction and change at various scales of social reality, including communities, societies, cultures and corporations, from an SPT perspective. While this makes

SPT a viable theoretical approach for the research, it was ultimately deemed inappropriate for two main reasons.

First, when choosing a theoretical approach for the research, the interaction with the case-study work environment was considered. BAE has been involved in the research at every stage through quarterly meetings with the core industrial team (see Chapter 3 for more detail). These meetings provided BAE with an update on research progress, and having a good relationship with the team was a priority to ensure the success of data collection. After reviewing SPT and its application, it was determined that a background in social science, sociology or anthropology – or time to read and learn – was required to gain an understanding of this approach. To ensure BAE employees supported the research, it was deemed vital that it was easily understandable, without prior background knowledge, and could be easily explained to disparate audiences in a short space of time. As introduced in Chapter 1, the strong engineering identity of BAE was observed during the early stages of the research in the initial quarterly meetings. Social science approaches are not dominant within the organisational culture of BAE (more details on this culture are provided in Chapter 5) and initial quarterly meetings suggested potential challenges with members of the team understanding SPT.

Second, the nature of the mixed-use site at Samlesbury means there are an array of practices that use energy. At the very early stage of the research, it became apparent that access to site and employees would be limited (more information on this, and the evolving methodology, due to data collection challenges, is provided in Chapter 3). This highlighted to the researcher that putting practices at the core of the research, as proponents of SPT do, might be challenging. As such, it was deemed that SPT would not be appropriate for the research. Instead, a cultural approach to examine energy use was considered, and was deemed a more suitable theoretical framework for the purposes of this study.

In addressing the limitations of each of the theories and frameworks discussed in this section, the thesis develops and applies a cultural approach to examine energy use, and by focusing on the energy culture of an individual or workforce, it demonstrates the nexus of determinants of energy use and an integration of the dualisms of structure and agency. To assist in directing the research, a framework was developed and applied throughout the research; however, it is a cultural framework, and – as detailed below – it provides opportunity to explore all determinants of individual energy use.

2.6 Cultural Approaches

Culture can mean different things to different people. Sovacool (2016) identifies four different cultural viewpoints – 'economic', 'political', 'professional' and 'epistemic' (Sovacool, 2016:812) – as ways to explore energy. Citing Allum *et al.,* (2008), he also acknowledges that 'geographical, cultures vary spatially or nationally' (Sovacool, 2016:812). The research acknowledges these differences in cultural viewpoints from a number of different directions. All four of Sovacool's (2016) cultures are explored when addressing research Objective 4 in Chapters 8 and 9. These chapters also highlight how different national and international cultures can influence energy use in the workplace. This cultural approach is very much a way of exploring determinants of energy use, and it resonates most closely with the term 'epistemic culture' (Sovacool, 2016:812). The cultural framework presented towards the end of this chapter is not a rigid framework; rather, it is a lifestyle approach encompassing the various determinants of energy use identified in this chapter. In doing so, it addresses the limitations of much academic work, namely that a one-size-fits-all approach (Christoffersen *et al.*, 2006) is not appropriate for addressing energy efficiency in industry. As is detailed in the thesis, the research views the energy culture of an organisation as holistic, encompassing many influences on energy use, and as a culture that will continually evolve with space and time.

Applying a cultural approach to examine topics of energy use is particularly relevant for the workplace setting being examined. Organisations often use the term 'culture' to describe the day-to-day activities in the workplace; for example, the organisational culture or safety culture (Hofstede, 2001; Straub *et al.*, 2002; Cole, 2004; Mullins, 2007; Brooks, 2009). In addition to this, workplaces often have subcultures (Straub *et al.*, 2002; Boisnier and Chatman, 2013), such as safety cultures (Olive *et al.*, 2006; Guldenmund, 2008; Beus *et al.*, 2015), which are often acknowledged and talked about in organisations. The thesis proposes that discussing energy use in terms of culture can help organisations understand how they use energy, which could lead to reductions in energy use. This topic, and associated literature, is discussed in greater depth in Chapter 6 within the context of BAE Systems.

Energy Culture Framework

A major influence on the evolution of the research was the work of an interdisciplinary team who developed the energy culture framework (ECF; Stephenson *et al.*, 2010, 2015) and applied it to a variety of scenarios, including the energy efficiency of timber drying technology (Bell *et al.*, 2014), transport (Hopkins and Stephenson, 2014), legal frameworks (Eusterfeldhaus and Barton, 2011) and household environments (Mirosa *et al.*, 2013).

The aim of the ECF developed by Stephenson and colleagues is to:

> ‘centre on the behaviour of individuals within the system, and to explore outwards from that point the aspects of the system that most strongly influence behaviour, and from there consider what interventions might be successful in achieving behaviour change.’
>
> (Stephenson *et al.*, 2010:6121)

With this in mind, they use the term ‘culture’ to ‘signal … [that] distinctive clusters of knowledge, belief, behaviour and material objects (as held by individuals and groups) will have some bearing on the way energy is used’ (Stephenson *et al.*, 2010:6123). It is very much a way of exploring and examining activities, what Sovacool (2016) describes as an epistemic culture.

In developing the ECF, Stephenson *et al.,* (2015) examine the interaction between three core themes: material culture, practice and norms. Each of these core themes can be seen as an individual interacting system. The authors see material culture ‘as a technical system in its own right’ (Stephenson *et al.*, 2010: 6124), comprising ‘the technologies, structures and other assets that play a role in how energy is used’. It is the physical environment where energy behaviours occur, and may include infrastructure and technologies. Recognising that energy may be a by-product of practices, they see practices as ‘the interactions between individual, social and institutional behaviours’ (Stephenson *et al.*, 2010:6124). The ‘energy practice’ is how energy is physically used. Finally, norms are ‘people’s expectations and aspirations about their practices and material culture’ (Stephenson *et al.*, 2015:119). This theme focuses on what people believe or what they perceive as being the norm.

Figure 2:9 shows an example of how the ECF can be used to characterise home heating behaviours. At the centre of the ECF are the three interacting core themes, material culture, cognitive norms, and energy practices (blue circle); clustered around each of the three core themes are energy behaviours and decisions made around home heating behaviours (green text). Stephenson *et al.,* (2010) use the ECF to explore the wider systemic influences on these behaviours and decisions (black text). These are the ‘factors that are largely beyond the control of the subject in question, and yet have the potential to shape their norms, practices or material culture’ (Stephenson *et al.*, 2015:120). One of the purposes of the ECF is to view these wider systemic influences as opportunities, where interventions could be applied, which would then change the behaviours/themes of choice and subsequently lead to a sustained change in energy culture.

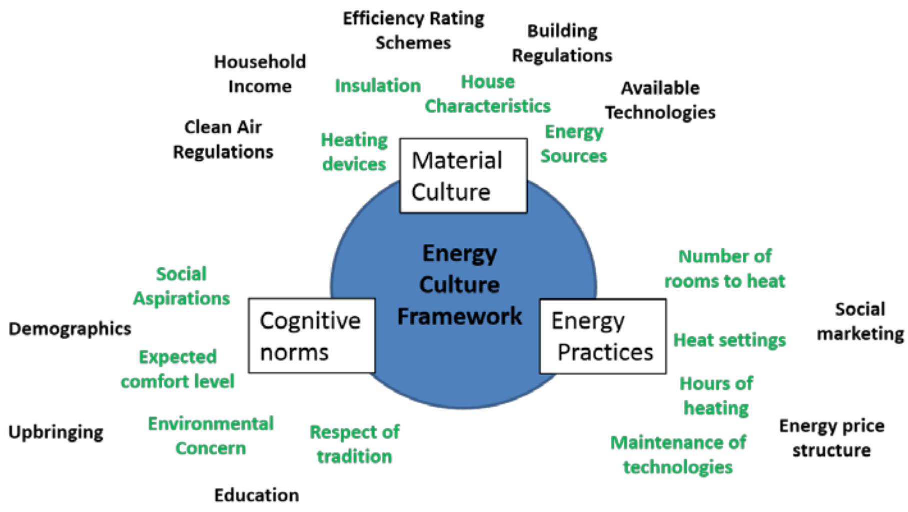


Figure 2:9: An example of an energy culture framework for home heating behaviours (adapted from Stephenson et al., 2010:6124)

When exploring the suitability of the ECF for use in the research, the question of where the organisation would fit into the framework was explored. Organisational influences such as organisational culture, informational communication channels and management (Ramus and Steger, 2000; Johansson *et al.*, 2011; Robertson and Barling, 2012; Walls and Hoffman, 2012; Endrejat *et al.*, 2015), as highlighted in Section 2.4, can influence all three core principles of the ECF. For example, the energy practices in a workplace are based on the individual energy culture and also what the organisation dictates as work tasks. The ECF has the capacity to include organisational elements but it does not reinforce the importance of these influences, in its current diagrammatic form. It was therefore deemed inappropriate to use this framework as it stands; however, the ECF was used as the foundation to the cultural approach used in the research (detailed in Section 2.7).

2.6.1 Evolution of the Cultural Approach to Consumption and Energy Cultures

The ECF is not the only cultural approach applied by researchers exploring energy usage topics. One of the first examples of how a cultural approach may be applied is provided by Lutzenhiser (1992), who developed a cultural model drawing on research from sociology and anthropology when addressing consumption. His results highlight the interwoven nature of roles, relationships, conventional understandings, and rules and beliefs, with technology in different environments (Lutzenhiser, 1992). The ECF builds on Lutzenhiser's work and addresses his call for more theoretical developments on cultural analysis of consumption. This PhD research builds on Lutzenhiser's (1992) and Stephenson *et al.*'s (2010, 2015) work by addressing this lack of empirical research using a cultural analysis.

Aune (1998, 2007, 2012) also uses a cultural approach in research on energy consumption and everyday life in Norwegian households. The research findings highlight how using a cultural analysis can show the various factors shaping consumption patterns. It also highlights how practical, symbolic and material aspects of everyday life frame consumption. This approach is very similar to the ECF with the exploration of three core aspects of everyday life, material, cognitive norms and practices themes.

Additional cultural approaches to examine behaviour are provided in the work of Higgs and McMillan (2006), who discuss the different avenues taken by secondary schools to promote sustainable behaviours and sustainability. Higgs and McMillan focus their research on four themes – individual role models, facilities and operations, governance and school culture – through which schools promote sustainability. The associated separate discussions on these themes demonstrate how each school's culture differs. Building on this school research, Schelly *et al.,* (2011) compare two different public schools and use 'conservation culture' terminology to discuss electricity use and savings. Their research observes that there are distinct differences in leadership, communications, efficiency and school cultures between the two schools. This research concludes that 'organisational change may be most effective through a complex interplay of infrastructural and organisational factors and the participation of leaders at multiple levels of the organisational structure' (Schelly *et al.*, 2011:339). It highlights how two different workplaces can experience different approaches and cultures through an interplay between infrastructure, leadership and the organisation. This may explain why Schleich and Gruber (2008) found differences in barriers with different subsectors, and may contribute to additional reasons why comparative feedback was successful in the workplace explored by Siero *et al.,* (1996). The work by Higgs and McMillan (2006) and Schelly *et al.,* (2011) does not directly examine energy use; however, it does demonstrate how a cultural approach can be applied to workplaces to identify the variety of determinants on a school culture.

2.7 PhD Conceptual Framework

This chapter has demonstrated that there are a wide range of determinants for the adoption of energy-efficiency practices and wider pro-environmental behaviours such as environmental orientation (Dunlap *et al.*, 2000; Zelezny *et al.*, 2000; Urban and Scasny, 2012), psychological variables (Ajzen, 1991; Stern, 2000; Greaves *et al.*, 2013; Chen and Knight, 2014) and the attitudes of managers, colleagues and boards of directors (Ramus and Steger, 2000; Abdelaziz *et al.*, 2011; Johansson *et al.*, 2011; Robertson and Barling, 2012; Walls and Hoffman, 2012; Endrejat *et al.*, 2015). In addition, this chapter has identified a number of barriers to the adoption of energy-efficiency practices in the workplace, such as concern about the impact on production (Hasanbeigi *et al.*, 2010), investment concerns (Schleich, 2004; Hasanbeigi *et al.*, 2010), lack of appropriate knowledge on energy use and improvement options (Schleich, 2004; Schleich and Gruber, 2008; Liu, 2012) and organisational structure (Andrews and Johnson, 2016). By examining the workplace it becomes apparent that barriers, some of which are listed above, can be examined at individual and organisational levels. These themes of individual and organisation form the basis of the *workplace energy culture framework* that this research proposes. In doing so, it addresses the calls for research to incorporate both organisational and individual influences on energy use (Lo *et al.*, 2012; Andrews and Johnson, 2016) and the call to explore energy use through a cultural lens (Andrews and Johnson, 2016).

The workplace energy culture framework (Figure 2:10) provides an opportunity to examine the energy culture of a workplace. It bridges the gap between structure and agency debates, discussed previously, by providing opportunities to examine the individual and how employees can act as free agents, and also how they act in the wider structures of the workplace and the organisation. Earlier it was explained why SPT was deemed inappropriate for the research. However, the SPT approach of looking at the interaction of practice and material objects has influenced the development of this framework. Practice theorists see the social world as:

> 'a vast array of assemblage of performances made durable by being inscribed in human bodies and minds, objects and texts, and knotted together in such a way that the results of one performance become the resource for another.'
>
> (Nicolini, 2012:2)

This is one of the foundations for the cultural lenses applied in the research. It acknowledges that energy activities that occur in the workplace are constructed from a nexus of interacting influences on the individual, which may be structure or agency-oriented, related to individual cognitive norms, material objects, normative individual energy practices, peers or organisational cultures.

In addition to SPT, the framework also draws on key elements of the TPB (Ajzen, 1991), VBN theory, (Stern, 2000), the energy culture framework (Stephenson *et al*., 2000, 2015), the sustainable waste management conceptual framework (Tudor *et al.*, 2007, 2008) and wider cultural approaches (Lutzenhiser, 1992; Aune, 1998, 2007, 2012; Higgs and McMillan, 2006), while also incorporating ways to examine the physical environment. Table 2:1 demonstrates how the literature discussed in this review has been incorporated into the workplace energy culture framework.

The research proposes that by applying the workplace energy culture framework, a workplace can gain an understanding of the nexus of interacting organisational and individual determinants on energy use. By gaining an understanding of the current energy culture, the thesis also proposes that workplaces can then target specific determinants, and seek to change or alter them. These changes could involve modifications to infrastructure, business structure or technologies to change organisational themes, or the development of tailored interventions to change individual determinants. By doing so, the research suggests that workplaces can then create or develop an energy-efficient energy culture. This theme is discussed further in Chapter 9, which reflects on the application of the workplace energy culture framework and discusses future applications.

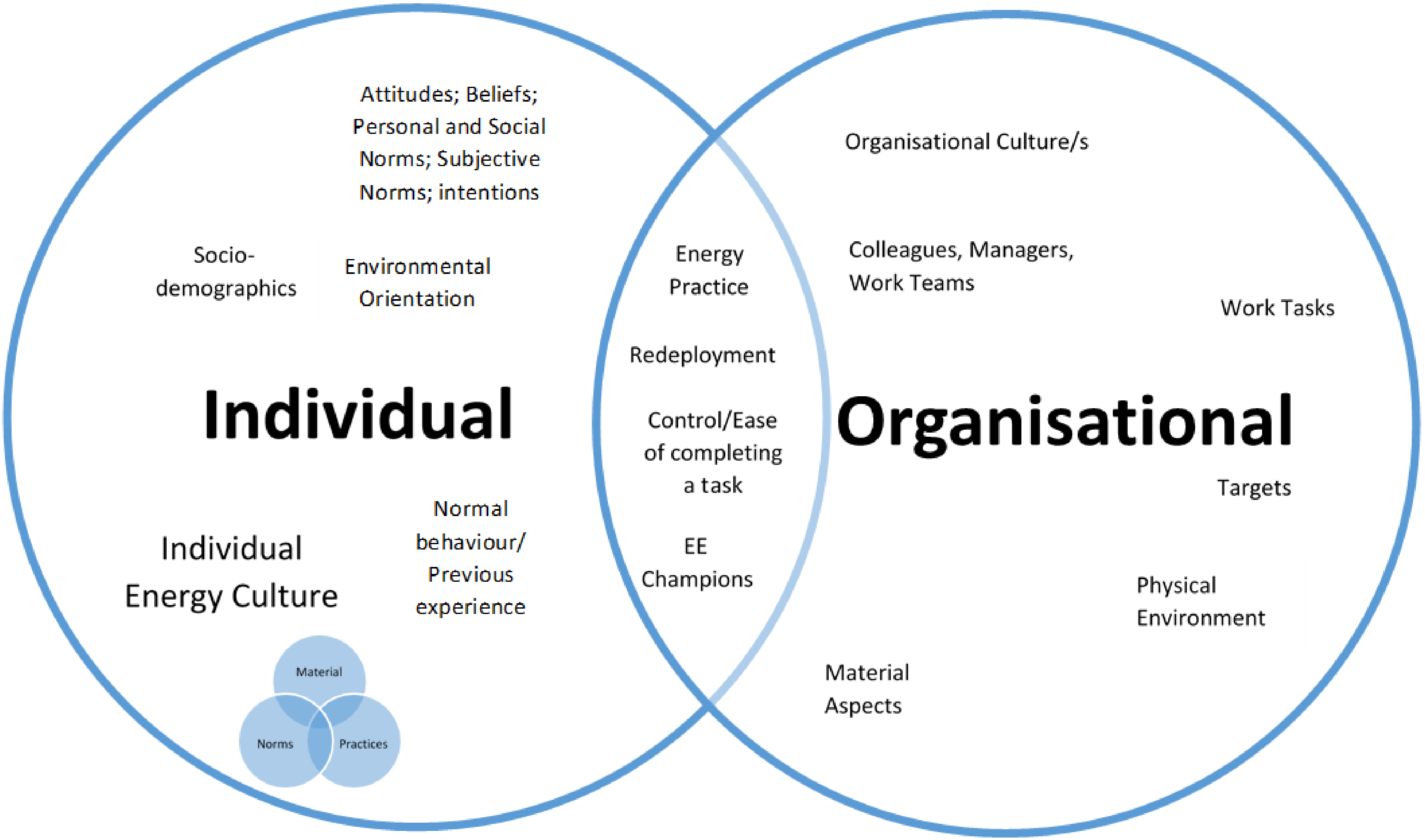


Figure 2:10: Workplace energy culture conceptual framework for the research

Table 2:1: How the literature in this review has assisted in developing the conceptual framework associated with this PhD research

	Influence	**Summary of behaviour/theme**	**Details of the research that has influenced this behaviour/theme**
Individual	Individual energy cultures	Workplace environments need to understand that employees will have their own individual energy cultures that need to be considered when seeking to change workplace energy tasks	Stephenson *et al.,* (2010, 2015) provides a detailed framework that explores individual energy cultures
	Attitudes, beliefs, personal norms, social norms, subjective norms, intentions	This group of influences explores the personal values of individuals. These include employees attitudes towards a particular behaviour, their beliefs surrounding that behaviour, what they perceived as normal or appropriate behaviour and their intention to perform a given behaviour	1: TPB (Ajzen, 1991) 2: VBN theory (Stern, 2000) 3: Scherbaum *et al*., (2008) explored these in a workplace environment 4: More recently, research by Ucci *et al.,* (2014), Stephenson *et al.,* (2010, 2015) and Unsworth *et al*., (2013) has also incorporated these psychological influences in frameworks/models
	Environmental orientation	Explores the environmental values of an individual. Research has shown some correlation between environmental values and pro-environmental behaviours	1: Dunlap *et al*., (2000) and studies cited have applied the NEP scale to explore environmental orientation 2: Urban and Scasny (2012) also found links between environmental values and pro-environmental behaviours 3: Uses of the NEP scale are seen in research by Stephenson *et al.,* (2010, 2015), Zelezny (2000), Ucci *et al.,* (2014) and Stern (2000)
	Normal behaviour/ previous experience	Research has demonstrated a ‘spill-over’ effect, when behaviours may ‘spill-over’ or be transferred to different scenarios. This can also be described as an individual’s previous experience conducting a particular behaviour	1: Whitmarsh and O’Neill (2010) and Austin *et al.,* (2011) – spill-over effects 2: Lee *et al*., (1995) applies this theory by exploring workplace recycling tasks
	Socio-demographics	Previous work has found links between a range of demographic variables and pro-environmental behaviour	1: Abrahamse and Steg (2009) 2: Laidley (2013) 3: Zelezny *et al*., (2000)

Table 2:1 continued

	Influence	Summary of behaviour/theme	Details of the research that has influenced this behaviour/theme
Organisational Influences	Physical environment and work tasks	Many of the previous frameworks exploring workplace pro-environmental behaviour or energy use have failed to explore the impact of the physical environment. This influence stresses the importance of the physical environmental and material objectives employees are required to interact with	The physical environment and material objects are also incorporated into wider cultural approaches, for example Aune (1998, 2007, 2011), Lutzenhiser (1992), Stephenson *et al*., 2010, 2015)
	Material aspects	Explores the more technical side to energy use such as heating devices, insulation, energy systems	Stephenson *et al*., (2010, 2015) incorporate these aspects into their work
	Safety, health, environment (SHE) team	This is a specific influence to BAE Systems. This team look after all elements of safety, health and environment within the case-study environment	1: Discussions with core BAE team have highlighted the role of SHE 2: Higgs and McMillan (2006) highlight facilities and operations as areas to promote sustainability 3: Argote and Ingram (2000) detail how teams can act as a form of knowledge transfer
	Managers	Managers directly influence departments' and work teams' energy consumption through providing day-to-day tasks, setting agenda, encouraging debate. Colleagues can influence energy consumption of others. They can set a norm level of behaviour in a given place. This cluster will specifically focus on the informal networks in the organisation. The TPB (Ajzen, 1991) and its application (Scherbaum *et al.*, 2008; Chen and Knight, 2014; Bamberg and Schmidt, 2003; Dixon *et al.*, 2015) highlight the role of colleagues and managers as an important consideration in the subjective norms	1: Johansson *et al.,* (2011) 2: Schelly *et al.,* (2011) – leadership 3: McGrath and Argote (2008) – knowledge transfer through members 4: Higgs and McMillan (2006) – individual role models 5: Supportive role of managers and supervisors had an impact on employee willingness to promote pro-environmental behaviours (Ramus and Steger, 2000; Walls and Hoffman, 2012; Robertson and Barling, 2012; Lo *et al.,* 2012; Kasim, 2009) 6: TPB (Ajzen, 1991)
	Colleagues		1: Higgs and McMillan (2006) – individual role models 2: Argote and Ingram (2000) – knowledge transfer through informal networks 3: TPB (Ajzen, 1991) 4: Chen and Knight (2014)
	Organisational culture/s	Within workplace there will be a specific workplace culture/s, which may provide unofficial knowledge/rules about how employees should act	1: Higgs and McMillan (2006) 2: Schelly *et al.*, (2011) 3: Wider organisational literature (Hofstede, 2001; Cole, 2005; Mullins, 2007; Brooks, 2009)

Table 2:1 continued

	Influence	Summary of behaviour/theme	Details of the research that has influenced this behaviour/theme
Cross-over section	Control/ease of completing a task	This theme is intended to explore the amount of control employees have when exploring energy activities. The TPB has highlighted that perceived behavioural control is important when considering individual behaviours. In addition to this theme, this relates to the physical environment theme, when exploring individuals access to control	1: Ajzen (1991) 2: Chen and Knight (2014) 3: Consequence of conducting a task (Stern, 2000)
	Energy and environment champions (EE champions)	Specific influence to BAE Systems. The role of the EE champions within the organisation with regards to energy, is to promote conservation and highlight areas where energy consumption can be reduced. This is in the cross over section as each EE champion will have their own individual personality, norms, beliefs, but they can also influence other employees	1: Discussions with core BAE team have highlighted the role EE champions have 2: Higgs and McMillan (2006) – individual role models 3: Argote and Ingram (2000)
	Redeployment	The case-study organisation in question has seen a lot of redeployment between departments in recent years. Redeployment is an organisational decision and has a direct impact on the individual who is being redeployed. However, the movement of that individual to a new environment also has the potential to change energy use of other employees with the transfer of knowledge/behaviours	1: McGrath and Argote (2008) – knowledge transfer through members 2: Argote and Ingram (2000) – knowledge transfer through informal networks 3: Higgs and McMillan (2006) – individual role models
	Energy practice	This is the physical energy task that is conducted by the employee. This fundamentally impacts energy use in the business but is both an influence of the individual and the organisation	Stephenson *et al.,* (2010, 2015)

2.8 Conclusion

This chapter has provided details of how and why the workplace energy culture framework presented in Figure 2:10 has been developed to inform research on energy use in the workplace. It has detailed how there is a need for more energy research that explores the end-user in the workplace. In doing so, it has demonstrated how energy research and government legislation often fail to acknowledge the end-user and often focus on technological approaches to improve energy efficiency. This chapter has explained how end-users are often required to interact with technological systems, and how they can often determine the success or failure of them. This stresses the important role the end-user plays in improving energy efficiency. The framework presented in this chapter acknowledges this role, and provides opportunities to examine the various technological, organisational and individual influences on the way energy is used in the workplace. By examining the energy culture of a workplace, an understanding of these influences can be gained, and in a similar way to the energy culture framework (Stephenson *et al*., 2010, 2015), elements of the workplace energy culture can then be targeted to change the culture of the site, and consequently improve energy efficiency.

In the development of the workplace energy culture framework, this chapter has provided an overview of research that can be categorised into that focusing on barriers to adopting energy-efficiency behaviours, the links between socio-demographics and energy use, the analysis and development of interventions to change behaviours and address barriers, and various approaches to examining energy use. It has also reviewed research that assists with gaining an understanding of the workplace. It has argued that current approaches and frameworks applied to examine energy use have limitations that prevent adequate applications to examine energy in a workplace setting. To address this, the workplace energy culture framework has been developed, which consequently addresses the first research objective.

The framework presented in the chapter has informed this PhD research, and consequently appears throughout the thesis. Chapter 3 provides details on how it has been operationalised to achieve the research aim, and subsequent chapters address the remaining research objectives. The penultimate chapter of the thesis evaluates the application of this framework and provides a critique of the framework. It demonstrates how results from the research can be incorporated into a revised framework to inform future research on energy cultures in the workplace.

3 Methodology

This chapter details how each of the following objectives has been operationalised through a mixed-methods methodology:

1. *Define a framework for informing research on energy cultures in the industrial workplace.*
2. *Detail the evolving nature of organisational priorities and organisational cultures.*
3. *Detail and review employees' attitudes towards energy use.*
4. *Examine the geographies of energy cultures.*

3.1 Introduction

This chapter details how the workplace energy culture framework presented in Chapter 2 has been operationalised to address the research aim 'apply an energy culture approach to examine energy use in an industrial workplace'. It provides details on how the framework has directed decisions on which research methods to conduct, and also outlines how the remaining research objectives will be addressed. It also provides a discussion on some challenges experienced during the course of the research in gaining access to the workplace. This, along with delays in obtaining ethical approval, led to an evolution of the research design. This chapter provides an account of this evolution, along with details of the methods of analysis.

The chapter is structured in eight sections. The first section discusses the philosophical groundings of the research and how it resonates with the research paradigm of pragmatism. It explains why this approach is appropriate for addressing the aim of the research and moves on to describe why a case-study approach was adopted. It also describes how access to BAE and participants was gained through a process of establishing relationships with gatekeepers within BAE. The second section details how and why a mixed-methods approach was used in the research. It describes the research methods of surveys, interviews, focus groups, and observations, which were used in the research, and explains how each method contributes to addressing each research objective. The third section describes some of the ethical considerations and challenges associated with the research. The fourth section provides details of how the methods were applied, showing how a pilot study was operationalised and how the findings impacted the main survey design. The fifth section provides details of how the methodology evolved during the course of the research, describing a proposed schedule of fieldwork and the problems encountered in survey distribution and gaining access to participants. It also describes how the research design was altered to overcome these problems, and details the actual schedule of fieldwork. The sixth and seventh sections discuss how the empirical material collected from the mixed-methods design was analysed. They describe how different analytical methods were applied to address each research objective. The final section describes how the workplace energy culture framework presented in Chapter 2 developed during the course of the research, and where this development is articulated throughout the thesis.

3.2 Research Paradigm

The 'research onion' (Saunders *et al.*, 2009) demonstrates how the philosophical grounding of the researcher and the research can influence decisions about which approach to apply to address research aims and objectives, what research design to conduct, and what methods of analysis to undertake. This is a common approach in social science research (see Figure 3:1).

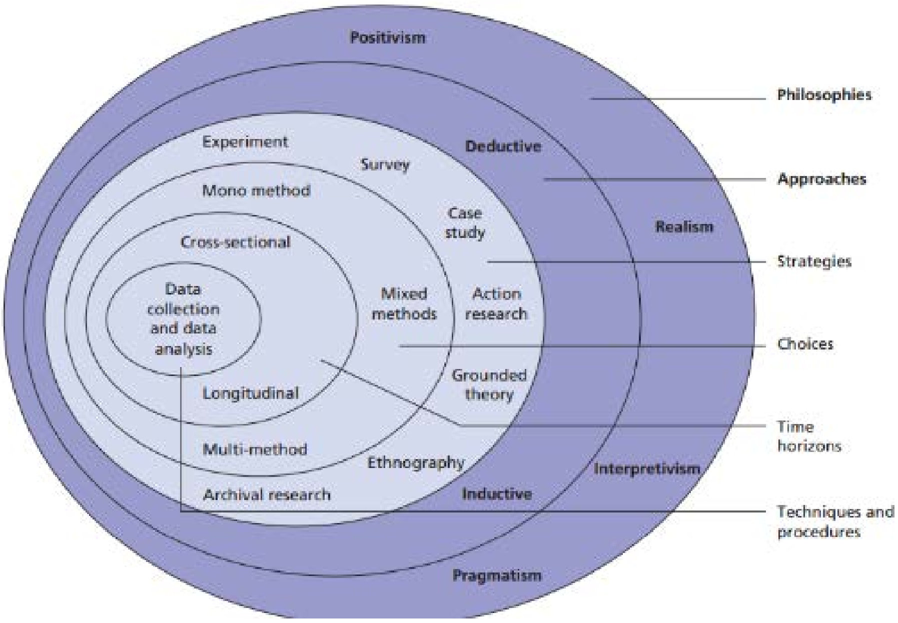


Figure 3:1 The 'research onion' (Saunders et al., 2009:83)

This research uses the terminology of the research paradigm to describe the researcher's worldview to avoid any hierarchical order associated with ontological, epistemological and methodological discussions (Morgan, 2007). There are multiple views of the definition and use of paradigms (Bryman, 2006; Morgan, 2007; Mertens, 2012; Freshwater and Cahill, 2013; Shannon-Baker, 2015); the research uses the definition provided by Morgan (2007). A paradigm is a:

> 'system of beliefs and practices that influence how researchers select both the questions they study and methods that they use to study them.'
>
> (Morgan, 2007:49)

BAE, the industrial partner of this EPSRC CASE award, was involved in this project from the beginning, co-writing the studentship and appointing the researcher. Although the researcher designed and conducted the research, regular meetings with the core BAE team and site visits shaped research decisions. It is not uncommon for the philosophical grounding of a researcher to be influenced by practical considerations (Saunders *et al.*, 2009). Consequently, the design of the research involved an interplay of ontology, epistemology, methodology and practical considerations associated with the workplace. Morgan argues that this approach, as well as 'rejecting a top-down privilege of ontological assumptions' (Morgan 2007:68), is one that resonates with the research paradigm of pragmatism. Prior to discussing the pragmatism research paradigm, an overview of other research paradigms is provided. Doing this demonstrates the appropriateness of using a pragmatic approach by providing some reasoning for rejecting other traditional metaphysical paradigms. There is a vast array of research on paradigm discussions (e.g. Lincoln and Guba, 1985; Saunders *et al.*, 2009; Teddlie and Tashakkori, 2009; Bryman, 2012). However this overview is limited to the paradigms highlighted by the outer ring of the 'research onion' (see Figure 3:1; Saunders *et al*., 2009):

- *Positivism* is often referred to as the 'scientific method' and is predominantly associated with quantitatively oriented methods (Teddlie and Tashakkori, 2009). Research with a positivist stance often takes the form of a hypothesis, which leads to the gathering of facts and hypothesis testing (Saunders *et al*., 2009). However, critics of this paradigm argue that the study of humans and real-life settings cannot always be measured (Hughes and Sharrock, 1997; Giddens and Sutton, 2013).

- *Realism* shares features of positivism in that it explores the meaning of the world through scientific practices (Bryman, 2008), but it sees knowledge as advancing through theory-building processes and holds that social structures are products of social relationships (Gray, 2009). Researchers with a realist view also acknowledge that some observations or 'facts' may be 'illusions', and some phenomena cannot be observed but may still exist (Gray, 2009). They see reality as being independent of the mind (Saunders *et al*., 2009).

- *Interpretivism* is a contrasting paradigm to positivism (Bryman, 2008) and is closely linked to the constructionist paradigm (Gray, 2009). It seeks to gain an understanding of the social world of participants (Saunders *et al*., 2009) and assumes that 'knowledge can only be created and understood from the point of view of the individual' (Hatch and Cunliffe, 2006:13). However, as Hatch and Cunliffe (2006) explain, this paradigm requires the interpretation of reality by the researcher.

As stated earlier the research resonates with the research paradigm of pragmatism, which is the 'primary philosophy of mixed [methods] research' (Johnson *et al.*, 2007:113). A common overview of this paradigm is that it places importance on the research question (Saunders *et al.*, 2009; Tashakkori and Teddlie, 2010) and chooses methods most appropriate to address the research question or aim (Mertens, 2012). One definition of pragmatism is:

> 'a deconstruction paradigm that debunks concepts such as 'trust' and 'reality' and focuses instead on 'what works' as the truth regarding the research questions under investigation. Pragmatism rejects the either/or in choices associated with the paradigm wars, advocates for the use of mixed methods in research, and acknowledges that the values of the researcher play a large role in interpretation of results.'
>
> (Tashakkori and Teddlie, 2010:173)

Using this research paradigm acknowledges the positivist, realist and interpretivist ways of viewing knowledge, and explores what is meaningful from each (Biesta, 2010). It also acknowledges the quantitative and qualitative divide associated with the 'paradigm wars' (Bryman, 2008) and allows paradigms to be both mixed and, if required, applied to different aspects of the research to address the advantages and disadvantages associated with each (Johnson *et al.*, 2007; Biesta, 2010; Shannon-Baker, 2015). The research cited in Chapter 2 demonstrated how the pragmatism research paradigm resonates well with cultural approaches. Research by Aune (1998), who applied a cultural approach to examine household energy use, uses elements of a variety of research paradigms where appropriate, and the work by Stephenson *et al*., (2010, 2015) involves multidisciplinary researchers and applies a mixed-methods research design and analytical approaches. This demonstrates how a pragmatism research paradigm is appropriate for a cultural approach.

As is explained in this chapter, a major unknown during the course of research design and data collection was how much access the researcher would have to the Samlesbury site and its employees. Consequently, the methodology continually evolved throughout data collection. Pragmatism is sometimes described as a problem-solving paradigm (Morgan, 2014), which makes it particularly suitable for the research and its evolving methodology. The five steps of pragmatic inquiry can be described as:

> ‘1 – Recognizing a situation as problematic,
>
> 2 – Considering the difference it makes to define the problem one way rather than another,
>
> 3 – Developing a possible line of action as a response to the problem,
>
> 4 – Evaluating potential actions in terms of their likely consequences,
>
> 5 – Taking actions that are felt to be likely to address the problematic situation.’
>
> (Morgan, 2007:1047)

This extract shows the relationship between researcher actions and beliefs throughout the research process. Researchers have to make choices about what they believe is right or wrong through a process of inquiry (Morgan, 2007). Inquiry serves at the centre of the pragmatism paradigm, moving away from metaphysical views and the top-down nature of ontology, epistemology and methodology. More detailed discussions on the pragmatism paradigm can be found in Morgan (2007, 2014), Teddlie and Tashakkori (2009), Biesta (2010) and Hall (2013).

3.2.1 Case-Study Approach

The mixed methods associated with the research were situated within a case-study research design. The case-study approach has different definitions depending upon the researcher and his/her disciplinary background (Platt, 2007). Yin defines a case-study approach as:

> ‘an empirical inquiry that:
>
> - investigates a contemporary phenomenon in depth and within its real-life context, especially when
> - the boundaries between phenomenon and context are not clearly evident.
>
> … The case study inquiry:
>
> - copes with the technically distinctive situations in which there will be many more variables of interest than data points, and as one result
> - relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result
> - benefits from the prior development of theoretical propositions to guide data collection and analysis. ‘
>
> (Yin, 2009:18)

As this extract suggests, a case-study inquiry involves a mixed-methods research design, which is developed from established theoretical frameworks that produce rich datasets. There are three types of case-study inquiry: exploratory, descriptive and explanatory (Yin, 2009). The research outlined in this chapter crosses over each of these three types. It is *exploratory* because it applies an energy culture approach to examine energy use in an industrial workplace, which has not been applied previously. It also has characteristics of a *descriptive* case study when detailing and reviewing employees' attitudes toward energy use. Finally, it also has some aspects of *explanatory* case studies as it uses the energy culture framework to provide some possible explanations for the energy culture at BAE. Doing this provides information on how an energy culture approach could be applied to other industrial workplaces.

The research primarily used a single case-study approach. However, during the early stages of research design a multi-case-study approach was designed (see Figure 3:2). One of the limitations of using a case-study methodology, applicable to the research, is that 'they provide little basis for scientific generalization' (Yin, 2009:15), a point reiterated by others (Denscombe, 2010; Chadderton and Torrance, 2011; Bryman, 2012). The research does not seek to provide generalizations that could be applied to other workplace environments. As previously mentioned, a 'one-size-fits-all' approach is not appropriate for workplaces (Christoffersen *et al.*, 2006:516). However, in addressing the aim and objectives, it defines a framework that could be used by others to explore energy use in the workplace.

At the start of this research, a multi-case-study approach was designed, which aimed to explore energy cultures within a public and a private organisation. It soon became apparent during the early stages of research within BAE that this was an ambitious task for a novice researcher with no previous relationships with the workplaces. The CASE award nature of this PhD had already created contacts with a private organisation; however, a public organisation would also be required. Research letters were sent out to Manchester City Council to try to establish another case-study environment, and a meeting was held with representative from the council. However, the early stages of research at BAE created a realization that gaining an understanding of one organisation, and its organisational culture, would be challenging as it involves working in 'complex social situations' (Cunliffe and Alcadipani, 2016:1). The early stages of contact with BAE highlighted challenges with relying on other people to assist with data collection, and the impact this can have on timescales. Consequently, the research was defined by focusing on a single case-study approach.

Figure 3:2: Reflective account of the early stages of research design

3.2.2 Access to BAE

In outlining the methods for gaining access to participants and sites, authors such as Hodgson and Alcadipani (2009), Bryman (2012) and Bell and Thorpe (2013) often describe this as a linear process. However, as Cunliffe and Alcadipani (2016) and Buchanan and Bryman (2007) point out, this is frequently not the case. Gaining access to organisations adds a further complexity to the challenges associated with accessing participants (Bryman, 2012). Gaining access often involves a mix of negotiations, many of which remain ongoing throughout the research project. These include discussions on trust between researcher and participants, and researcher and the workplace, the logistics of conducting research, the organisational and researcher history, any organisational politics, permission to conduct research and gain access to the workplace, potential politics of publishing and ethical dilemmas (Buchanan and Bryman, 2007; Cunliffe and Alcadipani, 2016). It is not in the scope of the research to review these challenges; however, a detailed description of access, and gaining access, is required to provide an understanding of how it shaped the methodology.

Earlier, the research stated that being granted HMG Baseline Personal Security Standards (BPSS) (Figure 1:8) was a requirement to gain access to the Samlesbury site. This was a formal process, conducted at the early stages of this EPSRC CASE award studentship. However, it was a security check and did not grant physical access. This can be described as 'primary access', where formal permission has been granted, with 'secondary access' involving the building of relationships and gaining of access to relevant information or participants (Brannick and Coghlan, 2007:67). Using their terminology, the 'secondary access' for the research involved frequent meetings with the BAE core team (TM1, TM2 and TM3). Frequent discussions occurred with TM1 at the early stages to assist with defining the research area, and to discuss potential fieldwork opportunities within BAE. This is a common process in research conducted within organisations where the choices of methods, research aims and epistemological concerns may be shaped by characteristics of the organisation, with research methods potentially changing as organisational circumstances change (Buchanan and Bryman, 2007).

TM1 acted as the initial gatekeeper for the research. Gatekeepers are people who act as intermediators between the researcher and participants; they may grant access or put the researcher in contact with other employees who can assist with research (De Laine, 2000; Bryman, 2012; Crowhurst and Kennedy-Macfoy, 2013). Discussions with TM1 led to the involvement of TM2 and TM3 in shaping the research methodology. The BAE core team proved an invaluable resource to the research, informing the research methods with many ideas, some of which were applied on site, acting as gatekeepers to employees and site access, providing knowledge of the site and organisational structures, and translating site terminology.

During the course of the research, as stated in Figure 3:3, the research methodology evolved. In the following section the work of Cunliffe and Alcadipani (2016) is used to assist with detailing the process of gaining and maintaining access. Table 3:1 provides an overview of Cunliffe and Alcadipani (2016), and reference is made to it throughout the next section.

At the start of this research, the researcher understood access to the site would not be a problem, considering the relationship BAE had with UCLan, and the co-written PhD advert for this research. However, during the course of the research, access was not as easy as was first thought, and the research approach changed on several occasions. Consequently, a section that details access to BAE was included within the methodology to show how these difficulties were approached and overcome. As the core industrial team were all volunteers on this research project, workplace priorities sometimes ranked higher than commitments associated with the research. When reflecting on this process and to determine what alternative approaches could have been taken, the researcher found the work of Cunliffe and Alcadipani (2016) useful (see Table 3:1).

Figure 3:3: Reflective account of access with BAE during course of this research

The involvement of the BAE core team resonates with the *immersion* category of Table 3:1, and during this phase of work a researcher–research relationship was built with the core team. It is important to note that TM2 and TM3 were involved in the research due to their personal interest in the topic, not from a work commitment perspective. The researcher was very aware of this, and subsequently wanted the research to be valuable for these team members in their everyday work tasks. Thus, during this immersion stage of research, the subject of access in Table 3:1 was also discussed.

The UCLan and BAE partnership and the appointment of this EPSRC CASE award studentship and subsequent BPSS would fall into the 'front-stage public performance' area of the 'backstage drama' feature of Table 3:1. However, within this feature are many 'secondary access' requirements – the backstage 'real work'. As Chapter 6 details, during the course of the research the organisational strategic priorities with regard to energy changed. Coupling this change with the uncertain economic climate – one of global recession – the priorities of the site altered to a focus on manufacturing and cost savings, rather than investment in energy and environment. This shaped this methodology, and as discussed below, methods were required to change after multiple attempts to conduct surveys. Another example of backstage 'real work' presented itself within the core research team. The research avoids using the phrase 'research team politics', as suggested in Table 3:1, as this phrase suggests a sense of negativity and problems with the research team. This was not the case. As stated in the *immersion* theme, TM2 and TM3 volunteered to be involved in the research, in addition to their everyday work tasks. This shaped the fieldwork. As this chapter explains, the researcher faced challenges with receiving responses to emails and confirming dates for commencing fieldwork with TM2 and TM3. Meetings would be held with the core team, where dates to complete tasks would be agreed. Post-meeting minutes and reminder emails would be sent detailing the agreed tasks that needed to be conducted. However, on many occasions the fieldwork was delayed, or emails were unanswered. The researcher does not believe that this was due to a lack of interest from TM2 and TM3, but rather from an immersion in everyday workloads and the research not being part of this workload (Munro *et al.*, 2005). Clark reiterates this point by stating 'gatekeepers have their own priorities, aims and interests' (Clark, 2011:489). The voluntary nature of TM2's and TM3's involvement in the research led the researcher to carefully manage and conduct research on site, by establishing and sustaining a good relationship with TM2 and TM3, who were the gatekeepers to the Samlesbury site.

Table 3:1: Key features of gaining and maintaining access (Cunliffe and Alcadipani, 2016:541)

Immersion	**Backstage drama**	**Deception**
Obtaining approval to do research in the organisation. Gaining acceptance and credibility. Establishing relationships and trust 1 – Who knows what you need to know? Access to data may require methodological creativity 2 – Who are the formal/informal gatekeepers and internal sponsors? 3 – The rhetoric of access: connecting the research with the interests of the organisation 4 – Building researcher–research participant relationships	Front-stage public performances (primary access) versus backstage 'real work' (secondary access). Researchers need to be aware of: 1 – 'Normal' interactions, conversations, tensions, and dissent 2 – Organisational politics, e.g. appropriating the researcher or research 3 – Potentially controversial data 4 – Deviant practices 5 – Research team politics	Being aware of how researchers and organisation members present themselves and their work. Understanding ethical choices in relation to: 1 – Managing impressions: potted biographies, self-presentation, faking/developing identity and interest, concealing and sharing intentions 2 – Revealing your hand – or not? Full disclosure of the purpose and nature of the research. Managing impressions. Evading or addressing conflicting expectations. Symbolic and rhetorical alignment 3 – Writing 'truthful' accounts: choices about what to include and exclude, translating fieldwork into meaningful knowledge

Finally, the *deception* theme of Table 3:1 was also present in the research. During site visits or meetings with the BAE core team, the researcher dressed smartly to impress the organisation's representatives. In addition to this, during the research process, a further change in appearance occurred when conducting fieldwork with manufacturing employees. Initially during these visits, the researcher would dress in office attire in an attempt to fit into the organisational environment, so as not to appear as an outsider. However, when conducting fieldwork in manufacturing areas, it became apparent that this appearance of an organisational employee was detrimental to the fieldwork, with one participant in the focus group asking 'do you work with TM2?'. This led to the researcher reflecting on her appearing within the BAE context, and the need to change appearance at different stages of fieldwork – that is, 'managing impressions' (Cunliffe and Alcadipani 2016:18). In an opposite move to that of Van Maanen (1978), who shifted from a student appearance to one that fitted in more appropriately with gaining access to the US police, the researcher adopted a more student-like appearance. This involved the purchase of an UCLan-branded hooded sweatshirt to wear during subsequent visits to manufacturing environments, which helped give the impression that the researcher was not an employee of BAE. This helped interaction with the employees in the manufacturing areas.

As this section has outlined, gaining and maintaining access to the site presented a number of methodological considerations. The researcher–research relationships needed to be developed, and more importantly understood, to ensure fieldwork would be successful and gatekeepers were engaged. This review of access has avoided discussing the ethical dilemmas associated with organisational research, and the nature of the research being conducted in a defence manufacturer. This discussion is grouped with wider ethical discussion of the research methods (Section 3.5).

3.3 Mixed-Methods Approach

As is common with the pragmatic paradigm, and when applying a case-study approach, the research uses a mixed-methods approach to explore energy cultures within BAE. Mixed-methods research, as Teddlie and Tashakkori (2009) state, has been described in a number of ways, including as a third path (Gorard and Taylor, 2004), a third research paradigm (Johnson and Onwuegbuzie, 2004) and a third methodological movement (Tashakkori and Teddlie, 2003). There are several definitions and a variety of ways to integrate mixed-methods research (Bryman, 2006, 2007; Johnson *et al.*, 2007; Creswell, 2009; Tashakkori and Teddlie, 2009; Yin, 2009). This section details what the thesis defines as a mixed-methods approach and also demonstrates how each objective had a different mixed-methods design.

In seeking a definition of mixed methods, Johnson *et al.,* examined thirty-six leading research methodologists for their current definition of mixed-methods research (Johnson *et al.*, 2007). They offer the following definition:

> 'Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research). It recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice that often will provide the most informative, complete, balanced, and useful research results.'
>
> (Johnson *et al.*, 2007:129)

This definition acknowledges how mixed methods can be referred to as a third paradigm, which highlighted the integrated nature of research methods and research paradigms. It does not, however, provide any specific definition of what mixed methods entails, with the exception of recognizing the quantitative and qualitative research methods. In seeking a further definition, work by Tashakkori and Teddlie (2003) highlights the differences between multi-method (where research methods are in parallel but inform research) and mixed methods (where there is some form of integration of methods or analysis). The research applied a mixed-method research approach. However, one of the challenges with using a mixed-methods approach is how to proceed with data collection and analysis. Does one integrate both methods? Or does one use a quasi-mixed approach (Teddlie and Tashakkori, 2006) where no integration occurs (multi-method)? Teddlie and Tashakkori, categorise mixed methods designs into five themes (see Figure 3:4).

1. **Sequential** … designs are where there are at least two research strands that occur chronologically. The data from one strand and the subsequent analysis, then leads to the development of further questions, data collection and analysis for the next strand.
2. **Parallel** … designs in which there are at least two interconnected research strands. In these designs the qualitative and quantitative data collection and analysis are independent of each other. However, the analysis of one type of data may influence the other.
3. **Conversion** … designs are multi-strand parallel design in which mixing of qualitative and quantitative approaches occurs in all components/stages of research design, with data transformed and analysed both qualitatively and quantitatively.
4. **Multilevel** ... mixing occurs as qualitative and quantitative data from different levels of analysis are analysed and integrated to answer aspects of the same or related questions.
5. **Fully integrated** … takes advantage of both a parallel and a sequential process in which mixing of qualitative and quantitative approaches occurs in an interactive manner at all stages of the study.

Figure 3:4: Types of mixed-methods design, as defined by Teddlie and Tashakkori (2006). Adapted from Teddlie an Tashakkori (2009:11,12)

In applying a mixed-methods research design, a number of approaches from Figure 3:4 were applied, as follows:

- *Objective 1 – Define a framework for informing research on energy cultures in the industrial workplace:* This objective was addressed in a preliminary manner in the previous chapter. However, the discussions associated with the remaining objectives directly impact this objective. Thus this objective uses a fully integrated mixed-methods approach. Further details on the development of the framework are presented in Section 3.9.

- *Objective 2 – Detail the evolving nature of organisational priorities and organisational cultures:* Observations, survey data, focus groups and interview data are all integrated to address this objective. Consequently, a fully integrated mixed-methods research design is implemented using aspects of parallel, sequential and multi-level mixed-methods design. Periodically during the research the collected data was reviewed with different knowledge gained through the process of analysis.

- *Objective 3 – Detail and review employees' attitudes towards energy use:* To address this research objective a sequential research design is used. The main focus is on survey data that explores general attitudes, although the questions asked in subsequent focus groups and interviews are structured to explore the main findings from the survey data in more depth.

- *Objective 4 – Examine the geographies of energy cultures:* This research objective uses a sequential research design. The results obtained from addressing Objective 3, and other research findings from site visits, provide indications of the different spaces to explore and subsequently address this research objective.

One of the main benefits of using a mixed-methods design for the research is the ability to generate a better understanding of the research environment (Weisner, 2005). A common method of validation of mixed methods is the triangulation method, originally introduced by Campbell and Fiske (1959). During this process, methods are combined to better inform the research, and act as a method of validation. Detailed discussion of triangulation is provided by Johnson *et al.,* (2007). It is important to note that throughout the research, the researcher was an 'outsider' to both the research and BAE. Applying triangulation allowed the researcher to gain more confidence in the results, while also providing opportunities to uncover any contradictions (Saunders *et al.*, 2009).

3.4 Methods

The primary methods of the research were surveys, interviews and focus groups. However, additional empirical material was collected from observations during site visits, document analysis and meetings with the core BAE team. Throughout this section, which details how each method was operationalised, a narrative of the proposed methodology and the employed methodology is provided. The purpose of this is to demonstrate the evolving nature of the methodology and to demonstrate why the operationalisation of the methods changed. To assist with navigation throughout this section, Table 3:2 provides an overview of the proposed and employed schedule of fieldwork. The remainder of this section provides details of each of the points in the table.

Table 3:2: Overview of the proposed and actual schedule of fieldwork

Method		**Proposed schedule**	**Actual schedule**
Site Visits	Pilot study survey and focus group	End of Nov 2013	Feb 2014
	Additional pilot study surveys	Nov and Dec 2013	Distribution: March–April 2014 Outcome: No surveys completed
	Main survey distribution	Jan–March 2014	July 2014–Feb 2015 Further details provided in Section 3.7
	Focus groups (FG) and interviews (Int) with: 2 × FG manufacturing areas 1 × FG Energy/environment champions 1 × Int with TM1 1 × Int with Rob Wallace (Dean of School of Engineering, UCLan)	April–Dec 2014	April–June 2015 1 × FG manufacturing area 2 × FG BAE sites in USA 1 × Int with Rob Wallace 1 × Int with TM1 1 × Int with TM2 and TM3

Surveys

> 'Survey research is a research method for gathering information about the characteristics, behaviors and/or attitudes of a population by administering a standardized set of questions … to a sample of individuals.'
>
> (McLafferty, 2010:77)

The extract above shows how surveys are a useful method for gathering information on attitudes and behaviours. Consequently, the results obtained from the survey provide the foundations for addressing research Objective 3: 'Detail and review employees' attitudes towards energy use', while also assisting with addressing Objective 4: 'Examine the geographies of energy cultures'. The results also provide additional empirical data for Objectives 1 and 2.

To ensure this was the most appropriate method to address Objective 3, discussions were held with the core BAE team. During these discussions it became apparent that as a business BAE administers an employee satisfaction survey (PULSE Survey) every two years. The core BAE team stated that employees would be familiar with a survey research method and they considered it to be the best means by which to obtain a variety of employees' attitudes across the site without requiring a lot of access.

Surveys can take a variety of different formats (Burns, 2000; Bryman, 2012; De Vaus, 2014). Through discussions with the core BAE team, it was determined that the most appropriate method for this work environment was the use of a self-administered survey (Bryman, 2012). To ensure the development and format of a survey was suitable for the employees on site, a survey was initially developed for a pilot study. Details on the survey design, including the formulation of questions and changes to the survey post-pilot study, are presented in Section 3.6.

Interviews and Focus Groups

Two focus groups (one in manufacturing areas, one in office areas)
Focus group with energy/environment champions
Interview with TM1
Interview with Rob Wallace (Dean of School of Engineering, UCLan)

Figure 3:5: Proposed interview and focus group schedule

After collection of survey data, a proposed schedule of semi-structured interviews and focus group discussions was discussed with the core BAE team. The proposed schedule (Figure 3:5) was to take place between July and December 2014. It was anticipated that this method would assist with addressing all four of the research objectives:

- *Objective 1 – Define a framework for informing research on energy cultures in the industrial workplace*: All the interviews and focus groups contribute knowledge about BAE and assist with developing the framework further.
- *Objective 2 – Detail the evolving nature of organisational priorities and organisational cultures*: The interview with Rob Wallace (UCLan) and TM1 provides insight into the wider BAE culture. Rob Wallace and TM1 have worked at BAE for a long time and have vast experience of the organisational structure. They have also worked at BAE during company mergers and have witnessed organisational culture changes. This makes them key persons to interview, who would be able to provide information regarding the organisational influences on energy use. Rob Wallace (UCLan) was heavily involved in creating the strategic partnership between UCLan and BAE. Prior to his appointment at UCLan, he was a BAE employee for approximately 22 years. This interview provided information on where the strategic partnership fits into BAE and its wider energy agenda, and also provides a further insight into organisational influences within BAE.

- *Objective 3 – Detail and review employees' attitudes towards energy use*: The proposed focus groups with manufacturing, office, and energy and environment (EE) champions act as a means of validating the survey data, while also providing a further insight into employees' attitudes towards energy use. The interview with EE champions would seek to gain their opinions on how they influence energy use in the workplace.
- *Objective 4 – Examine the geographies of energy cultures*: The schedule of research proposed that the survey data would determine whether there were differences in manufacturing areas on site. The focus groups would explore these differences further by asking employees specific questions relating to their work area and the energy use that occurs in it.

Observations

Throughout the course of the research, meetings were held at UCLan, BAE Samlesbury and BAE Warton with the core BAE team. The researcher was provided with opportunities to attend site meetings with the EE champions and SHE quarterly meetings. These interactions with BAE contributed to the researcher's understanding of the organisation, while also shaping the her view of BAE. The empirical material collected from these experiences resonates with the methods associated with ethnographic research, where ethnography is:

> 'an intersubjective form of qualitative research through which the relationships of researcher and researched, insider and outsider, self and other, body and environment, and field and home are negotiated'
>
> (Watson and Till, 2010:121)

In the research, the researcher is trying to gain an understanding of the culture and the wider organisation of BAE, through ethnographic methods of observations of everyday tasks conducted on site. This was undertaken through the writing of field notes, memos and reflections during and after site visits. Additional empirical material was collected by engaging in informal communications (during survey distribution) and through exploring the differences and sameness (Hyndman, 2001) of BAE sites.

3.5 Ethical Considerations

Ethical considerations were important in designing and conducting the research. This section discusses some of these considerations, focusing on topics of informed consent, confidentiality and data protection, and UCLan ethical procedures. Prior to designing and conducting the research, the researcher became familiar with ethical guidelines associated with various professional groups (British Sociological Association, 2002; Social Research Association, 2003; ESRC, 2012).

Informed Consent, Confidentiality and Data Protection

Attached to each survey was a participant information sheet and a participant consent form (see Appendix 1). The information sheet outlined the research project, funding of the research, how participants' information may be used in the future, the ability for participants to decline to answer questions, the researcher's contact details and information on the Love2Shop prize draw (further details on the prize draw are provided in Section 3.6.3). It also explained how consent forms and prize draw entries would be removed from surveys prior to analysis to ensure anonymity of participants.

- I have read and understood the participant information sheet
- I have been given the opportunity and relevant information to ask questions
- I understand that participation is voluntary
- I understand that anonymity is ensured throughout this study
- I agree to take part in the study

Figure 3:6: Statements that appeared on the participant consent form

The consent form was used as a means of obtaining informed consent. This form asked participants to answer yes/no to the statements in Figure 3:6. The bottom part of the consent form provided space for participants to leave their name and contact details to be entered into the prize draw. Where participants completed an online version of the survey, the information sheet and consent form were presented in a similar format to the paper version of the survey.

Prior to analysis of the surveys, the paper consent forms were removed. If participants had answered yes and signed the consent form, their survey was included in the sample. Any surveys completed a consent form were not included in the sample. A similar process was conducted with the online survey results, where these were first reviewed to ensure consent and then participants' contact details were removed from the dataset to be included in the prize draw.

Similar participant information and consent forms were completed by participants before interviews and focus groups commenced (Appendix 2). The researcher also asked participants if they had any questions, and explained that the session would be recorded, prior to switching on recording equipment and starting the session. Throughout this study, those interviewees who were BAE employees were anonymised. During the interview with Rob Wallace, anonymity of the participant was discussed. The participant noted that his close involvement in the strategic partnership with BAE would ensure that he was easily identifiable, therefore he deemed it appropriate to provide his name in the research. At the end of each interview the researcher asked participants if they wished to review the transcript prior to analysis. None did, although during a review of chapters with the core BAE team, some participants asked for changes to the wording of some quotations.

As the empirical material collected in the research contains personal data the researcher has ensured it complies with the Data Protection Act 1998, with all papers being stored in a locked filing cabinet and electronic data being stored on the UCLan network with restricted access. When electronic data was removed from the UCLan network it was stored on an encrypted USB device, which was stored in a locked filing cabinet when not in use.

UCLan Ethical Procedures

In addition to ethical decisions made by the researcher, permission to conduct the research was sought and gained from UCLan's research ethics committee. The mixed-methods and sequential case-study design led to this project being subject to a staged ethical approval process, where three applications had to be submitted. The first was for the pilot study, the second for the survey and the third for interviews and focus group discussions, which used information obtained from the survey.

Part of UCLan's ethical approval application asks researchers to answer yes/no to the question of whether the research involves the defence industry. Even though this research focuses on energy use in an industrial environment, BAE is involved in the defence industry and the researcher answered yes to this question. This, along with ethical approval applications being submitted during summer months, and a change in committee members meaning members were not familiar with the previous applications, led to applications taking between 6 and 25 working days before approval was granted. Unsurprisingly, this led to delays in data collection and impacted the research schedule.

The research was also subject to what Bryman describes as 'politics in social research' (Bryman, 2015:141). The thesis is the outcome of an EPSRC CASE PhD studentship in collaboration with BAE, and, as stated in Chapter 1, BAE has to comply with BPSS. Because the researcher required access to various sites and conducted research within BAE, BAE has a contractual agreement with UCLan to review the thesis prior to submission. This was a trouble-free process as TM1 was provided with chapter drafts throughout the writing-up period. Feedback and discussions of these drafts occurred at regular intervals in meetings with TM1, during which there were a few differences of opinion with regard to content and quotations, but these stemmed from the different disciplinary backgrounds of the researcher (a geographer/social scientist) and TM1 (an engineer).

3.6 Pilot Study

As suggested by some authors (e.g. Saunders *et al.*, 2009; Bryman, 2012), a pilot study was conducted to determine the suitability of the research design. The aims of the pilot study were to:

- test and discuss the pilot survey: discuss layout, terminology and language used, themes of questions, and willingness of employees to complete survey;
- determine whether access to employees was possible: BAE has strict security procedures and it was unclear whether access and a focus group would actually be feasible;
- discuss employee attitudes towards energy use: determine if there are any themes that had not been included in the survey;
- use the pilot study as a mini research project to determine which analysis tools to use in preparation for main data collection.

Prior to discussing the outcomes of the pilot study, and the influences it had on the research design, a detailed description of the survey design is provided.

3.6.1 Survey Design: Part 1 – Pilot Study

The pilot study survey (Appendix 2) consisted of eight pages, with a mix of open-ended qualitative questions and closed-ended 5-point Likert scales questions (Likert, 1932). Survey design was carefully considered, with attention being paid to making it both aesthetically pleasing and easy to navigate. Open-ended questions were located towards the start of the survey. Easier to answer demographic data appearing in the middle. NEP scale (Dunlap *et al*., 2000) questions were located at the end.

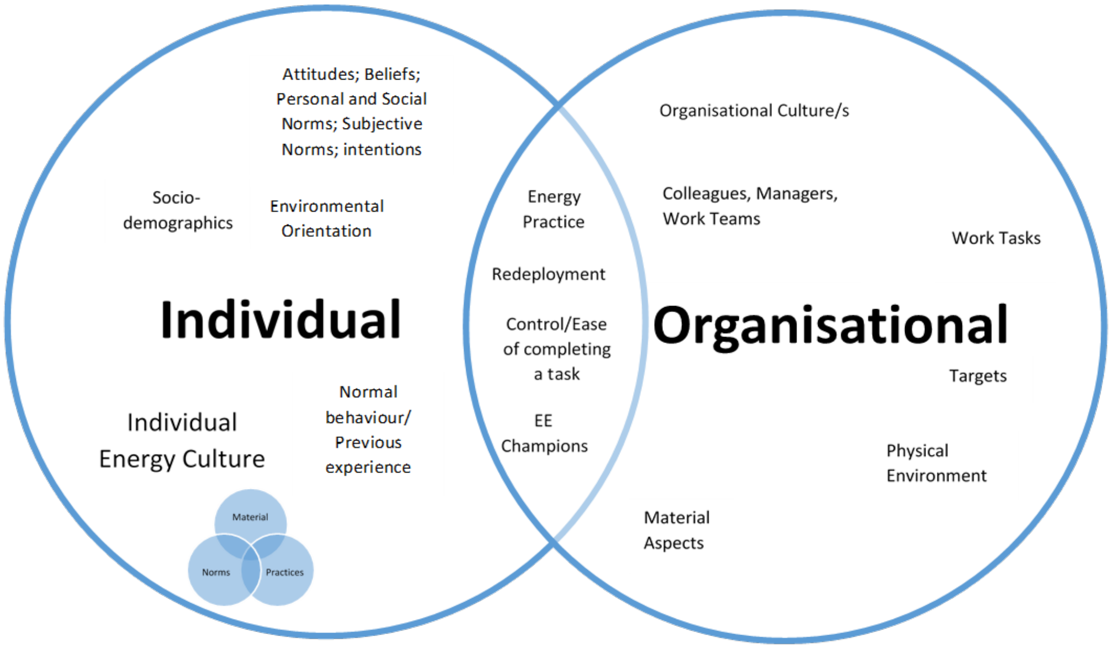


Figure 3:7: Workplace Energy Culture Framework

The questions were developed with assistance from the workplace energy culture framework (Figure 3:7) and were organised into the following themes:

- *Socio-demographic (6 questions)*: During the review of literature presented in Chapter 2, a link between socio-demographic data and energy use was found (Zelezny *et al.*, 2000; Abrahamse and Steg, 2009; Mills and Schleich, 2012). Questions were constructed to explore the individual elements of employees' role (Figure 3:7). These included length of time employed at BAE, length of time in current role, department, whether their job was managerial, skilled/trade/shop floor, or professional, age and gender.
- *Workplace energy efficiency and reduction knowledge (5 questions)* and *home energy behaviours/actions (7 questions)*: Previous research has touched upon how important previous behaviour can be in influencing new behaviours (Lee *et al.,* 1995). This theme sought to explore this further by seeing what behaviours were conducted in the home environment. It also provided an opportunity, similar to the work by Lee *et al.,* (1995) and Tudor *et al.,* (2008), to explore whether home and workplace energy use differ. Eleven 5-point Likert scale questions asking about energy practices and concern about cost of energy at home and work were developed. There was also an open-ended question asking employees to state how they reduced energy use in the work environment.

- *Environmental orientation (15 questions)*: The review of literature highlighted many studies (Stern, 2000, Dunlap *et al.,* 2000, Tudor *et al.,* 2008, Stephenson *et al.*, 2010, 2015) exploring the link between individual environmental orientation/values and pro-environmental attitudes. To examine environmental orientation this theme consisted of the full 15-point NEP scale developed by Dunlap *et al*., (2000).
- *Energy concern, in relation to the business and business priorities (6 questions)*: This set of questions sought to explore how individuals perceive the business's energy use priorities. Previous research has identified that attitudes can correlate with behaviours (Ajzen, 1991; Stern, 2000) and these questions start to explore these attitudes by focusing on how engaged employees are with energy topics. This theme also sought to explore whether BAE focused on technical or human-centred approaches when improving energy efficiency. This was operationalised through questions asking about energy use and energy demand. Energy use referred to approaches aimed at improving employee energy efficiency, while energy demand focused on infrastructure and workplace improvements. The survey included a definition of this terminology. This set of questions also explored whether employees considered the site where they worked to be more focused on reducing energy use than other sites.
- *Organisational influences (5 questions)*: This set of questions directly explores the organisational influences in Figure 3:7. Information about organisational influences was also obtained from meetings with the core BAE team, but these questions sought to confirm and provide further information on employees' views. The questions were a mix of open- and closed-ended questions, focusing on the SHE function, the BAE energy champions on site, staff training and whether employees had received any energy education. There was also an open-ended question in this theme that provided space for employees to write suggestions on where improvements in site energy use and demand could be made.
- *Perceived pressure from line manager and colleagues (2 questions)*: These questions sought to incorporate the subjective norms aspect of the TPB (Ajzen, 1991). Subjective norms are 'the perceived social pressure to perform or not to perform the behavior' (Ajzen, 1991:188). These questions specifically focused on whether participants believed they would be well thought of by their line manager and colleagues if they took action to save energy at work. They are exploring whether the judgement of others affects individual energy use.

- *Colleagues/work team energy actions (4 questions)*: In exploring the subjective norm aspect of the TPB (Ajzen, 1991), and the 'behaviors in organisations' outcome of the VBN theory (Stern, 2000), this group of questions explored the dynamics of work team and colleague energy actions. This section consisted of 5-point Likert scale questions focused on themes of awareness, energy attitudes and conversations with colleagues about energy use. These questions also provided an opportunity to determine managerial attitudes towards energy use, which previous research has found can be linked to pro-environmental behaviour (Lo *et al*., 2012).

3.6.2 Pilot Study Outcomes

A pilot study was conducted on 26th April 2014 with the assistance of TM2, who was involved in organising the session and escorting the researcher around the site. It consisted of an hour-long focus group with seven employees, a mix of supervisors and manufacturing employees. The researcher's report on the pilot study is presented in Appendix 4. The pilot study shaped the research design by demonstrating:

- how qualitative fieldwork sessions may not go to plan – during the session half of the participants turned up with completed surveys, which was unexpected;
- how gatekeepers have work priorities and may not follow up on research commitments, which can lead to delays in data collection and access to participants;
- modifications that can be made to the workplace energy culture framework to address additional organisational themes (Table 3:3);
- issues of anonymity and confidentiality of participants;
- how the identity of the researcher and the research needed to be improved;
- the need for some modifications to the survey (Figure 3:8).

Format – Have a mixed layout of the Likert scale questions: mix of tick boxes and circling of numbers

Format – In the qualitative questions a certain number of responses are asked for. Write the numbers in the text box to encourage that number of answers

Format – Questions were grouped into specific themes, and the layout changed to make it more aesthetically pleasing and to inform employees of the theme of questions in that section

Format – Reinforce the nature of this work being associated with UCLan, not BAE, by putting the UCLan logo on each page

Questions – Q1c was taken out because employees in the focus group did not have knowledge of what was going on across the site

Questions – Q1dii was taken out because the completed surveys indicated that if a suggestion was made it was often implemented

Questions – Two Likert scale questions were put into the SHE section of the survey to address whether SHE influences employee energy use and if employees associate themselves with SHE. In the qualitative questions of the survey, energy was not mentioned when participants were asked to write down five things they associate with the SHE function

Questions – Q2ci was taken out and replaced with a Likert scale question asking whether the energy/environment champion/s influence how the employee used energy at work

Questions – definitions of energy use and energy demand were repeated on every page that asked about these subjects

Questions - Four Likert scale questions were added to the survey to address communication and feedback on suggestions

Questions – Two Likert scale questions were added to ask about home behaviours – if employees know approximately how much energy is used and about turning equipment off when not in use.

Figure 3:8: Changes made to the survey design in relation to pilot study results

Table 3:3: Coding themes from the focus group transcription

SHE influence	**Colleagues' energy use**
Energy/environment champions	Home and work
Priority of energy use within BAE	Organisational influences (*not* SHE or energy/environment champions)
BAE communication with staff*	Non-energy issues*
Share price*	Drivers of energy use reduction
Solutions to reducing energy use	Them and us*

**Indicates an unanticipated theme.*

3.6.3 Survey Design: Part 2

Between the pilot study and main survey development, a survey (Mirosa *et al*., 2013) used in the development of the energy culture framework (Stephenson *et al.*, 2010) was obtained. In addition, the work by Ucci *et al.,* (2014) was published, which explored differences between manufacturing and office areas. These pieces of work shaped the survey by the inclusion of further questions. The Mirosa *et al.,* (2013) survey confirmed that use of the NEP scale (Dunlap *et al.*, 2000) was appropriate, and Figure 3:9 provides information on the additional questions added to the survey. Figure 3:10 and Figure 3:11 shows the conceptual grouping of all the survey questions based on the literature, as highlighted in Section 3.6.1.

The increase in the number of questions and the inclusion of the UCLan logo on every page increased the length of the the survey (Appendix 5) to 10 pages, not including the 2 pages of participants' information and consent form. With the increase in length, and the potential issue with respondent fatigue (Bryman, 2012), survey design was carefully reviewed. To make it aesthetically pleasing, Likert scale boxes were shaded and all the surveys were printed in colour. As an incentive to complete the survey, participants had the choice of being entered into a prize draw to win one of two £50 Love2Shop vouchers. TM2 and TM3 stated they had used Love2Shop vouchers with previous surveys and these had been successful, and improved response rates.

Proposed Survey Distribution

Survey distribution options such as mail-out, telephone and face-to-face (Bryman, 2012) were not appropriate for the research due to the need to gain unescorted access to site or obtain employee contact details, which are not in the public domain. The only viable method of distribution was through self-completed surveys distributed by the BAE core team.

During discussions with the core BAE team, it was decided that a paper version of the survey would be distributed to areas on site. The proposed distribution involved TM2 or TM3 dropping surveys off with managers of manufacturing buildings, who would distribute them in team meetings. To address anonymity concerns raised in the pilot study, each paper survey had a pre-paid enveloped attached and instructions for the employees to post the survey back to the researcher. A total of 500 surveys were distributed to the manufacturing areas of 1 Shed, 2 Shed, 3B Shed and 430 Shed. TM2 and TM3 estimated approximately 1,000 employees work in these sheds. Accurate population figures were not made available to the researcher due to this information not being in the public domain.

Number	Question	Reference from Ucci *et al.*, (2014)	Link to energy culture framework and themes of survey
7	Are you aware of any energy saving targets for your area? If answered yes what do you know about them	Pg 43 Q6	Organisational influences
8a	I get enough supervision and guidance on saving energy at work	Pg 44 Q13	
8b	I have received enough training on energy saving (reducing energy use and energy demand) at work	Pg 44 Q15	
8c	I know the amount of energy my team/department use	Pg 43 Q10	Workplace energy efficiency and reduction knowledge
9a & b	Energy demand (a)/Energy use (b) is an important issue to BAE Systems	Pg 43 Q8	Already in pilot survey
9f	It is clear to me what BAE Systems is doing to reduce energy use and demand	Pg 43 Q9	Energy concern/in relation to business theme
10e	I discuss ways to reduce energy use and demand with my work colleagues	Pg 45 Q16	Colleagues/work team energy actions
10f	Colleagues within my work environment support the need to reduce energy use	Pg 45 Q18	
10h	I would be well thought of by my colleagues if I took action to save energy at work	Pg 45 Q17	
13c	If I notice a fault with equipment I am using, I always report this to my line manager	Pg 48 F32	Workplace energy behaviours/actions
13e	It is clear to me who is responsible for switching machines/equipment off during downtimes (when work areas are unoccupied, e.g. Christmas)	Pg 46 Q23	Workplace energy efficiency and reduction knowledge
13f	It is clear to me who is responsible for switching off the lights	Pg 46 Q24	
13g	If I wanted to turn equipment/machines off in my work area, I know where the relevant switches are	Pg 47 F21	
13h	I know where the relevant light switches are to turn the lights off in my work area (if you have automated lights please ignore this question)	Pg 47 F22	
13i	I know what to do to save energy within the workplace	Pg 46 Q19	

Figure 3:9: Details on additional questions included in the questionnaire

Colleagues/Work Team Energy Actions

Q10b – Within my specific work team we are conscious of our energy use
Q10c – Within my specific work team we regularly try to reduce our energy use
Q10d – Within my work environment, energy use and energy demand are discussed regularly
Q10e – I discuss ways to reduce energy use and demand within my work colleagues
Q10f – Colleagues within my work environment support the need to reduce energy use

Workplace Energy Efficiency & Reduction Knowledge

Q8c – I know the amount of energy my team/department use
Q13e – It is clear to me who is responsible for switching machines/equipment off during downtimes
Q13f – It is clear to me who is responsible for switching off lights
Q13g – I know where the relevant switches are
Q13h – I know where the relevant light switches are
Q13i – I know what to do to save energy within workplace

Organisational Influence

Q1da – The SHE function influences how I use energy in work
Q1db – I associate energy related topics with the SHE function
Q2c – The energy/environment champion/s influence how I use energy in work
Q8a – I get enough supervision and guidance on saving energy at work
Q8b – I have received enough training on energy saving at work
Q10a – My line manager influences my energy use

Energy Concern in Relation to Business

Q9c – Reducing energy demand should be a higher priority for BAE Systems
Q9d – Reducing energy use should be a higher priority for BAE Systems
Q9f – It is clear to me what BAE Systems is doing to reduce energy use and demand
Q13a – I am concerned about the cost of energy to the business
Q13b – I am concerned that rising energy costs will affect my day-to-day tasks

Workplace Energy Behaviours/Actions/Self-Reporting

Q12a – I always turn equipment off after I have finished using it
Q12b – I always turn equipment off at the end of the day/shift
Q12c – I always turn lights off (where possible) after I leave that area
Q12d – I always make an effort to reduce energy use within the workplace
Q13c – If I notice a fault with equipment, I always report this to my line manager
Q13d – I am more conscious of my energy use than my work colleagues

Employee Energy Suggestions & Communication

Q9g – If I have a suggestion on how to reduce energy use and demand at work I know who to speak to
Q9h – If I make a suggestion on how to reduce energy use and demand, it will be taken seriously
Q9i – If I make a suggestion on how to reduce energy use and demand I will receive a response detailing any future changes or stating reasons for not implementing the suggestion
Q9j – Employees are encouraged to make suggestions to reduce energy use and demand

Perceived Pressure from Line Manager & Colleagues

Q10g – I would be well thought of by my line manager if I took actions to save energy at work
Q10h – I would be well thought of by my colleagues if I took action to save energy at work

Home Energy Practices, Price Concern and Attitudes At home:

Q14a – I always turn lights off after I leave a room
Q14b – I always leave electrical goods on standby when not in use
Q14c – I always turn electrical goods off at the mains socket when not in use
Q14d – I always unplug my phone charger when not in use
Q14e – I always make an effort to reduce energy use
Q15a – I am concerned about rising energy prices
Q15b – Rising energy costs have affected my day-to-day task
Q15c – I go around and turn off appliances/equipment that are not being used
Q15d – At home I know approximately how much energy I use

Importance of Energy Use to Business

Q9a – Energy demand is an important issue to BAE Systems
Q9b – Energy use is an important issue to BAE Systems
Q9e – There is a greater focus on reducing energy use and demand at the Samlesbury site compared with other BAE sites

Figure 3:10: Conceptual grouping of themes of survey

3.7 Methodology Evolution

During the course of the data collection, modifications in the research design were required due to ethical approval delays, unsuccessful data collection methods and delays in contact with BAE. This section provides details of the unsuccessful survey distribution. Table 3:2, presented earlier in this chapter, shows the impact on the fieldwork schedule.

The response rate of the survey distribution was poor, with only 18 surveys returned (3.6% response rate). Following this, TM2 and TM3 were contacted and they sent reminder emails to managers of each area. As a result, a further 3 surveys were received, but this was still a poor response rate (4.2%). After a meeting with the core BAE team, an additional survey distribution was proposed where the researcher, accompanied by TM2 and TM3, would drop surveys off at additional areas on site. Dropping surveys off provided an opportunity for the researcher to explain the research and stress its importance. The researcher and TM2 or TM3 would then pick up the completed surveys the following day. This occurred on the 29th and 30th September 2014. There was a delay of a month between receiving the initial returns by post and the second survey distribution because of members of the core team being on annual leave.

Table 3:4: Second distribution of surveys and response rates

29th September 2014		
No.	Area	Outcome
40	Mellor House	18 completed
50	CTF	1 completed
50	3B Shed	Not distributed
10	Maintenance	Not distributed
20	SHE Function	5 completed

30th September 2014		
No.	Area	Outcome
60	430 Building (the manager was not in the previous day)	3 completed
60	1 Shed (the manager was not in the previous day)	4 completed

The secondary distribution of surveys also had a low response rate of 9% (see Table 3:4), and during the visit on the 30th September some gatekeepers (managers of each area) suggested that manufacturing employees had no interest in energy and that the response rate would be low. Wanat (2008) describes this type of gatekeeper as ‘passing responsibility’ (Wanat, 2008:203) by being uncooperative and implying their employees would have no interest. The researcher also noted that in some areas the surveys had not been moved from when they had been dropped off, suggesting that no attempt had been made to distribute them. This ‘indirect communication' (Wanat, 2008:206) with participants, along with low response rates, suggested this method of distribution was not appropriate.

3.7.1 Revised Survey Distribution

A meeting was held with the BAE core team to develop a modified research design. Many ideas were discussed and it was decided that two approaches were needed, one to target office areas on site and the other to target manufacturing areas.

Initially the research was interested in comparing the different manufacturing areas on site. This was because TM2 and TM3 had stated that they had found different success rates with energy and recycling interventions with four of the high-energy users on site. The research aimed to explore this further and use the surveys and proposed focus groups to address Objective 4. However, with the low response rate from the manufacturing areas, the approach to how the research would address Objective 4 changed to examine how energy cultures differed between office and manufacturing environments.

Manufacturing Areas

Two manufacturing areas were targeted – 430 Building and 2 Shed – and a day was spent in each building distributing surveys, accompanied by either TM2 or TM3. Within the buildings, the three amenity areas (where staff take breaks and have lunch) were targeted, one area in the morning break, one during lunch and one during the afternoon break. The aim of this was to distribute the surveys to as many employees as possible. The researcher was unable to distribute surveys to specific work stations due to security access not being granted to the whole manufacturing area and to health and safety concerns. As a thank-you for filling out the survey and to entice employees into completing a survey, refreshments in the form of baked goods were on offer.

In addressing the anonymity and trust concerns from the pilot study, the researcher wore UCLan branded clothing during distribution of the surveys. When setting up in the amenity rooms, a UCLan pop-up banner was used, and a box was provided for individuals to submit their surveys. The aim of this was to inspire employees with confidence that no one would be able to identify individuals from the survey.

Surveys were distributed in 430 Shed on 9th October 2014, which equated to approximately 15% of the shed population, and in 2 Shed on 16th October 2014, which equated to approximately 18% of the shed population. Together with the previous attempts at survey collection, this gave a total of 139 completed surveys from manufacturing areas.

Office Areas

To target the office areas, an online version of the survey was constructed via Bristol Online Survey. This is a platform that UCLan uses to host online surveys. TM2 and TM3 distributed the link to the online questionnaire through email lists they had access to. Distribution of the link posed further research methodological challenges. First, there was no opportunity to distribute the link to all office staff. Second, the researcher was not able to send the email personally, so had to rely on TM2 and TM3 to control communications. Third, there was no opportunity to determine how many people would receive the link. To address the first challenge, TM2 and TM3 suggested sending out the survey via various BAE mailing lists. Wanat (2008) states that a disadvantage with gatekeepers managing communication channels with participants is that the personal touch, which can encourage participation in research, is often lost. To combat this, the researcher sent the link to TM2 and TM3 with a short email attached, designed to explain to participants what the research was about. Unfortunately, there was no way to assess the impact of the third challenge. This sampling technique relied on a 'snowballing' sampling, where one person receives the link and then sends it to someone else (Burns, 2000; Bryman, 2012). Despite the disadvantage of not knowing the sample population, this technique has the advantage of the survey potentially reaching a very large population. In total, 120 online surveys were completed.

3.7.2 Focus Groups and Interviews

The delay in survey distribution and collection of completed surveys had an impact on the fieldwork schedule. Consequently, there was not enough time allocated for conducting focus groups and interviews. As this fieldwork adopted a sequential mixed-methods design (Teddlie and Tashakkori, 2009), analysis of the survey was required prior to focus group and interviews. In addition to this delay in fieldwork, the gatekeepers, TM2 and TM3, were frequently not responding to emails. In light of this, the researcher pursued the arrangement of a focus group with the manufacturing areas and an interview with TM2 and TM3, as means of validating the results and exploring the site energy culture further. Details of the focus group, arranged by TM2 and TM3 and the local SHE person, are presented in Figure 3:11. It is disappointing that the proposed program of fieldwork could not be undertaken. However, it is not uncommon to have to change a methodological approach during fieldwork when relying on gatekeepers in an organisational setting (Wanat 2008; Bryman, 2012).

Focus group with manufacturing area:	30th June 2015
Length: 1 hour 2 minutes	*Location*: 430 Building in 'Brew room'
Members: 9 members (1 female, 8 males)	
Workplaces:	
- 1 SHE (co-organiser of session)	- 2 based in shed offices
- 1 office tasks but based on shop floor	- 4 shop floor
- 1 mainly office but bit of both	

Figure 3:11: Focus group information, including location, duration and members' details

In addition, an hour-long interview with TM2 and TM3 was held on 30th June 2015. Two further interviews were held as planned with TM1 (8th April 2015) and Rob Wallace, UCLan (19th August 2015). More details on these meetings are presented along with the empirical material in Chapter 6. All interviews and focus groups sessions were recorded, with the permission of the participants, at the BAE sites.

In April 2015, while attending the Association of American Geographers (AAG) international conference in Chicago an opportunity arose to conduct focus groups at BAE sites in the US. This opportunity manifested through one of the regular meetings with the BAE core team. During this session and following discussions regarding the challenges with arranging focus groups on site and survey distribution problems, TM1 asked whether it would help the research if access to sites in the US could be granted during the AAG visit. This prompted a further research design evolution whereby energy cultures across the wider international BAE organisation could be explored. This prompted a slight change in Objective 4 to examine how energy cultures differ at an international scale.

TM1 acted as the gatekeeper for these visits, putting the researcher in contact with another gatekeeper from the US arm of BAE, who in turn introduced the researcher to the SHE functions at two sites. As a result, two focus groups were held on 8th and 19th April 2015, at two manufacturing sites in the Platforms and Services business of BAE which were high users of energy. Conversations with staff on site visits to Samlesbury had indicated that visiting sites in the US was difficult due to security issues, therefore this was an opportunity not to be missed. Even though these sites are outside the UK and the case study site in question (Samlesbury), the results could be used to address Objective 4. Further details on the format of the sessions, and further methodological discussions associated with these focus groups, are presented in Chapter 8.

3.7.3 Revised Research Design and Research Objective Integration

Table 3:5 presents the final research design, and implementation of the research methods, while also showing how each method addresses different aspects of the research objectives.

Table 3:5: How each research method addresses different research objectives

Method	Objective 1 – Define a framework for informing research on energy cultures in the industrial workplace	Objective 2 – Detail the evolving nature of organisational priorities and organisational cultures	Objective 3- Detail and review employees' attitudes towards energy use	Objective 4 – Examine the geographies of energy cultures
Survey	• Qualitative answers – exploring these answers assists with providing additional themes of the framework • Quantitative answers – explore whether the themes from the literature are strong influences on individual energy use	• Qualitative answers – these were explored to determine any reference to the organisational culture • Quantitative answers – the SHE questions are particularly relevant in addressing this objective	Both sets of answers formed the basis for addressing the research objective. The qualitative answers assist in providing further details of any quantitative themes, while also acting as a means of validating the quantitative data	The survey results are explored through a different analytical lens by categorizing them into manufacturing or office areas. This enables a comparison of the two areas to occur and the geographies of energy cultures to be examined
Interview with TM1	Provides details on the organisational influences on individual energy use, while also providing a broader overview of BAE	Forms the basis of discussions on the research question by providing details of the wider organisational structures, cultures and processes	N/A	N/A
Interview with TM2 and TM3	Provides details on the wider organisational influences, and a further understanding of the site. This assists with defining the organisational elements of the framework	The wider organisational cultures and structures are discussed in this interview, while also exploring site priorities and how these interact with energy topics	Preliminary survey results are fed back to the team. This acts as a means of validating survey results, while also providing further details and potential reasons for the answers	Discusses differences between office and manufacturing areas on site
Interview with Rob Wallace	Explores the BAE partnership with UCLan and how this developed. This provides insights into the organisational structures that can change business priorities, and change industrial workplaces	The experience of Rob Wallace as a previous BAE employee provides an insight into the wider BAE organisational culture	N/A	N/A

Table 3.5 continued

Method	Objective 1 – Define a framework for informing research on energy cultures in the industrial workplace	Objective 2 – Detail the evolving nature of organisational priorities and organisational cultures	Objective 3- Detail and review employees' attitudes towards energy use	Objective 4 – Examine the geographies of energy cultures
Manufacturing focus group	Seeks to validate the survey answers, and in doing so it provides further insights into the determinants of individual energy use from an organisational and an individual perspective	The semi-structured nature of the focus group allows employees to mention any organisational cultures that can influence energy use	Preliminary survey results are presented to the group for discussions and validation purpose. This subsequently assists with providing details on employees attitudes towards energy use	Provides a valuable insight into the energy culture of the manufacturing area. The composition of the group, some office based and some manufacturing employees, provides understandings of the differences in areas
Two focus groups with US Sites	The multinational perspective assists with defining a framework for informing future research on workplace energy cultures	Allows for a discussion of the wider BAE organisation, and provides valuable insights into the dominant organisational cultures	N/A	This method directly explores this objective. The session involves the feedback of preliminary survey results conducted at Samlesbury site as a means to explore whether the group think similar results would be found on their site. It also explores the effect of the national culture on site energy cultures
Site tours/ observations	Site visits and observations allow the researcher to gain first-hand experience of the industrial environment. This experience has assisted with further defining a framework	Similar to addressing Objective 1, the researcher is able to observe the organisational cultures, and determine from a short period of time on site which dominant cultures on site appear to influence energy use	N/A	Tours of the sites allow the researcher to gain first-hand experience of the differences on site, such as communication methods, safety processes and security processes

3.8 Methods of Analysis

In order to address all the research objectives of this study, two analytical approaches were undertaken. To explain these, this section is split into two parts. Section 3.8.1 describes how survey data, interviews and focus groups were analysed to address the first three research objectives. Section 3.8.2 details the analytical method of survey data which addresses Objective 4. During this section details of how bivariate and multivariate statistics were operationalised to assess the differences between manufacturing and office areas on site are provided.

To assist with data collection, two software packages were used. QSR NVivo version 10 (NVivo) was used to transcribe and analyse interviews, focus groups and qualitative survey answers, and IBM SPSS Statistics version 22 (SPSS) was used to assist with analysis of quantitative data.

3.8.1 Method of Analysis: Part 1

This section explains how the closed-ended survey questions, open-ended survey questions, and focus groups and interviews were analysed.

Closed-Ended (Quantitative) Survey Questions

The paper surveys were manually inputted into SPSS with the coding of Likert scale questions from 1 to 5, and yes/no question coded as 1 or 2. Any missing answers were coded with 999 or 9999, as suggested by Field (2009). The demographic answers on age and job type were coded in a similar fashion, with codes from 1 to 9 being assigned to the corresponding age options. The remaining socio-demographic answers, which asked about building, section, length of time in current role, length of time employed at BAE and gender were inputted into SPSS as 'string' data (Field, 2009) by copying the participants' responses. All figures were inputted to two decimal places, which required changing measure of time into numeric form, for example: 3½ years inputted as 3.5. In the survey the only questions that required reverse coding (Field, 2009) were some of the NEP scale (Dunlap *et al*., 2000). After the input of survey data into SPSS, the researcher checked for any data input errors by verifying every fifth survey.

After confidence in the input of data was obtained, the researcher also recoded the questions on building name and length of time in current role. The purpose of this was to make the data more manageable. Upon closer inspection, many participants had written the building names in slightly different ways. In order to determine from which buildings the surveys were completed, a frequency table of the answers was produced, which revealed 13 different locations. The researcher then proceeded to code the surveys against the relevant building number. Any unknown buildings were reported to TM2 and TM3 during a meeting where they assisted with assigning a building to each survey. The research also coded the ‘length of time in current role’ into ten categories, less than 1 year, 1–5 years, 6–10 years and so on, through to the final code of 41 years and above.

The online survey results were imported into SPSS. The Bristol Online Survey automatically assigned each completed survey a six-figure identity, which enabled an easy distinction to be made between online and paper copies of the survey. Once the data was inputted into SPSS, the file was screened for any abnormal responses. During this screening one survey was picked out that had answered ‘neither agree/disagree’ to all questions and had failed to respond to any of the open-ended questions. This survey was deleted from the dataset as it was determined that the participant did not want to complete the survey. This left 259 completed surveys, obtained from the three survey distributions.

Open-Ended (Qualitative) Survey Questions

The qualitative answers were treated differently. All qualitative answers were first inputted into SPSS. This data was then exported into NVivo and each question was individually coded. During this process the researcher went through numerous systematic coding stages. The first stage involved coding questions under themes that occurred frequently; themes not coded were inputted into an ‘unknown’ code. The second stage of coding involved looking at these themes individually, and coding them into sub-themes. If the researcher determined that the themes were still large, or did not reflect all the answers coded to them, a third coding stage was conducted. The final coding process involved going through any ‘unknown’ codes to determine if they could be coded into any new codes.

Taking Question 1a as an example, participants were asked to write down five things they associate with the SHE function. As the SHE function consists of Safety, Health and the Environment, the first stage of coding was under these themes. Any answers that could not be easily assigned were coded to an ‘unknown’ theme. As the focus of the research is on energy, the subsequent coding required going through the environment theme and the unknown theme, and coding the relevant answers to energy. This process was undertaken on all open-ended questions of the survey.

Interview and Focus Groups

The first stage of analysis of the three interviews (TM1; TM2 and TM3; Rob Wallace) and three focus groups (Samlesbury and two US sites) was to transcribe the sessions. This was completed manually through the NVivo software. This was a time consuming procedure, but, as Bryman (2012) notes, it assists the researcher with understanding the research. To ensure the transcription was correct, the transcript was read and compared to the audio. Any discrepancies in the transcription were changed.

The next stage of analysis required the coding of the transcriptions; this was manually conducted through NVivo. As the interview and focus groups provide empirics for different research objectives, as demonstrated in Table 3:5, each interview and focus group is coded differently, as a means of addressing each research objective:

- *Objective 1: Define a framework for informing research on energy cultures in an industrial workplace* – All the interview and focus groups were coded for any additional influences to update the framework.
- *Objective 2: Detail the evolving nature of organisational priorities and organisational cultures* – The interviews with TM1, Rob Wallace, TM2 and TM3 provided the primary empirical material for addressing this research objective. The interviews with TM1 and Rob Wallace were coded in similar ways to assist the researcher in gaining an understanding of the organisation. Both interviews explored how the strategic partnership with UCLan was developed from a UCLan and BAE perspective. The first stage of coding involved categorizing the transcription under themes of strategic partnership and organisation. The secondary coding process explored these topics in more depth. In addition to these two interviews, all the additional interviews and focus groups were coded for additional organisational cultural influences in a similarly systematic coding process as described above.
- *Objective 3: Detail and review employees' attitudes towards energy use* – The manufacturing focus group provided the foundations for addressing this research objective. During the session, survey results were presented to the group as an act of validation. In addition to this, the semi-structured nature of the session sought to explore some of these findings in more depth, by encouraging discussions around them. In terms of coding, the manufacturing focus group was coded by an initial coding of answers to questions; following this, a subsequent coding of any cross=cutting themes was undertaken. In addition to the manufacturing focus group, the interview with TM2 and TM3 also assisted with answering this question. The

survey results were reported during the interview, and also acted as a means of validating and providing further explanations and insights into the results.

- *Objective 4: Examine the geographies of energy cultures* – The survey results provided an indication of the geographies of the Samlesbury site. An additional analysis of the survey results occurred as described in Section 3.8.2. The outcome of these results shaped the coding process for the manufacturing focus group. Any comments related to differences and reasons for differences between the manufacturing and office environments were coded. In a similar systematic process as above, the coding process was done in several stages, to enable the development of relevant themes. The focus groups conducted in the US sites were coded under similar themes to those that had come out of the coding process addressing Objective 3. Doing that enabled a comparison of sites across different spaces. In addition, any references to national politics or national culture were also coded.

3.8.2 Methods of Analysis: Part 2

The research addressed the research objectives in two ways. As the previous section has detailed, the focus group data from the two US sites provided opportunities to examine how energy cultures differ across geographical boundaries. However, the survey data presented the opportunity to explore both office and manufacturing areas at the Samlesbury site in the UK. The survey data asked employees where they worked. This data, along with the information obtained from TM2 and TM3 on the type of buildings on site (Table 3:6), enabled each survey to be categorised as being completed in either an office area or a manufacturing area.

Table 3:6: Categorisation of buildings at Samlesbury BAE

Office buildings	**Manufacturing buildings**
230	1 Shed
3A	2 Shed
420	3B
608/609	430
Mellor House	

To compare these two areas an independent *t*-test, which compares the means of the two groups, was undertaken. This analytical approach has been used in previous research comparing office and manufacturing areas (Ucci *et al.*, 2014). Prior to completing this, a data reduction technique, principal component analysis (PCA) was applied to the results to determine an appropriate scale. Applying PCA to the quantitative results enabled the research to determine the underlying empirical dimensions (themes) of the survey and the subsequent creation of a scale (Field, 2009; Tabachnick and Fidell, 2013). With the empirical themes defined, the research then proceeded to compare the means of these themes of questions and subsequently to determine whether differences exist between the office and manufacturing areas. The following sections provide details on the PCA process, explaining how PCA was implemented and any treatment of data. The results of these analytical approaches are provided in Chapter 5, and a discussion of the geographies of energy cultures is presented in Chapter 9.

Missing Answers

Prior to conducting any data reduction techniques, the dataset needs to be examined for missing answers. While it is natural to obtain some missing answers from participants in surveys (Bryman, 2012; De Vaus, 2014), they can have a large impact on PCA (Field, 2009; Tabachnick and Fidell, 2013). Questions that experienced a large number of missing answers were excluded from the dataset. Any remaining missing answers were screened to determine if they were subject to data input errors; if not, they were kept in the sample. Any missing answers were replaced by the median for the group (office or manufacturing) for that particular question, as suggested by Tabachnick and Fidell (2013).

Principal Component Analysis

PCA is a data reduction technique. Bryman (2012) defines it as a ‘technique for identifying clusters of variables’ and one that ‘reduce(s) a set of variables into a smaller set of dimensions’ (Bryman, 2012:636). Pro-environmental or energy use research that uses a large number of survey questions often uses PCA (Guagnano *et al.*, 1995; Lee *et al.*, 1995; Bamberg and Schmidt, 2003; Christoffersen *et al.*, 2006; Barr, 2007; Whitmarsh and O’Neill, 2010; Karlin *et al.*, 2012) as a data reduction method, to create scales representing empirical themes. Creating scales changes the level of measurement of the data from ordinal data (the individual Likert scale questions) to interval data (the PCA themed variable) (Boone and Boone, 2012).This change of measurement allows statistical tests such as an independent *t*-test (Tabachnick and Fidell, 2013), to be conducted.

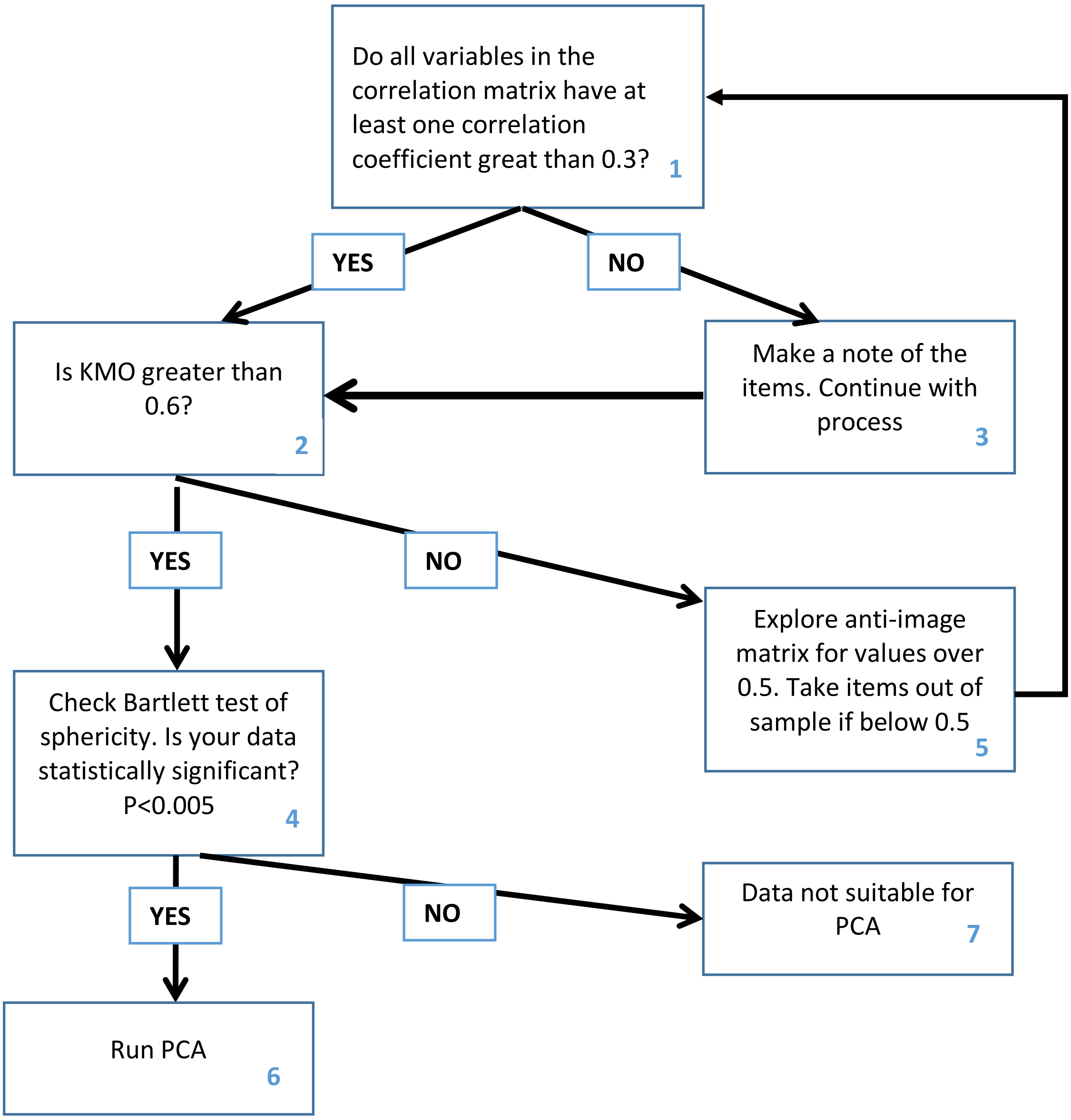
In addition to this change of measurement, De Vaus (2014) gives other reasons why building scales is useful for datasets with large numbers of questions:

- scales help get to the complexity of a concept
- multiple indicators (of which scales consist) assist in developing more valid measures

- multiple indicators increase reliability and enable greater precision. A single question does not allow differentiation between people with much precision
- analysis is simplified considerably.

Bryman (2012) builds on these reasons by stating that one use of PCA is to 'reduce a dataset to a more manageable size while retaining as much of the original information as possible' (Bryman 2012:636). The dataset in the research consists of a number of variables designed to measure different aspects of the energy culture framework stated in Chapter 2. The themes are fairly complex and difficult to measure through one question, hence the use of PCA and the creation of scales. An overview of the PCA process used in the research is provided in Figure 3:12, Table 3:7 and detailed below. This process was conducted in SPSS. For more information on this process, and the PCA flowchart below, please refer to the research by Field (2012), Hair *et al.,* (2010) and Tabachnick and Fidell (2012).

As the questions in the survey are not directly correlated, it was decided to use a varimax orthogonal rotation, as recommended by Field (2012) and Tabachnick and Fidell (2013). As suggested by Cattell (1966) and Field *et al.,* (2012), once the PCA analysis had occurred the eigenvalues were inspected alongside the scree plots to determine how many components PCA suggested for the survey questions. Once PCA had been conducted and a suggestion of groupings obtained, the results were reviewed to ensure they grouped together conceptually (Bryman, 2012; Tabachnick and Fidell, 2013; De Vaus 2014). In doing so, a comparison of the PCA grouping and the grouping of questions from the initial design of the survey (Figure 3:10) was undertaken. If the PCA grouping is appropriate, Cronbach's alpha is reported. Cronbach's alpha, the value of which ranges from 0 to 1, gives the reliability of the scale created (De Vaus, 2014). The higher the value, the more reliable the scale. Values of 0.7 or above are considered a reliable scale (Hinton, 2008; Field, 2009; De Vaus, 2014). If Cronbach's alpha groupings were adequate, new scales were created in SPSS from the groupings suggested by the PCA process. The results of each of these processes are presented in Chapter 5.



The figures in boxes 1, 2, 4 and 5 are based on recommendations by Field (2009), Hair *et al.,* (2010) and Tabachnick and Fidell (2013).

Figure 3:12: PCA analysis flowchart

Table 3:7: Key steps in the PCA analysis flowchart

Box	Title	Explanation
1	Inspect correction matrix	The process determines whether the variables (questions) correlate with each other. Low correlations (below 0.3) demonstrate that there are no similar underlying dimensions between the variables – they do not correlate with each other (Bryman, 2012)
2	KMO greater than 0.6	Kaiser-Meyer-Olkin measure of sampling adequacy (Kaiser, 1970). This test determines how suited the data is for PCA to take place
4	Bartlett test of sphericity	This test determines the sphericity of the data, to determine whether PCA can occur. If this test is significant it demonstrates that there are some relationships between the variables included in the analysis (Bryman, 2012), suggesting that PCA will be successful
5	Examine anti-image matrix	This matrix shows the individual KMO values for each variable. If the KMO Is greater than 0.6, examining the anti-image matrix will identify variables that could be excluded to improve the KMO values (Bryman, 2012)

Comparing Office and Manufacturing Environments

In the socio-demographic section of the survey, participants were asked in which building and section they worked (page 9 of the survey). Each building was coded, and, after discussions with TM2 and TM3, buildings were further coded into predominantly manufacturing or predominantly office areas.

This grouping, along with the newly created scales, enabled an independent *t*-test to be conducted. Prior to undertaking an independent *t*-test, the data needs to be examined for any outliers (Tabachnick and Fidell, 2013). This was done by creating a box-plot and histogram in SPSS, as recommended by Field (2009). Outliers were first checked for any errors in inputting data; if these had occurred, the results were corrected. Once the data has been checked for outliers, each group was reviewed for a normal frequency distribution. This was done by exploring the histogram for each group and exploring the P-plot, as suggested by Field (2012) as an appropriate method for identifying outliers in larger samples. After data checks were undertaken, an independent *t*-test was conducted, comparing the means of the two groups in SPSS.

3.9 Framework Evolution

Conducting research provides many opportunities to reflect on the process of research design and analysis with the aim of improving future work (Saunders *et al.*, 2009). In the following chapters, there are examples of reflective writing, often appearing in text boxes, which demonstrate aspects of the reflective process undertaken in this work. In addition, towards the end of each of the following chapters, there are short sections where comments about the suitability of the workplace energy culture framework (originally presented in Chapter 2) are presented. This provides an opportunity, in light of the research findings in each chapter, to comment on future improvements of the framework. The penultimate chapter (Chapter 9) brings together these comments and the evolving nature of the workplace energy culture framework by presenting a revised framework, and a discussion on how research findings are incorporated into it. Conducting this process further addresses research Objective 1 and assists with future research on energy cultures in the workplace.

3.10 Conclusion

This chapter has described the methodology of the research. It has detailed how the research resonates with the philosophical groundings of pragmatism. In describing this, it has articulated how the CASE award partnership with BAE, the regular contact with the core BAE team, and the suggestions they made have shaped the research.

This chapter has also detailed some of the challenges encountered during fieldwork which impacted the research schedule. Having a pragmatist research paradigm allowed the research to overcome these challenges, modify the research design, and take advantage of methodological opportunities where appropriate. This chapter has also demonstrated how an opportunity arose part way through the research, to conduct focus groups at BAE sites in the US, which were incorporated into the research design. Finally, this chapter has also described the evolution of the research methodology.

4 Employees’ Attitudes Towards Energy Use: Samlesbury Site

> This chapter directly addresses research Objective 3:
>
> *Detail and review employees’ attitudes towards energy use*
>
> by presenting results obtained from surveys, interview and focus groups. It also provides valuable empirical material to assist with addressing research Objective 2:
>
> *Detail the evolving nature of organisational priorities and organisational cultures.*

4.1 Introduction

Chapter 3 described the methodology of the research. It described how a sequential mixed-methods design was developed for the research. This chapter presents the results of the survey that was distributed at the Samlesbury site. Where appropriate, extracts from the manufacturing focus group and interviews with TM1, TM2 and TM3 are presented to provide additional understanding or validation of the results. The term ‘focus group’ is used throughout this chapter to refer to the manufacturing focus group. This chapter is structured into eleven sections corresponding to the themes explored in the survey (Figure 4:1). Chapter 3 detailed how these themes were created. In each section the results of the closed-ended questions appear first through a mix of histograms or bar charts, depending on the type of data (ordinal or categorical) (Bryman, 2012).

• Socio-demographics	• Importance of energy use to the business
• Workplace energy efficiency and reduction knowledge	• Organisational influences
• Perceived pressure from line manager and colleagues	• Colleagues and work team energy actions
• Employee energy suggestions and communication	• Workplace energy behaviour/actions/ self-reporting
• Environmental orientation	• Home energy practices, price concern and attitudes
	• Energy concern to/in relation to business

Figure 4:1: The eleven themes of questions, as per groupings detailed in Chapter 3

After presenting the results from closed-ended questions, appropriate empirical material from the qualitative data sources (Figure 4:2) is presented. This qualitative empirical material has two purposes. First, it provides further understanding and explanation of the quantitative answers, which assists with gaining an understanding of the Samlesbury energy culture. Second, it acts as a method of validation of the survey data, supporting results or, where it is conflicting, highlighting areas for further research. To validate the answers further, the results (where appropriate) are compared with results from Ucci *et al*., (2014), who conducted a similar energy use survey in an industrial workplace.

Qualitative data sources:	**Date**	**Length of session**
Interview with TM2 and TM3	30th June 2015	58 minutes
Focus group in 430 building	30th July 2015	1 hr 2 minutes
Pilot study focus group	29th April 2014	1 hr
Interview with Rob Wallace	19th August 2015	38 minutes
Open-ended questions in survey	From survey results	July 2014–Feb 2015

Figure 4:2: Qualitative data sources used in this chapter

The short discussions provide an opportunity to demonstrate how the findings of this project correspond to other research. A more detailed discussion of these results and how they contribute to achieving the aim of the research is presented in Chapters 7 and 9, where discussions of the energy culture of the Samlesbury site are provided.

Readers' note: Interview and focus group extracts are numbered for identification purposes only. This numbering does not imply an order in which the extracts appeared in the interview and focus group.

4.2 Socio-demographic Data

This group of questions explored employee demographics (age and gender) and employment (job role; length of time in role; length of time employed by BAE; building and section). During a regular meeting with the core BAE team, they were asked for accurate figures of the population of the Samlesbury site, to determine whether the survey population was a good representation of the site. However, as this data is not publicly available the researcher was not allowed access. To address a need to report the population size the survey represents (Bryman, 2012; De Vaus, 2014), TM2 and TM3 provided estimated population values of each building, and indicated the site has a predominantly male workforce.

Building

The majority of surveys came from 430, 3A, 609 and 2 Shed. Buildings 430 and 2 Shed are manufacturing areas targeted in the paper survey distribution, while 609 and 3A are the main office buildings on site, which would have received the online survey link. Table 4:1 shows the total number of surveys from each building, along with the estimated population of each. The table shows the range of building populations sampled was between 4.5% and 42%.

Table 4:1: The number of surveys completed in each area on site

	Frequency (*n*)	**Percentage of total surveys (%)**	**Estimated building population**	**Estimated percentage of population sampled (%)**
1 Shed	24	9.3	200	12
2 Shed	38	14.7	200	19
230	8	3.1	50	16
3A	42	16.2	100	42
3B	9	3.5	200	4.5
420	20	7.7	150	13.3
430	66	25.5	400	16.5
609	39	15.1	600	6.5
Mellor House	11	4.2	60	18.3
Samlesbury	1	0.4	n/a	n/a
Several	1	0.4	n/a	n/a
Total	259	100.0	1960	13.21

The participant who answered with 'several' was included in this sample as they completed a paper version of the survey, which had only been distributed at the Samlesbury site.

Gender and Age

Table 4:2 and Table 4:3, respectively, show the gender and age range of the participants who completed the survey. The results report a majority of male participants, which confirms the comments from TM2 and TM3 about a predominantly male workforce on site.

Table 4:2: The gender of the participants who completed the survey

Gender	Frequency (*n*)	Percentage
Male	196	75.67
Female	59	22.78
Total	255	98.46
Missing data	4	1.54

Table 4:3: The age groups of the participants who completed the survey

Age group	Frequency (*n*)	Percentage (%)
Under 25	14	5.4
25–30	26	10.0
31–35	36	13.9
36–40	15	5.8
41–45	34	13.1
46–50	51	19.7
51–55	52	20.1
56–60	20	7.7
over 60	8	3.1
Total	256	98.8
Missing data	3	1.2

Employment Time and Length of Time in Role

Figure 4:3 and Figure 4:4 show the length of time employed at BAE and the length of time each participant had been in their current role. Results were inputted into SPSS to the nearest year for example: 3¾ years = 4 years.

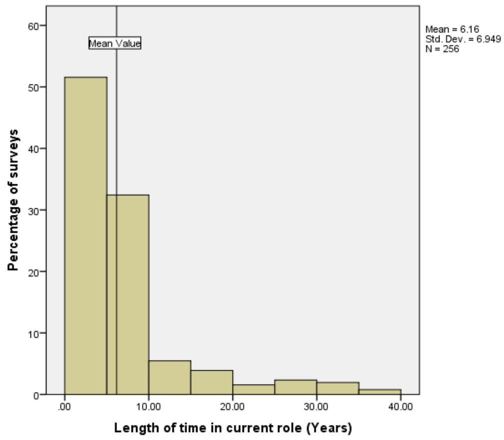


Figure 4:3: Histogram showing the percentage of surveys against the length of time in the current role

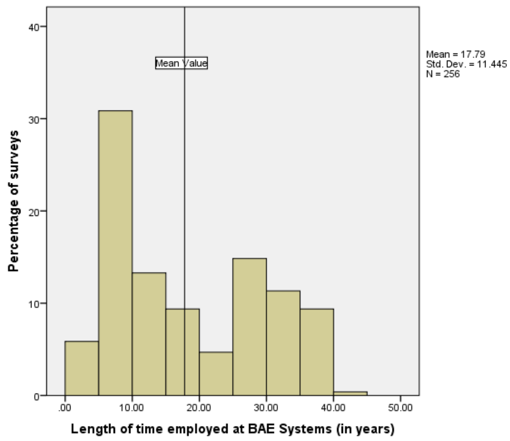


Figure 4:4: Histogram showing the percentage of surveys against the length of time employed by BAE Systems.

The mean results differ significantly for the two questions, which suggests that employees move around roles within the business. Examples of this were observed throughout the research.

Job Role

During survey distribution it became apparent that the question aimed at examining participants' job role was not worded correctly. The categories of Managerial, Skilled/Trade/Shop Floor, and Professional were not clearly defined and in conversations with participants during survey distribution it became apparent that some people who were shop-floor staff chose the managerial option as they were in supervisory roles. Therefore it is anticipated the skilled/trade/shop floor figure is actually higher.

Table 4:4: The job role of participants who completed the survey

	Frequency	Valid percentage
Managerial	31	11.97
Skilled/Trade/Shop Floor	57	22.09
Professional	170	65.89
Total	258	99.61
Missing data	1	0.39

Table 4:4 shows that the majority of participants chose the 'Professional' job role. This was expected as the office workers who were the main targets for the online version of the survey, should have chosen the professional role. In addition to this, the paper version of the survey that was distributed in the manufacturing areas would also have attracted a small number of office workers based in the manufacturing sheds.

Qualitative Data

During the focus group participants were asked, as a form of introduction, to provide their name, work area, length of time in current role and length of time at BAE. The group, predominantly male (8 male, 1 female), stated how they had all been in employment with BAE for longer than a year. The majority of the group (5 people) also stated they had previous roles in BAE, which supports the results above. The socio-demographics of TM2 and TM3 also support the findings as TM2 had been in their role for 3.5 years and at BAE for 6 years, while TM3 had been in their role 10 years and at BAE for 15 years.

During the interview with Rob Wallace (UClan) on 19th August 2015, further support for these results was provided, when he stated: 'I'm not normal in, I left the business' (19th August 2015). This, along with the survey empirics, information from TM2 and TM3, and focus group data, suggests it is common for employees to stay employed with BAE, but to move around the business in different job roles. This suggests BAE is an attractive place to work.

4.3 Workplace Energy: Efficiency and Reduction Knowledge Theme

This theme sought to explore what level of knowledge employees had about energy reduction, and consisted of six questions, located on pages 7 and 10 of the survey.

Knowledge on Energy Use by Team/Department

The majority of participants did not know how much energy their team/department used, with 78.13% (n = 256) answering strongly disagree/disagree (Figure 4:5). These results are similar to those of Ucci *et al.,* (2014), who reported around 70% of disagree answers, which suggests this may be common in industrial environments.

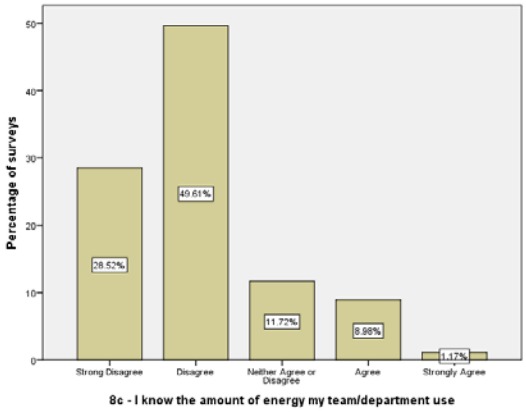


Figure 4:5: Frequency distribution of percentage of answers to questions 8c

During the focus group participants were asked if they knew how much energy they use, and their immediate response was 'No', which supports the findings from the survey. After this initial reaction the SHE representative and organiser of the group responded with:

> *'… I do, but I only know it in terms of thousands of kilowatts, I'd love to know, say I'm more interested to know what that meant …'*
>
> *Extract 1*

This extract highlights that in some cases, employees are aware of the energy use in terms of figures, but are unclear what these figures actually mean. During the pilot focus group (26th April 2014),a similar discussion occurred, with participants being asked how they would like to receive information about energy and the environment. Participants answered by stating they would like figures that they could relate to, for example:

> *'things like holiday …, a car whatever, especially when you're getting at energy and … can say, x amount of money we must use in here a month, could probably sort all our houses out for a year, you know, that kind of stuff'*
>
> *Extract 2*

During the main focus group, extract 1 sparked a discussion between participants in the focus group about the smart meter roll-out in the UK (Department of Energy and Climate Change, 2009). Several participants asked if there were energy meters on site, and the SHE representative informed the group that the site does have portable energy monitoring devices. This dialogue demonstrates that knowledge on energy topics is variable on site, with some participants being more knowledgeable than others.

The researcher asked if employees had opportunities to look at energy usage figures or monitor machines' energy use, and the SHE representative responded with:

> *'We are doing now, yeah …, it's one of our Shed objectives to reduce the energy base [level] down … by five percent, which we're just on at the moment and I think that's made us, especially with the 50001 certification that came in earlier this year, that's made us think about these things and investigate metering and individual metering of areas to see which ones use large power consumption so we can take it down, but I don't think that gets to, to you guys does it? [question aimed at shop floor members] The 50001 certification that we're going forward with, with what that is, did you know there was an objective to reduce the energy baseline by five percent? [pause] You know what I mean? This is the sort of thing that doesn't probably get communicated, it's one thing putting posters up saying turn it off but unless probably you, you know the reasons why and what we're trying to strive for, that probably doesn't get through does it?'*
>
> *Extract 3*

This extract highlights that this shed is now exploring in more detail how much energy is being used, and it suggests that the driver for this is the ISO 50001 certification, and energy objectives. The ISO 50001 certification is discussed further in Chapter 6. However, it also indicates that energy topics do not get communicated to manufacturing employees. In response to the above statement one member of the group said:

> *'Yeah, it's knowing how you can help it [energy] as well, it's all right trying to reduce it [energy]'*
>
> *Extract 4*

This response suggests a lack of knowledge by employees about what action to take to reduce energy (explored further in Figure 4:10 and associated extracts). Continuing this discussion, the group highlighted how there are some issues regarding what they have control of in terms of reducing energy, with one participant stating:

'There's a lot of things out of our control aren't there? Like the IC [one of the large [energy] consuming machines in the shed] the bigger stuff that consumes the most energy we have no input into them, things like light switches which is probably trivial compared to the, the kit we're powering.'

Extract 5

This last extract gives an indication of the physical environment impacting employees' energy use. It demonstrates how this lack of control or lack of knowledge about control is having a negative impact on consumption, with employees thinking that energy practices such as turning lights off will have little impact when compared with the larger machines that they do not have any control over. All these extracts support the survey data while also providing a greater insight into employees' knowledge of energy use of their team and department.

Responsibility for switching off lights and machines

Figure 4:6 and Figure 4:7 explore responsibility for switching off lights and machines (*n* = 254). The majority of participants agreed with the statements, with 49.4% (Q13e) and 52% (Q13f) of answers being strongly agree/agree answers. These questions also produced similar results to those produced by Ucci *et al.*, (2014), who reported around 50% strongly agree/agree and similar distributions of remaining answers.

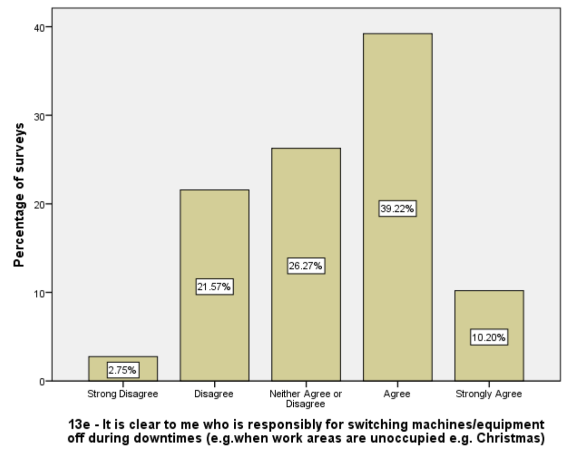


Figure 4:6: Frequency distribution of percentage of answers to question 13e

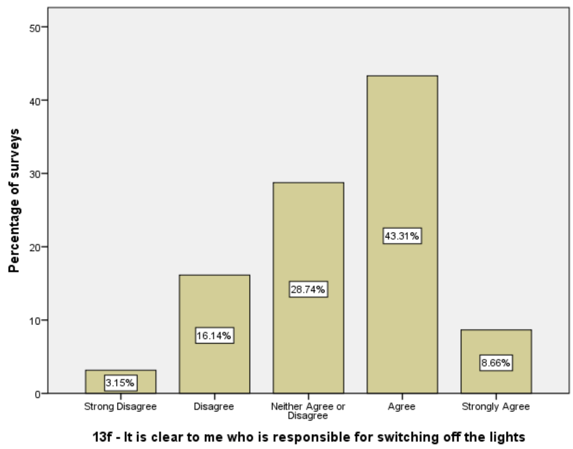


Figure 4:7: Frequency distribution of percentage of answers to question 13f

During the focus group, members were asked: 'Who do you think is responsible for reducing energy?' This question does not focus on specific tasks but the researcher was interested in exploring whether participants answered with names of individuals, the business or themselves. Two members of the group answered, at the same time with:

'All of us'

Extract 6

This extract supports the findings from the survey, with participants acknowledging that they are responsible for reducing energy, which fundamentally relates to switching machines and equipment off during downtimes. Shortly after Extract 6, another member asked the question 'Responsible or who drives it?' This sparked a discussion between members on how site management needed to be a driver for improving energy efficiency, with participants stating how energy was:

> *A: 'a site thing rather than, than a shed thing, or a, or an office managers' thing'*
>
> *B: 'The man who manages the whole site.'*
>
> *Extract 7*

Following this discussion, and creating a link to established cultures on site (discussed in Chapter 6), the researcher asked:

> *'Do you think that's different with safety, though, in terms of if I said who's responsible for safety?'*
>
> *Extract 9*

This sparked a very contrasting response to the energy question, with two participants saying: 'No, safety's more at a local level' and 'different issues in different areas, has to be local whereas use of energy is a site one'. The other participants in the group agreed with these comments. This short dialogue shows how participants see energy use as being very different to safety on site, a point that is discussed further in Chapters 6, 7 and 9. It also demonstrates how employees believe energy should be directed from a site level (Extract 7).

Energy Reduction Knowledge

Figure 4:8 and Figure 4:9 show that the majority of participants know the locations of switches to turn off equipment and lights in their work area, with 72% and 81.7% responding with strongly agree/agree answers. Q13h had a large number of missing answers due to some areas having automated lights (missing answers = 186) while Q13g only had 5 missing answers. The results reported here differ from those reported by Ucci *et al*., (2014), who reported higher percentages of strongly agree/agree answers (90% and 84%). There are several reasons why these results may differ, for example:

- Ucci *et al*., (2014) only asked these questions in the manufacturing areas, whereas this survey also asked office areas. If office areas are on automated lights, they may have answered neither agree/disagree, rather than leaving the question unanswered.

- BAE may be a different industrial workplace to where Ucci *et al*., (2014) conducted their research. Some manufacturing employees at the Samlesbury site may never be required to switch lights off because of people continually working in their area.

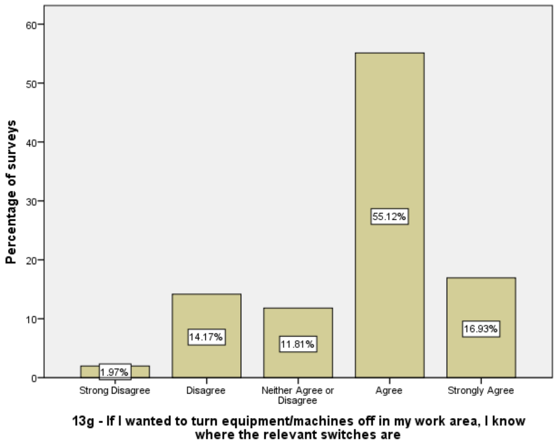


Figure 4:8: Frequency distribution of percentage of answers to question 13g

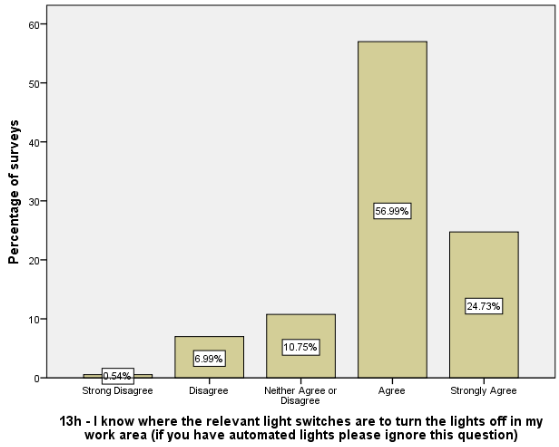


Figure 4:9: Frequency distribution of percentage of answers to question 13h

The final question in this theme addressed knowledge on what to do to save energy within the workplace (Figure 4:10). The sample size for this question was reduced (*n* = 162), which may have been due to potential confusion with the wording of the proceeding question, 13h, which asked participants not to answer if they had automated lights.

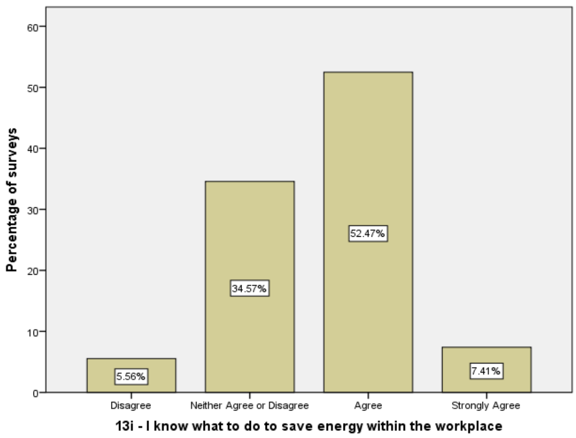


Figure 4:10: Frequency distribution of percentage of answers to question 13i

The results report that the majority of participants know what to do to save energy in work (59.9% strongly agree/agree), with no participants answering strongly disagree to this question. The percentages of strongly agree/agree answers were similar to those reported by Ucci *et al.,* (2014).

When exploring these questions in the focus group, participants were asked if they knew how to turn off equipment in their immediate work area. The SHE representative immediately responded with:

> *'Well, do you know what you can turn off and can't turn off? We mentioned earlier, maintenance [know] how to turn service things off don't they and all that?'*
>
> *Extract 10*

There was some confusion in answering this question, with some participants providing examples of specific energy-saving practices. The SHE representative brought the discussion back to the original question by asking:

> *'If we suddenly said today, whatever reason, hypothetically, we're closing site down for a week, everyone on site's going home, including security, just hypothetically, would you know what you could turn off, if we said we're going to do a massive shutdown, would you, would you know which switches or what you could turn off and couldn't turn off?'*
>
> *Extract 11*

Two participants then responded with:

> *'We do, we just turn PCs off and I think that'd be about it.'*
>
> *Extract 12*

There was no mention of turning off other equipment such as machines, with one participant stating:

> *'I think it's difficult, nobody designed the stations, and each one is different … [we have] access to plug sockets underneath the PCs whereas on M [a different work station] they're integrated into the family units and you need a key to get into the cover to get the plug sockets.'*
>
> *Extract 14*

And following on with:

> *'so … I think, to be fair you wouldn't be able, … you know in your station, you've got these speakers, you've got your computers, maybe a few chargers, most of their stuff's powered by there anyway so that you turn off, so, but like I say if it is on the M line, it's hidden, it's not easily accessible so that might be where you see the difference between one side and the other.'*
>
> *Extract 15*

These discussions indicate that employees often know how to turn equipment off in their immediate work area (terminology of workstation), so the extracts support the results obtained from the survey data. However, they also highlight how participants do not know how to turn off the larger machines and how there may be some difficulties with access to switches to turn equipment off. Extract 15 is particularly interesting as it suggests that some work areas are different to others, which contrasts with previous extracts on safety and energy use. Earlier, participants had stated that energy was a site-level issue and safety was more local as different areas have different issues, but the above extract highlights how energy is in a similar situation, with different infrastructures/designs at local levels leading to different abilities to turn equipment off.

During the discussion on turning machinery off, one participant said:

> *'Well, you have to think of energy in the realms of how much does it costs to start things up again? Because if they do have a shutdown obviously you've got the heat sink effect where if it starts to cool down and then when you fire it up again you've got to try and ramp it up, so there's wasted energy getting back to where you were so it isn't always cost effective to shut everything down'*
>
> *Extract 16*

Other participants agreed with this statement, demonstrating that these employees are engaged with energy use and aware of the complexity of improving energy efficiency in manufacturing areas. However, similar to Section 4.3, it appears employees do not have the specific knowledge to assist them in making decisions of what to turn off, and determine what is worth turning off.

4.3.1 Summary

This section has highlighted that the majority of participants:

- Do not know the amount of energy their team/department uses,
- Know what to do to save energy within the workplace,
- Know who is responsible for switching off lights off and machines/equipment during downtime,
- Know where switches are to turn lights and machines/equipment off.

It has also highlighted how knowledge of site approaches to reducing energy use varies across the workforce, with only a minority of employees being aware of site energy monitoring devices. The focus group extracts also suggest that employees believe approaches to energy use are different to approaches to safety on site, and they think energy should be directed from a site level, while safety is more shed/local level. When discussing access to switches, it appears the layout of the work environments can mean limited access to equipment switches, which highlights the need to incorporate the physical environment into energy use frameworks. This finding agrees with the ECF framework (Stephenson *et al.,* 2010, 2015), which argues that the physical environment and material aspects of energy use are key influences on decision making. The qualitative data also highlight how there are ineffective methods of energy communication on site, with employees not being aware of energy figures and manufacturing staff suggesting messages may not always get transferred to them.

4.4 Perceived Pressure from Line Manager and Colleagues Theme

This group of questions focused on the influence of peers' thoughts on individual energy-saving practices.

The majority of participants answered neither agree/disagree to both Q10g (45.7%, n = 258) and Q10h (52.7%, n = 257). The questions which focused on line managers (Figure 4:11) had slightly more strongly agree/agree answers compared with the question focusing on colleagues (Figure 4:12).

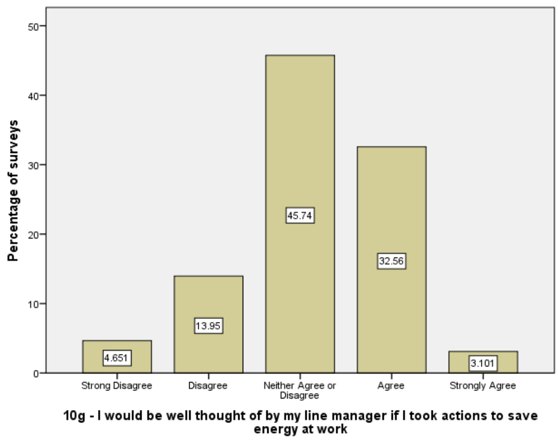


Figure 4:11: Frequency distribution of percentage of answers to question 10g

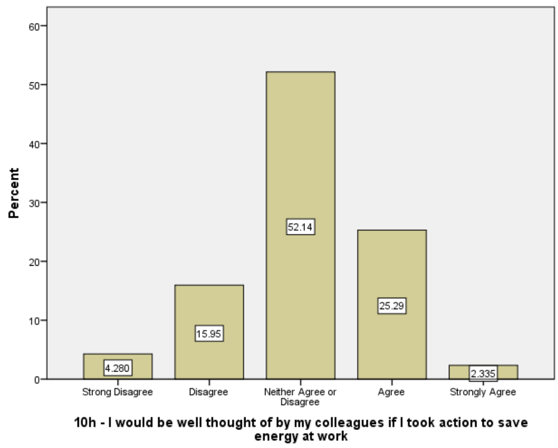


Figure 4:12: Frequency distribution of percentage of answers to question 10h

These answers differ to those reported by Ucci *et al.,* (2014), who reported that approximately 40% of participants agreed they would be well thought of by their supervisor if they took energy-saving actions at work, but 40% also responded with neither agree/disagree. Reasons for these differences could relate to the different workplace cultures experienced in these work environments. Chapter 6 provides further discussion on organisational cultures and subcultures.

4.4.1 Summary

This section has highlighted that the majority of participants think their colleagues and line manager would not think differently of them if they took actions to save energy at work.

This demonstrates that the subjective norms aspect of TPB (Ajzen, 1991) does not appear to have an influence on energy use in this industrial environment. There is no focus group data to enable the exploration of these results further as the researcher deemed it an inappropriate question to be asking employees, as they may have felt uncomfortable answering with work colleagues and potential line managers present in the work environment.

4.5 Employee Energy Suggestions and Communication

Questions 9g, 9h, 9i and 9j examine whether employees are encouraged to make suggestions regarding energy use reduction and if they know how to do this.

The majority of participants (56.28%, n = 255) know who to speak to to make a suggestion on how to reduce energy use and demand at work (Figure 4:13). There are similar distributions of answers for Q9h (Figure 4:14) and Q9j (Figure 4:16), which suggests that participants are either unsure, or, agree that they are encouraged to make energy suggestions and these suggestions will be taken seriously.

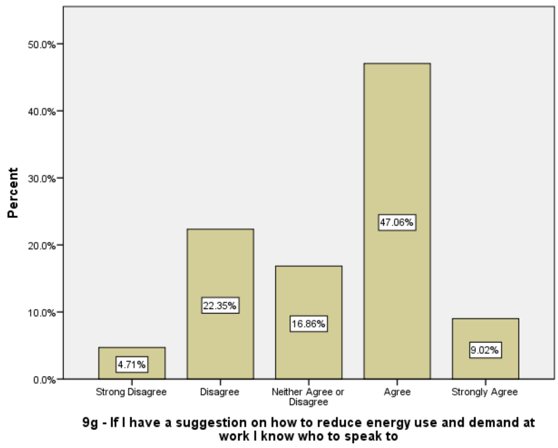


Figure 4:13: Frequency distribution of percentage of answers to question 9g

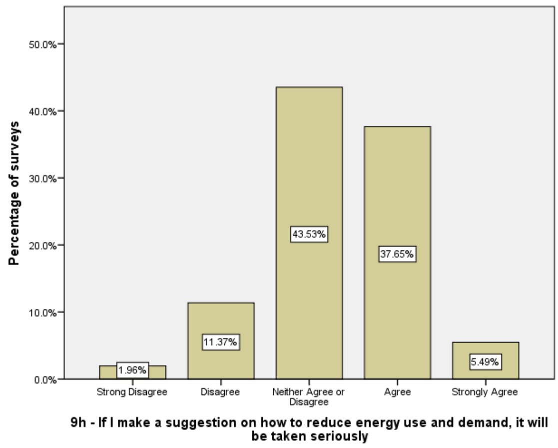


Figure 4:14: Frequency distribution of percentage of answers to question 9h

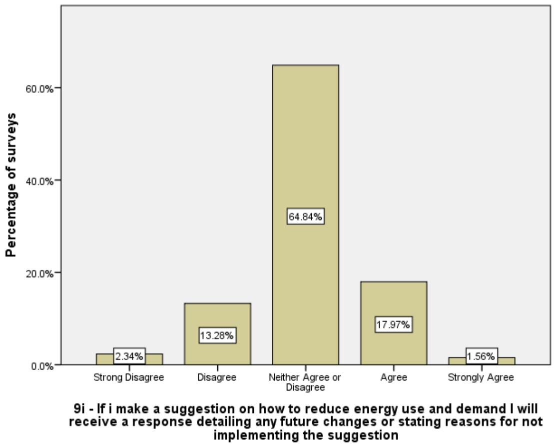


Figure 4:15: Frequency distribution of percentage of answers to question 9i

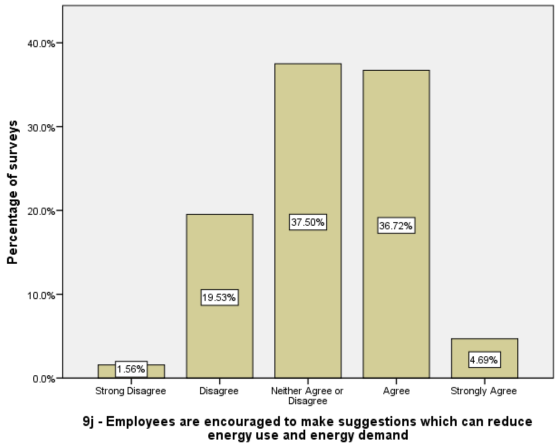


Figure 4:16: Frequency distribution of percentage of answers to question 9j

Question 9i had contrasting results to the other questions in this section, with the majority of participants reporting neither agree/disagree (64.84%, *n* = 256), with approximately 20% strongly agree/agree and 25% strongly disagree/disagree (Figure 4:15). This suggests participants are unsure whether they will receive a response to any suggestion they make.

During the focus group, a discussion on making energy suggestions was brought up by the participants when they were asked about energy training. The group described how a suggestion board had been put up in the shed as part of the ISO 50001 accreditation. This was a new initiative, to encourage employees to make suggestions regarding saving energy. One of the participants said:

> *'sometimes I just walk past it, then other times, if you have a look at them [suggestions], there's all ideas on there, you wouldn't have thought of the ideas, unless asked…'*
>
> *Extract 17*

This employee is describing how the board does not just act as an opportunity to voice a suggestion, but also as a stimulus for further energy ideas. The conversations between participants highlight how the group thought it was a good idea to get feedback from the manufacturing staff regarding energy topics. In pursuing this theme further, the researcher asked whether anything had been done like this previously. One participant responded with:

> *'I think so, but I think a little bit better this time, and I think gradually they know it's better to have everyone involved'*
>
> *Extract 18*

The group were asked whether any of them had made a suggestion and had any feedback on it. One participant said:

'I think I've made one or two suggestions and I think it, I think it's just part and parcel of them, sort of whether we'll find that out, it's like when we find out how much we've saved after the shutdown and things. It's an ongoing thing'

Extract 19

Extracts 17–19 imply the suggestion board is a new initiative, and that the process is still evolving. The participant in extract 19 did not expect to gain any feedback but saw the process changing over time, when the issues were addressed. Extract 18 also suggests that the site is learning that encouraging employee suggestions is a good thing. These statements are positive towards the suggestion board, which is in contrast to some of the comments about suggestions and feedback from the pilot focus group:

'one of my guys put a suggestion in about low energy lighting and it got kicked back saying it was not feasible and he went on the internet and priced up so many of these strip lights, I think it was this conference room … he actually worked out how many fluorescent tubes there were, how much they cost and how much the energy efficient ones cost and it was less than half price and then half usage and it got kicked back so he went don't ask me anything else about anything'

Extract 20

Extract 20 does not describe how the suggestion was put forward, but it does highlight how a lack of feedback or response has led to an employee having an attitude of 'don't ask me again'. This lack of feedback to employees, illustrated in extracts 19 and 20, and in the survey results, appears to be a theme in BAE. During the manufacturing focus group the SHE coordinator mentioned how the recent employee satisfaction survey (PULSE survey) showed that employees thought BAE was very good at engagement with employees but not that great at feedback. He continued by saying:

'I think we're very good at asking the questions but doing things like this [the focus group] I think that's where we can sometimes let ourselves down, not just here but as a site, it's the feedback to a suggestion … "we'll look into it and get back to you" and then it doesn't happen but you're only going to raise that a couple of times before you, you lose interest, don't you think, and you don't raise stuff again'

Extract 21

This echoes comments from the pilot focus group, which suggested that lack of feedback can lead to negativity, and potential suggestion fatigue by employees. This process of a need for feedback from suggestions and how it can act as a motivator to make more suggestions was confirmed by the rest of the main focus group:

'A – It's like the initiative thing again, they think oh, it's just another.

B – yeah

B – Idea in the pan, flash in the pan

A –yeah, sometimes they do

D – You want to see the changes are done as well, you want to be able to say, I've got a suggestion and have it implemented and see it, see what change it is making

A – yeah

D – and it'll drive everyone to put more change through, if we had like, we say, like in general we spent so much money on electric and then, you know, you saw it decreasing, you might think, of that's from the suggestion I made.'

Extract 22

These extracts support Figure 4:13, as employees spoke about suggestions as if they were familiar with the process of making suggestions. The extract also supports the results in Figure 4:14, as there are mixed responses about what happens to suggestions. None of the participants were negative about the suggestion process but it is clear from the extracts that they think the process could be improved.

Communication of ideas was discussed again towards the later part of the focus group when the researcher asked the group if they knew who to make a suggestion to. Participants responded with:

'Yeah, you'd probably go straight to your supervisor, and they would know … I think I know myself, but some supervisors might not seem too bothered, they're too into their job'

'Yeah, yeah, they've got an incentive to get more work done, so they're going to concentrate on that'

'… be good to have someone who supervises but their job is more specific to that [energy], so help us aim to reduce energy and shut down things'

Extract 23

This extract supports the survey findings in this theme but also highlights an issue of supervisors who may not do anything about a suggestion, or be too busy with their own jobs, with extract 23 indicating that supervisors are focused on getting the work done. This links with the previous theme (Section 4.4), which explored perceived pressure from supervisors. If employees believe supervisors won't act on any suggestions, they are not going to feel inclined to make any energy-efficiency reductions. The last extract also suggests that employees would like to have a specific person, in a supervisory role, they could speak to about energy and shut downs.

Communication Comments from Focus Group

In order to explore the communication with staff theme further, the methods of communication were explored in the interview with TM2 and TM3, and during the manufacturing focus group. The interview with TM2 and TM3 highlighted how office staff get emails on a range of topics:

> *'We get email updates on all sort of things … charity challenges, and when the National Blood Service are coming … health awareness, newsletters, so we get all sorts'*
>
> *Extract 24*

As the researcher was already aware of office staff communication from the interview with TM2 and TM3, she wanted to focus on methods of communication with manufacturing staff during the focus group discussions. The researcher asked how messages are transferred and if the group thought they get transferred appropriately. During this question the researcher suggested that office staff were easier to communicate with via email than the manufacturing staff. The shop floor employees responded with:

> *'It's exactly what you said, … but it's the stuff that doesn't always get filtered through … we still get emails and stuff, but we don't need to look, to access them everyday'*
>
> *Extract 25*

The participants were agreeing that they are harder to communicate with, due to not being required to look at their emails, and they point out that messages may not always get filtered down to them. A few participants expanded upon how information was transferred to them, while agreeing with the previous comments:

> *A - 'Yeah, we're not left behind with stuff, it gets mentioned in meetings.'*
>
> *B – 'Exactly'*
>
> *A – 'So sometimes, it's it's, it's a sort of play of the month type of thing in the start-ups. Like we're doing this type of thing or that type of thing and we'll have to start doing this. Whichever was mentioned in the big meetings. Then next month it'll be something different'*
>
> *B – 'Yeah'*
>
> *C – 'Yeah, there's not like the follow through of the same message all the time then?'*
>
> *A – 'No there isn't.'*
>
> *Extract 26*

This extract provides an insight into how business messages get transferred to shop-floor employees, and how the manufacturing employees perceive this transfer process. The conversation describes a process where supervisors attend larger group meetings, at which they are provided with information to transfer to employees in their team start-up meetings. It highlights how these messages vary on a month-by-month basis, and how employees feel there is no consistency with messages over time. This process of meetings and the transfer of knowledge was reiterated by the SHE Coordinator, who provided their insight into the process:

> *'it's very hard to put a priority on it if you're being told I suppose in a meeting and I'm, I'm the same, you know, when I've been, I've got this and that as well, priorities on delivery, priorities on this and we've got to get this finished and we've got that day job what you're being measured on then, at the end they go oh by the way we're having an initiative this month on getting, turning light switches off, maybe use that as a bit flippant but it's very hard to put that emphasis on, know what I mean? And I, I do it as part of the SHE role and I've got the E [referring to E in SHE] in it as well, you know, this is all priority, "oh by the way don't forget we've got this thing popped on at the end as well" and that's what I find difficult, I think it needs a lot more emphasis on in the right way, the comms.'*
>
> *Extract 27*

These extracts provide an insight from both a coordinator and a manufacturing view of the different communication methods. Extract 27 highlights how priorities are often placed on delivery in manufacturing areas, with the aim of getting jobs finished, with environmental-related topics being on the agenda but as additional items. This coordinator highlighted how the 'E' in SHE is 'popped on at the end' but still needs to be addressed.

The researcher also asked the group if they thought they could be communicated with better. The manufacturing participants answered:

> *A - 'we don't mind if they don't tell us anything, that's what it is'*
>
> *B – 'I think [communication] could be a little bit better but I don't think it is a major issue personally. I don't think it is, then again, I don't know what we are not being told'*
>
> *Extract 28*

These extracts give an insight into potential reasons for the neither agree/disagree answers in Figure 4:15, employees may not mind whether they are given any feedback. This contradicts comments from the pilot focus group, which suggested a lack of feedback on suggestions had led to negativity in the workplace. To investigate this further, more research is needed in this area. Extract 28 also poses further questions for the research – how could participants know whether communication could be improved in BAE, if they are not aware of what information they should be told. These questions are discussed in Chapter 9.

4.5.1 Summary

This section has highlighted:

- a mixed response about whether employees are encouraged to make suggestions to improve energy efficiency and reduction,
- employees know who to speak to if they want to make a suggestion,
- employees are unsure whether their suggestions will be taken seriously,
- employees are unsure whether they will receive feedback about their suggestion.

It has also provided further details on the communication methods applied on site. During the focus group it became apparent that manufacturing employees have email addresses but are not required to regularly check emails in their day-to-day tasks. The session also highlighted how chain-type communication methods (Martin, 2005; Mullins, 2007) are used in the manufacturing environments, where messages are given to supervisors, who then have to transfer them to employees.

Qualitative results also suggest that a lack of response or feedback from suggestions can lead to negativity in the workforce with regards to making future comments. The focus group also suggested that feedback from suggestions may lead to increased engagement in energy topics. The group did discuss how there had been changes in communication methods, with the introduction of a suggestion board, which appears to be driven by the site seeking to achieve ISO 50001 status. Employees appeared positive about these changes and the board also appeared to be acting as a visual stimulus for energy suggestions.

4.6 Environmental Orientation

The last set of questions on the survey consisted of the 15-question NEP scale (Dunlap *et al*., 2000). As suggested by Dunlap *et al.,* (2000), to analyse this appropriately the data reduction technique of principal component analysis (PCA) should take place to determine the underlying variables of the scale. The procedure for PCA was reported in Section 3.8. However, prior to undertaking this process, the questions were examined for the number of missing answers. During this process it became apparent that a large number of surveys (n = 35) had answered neither agree/disagree to each question. There was also a large number of missing answers across the survey (n = 50). As this set of questions appeared at the end of the lengthy survey, it is likely that participant fatigue may have impacted these results. Consequently, it was decided that due to the reduced sample size, it was not appropriate to present results and draw conclusions from them.

4.7 Importance of Energy Use to the Business

Questions 9a, 9b and 9e explore employees' opinions on the importance of energy use to the business.

Importance of Energy Use and Energy Demand to BAE Systems

Participants answered very similarly to questions 9a and 9b, which explored whether employees thought energy demand and energy use were important issues to BAE Systems (Figure 4:17 and Figure 4:18). The majority of participants (Q9a, 94%; Q9b, 92%, *n* = 258) answered strongly agree/agree. During the completion of surveys in the manufacturing areas, the researcher overheard many participants making comments to colleagues about what the point of these questions was, and that they were saying the same thing. These comments and the similarity in answers may suggests that the aim of developing and distinguishing between these questions was not a success and participants simply answered the same for both questions.

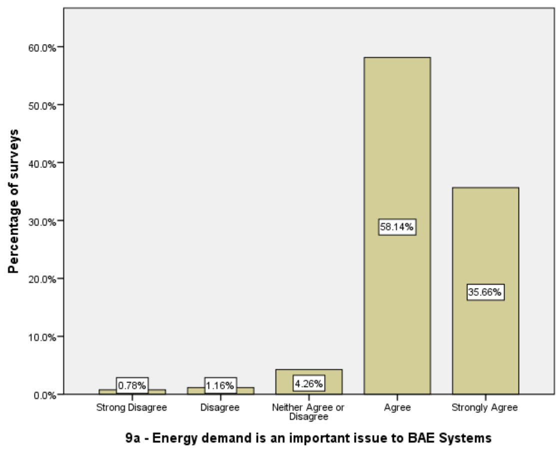


Figure 4:17: Frequency distribution of percentage of answers to question 9a

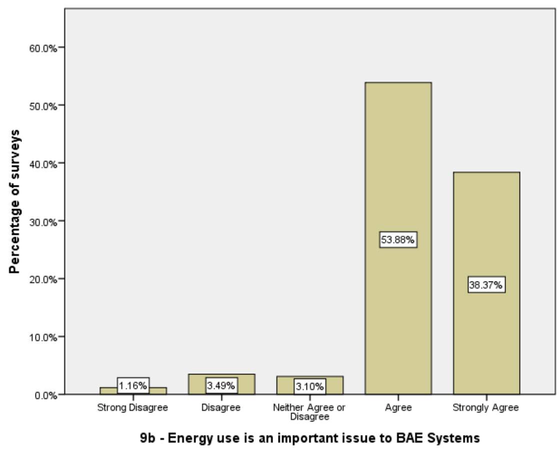


Figure 4:18: Frequency distribution of percentage of answers to question 9b

Greater Focus on Reducing Energy at the Samlesbury Site

The majority of participants reported neither agree/disagree (80.24%, *n* = 253) to question 9e, which explored whether participants thought there was a greater focus on reducing energy use at Samlesbury compared with other sites (Figure 4:19). The aim of this question was to explore potential differences between sites. Upon reflection, and from gaining a further understanding of BAE's structure (post-survey design and distribution), it was unlikely that participants would answer agreeing or disagreeing with this statement. The majority of Samlesbury employees did not have any experience of working at different sites within BAE so would not be in a position to have an understanding of other BAE sites.

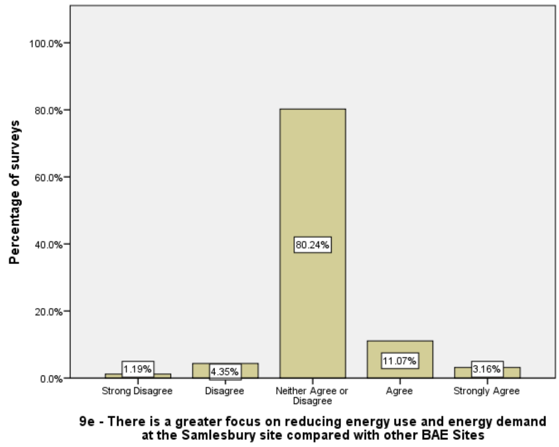


Figure 4:19: Frequency distribution of percentage of answers to question 9e

4.7.1 Summary

This section has highlighted that:

- employees believe energy use and energy demand are important issues to BAE,
- employees are unsure whether there is a greater focus on reducing energy use and demand at the Samlesbury site compared with other BAE sites.

However, the qualitative data suggests the attempt to distinguish between energy use and energy demand was not successful (this is discussed further in Chapter 9). Post-survey reflections on question 9e highlight how employees would be unaware of other sites' energy use and approaches to energy use due to having no experience of these workplaces.

4.8 Organisational Influence

This group of questions (Q1da, Q1db and Q2c) directly explores the organisational elements of the workplace energy culture framework (Chapter 2). It focuses on exploring organisational structures, such as the SHE function and energy/environment champions, and their influence on employee energy use. It also explores other direct influences on employee energy use, such as training, supervision and guidance, and the role of their line manager.

Influence of SHE Function

Around half of the participants answered strongly agree/agree to Q1da, stating the SHE function influences how they use energy in work (53.44%, *n* = 246), with slightly fewer participants associating energy-related topics (monitoring, training, energy conservation) with the SHE function (43.9%, *n* = 247). Both questions had a similar number of participants answering strongly disagree/disagree (21.46% and 21.95%), but Q1db, which focused on associating energy-related topics with SHE, received a larger number of neither agree/disagree (Figure 4:20 and Figure 4:21).

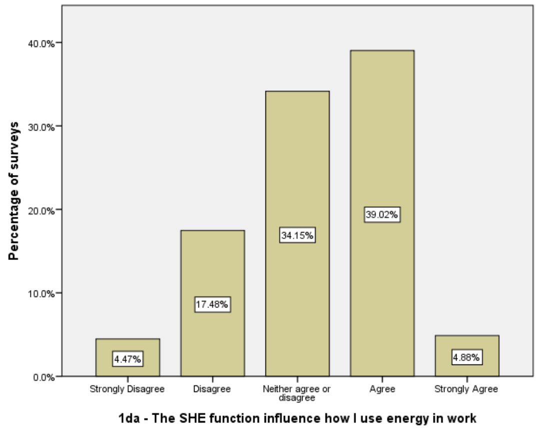


Figure 4:20: Frequency distribution of percentage of answers to question 1da

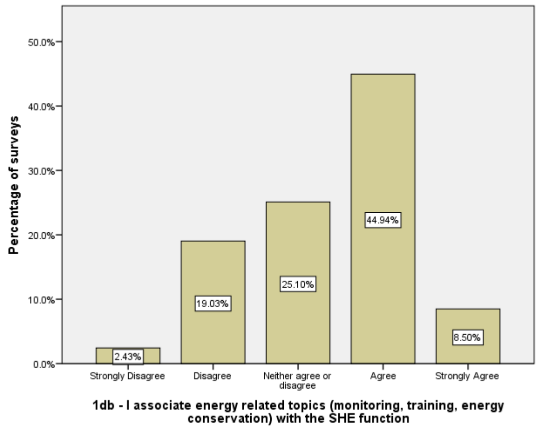


Figure 4:21: Frequency distribution of percentage of answers to question 1db

Open-Ended Survey Questions

In addition to the two closed-ended questions focusing on the SHE function, there were three open-ended questions:

- Q1a: Name five things you associate with the SHE function.
- Q1b: In the past year, name 3 impacts the SHE function have had on your work.
- Q1c: Thinking of your specific work environment, have the SHE function made any suggestions as to how to improve energy efficiency and reduce energy demand in your workplace?

These questions were coded in NVivo as described in Chapter 3. Figure 4*:*22 represents the coded themes for Q1a. In total there were 1060 answers from 261 surveys. The majority of participants wrote five comments, as per the question instructions; however, some participants did not (Table 4:5).

The majority of themes in Figure 4:22 were neutral comments, where participants stated the activities they associated with the SHE function. However, some participants used the survey as an opportunity to write negative or positive comments about the SHE function (Figure 4:23).

Coding theme	No. of answers	Coding theme	No. of answers
Advice	7	Auditing	11
Energy	29	Energy and environment	3
Environment	82	General duties*	24
Health	95	Health and safety	44
Negative**	19	Positives**	8
Posters	4	Safety-related theme**	681
Waste and Recycling	52		

Figure 4:22: Coding themes from Question 1a of the survey

**Added after secondary coding process. **These themes are expanded on below.*

Table 4:5 Frequency of number of answers participants gave to Question 1a

Number of answers written	Frequency
0	23
1	3
2	12
3	23
4	37
5	159
6	1
7	0
8	3
Total surveys	**261**

- Inability to grasp serious issues
- Bureaucratic
- Overbearing
- Little in the way of support
- Do not engage readily with operational areas
- Lots of procedures and big budgets
- Lack of clear direction
- Wishy washy direction (organisation)
- Everything they do is well over the top and the costs are excessive
- The street lighting is excessive. It is better than most councils provide
- The speed humps on site are too high
- They can't get a budget for decorating the foyer
- Dependent upon team member – the ability to 'hinder & not help' the project (casts a bad light over SHE)
- Overbearing endless info about common sense
- Short-lived safety initiatives
- Restrictive
- Repeating work (doing same job differently for several meetings)
- Unnecessary posters, information overload, cheap safety shoes, speed bumps & nanny state

Negative answers for Question 1a

- Not enough of them
- Professional
- Overworked
- Enthusiastic individuals
- Happy to help attitude
- Professional
- Dedicated
- Easily accessible

Positive answers for Question 1a

Figure 4:23: Negative and positive answers for Question 1a

The safety-related theme was the largest of the coded categories for this question. All participants who responded to this question wrote at least one safety-related activity. This theme involved all comments that included the words/phrases safety, fire, risk assessment, accident, personal protective equipment, display screen assessment, with a total of 681 comments. The number of answers relating to safety, and the results showing how each participants wrote at least one safety-related comment, highlight how the majority of employees associate safety-related topics to the SHE function. This suggests there is a dominant safety culture on site. This is discussed further in Chapter 6.

In total, there were 114 comments that were coded to energy and/or environment themes, with only 29 comments specifically mentioning the term energy. This is a small number of energy and/or environment-related comments, in comparison with the total number of answers. Table 4:6 and Table 4:7 show where the energy and environment comments featured in the participants' five-item list. The majority of answers appeared in the third, fourth or fifth position in participants' answers, which demonstrates how employees associate topics of safety with the SHE function before energy and/or environment topics. Question 1da (Figure 4:20), which specifically asked whether employees associate energy topics with the SHE function, showed the majority of answers were in agreement. However, the small number of energy and/or environment comments, and their placement in the list of five answers to question 1d, suggests that employees immediately associate safety-related tasks or activities with the SHE function, before energy and environment.

The answer number where environment was mentioned	**Frequency**
1	4
2	8
3	25
4	29
5	19

Table 4:6: Where people mentioned environment comments when asked to write down five things in question 1d

The answer number where energy was mentioned	**Frequency**
1	4
2	4
3	10
4	9
5	2

Table 4:7: Where people mentioned energy comments when asked to write down five things in question 1d

Energy/Environment Champions' Influence

The majority of participants answered with neither agree/disagree or agree answers for energy/environment champions influencing their energy use, with approximately 40% of answers for both neither agree/disagree and strongly agree/agree (n = 167, Figure 4:24).

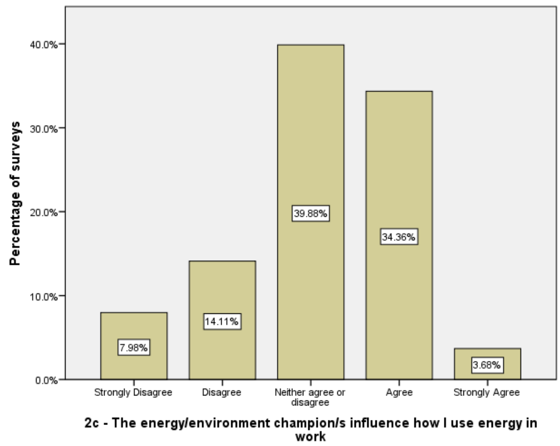


Figure 4:24: Frequency distribution of percentage of answers to question 2c

Missing Answers

This question was the last in Section 2 of the survey. Participants were first asked to respond with Yes or No to a question asking if they were aware that BAE had energy/environment champions at the Samlesbury site (Q2). If they responded with No, they were asked to proceed to Section 3. Of the 259 surveys in the sample, 167 reported Yes and 91 reported No, and there was 1 missing answer. Therefore it was only expected that 167 surveys would answer Q2c; however, there were only 49 missing answers. The answers of people who said No to Q2 (awareness of energy/environment champions at Samlesbury) but answered Q2c were reviewed. The majority of answers to Q2c were strongly disagree/disagree or neither agree/disagree, and the decision was taken to exclude them from the analysis of Q2c.

Qualitative Data

During a discussion on supervision and guidance in the focus group (as highlighted earlier) a participant stated:

> *'…be good to have someone who supervises but their job is more specific to that [energy], so help us aim to reduce energy and shut down things'*
>
> *Extract 29*

After this statement, the researcher asked if they were referring to the energy and environment champions. The participants then went on to name two energy and environment champions for that area. However, the participants proceeded to make comments about how they thought these champions were more focused on waste and recycling rather than energy. This suggests that energy and environment champions may not focus on energy topics, and consequently their colleagues may not identify them as a person to go to to discuss energy suggestions.

The survey asked participants if they could name the energy/environment champion in their areas. Just over half (51%) of participants wrote down at least one name, with an additional four participants writing a name but saying they were unsure.

Supervision and Guidance on Saving Energy

The majority of participants (76.06%, n = 259) reported neither agree/disagree or strongly disagree/disagree to question 8a 'I get enough supervision and guidance on saving energy at work' (37.45% strongly disagree/disagree and 38.61% neither agree/disagree; Figure 4:25).

These results differ from those reported by Ucci *et al*., (2014), who found the majority of participants disagreed with the statement (around 60%), with around a third responding with neither agree/disagree statements. The results reported in Figure 4:25 show a much smaller percentage of disagree statements. Each workplace will have different organisational structures, priorities and approaches, which will be very specific to that work setting. As is discussed in Chapter 9, the Samlesbury site is more involved in energy-reduction strategies compared with some of the other BAE sites. This could be a similar situation with different businesses and would explain the differences between these research results and those of Ucci *et al.,* (2014).

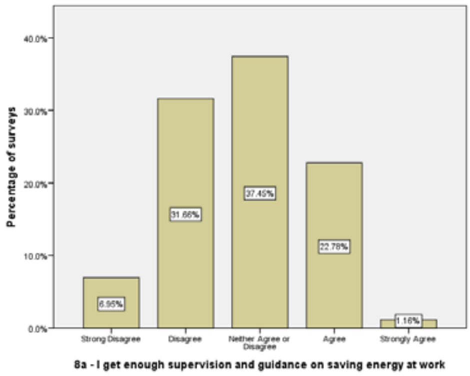


Figure 4:25: Frequency distribution of percentage of answers to question 8a

Qualitative Data

The researcher asked the focus group if they agreed with the survey results showing that participants wanted more supervision and guidance when it came to energy. Many members of the group answered with 'yes' comments. However, this question sparked a longer discussion between participants, where they spoke of the complexities of the work environment:

‘I think it’s more of the supervisors might get told from the managers, “tell your guys to turn the computer off after their shift, the lights off” but when it gets to us, at the end of the shift, my section has two computers and two sets of lights. It’s all right turning the lights off, but if I turn the computers off and DLS [machine] goes off and HMS [machine] goes off, then night shift comes in, then they’d be pissed off if it takes twenty minutes to boot everything back up. So I think there is a disconnection what actually works out and what’s, what we’ll do because, I mean I’ll turn stuff off and go home but then night shift will be angry.’

Extract 30

This extract highlights several points about processes in BAE. First, it provides an insight into the hierarchical structure of BAE by suggesting that supervision and guidance may only be given if managers tell supervisors to reduce energy, and then they tell the manufacturing staff. Second, it suggests there may be a disconnect between what is practical in the work environment and initiatives that managers are trying to implement. In extract 30, the participant is describing how this shed experiences shift work, and if this employee turns off equipment at the end of a shift, this could delay work for the other shift. Another participant reiterates this point by saying:

‘you’ve got twenty minutes of a guy waiting for it [machine] to load up, there’s a cost to that [time] as well’

Extract 31

These two extracts (30 and 31) also demonstrate an awareness of how energy is used on the machines the participants use, and the impact that turning machines off can have on the wider work population.

Energy Saving Training

The majority of participants reported strongly disagree/disagree to Q8b (48.06% strongly disagree/disagree, *n* = 258), with around equal numbers of responses to neither agree/disagree (26.36%) and strongly agree/agree (25.58% Figure 4:26). Supporting these results, only 9.7% of participants answered Yes to Q3, which asked ‘Have you, in the last 6 months, received any energy related training?’ (*n* = 258). Following this, a question asked participants to give details of the training they had received (results presented in Figure 4:27). As can be seen, the majority of the answers related to an environmental training module that was accessed via a system called Skillport.

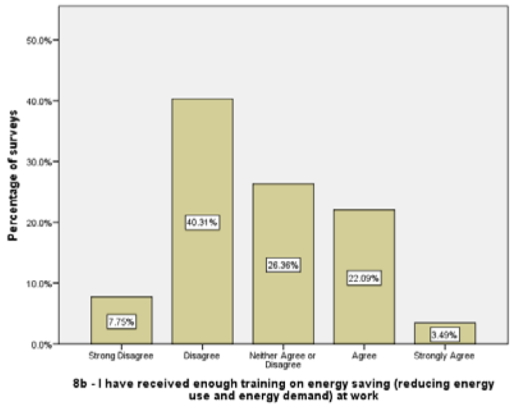


Figure 4:26: Frequency distribution of percentage of answers to question 8b

Energy Saving Targets

The survey asked employees if they were aware of any energy saving targets for their area (Q7), and also asked employees to provide details of such targets (Q7a). Only 22.2% were aware of energy saving targets, with the majority of employees not aware of energy saving targets for their area (77.8%, *n* = 257). Figure 4:28 indicates the answers employees gave when asked to provide details about the targets in their area. The results show a variety of comments, with two participants stating different reduction targets (2% and 5%), with several others detailing how it is the responsibility of the SHE team, the energy and environment champions and managers to look at the targets. Many of the comments suggest that employees are aware that targets exist but cannot provide any further details about them. The comments in Figure 4:28 also suggest that employees associate recycling and waste reduction targets with energy use.

Environmental Online Training

- Environment module on line training – I believe this was compulsory across site
- Environmental ETM
- Part of IT online course – 30 minutes
- I have completing training on Skillport. Not sure of the exact details but believe it could have been around 20 mins long. It was about energy consumption (I think!)
- Online training. Approx. 30 mins
- Online ETM Training
- Presented at SHE training via Skillport
- All aspects – electricity, water, heating, conducted by Preston training centre, completed on Skillport (estimated 30 mins)
- A Skillport-based training called Office ETM. On-line course completed August 2014 of around one hour's duration.
- Can't remember the details but it was the mandated environmental training module in Skillport
- Online training and presentation material.
- On-line through Skillport
- Environmental awareness training office energy saving
- Environmental Awareness ETM – note I am also IEMA trained
- I did do an Environmental Awareness training course online via Skillport, but back in April 2014.
- Online training course mandated for BAE employees
- Environmental ETM
- Yes – online training

Other Energy-Related Training Comments

- Speed awareness course – effective use of gears etc to reduce fuel consumption
- I was just asked to be made aware of turning lights, computers off etc.
- Awareness raised by conducting a process confirmation off the 430 environmental process
- Shut down process – Dave Leaver – 2 hours
- Turning off lights and computers
- I believe I did some mandated training approx 12 months ago covering energy usage in BAE and how we can reduce it.

Non-Energy-Related

- I have received online training for 'Office Safety Awareness' which was to understand the hazards in an office environment. Appreciate factors that influence the risk of harm or ill health arising and understand the precautions that are required. I also voluntarily decided to take an online course on 'Managing Stress and Mental Wellbeing' which explained what is meant by stress and why it is experienced, Identify the signs and symptoms of stress, Explain the role of the HSE Management Standards in the workplace, Describe how to conduct a Stress Risk Assessment in line with HSE recommendations

Other Comments

- Think that it would be a very good idea to highlight ways in which energy is wasted and how we can reduce the impact and escalate issues where appropriate
- Not training as such but emails outlining what is going on.

Figure 4:27: Participants' answers to Q3a

Targets Deployed via Scorecard

- Targets deployed through scorecard based on a 5% yearly reduction, this business is responsible however remain semi-toothless to initiate reductions based on workloads
- Basic data shown on scorecard
- Scorecard but unsure what they refer to building, site or organisation. Target – 5% stretch target on 2013 (2013 act £9.5 Million)
- I know there is some because of the scorecard updates, but I can't recall the exact details

SHE

- Targets provided by J Farmers and reviewed at 430 SHE review
- The SHE co-ordinator is responsible and periodically tells us how we are doing. But I've probably not been bothered to read the slide, it will be hidden amongst the large SHE brief we get sent
- Energy usage trends plotted on SHE boards and break out area
- On the SHE board is the cost of energy to the build compared to the target by year
- I'm only vaguely aware there are some targets but I'd know to go to the SHE board to look for the detailed information.
- Informed via SHE updates
- Monthly SHE review and team meetings

Graphs and Team Boards

- Target for energy saving on gas/electricity set for site and monitored on team boards
- Some graphs are available
- Seen the graph comparing last year to this year on energy
- Been shown a graph of last year to this year and we are better this year, due to the mild winter

Other Comments

- Responsibility – Building manager/employees
- Plan on a page – KWK etc.
- Only that info is purchased and distributed
- I know there are targets as a board was put up some time ago, but since then not aware what current targets are and whether we are meeting them
- 5% reduction
- Targets are linked to top level objectives and flowed down to all staff. 'League Tables' published on intranet
- Used to be but no longer get this information since SHE plan meetings only invite 1 or 2 people now, who are responsible and get visibility of organisation MAI targets at higher level. Ours and assume aim to help achieve overall.
- Could guess at development of 3 point environment plan for our office area but have not seen this for 2014
- I can find energy use for area on intranet
- Energy saving kaizens can be raised and form part of overall kaizen target
- Energy league tables
- Targets are published on the intranet and are part of our EIS (employee bonus) scheme
- League table.
- Aware of site energy reduction targets via site objectives and site safety review
- Probably for the larger area but hard to relate to your own area especially in a factory with large equipment
- Targets are site based, mainly for energy intensive users and areas.
- I'm aware of the targets and monitoring against them as they are reported monthly to management

Figure 4:28: Answers to Q7a

Other Comments *Continued*

- Reported monthly via standard report. Energy champion reports on behalf of the business.
- Shut down plans
- Past year have had 2% reduction in water, gas, electricity
- This year energy plan in place
- We don't have any specific targets in our area as we are office based and not high energy users, but we do run energy initiatives and discuss this around our teams. We implement shut-downs and issue reminders of key things that can and should be done to help save energy. I have access to the energy usage stats for our building and I post these monthly on the notice board so everyone is aware of the amount of energy used
- Not aware of targets, but aware

Recycling, Waste and Water Comments

- There are targets regarding a charting system that shows which building uses the most energy and which building recycles more successfully. The SHE team are in charge of creating these charts and put posters up in printing areas to highlight where this building is on that chart
- We have a department league table for recycling displayed on the notice board
- Waste recycling targets with current updates on the percentage towards the targets and the production of a league table
- Everybody in departmental environmental waste champion
- Waste collection in designated bins
- Only recycling targets for the building
- Waste recycling
- Recycling targets
- Opportunities plan in place look at water also. Ice reduction is captured here

Aware targets exist on site but not aware of any details

- I am aware that they exist but don't know the figures. The department SHE reps are responsible for them
- Targets have not been visually shown this year
- Aware of targets for site but not individual areas
- Know there are targets to reduce costs but not sure what the exact figures are
- I have probably answered this incorrectly as I am certain that our departmental targets will be in the functional plan – but I can't remember what they are or where to locate this to enable me to check
- Believe there are targets for the site, but not aware of any specific to my area/office
- I am aware that there is a target, yet not of any details/champions of the area
- I'm vaguely aware there is one but couldn't say exactly what it is and who owns it
- I know there are some but don't know the details
- I know there are targets but don't know what they are
- I know there is one for site but what it is I don't know
- Energy/waste reduction – not sure of targets
- Aware targets are linked to EIS bows and cover electricity and gas usage however unaware what these targets are

Figure: 4.28 (Continued): Answers to question 7a

Line Managers' Influence

The majority of participants answered strongly disagree/disagree to Q10a 'My line manager influences my energy use' (52.12% strongly disagree/disagree, *n* = 259 Figure 4:29). This question was not explored in the focus group: it was deemed inappropriate as the group consisted of a mix of manufacturing employees and supervisors

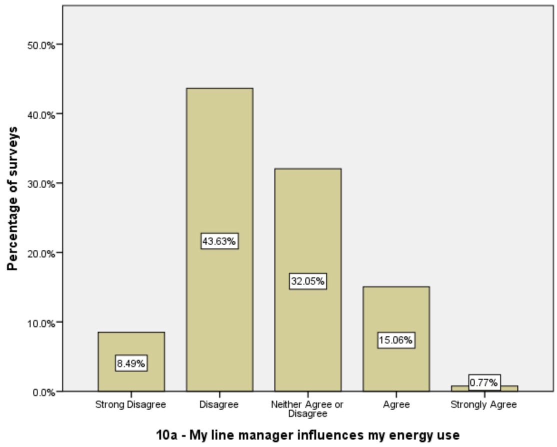


Figure 4:29: Frequency distribution of percentage of answers to question 10a

4.8.1 Summary

This section has highlighted that:

- employees associate energy use and energy related topics with the SHE function,
- employees are unsure or in agreement that environment champions influence their energy use,
- employees are unsure or don't think they receive enough supervision and guidance on energy use,
- employees don't think they receive enough training on energy saving,
- employees don't think their line manager influences their energy use.

It has also demonstrated through the qualitative answers that the site appears to have a strong safety culture, and participants associate topics of safety with the SHE function, before energy and environment topics. It also highlighted how some participants have taken the survey as an opportunity to report negative, or positive, comments regarding the SHE function, even though the question specifically asked for tasks associated with them. The open-ended questions highlighted how the majority of training is conducted through a 'Skillport' online system, within an environmental module. The focus group suggested that employees associate waste and recycling topics with the energy/environment champions rather than topics of energy. Also the nature of activities conducted in the manufacturing area can affect energy use, with employees stating that there is sometimes a disconnect between suggestions or comments from supervisors, and the practical application of reducing energy use. The results and discussion points raised in this section are discussed in greater detail in Chapter 7, where a description of the Samlesbury energy culture is provided.

4.9 Colleagues and Work Team Energy Actions

This group of questions (Q10b, Q10c, Q10d, Q10e and Q10f) explored the dynamics of work team and colleague energy actions by focusing on awareness, attitudes and conversations about energy use.

Energy Use and Demand Discussions

The majority of participants reported that energy use and energy demand are not discussed regularly in their work environment, with 68.48% strongly disagree/disagree statements (Figure 4:30, *n* = 257). Similar results were shown to Q10e – 'I discuss ways to reduce energy use and demand with my colleagues' – with 65.5% strongly disagree/disagree statements (Figure 4:31).

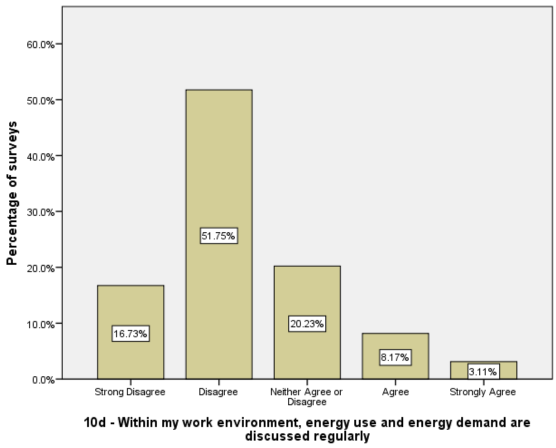


Figure 4:30: Frequency distribution of percentage of answers to question 10d

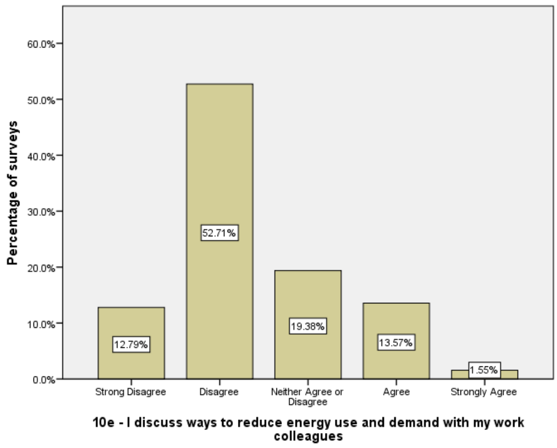


Figure 4:31: Frequency distribution of percentage of answers to question 10e

Ucci *et al.,* (2014) asked a similar question to Q10e: 'I discuss energy saving at work with my colleagues'. They reported similar results to those in Q10e (around 58% strongly disagree/disagree, 24% neither agree/disagree and 16% agree).

The focus group data confirms the results in Figure 4:30 and Figure 4:31. The group were asked if they talk about energy, and if energy gets spoken about during start-up meetings. One of the shop-floor members responded with:

'No, it just gets mentioned like before holidays, like say if you know you're going to be off'

Extract 32

The researcher then asked if the participant was referring to the shut-down plans that BAE has. The participant answered:

'yeah, and when you're away, then you turn your computer off'

Extract 33

The participant was referring to times when individuals take annual leave in addition to the shut-down plans. The researcher posed the same question to the other shop-floor members, who responded with a similar answer:

'Again, it's like at Christmas and Easter … Christmas we shutdown but Easter with the night shift and stuff, we only probably had a day, so shutting down can be, it's difficult sometimes, you know what I mean. How far do we go as a building, we're probably a bit special in that'

Extract 35

Both these extracts support the survey findings by highlighting that energy is generally not discussed on a day-to-day basis, but discussions may occur prior to shed shut-downs or before individual annual leave.

Work Team and Colleagues' Attitudes and Practices Towards Energy Use

The results from Q10b, which stated, 'within my specific work team we are conscious of our energy use', were split, with 42.41% of participants answered strongly disagree/disagree but 35.02% strongly agree/agree (Figure 4:32, *n* = 257). Q10c produced similar results to Q10b, with 40.42% of participants answering strongly disagree/disagree to the statement, 'Within my

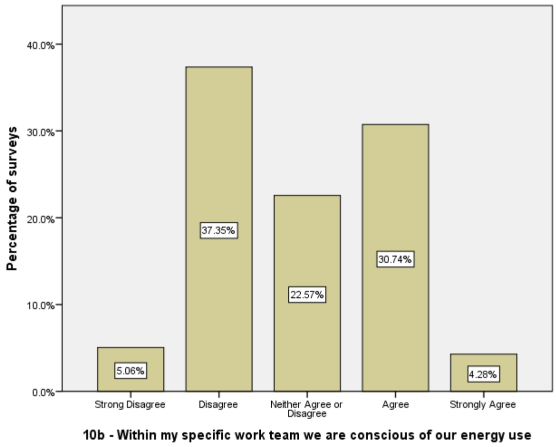


Figure 4:32: Frequency distribution of percentage of answers to question 10b

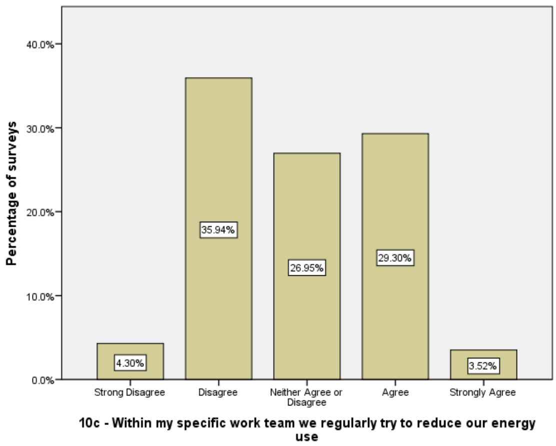


Figure 4:33: Frequency distribution of percentage of answers to question 10c

specific work team we regularly try to reduce our energy use', and 32.82% strongly agree/agree (Figure 4:33, *n* = 256).

The final question in this subtheme addressed colleagues supporting the need to reduce energy in the workplace (Figure 4:34). The majority of participants (78.12% *n* = 256) reported neither agree/disagree (40.23%) or strongly agree/agree (37.89%).

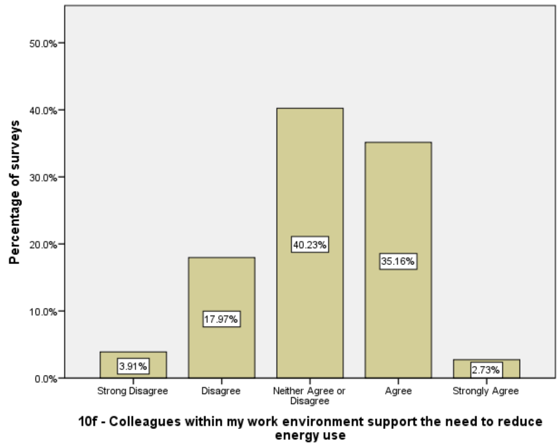


Figure 4:34: Frequency distribution of percentage of answers to question 10f

The focus group supported the answers shown in Figure 4:34. The researcher asked the group to think about their everyday tasks and if they think about how much energy they are using during those tasks. The question did not specifically ask if colleagues and work teams were conscious of their energy use but one participant (who works in an office within the shed) responded with:

> *'I think we are quite conscious [of our energy use], and we have fans in the office, [we] always make sure the fans are off when we go home, we shut down the computers … we log them off during the day, during the week and we log them off at weekends, and then shut them down.'*
>
> *Extract 36*

The participant talks in a collective way, not talking about themselves individually and uses 'we' throughout this extract. They are addressing the work team as a whole, and stressing that the work team are conscious of their energy use by informing the researcher of certain energy practices that they participate in. Following this extract another member of the group responded with:

> *'yeah, there's a kind of culture they're on, isn't there?'*
>
> *Extract 37*

The researcher focused the question to the rest of the group and one member responded with:

> *'Probably don't think about it that much, at the end of the week I'll probably turn lights off around my section but there's some things we are not able to turn off. It all depends where I am. I sometimes think about it on the way home, and think I should do it, but sometime I just want to get home'*
>
> *Extract 38*

This extract highlights how employees are prioritising their work tasks. This participant has acknowledged that they don't really think about how much energy they use. They also provide an insight into their workplace priorities. They do not regard energy practices such as turning off equipment and lights as being on their list of work tasks they need to complete before finishing work.

4.9.1 Summary

This section has highlighted:

- energy use and demand are not discussed regularly in work teams or with colleagues,
- employees are unsure or agree that their colleagues support the need to reduce energy use,
- mixed results were obtained for the statements addressing work team consciousness of energy use and work teams regularly trying to reduce energy use.

The focus group discussions highlight how energy topics only appear to be discussed regularly in team meetings prior to a shut-down period, or if an employee is going on annual leave. This suggests that the intervention of shut-down periods is successful at engaging employees with energy discussions, but this behaviour is not sustained across other periods of time.

4.10 Individual Workplace Energy Practices and Attitudes

This theme of statements (Q12a, Q12b, Q12c, Q12d, Q13c and Q13d) explored energy practices, through the means of self-reporting of behaviour, attitude towards energy use and colleague comparison.

Energy Practices

Four statements make up the energy practices section:

- At work I always turn equipment, which I personally use, off (where possible) after I have finished using it (Q12a)
- At work I always turn equipment, which I personally use, off (where possible) at the end of the day/shift (Q12b)

- At work if I am the only person in an area I always turn lights off (where possible) after I leave that area (Q12c)
- If I notice a fault with equipment I am using, I always report this to my line manager (Q13c)

More than 80% of participants reported strongly agree/agree to Q12a (*n* = 256, Figure 4:35), 12b (*n* = 254, Figure 4:36) and 13c (*n* = 255, Figure 4:38). Q12c (*n* = 253, Figure 4:37) received a lower percentage of agreeing answers (68.78% strongly agree/agree) but a higher percentage of neither agree/disagree answers (17.39%). One reason for the difference in these percentages may be due to the wording of the question. The question did not directly ask participants not to answer the question if they had automated lighting, so participants may have written neither agree/disagree when answering.

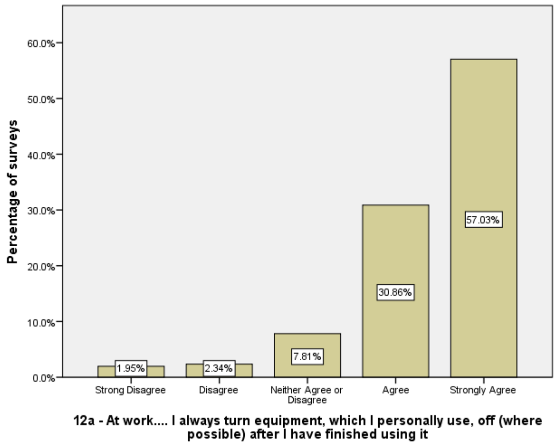


Figure 4:35: Frequency distribution of percentage of answers to question 12a

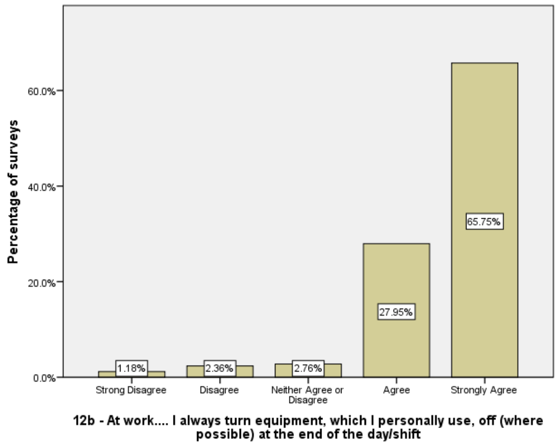


Figure 4:36: Frequency distribution of percentage of answers to question 12b

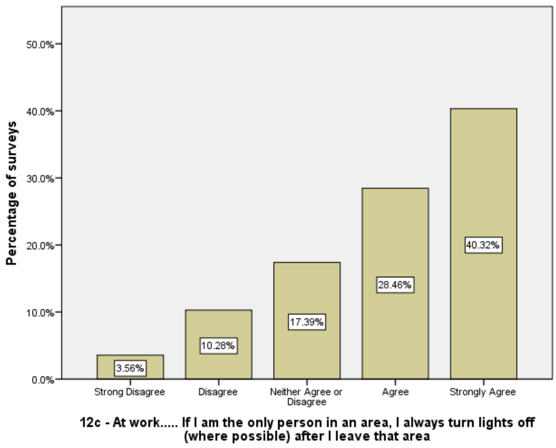


Figure 4:37: Frequency distribution of percentage of answers to question 12c

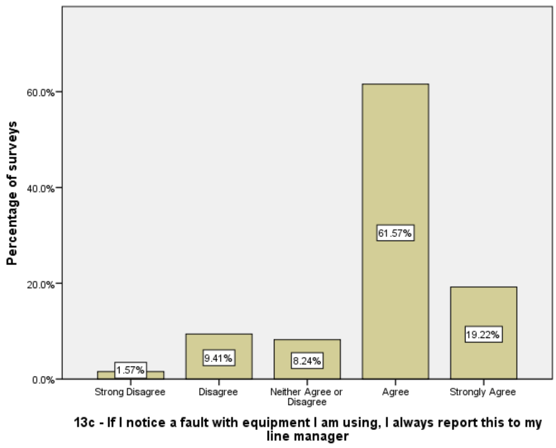


Figure 4:38: Frequency distribution of percentage of answers to question 13c

The focus group supported these results. Throughout the session, there were many occasions where participants discussed energy-saving practices. Some of these have already been highlighted in extracts 12 and 36. However, the focus group also highlighted the complexity of some energy practices and how simply turning equipment off is not always possible (extract 30).

Attitudes Towards Energy Practices and Colleague Comparison

These statements focused on general energy-saving practices and comparisons with work colleagues:

- I always make an effort to reduce energy use within the workplace (Q12d)
- I am more conscious of my energy use than my work colleagues (Q13d)

The majority of participants agreed with statement Q12d (*n* = 255; Figure 4:39), with 71.37% answering strongly agree/agree. These answers are different to those of Q13d (*n* = 255), which asks employees to compare how energy conscious they are compared to their work colleagues. The surveys report 65% neither agree/disagree answers, and 25% strongly agree/agree answers Figure 4:40.

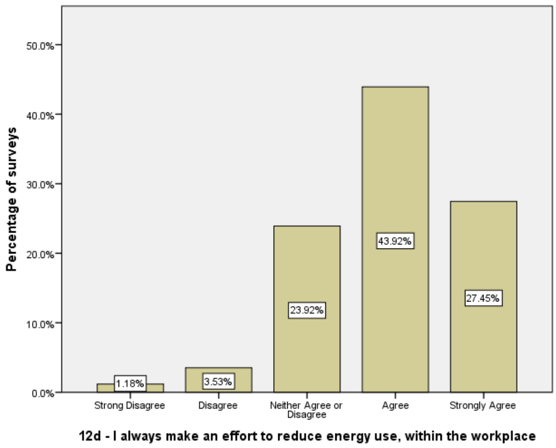


Figure 4:39: Frequency distribution of percentage of answers to question 12d

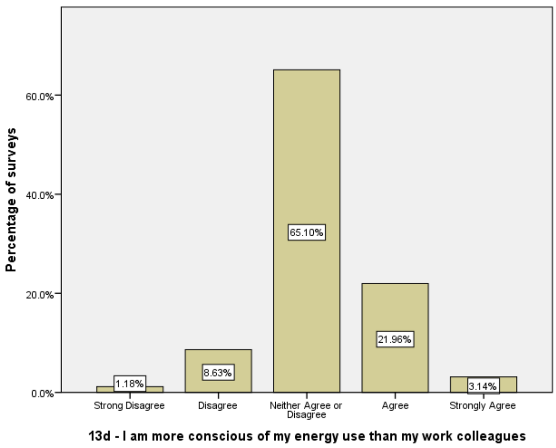


Figure 4:40: Frequency distribution of percentage of answers to question 13d

4.10.1 Summary

This section has highlighted that:

- employees are proactive in reporting faults with equipment and turning off equipment and lights,
- employees report that they always make an effort to reduce energy use within work,

- employees do not know if they are more conscious of their energy use compared with colleagues.

Previous focus group discussions have detailed some examples of the energy practices that employees partake in. These along with the survey results suggest employees are engaged in energy topics but are not able, or willing to compare themselves to their colleagues.

4.11 Home Energy Practices, Price Concern and Attitudes

This theme explored energy practices in the home (Q14a, Q14b, Q14c, Q14d and Q14e), through the means of self-reporting of behaviour, concern with rising energy prices and their effect on tasks (Q15a, Q15b and Q15c) and knowledge of energy use (Q15d).

In a similar format to the workplace questions, five statements make up the energy practices section:

- At home I always turn lights off after I leave a room (Q14a)
- At home I always leave electrical goods on standby when not in use (Q14b)
- At home I always turn electrical goods off at the mains socket when not in use (Q14c)
- At home I always unplug my phone charger when not in use (Q14d)
- At home I always make an effort to reduce energy use (Q14e)

In addition, four questions were developed to address attitudes to energy use at home:

- At home I am concerned about rising energy prices (Q15a)
- At home rising energy costs have affected my day-to-day task (Q15b)
- At home I go around and turn off appliances/equipment that are not being used (Q15c)
- At home I know approximately how much energy I use (Q15d)

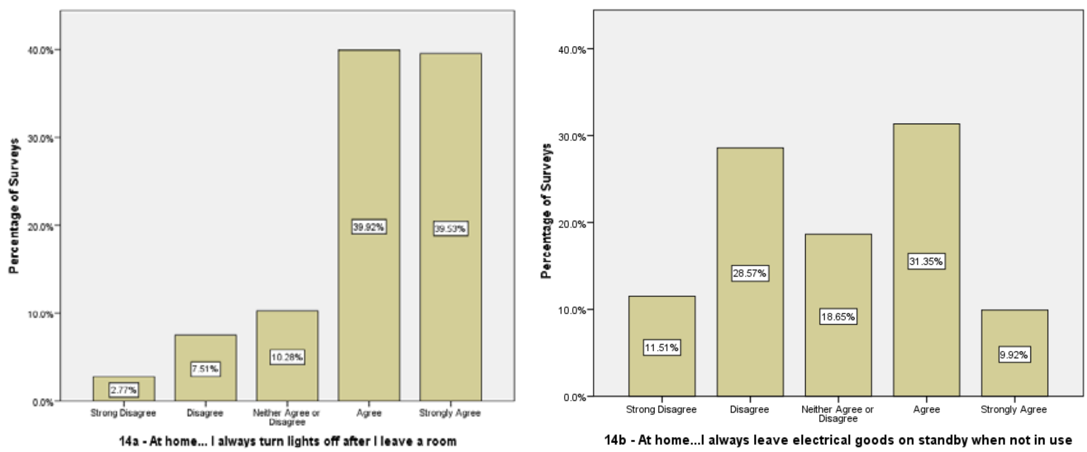


Figure 4:41: Frequency distribution of percentage of answers to questions 14a and 14b

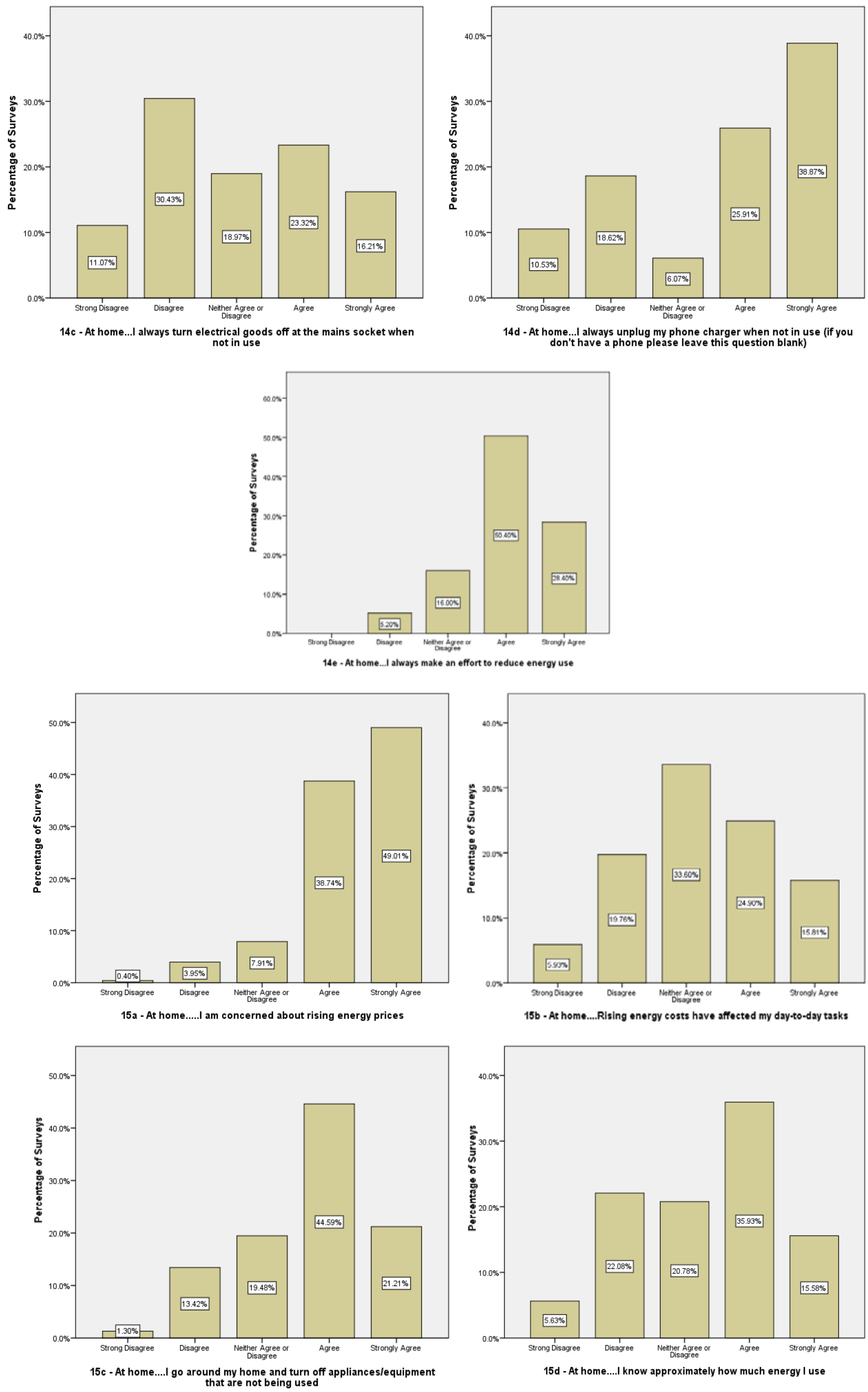


Figure 4:42: Frequency distribution of percentage of answers to questions 14c, 14d, 14e, 15a, 15b, 15c and 15d

The results in Figure 4:41 are similar to those for the workplace energy practices question 12c (Figure 4:39), with the majority of participants answering strongly agree/agree to Q14a. There were mixed responses to Q14b and Q14c, with approximately 40% strongly agree/agree and 30% strongly disagree/disagree answers. However, the majority of employees appear to always make an effort to reduce energy use in the home environment, with 78.8% strongly agree/agree answers (Graph 14e Figure 4:42). Participants also appear to be concerned about rising energy prices, with 87.75% strongly agree/agree answers (Graph 15a Figure 4:42). However, this concern is not always transferred into changes in day-to-day tasks (Graph 15b Figure 4:42), with only 40.71% answering strongly agree/agree. The majority of participants appear to conduct energy-saving activities of turning equipment and appliances off in their homes (Graph 15c Figure 4:42) but only half of the sample know their energy use at home, with 51.51% strongly agree/agree answers (Graph 15d Figure 4:42). These results demonstrate similar percentages of responses for energy practice questions at the home and the workplace.

4.12 Energy Concern in Relation to Business

This set of questions (Q9c and Q9d) explores employees' views of how BAE addresses energy use in its business priorities and whether employees thought rising energy costs would impact their work.

Priority for the Business

Two statements explored how employees viewed energy in relation to BAE's priorities: 'Reducing energy demand should be a higher priority for BAE Systems' (Q9c) and 'Reducing energy use should be a higher priority for BAE Systems' (Q9d). The purpose of these questions was to explore difference between energy use and energy demand.

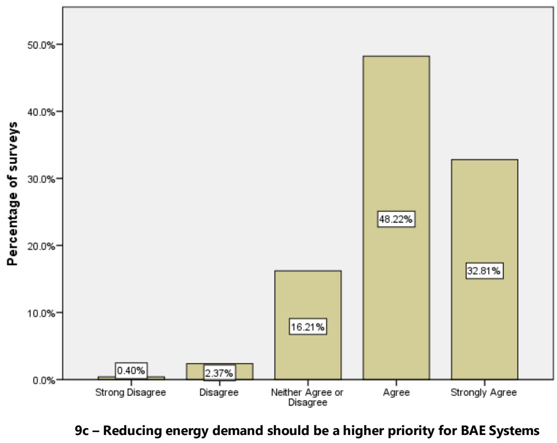


Figure 4:43: Frequency distribution for percentage of answers to question 9c

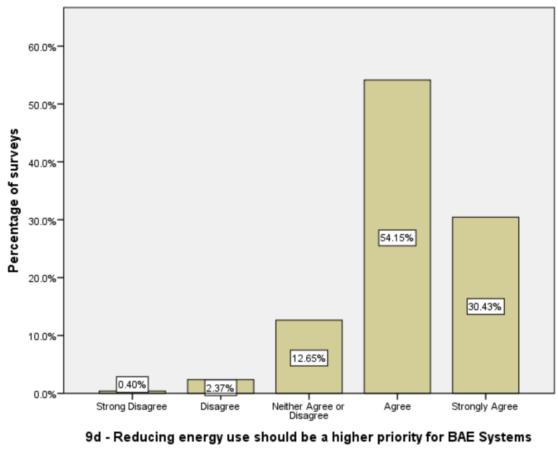


Figure 4:44: Frequency distribution for percentage of answers to question 9d

Both statements produced similar results, with the majority of participants agreeing that energy use and demand should be a higher priority (Q9c, 81.03% strongly agree/agree, Figure 4:43 and Q9d, 84.58% strongly agree/agree, Figure 4:44, *n* = 253).

The focus group did not directly ask participants about energy being a higher priority for BAE but it did explore whether participants view energy as a priority for the site. Two manufacturing employees responded with:

> *A 'I would say so, because we've had, I think recently, we've done a lot more about it I think, I say recently, I mean the last few years, not few months. Because, and especially in here, I don't know about in 4 Shed, I don't think they're as aware of the saving benefits as we are'*
>
> *B 'Yeah, it can really make a big difference'*
>
> *Extract 39*

Then the conversation stopped.

The extracts show how energy has become more of a focus for this shed in recent years. This could be in relation to the focus on achieving ISO 50001 status. It also suggests that there may be differences in opinions and approaches towards energy use in certain areas. Participant A suggests that employees in this shed are aware that changes they make can make a big difference in terms of saving energy.

The lack of answers and conversation about this question was very different to other questions asked in the focus group. There was a long pause after the question was asked by the researcher and the comments did not spark any further discussions, unlike some of the other questions. This could suggest that the focus group do not know how to answer this question.

Concern of Energy Cost to Business

These statements explore employee concern about rising energy costs:

- I am concerned about the cost of energy to the business (Q13a)
- I am concerned that rising energy costs will affect my day-to-day tasks (Q13b)

The results from these two questions were mixed, with employees agreeing they were concerned about the cost of energy to BAE (69.29% strongly agree/agree, *n* = 256, Figure 4:45) but unclear on whether rising energy costs would affect their day-to-day tasks, with the majority of participants answering either neither agree/disagree (41.57% *n* = 256) or strongly agree/agree (41.57% Figure 4:46).

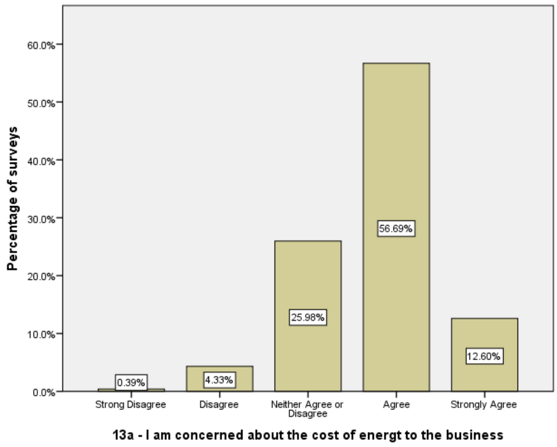


Figure 4:45: Frequency distribution of percentage of answers to question 13a

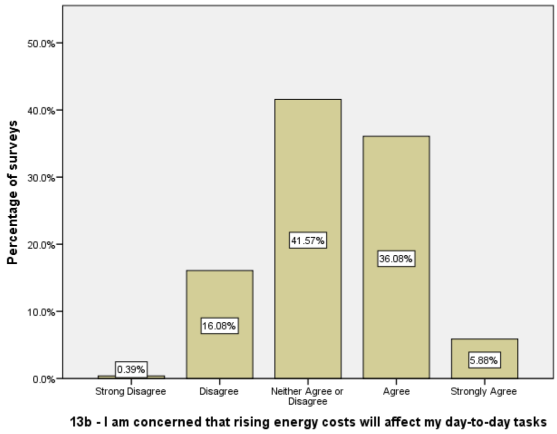


Figure 4:46: Frequency distribution of percentage of answers to question 13b

The focus group echoed the results in Figure 4:45 and Figure 4:46, when asked if they were concerned about cost of energy to the business. This questions sparked a lengthy discussion where participants discussed jobs and pay rises.

> *A - 'I think we understand how it's related to jobs in the future, I think we can see the bigger picture, I think that's how we see it, from that point.'*
>
> *B- 'Yeah, probably day-to-day we're too busy doing all your tasks, although you do think about it, turn computers off, but it's not always, you're not always thinking about it, then something, some communication comes out.'*
>
> *C- 'Always other things going on isn't there?'*
>
> *Extract 40*

These extracts highlight how participants are concerned about the cost of energy to the business. They also highlight how day-to-day this concern is not always translated into energy practices. Everyday work tasks seem to be a higher priority for completion over energy tasks. This is further highlighted by the following extract:

'I don't see [energy reduction] as much as a benefit to me, turning off lights doesn't benefit me directly, immediately, but I can see that, how competitive the market is now, and how much money BAE Systems needs to save on projects… I get that bigger picture [saving energy] but what probably doesn't work is I don't get a direct quick instant gratification myself doing anything from them [saving energy].

Extract 41

This extract sums up a number of the comments in this section. Employees can understand the need to reduce energy, to reduce business costs, and make BAE more competitive with jobs and projects. However, individually employees are disconnected from this and there are no direct consequences for employees doing day-to-day tasks.

Knowledge of Business Approach to Reducing Energy

The final question in this section explored employees' knowledge of what BAE is doing to reduce energy use and demand (Q9f). The results showed no significant response from employees, with 38.68% strongly disagree/disagree, 32.81% neither agree/disagree and 28.51% strongly agree/agree answers to this statement (Figure 4:47, *n* = 256).

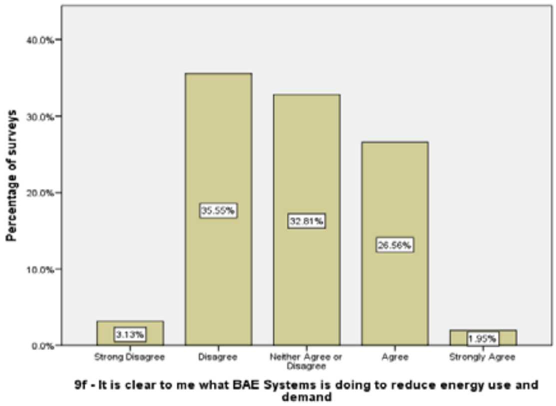


Figure 4:47: Frequency distribution of percentage of answers to question 9f

These results differ from those reported by Ucci *et al.,* (2014), who reported a much higher percentage of disagree statements (around 48%) with around 35% unsure and only 15% agree statements. This might imply differences in organisational cultures.

The focus group were not directly asked if they knew what BAE was doing to reduce energy use and demand but they had demonstrated during the session some knowledge about a recent solar farm development (discussed further in Chapter 6). The group were aware of the solar farm but had incorrect information about costings, how much energy it was producing and the purpose of it. In one example, one participant stated:

'The solar farm, it's going to be twenty five years before they've made their money back.'

Extract 42

This statement is incorrect as the solar farm will actually pay back within seven years (source interview with TM2 and TM3). Following on from this conversation, the researcher asked if the group were aware of any other buildings with energy-related infrastructures. The participants went on to discuss the wind turbine at the entrance to the site, making comments such as, 'Think it's broken' and joking, 'Maybe it just about powers the kettle or something'. The discussion then moved on to rainwater harvesting on some buildings, and the specific approaches that could be implemented in this shed, such as turning off air conditioning and improving natural light.

The discussions on this theme were mixed, so they support the results in Figure 4:47. Participants appeared to have some knowledge of the energy infrastructures on site, but on many occasions when they spoke they would make statements as if they were asking a question. This indicates that they may not be sure whether the statement is true. Extracts from other themes in this chapter highlight how some participants are aware of ISO 50001 and the changes this has brought to the site in terms of energy use, and also some specific energy practices that are targeted, for example turning computers off.

4.12.1 Summary

This section has highlighted that:

- employees think reducing energy use and demand should be a higher priority for BAE,
- employees are concerned about the cost of energy to the business but are unsure whether this will affect their day-to-day tasks,
- employees are unsure as to what BAE is doing to reduce energy use and demand.

Focus group discussions highlight how employees do not always have knowledge of improvements in site energy infrastructure changes, and those who do may not have the correct information, for example in figures regarding payback periods. The sessions have also highlighted how some employees have the opinion that reducing energy has no direct benefit to them, which also suggests there are no advantages to reducing energy use. However, employees do appear to establish a link between reducing energy use, reducing costs and the wider manufacturing market. Extract 39 also indicates that the approach to energy use on site is evolving.

4.13 Conclusion

The chapter presents the results from a survey conducted at the Samlesbury site. It is structured by the eleven themes that were created in the development of the survey. These themes were developed in Chapter 3 to address different elements of the workplace energy culture framework, which was created for the research. Along with the results from the survey, this chapter has provided additional empirical material from focus groups and interviews with participants who work at the Samlesbury site, or have a close connection with BAE. This material, along with the short discussions, has three purposes. First, it provides an additional understanding of the energy culture of the Samlesbury site. Second, it acts as a means of validation, or, where empirical material is conflicting, it identifies areas where more research is needed. Thirdly, by presenting the empirical material collected from a sequential mixed-methods design, and the short discussions, this chapter directly addresses research Objective 3 'Detail and review employees attitudes towards energy use'.

The results of this chapter describe a workforce who conduct a lot of energy-saving practices (e.g., turning off lights and equipment) and are engaged with energy topics, with employees thinking that reducing energy use and demand should be a higher priority for BAE. The results also describes a workforce who think energy use and demand are important issues for BAE and are concerned about the cost of energy to the business. However, the workforce do not appear to receive regular energy-related training or receive supervision and guidance on saving energy in work. In addition, energy topics do not appear to be discussed regularly with colleagues, supervisors or work teams. The workforce are also unaware how much energy their team or department use, but they are aware of who turns off lights and equipment, and where the power switches are located. The results also show that some energy practices that regularly occur in the workplace are also conducted regularly in the home environment.

The extracts from the qualitative sources (Figure 4:2) provide a valuable understanding of the survey results presented in this chapter. They indicate communication methods on site may not be appropriate for engaging with all employees, with the manufacturing employees reporting that information may not always get transferred to them. The discussions also highlight how wider workplace tasks can often be prioritised above energy efficiency activities, which can lead to energy suggestions made by employees not being transferred to appropriate departments. The results have detailed how the site is seeking to achieve ISO 50001 accreditation, which appears to be driving changes in energy use and communication on site, with the introduction of suggestion boards in manufacturing areas. In addition, the site intervention of shut-down plans appears to engage employees in energy topics in the workplace but this is a short-term effect that is not followed by sustained engagement.

The results presented in this chapter provide valuable empirical material that can be used to address the aim of the research: 'apply an energy culture approach to examine energy used in an industrial workplace'. Consequently it is used in the following chapters:

- Chapter 5: the survey data is explored through a different conceptual lens, with the data being analysed through multivariate data reduction methods (principal component analysis) and subject to bivariate statistics (independent *t*-test).
- Chapter 6: draws on the qualitative results in this chapter, which suggested the Samlesbury site has a strong safety culture. This chapter presents additional qualitative results from interviews with TM1, TM2 and TM3, and Rob Wallace to discuss how organisational culture and direction can influence site energy use.
- Chapter 7: provides a discussion of the data presented in this chapter by detailing the energy culture of the Samlesbury site.

5 Spatiality of Energy Cultures

> This chapter provides results that are used in Chapter 9 to address Objective 4:
>
> *Examine the geographies of energy cultures.*

5.1 Introduction

This chapter is the second results chapter of the thesis. The methodology presented in Chapter 3 explained how survey results would be subject to two different analytical procedures to address research Objectives 3 and 4. Chapter 4 presented results addressing the third research question. This chapter uses the same survey results but applies a different analytical approach to enable a comparison of two areas on site. In so doing, it presents results that are used in a discussion in Chapter 9, along with the empirical material collected in the preceding chapters, to address research Objective 4 'examine the geographies of energy cultures'.

The energy efficiency literature has failed to explore how employee attitudes and behaviours can differ within the workplace, with the exception of Marans and Edelstein (2010), Ucci *et al.,* (2014) and some of the wider intervention research (Carrico and Riemer, 2011). This is surprising considering research suggests supervisors and their attitudes influence employee pro-environmental behaviours (Ramus and Steger, 2000; Robertson and Barling, 2012). If attitudes and behaviours differ across a work environment, the success of any interventions implemented by the workplace to change behaviours will vary. Gaining an understanding of whether differences occur provides opportunities to develop tailored intervention strategies, which research has shown to be successful in leading to sustained behaviour change (Lutzenhiser, 1993; Siero *et al.*, 1996; Daamen *et al.*, 2001; Abrahamse *et al.*, 2005; Dixon *et al.*, 2015). This chapter begins to address the research enquiry by examining the differences between office and manufacturing areas.

Section 3.8.2 explained how each survey can be categorised as representing either an office or a manufacturing area on site. To compare these areas, the survey questions were first subject to a data reduction method called principal component analysis (PCA). The purpose of applying this technique is to create a set of principal variables (new components) that explore the underlying themes of the survey. PCA groups a number of questions together based on the underlying variance between them, to create new variables. These new variables can be described as a 'scale' constructed of multiple questions (De Vaus, 2014). As the new variables are composed of a number of questions, the scale of measurement changes from being an ordinal measurement to an interval measurement (De Vaus, 2014). This change means the data can now be subjected to bivariate analytical methods such as an independent *t*-test. Results from this test can be used to determine whether there are any statistically significant differences between office and manufacturing areas.

This chapter presents results from this analytical approach. First, the results of the data reduction method, PCA, are presented. Following this, the descriptive statistics for the newly created variables are reported, along with the results of the independent *t*-test. Where differences in the two areas are reported, a short discussion of the new variables is presented. Similar to the format of Chapter 4, and in keeping with the sequential mixed-methods design applied to address research Objective 4, qualitative data from the sources listed in Figure 5:1 are presented in this chapter. This assists with validating the results from the independent *t*-test, while also providing further explanations for any differences. The qualitative material is presented under three themes: communication, knowledge of energy use and explanations for differences. More details on these groupings are presented in Section 5.4.

Qualitative data sources:

- Interview with TM2 and TM3
- Focus group with manufacturing participants
- Open-ended questions in survey

Figure 5:1: Qualitative data sources used in this chapter

5.2 Principal Component Analysis

As detailed in Chapter 3, prior to running PCA the dataset was inspected to determine if there were any questions with a number of missing answers. Figure 5:2 shows the outcome of this process. PCA was run on the remaining 40 survey questions in SPSS, following the steps outlined in Chapter 3 (see Figure 3:12). During the inspection of the correlation matrix, four variables (Q9e, Q13c, Q13d and Q14b) were found to have a correlation coefficient below 0.3. An inspection of the rotated factor matrix found many complex items loading on various components (see Appendix 6 for more information). Because of this and the low correlation coefficients, it was decided to take variables Q9c, Q13c, Q13d and Q14b out of the analysis. Figure 3:12 was again followed, to ensure PCA results were reliable. No further correlation coefficients were found to be below 0.3.

Q13h and Q13i were excluded due to a high number of missing answers.

Q2c was excluded due to numerous missing answers, and, as Chapter 4 explained, because some people answered this question even though they were instructed in a previous question not to.

Q8d was excluded due to confusion of participants answering questions. Participants should only have answered if they answered either agree/disagree, disagree or strongly disagree to a previous question; however, many participants who answered agree or strongly agree completed this question.

Q14d was excluded as participants were only asked to complete it if they have a phone.

Q15c and Q15d were excluded due to a large number of missing answers.

Figure 5:2: Questions excluded from PCA analysis

PCA reported ten components with eigenvalues over 1, which explained 61.56% of the total variance. After visual inspection of the scree plot, as recommended by Tabachnick and Fidell (2013), it was determined that retaining eight components was appropriate (see Appendix 7 for more information). Consequently, the PCA was re-run, limiting PCA to produce eight values, and Figure 3:13 was again followed to determine PCA suitability. As suggested by Field (2009) and Tabachnick and Fidell (2013), the variable loadings and communalities of the Varimax orthogonal rotation are presented in Table 5:1. It shows eight component solutions explaining 56.19% of the total variance.

The PCA results (Table 5:1) produced two complex factors, Q9f and Q12c, which load highly (Field, 2009; Hair *et al.*, 2010; Tabachnick and Fidell, 2013) on more than one component. However, after reviewing the conceptual grouping of the variables, the decision was taken to keep them in the grouping where they loaded highest and not exclude these variables from the PCA process.

Table 5:1: Rotated structure matrix for PCA with Varimax rotation of eight components with communalities.

Note: Major loadings are in red

Variables	Components								Communalities
	1	2	3	4	5	6	7	8	
Q10b	**.771**	.018	−.029	.057	.022	.080	.130	.000	.622
Q10d	**.719**	.135	.045	.123	−.018	−.008	.308	−.051	.650
Q10e	**.696**	−.002	.000	.177	.039	.083	.159	−.045	.552
Q10h	**.690**	.081	.186	.001	.090	.144	−.199	**.376**	.727
Q10c	**.689**	.030	.014	.050	.094	.141	.192	.049	.547
Q10a	**.637**	.222	−.045	.094	.037	.119	.122	.103	.506
Q10g	**.628**	.067	.119	−.012	−.006	.189	−.077	**.370**	.591
Q10f	**.605**	.026	.177	.100	.036	.205	.008	.044	.453
Q9h	.111	**.953**	.086	.009	.039	.093	−.011	.030	.939
Q9i	.064	**.945**	.015	.031	.017	.041	−.046	−.012	.902
Q9j	.107	**.927**	.048	.053	.026	.059	.094	.033	.889
Q9g	.111	**.893**	.031	.038	.089	−.008	.103	.010	.831
Q9c	.060	.008	**.731**	.164	.127	−.088	−.048	−.067	.595
Q9d	.050	.040	**.692**	.170	.134	−.081	−.043	.003	.538
Q9a	−.028	−.012	**.691**	.009	.075	.088	.132	.090	.517
Q9b	.038	.065	**.644**	.018	.103	.102	.117	.098	.466
Q13a	.226	.068	**.417**	.234	−.018	.220	.026	.015	.334
Q14e	.017	.015	.123	**.750**	.164	.070	.052	−.019	.613
Q14c	.025	.059	−.010	**.629**	.126	.031	.057	.008	.420
Q15a	.041	.047	.254	**.557**	.114	−.071	−.032	.091	.406
Q14a	.025	−.044	.154	**.536**	**.303**	.014	.004	.181	.439
Q13b	.280	.117	.239	**.462**	−.014	.091	−.080	−.015	.378
Q15b	.168	−.027	−.037	**.455**	−.032	.032	−.102	.010	.250
Q12a	.029	.079	.132	.180	**.850**	.050	.033	.132	.801
Q12b	.027	.085	.136	.150	**.805**	.073	.059	.042	.708
Q12d	.228	.034	.208	.259	**.542**	.288	.117	−.027	.555
Q12c	.070	−.004	.140	.118	**.437**	**.419**	−.011	−.016	.405
Q13f	.148	.039	.004	.012	.171	**.740**	.135	.065	.623
Q13e	.149	.075	.052	−.006	.097	**.598**	.218	.108	.456
Q13g	.193	.030	−.006	.058	−.002	**.443**	.039	.042	.242
Q8b	.228	−.035	.097	−.092	.016	.271	**.672**	.213	.642
Q8a	.245	.037	.073	−.081	.044	.293	**.646**	.228	.630
Q9f	**.419**	.153	.200	.022	.154	.137	**.487**	.158	.544
Q8c	**.366**	**.316**	−.048	.041	.098	−.050	**.408**	.051	.419
Q1db	.111	.045	.021	.022	.015	.105	.173	**.681**	.517
Q1da	.119	−.016	.068	.157	.121	.050	.187	**.649**	.520

5.2.1 PCA New Variables

PCA groups questions together by examining the underlying variance between variables. However, a limitation of this process is the suggested outcomes may not group together conceptually. Consequently, prior to conducting any further analysis on the survey data, the results from PCA were conceptually reviewed (Figure 5:3). PCA groupings were also compared with the groupings of questions in Chapter 4. The purpose of this was to ensure the development of questions as per the eleven themes presented in Chapter 3, and the subsequent presentation of results in Chapter 4, were adequate. It also demonstrated how the new variables and the grouping of questions had a link to the *workplace energy culture framework*.

Figure 5:3: Picture of the process undertaken to determine whether the PCA results conceptually grouped together. The different colour top left-hand corner of each Post-it note denotes the grouping of variables from Chapter 3

The PCA eight-component grouping confirmed conceptually that the grouping of variables reported in Chapter 3 was appropriate. Because some of the questions were excluded from PCA due to insufficient correlation or missing answers, the PCA and conceptual groupings do differ slightly. Table 5:2 details how the PCA grouping corresponds to the theoretical grouping of questions. A visualisation of these points is provided in Figure 5:4 and Figure 5:5. Figure 5:5 also shows the associated Cronbach's alpha coefficients (α), which demonstrate a high level of reliability in the new scale. Figure 5:5 is a duplicate of Figure 3:10, and Figure 5:5 shows the new PCA grouping. New variables were created in SPSS, consisting of the sum of the suggested variables in each group.

Table 5:2: Detailing the similarities and differences between the PCA eight-variable grouping and the theoretical grouping of questions presented in Chapters 4 and 5

PCA group	The similarities to the previous grouping
1	All variables that were grouped into C*olleagues/work team energy actions* and all variables that were grouped as *Perceived pressure from line manager and colleagues*. It also includes one variable from *Organisational influence*
2	All the variables that were grouped into *Employee energy suggestions and communication*
3	All variables that were originally grouped into *Energy concern in relation to business* and *Importance of energy use to business*. Group 3 contains fewer variables because some variables did not have a correlation coefficient above 0.3
4	All the home behaviour variables with the addition of one question from the previous *Energy concern in relation to business* group. This variable did not specify workplace behaviours so has a conceptually good fit to this group
5	All variables originally grouped into *Workplace energy behaviours/actions/self-reporting*
6	Variables that were previously grouped into *Workplace energy efficiency and reduction knowledge*
7	A mixed group, consisting of variables previously grouped under the themes *Organisational influence, Colleagues/work team energy actions* and; *Workplace energy efficiency and reduction knowledge*. Even though this group consists of a variety of variables, the new grouping fits together conceptually as a variable exploring organisational influences and knowledge
8	Includes the two variables that were originally grouped together in the *Organisational influence* theme. They focus on the influence of the SHE function at BAE

Colleagues/Work team Energy Actions

Q10b – Within my specific work team we are conscious of our energy use
Q10c – Within my specific work team we regularly try to reduce our energy use
Q10d – Within my work environment, energy use and energy demand are discussed regularly
Q10e – I discuss ways to reduce energy use and demand within my work colleagues
Q10f – Colleagues within my work environment support the need to reduce energy use

Workplace Energy Efficiency & Reduction Knowledge

Q8c – I know the amount of energy my team/department use
Q13e – It is clear to me who is responsible for switching machines/equipment off during downtimes
Q13f – It is clear to me who is responsible for switching off lights
Q13g – I know where the relevant switches are
Q13h – I know where the relevant light switches are
Q13i – I know what to do to save energy within workplace

Organisational Influence

Q1da – The SHE function influences how I use energy in work
Q1db – I associate energy related topics with the SHE function
Q2c – The energy/environment champion/s influence how I use energy in work
Q8a – I get enough supervision and guidance on saving energy at work
Q8b – I have received enough training on energy saving at work
Q10a – My line manager influences my energy use

Energy Concern in relation to Business

Q9c – Reducing energy demand should be a higher priority for BAE Systems
Q9d – Reducing energy use should be a higher priority for BAE Systems
Q9f – It is clear to me what BAE Systems is doing to reduce energy use and demand
Q13a – I am concerned about the cost of energy to the business
Q13b – I am concerned that rising energy costs will affect my day-to-day tasks

Figure 5:4: Initial conceptual grouping of themes as detailed in Chapters 3 and 4

Workplace Energy Behaviours/actions/self-reporting

Q12a – I always turn equipment off after I have finished using it
Q12b – I always turn equipment off at the end of the day/shift
Q12c – I always turn lights off (where possible) after I leave that area
Q12d – I always make an effort to reduce energy use within the workplace
Q13c – If I notice a fault with equipment, I always report this to my line manager
Q13d – I am more conscious of my energy use than my work colleagues

Employee Energy Suggestions & Communication

Q9g – If I have a suggestion on how to reduce energy use and demand at work I know who to speak to
Q9w – If I make a suggestion on how to reduce energy use and demand, it will be taken seriously
Q9i – If I make a suggestion on how to reduce energy use and demand I will receive a response detailing any future changes or stating reasons for not implementing the suggestion
Q9j – Employees are encouraged to make suggestions to reduce energy use and demand

Perceived Pressure from Line manager & Colleagues

Q10g – I would be well thought of by my line manager if I took actions to save energy at work
Q10h – I would be well thought of by my colleagues if I took action to save energy at work

Home Energy Practices, Price Concern and Attitudes

Q14a – I always turn lights off after I leave a room
Q14b – I always leave electrical goods on standby when not in use
Q14c – I always turn electrical goods off at the mains socket when not in use
Q14d – I always unplug my phone charger when not in use
Q14e – I always make an effort to reduce energy use
Q15a – I am concerned about rising energy prices
Q15b – rising energy costs have affected my day-to-day task
Q15c – I go around and turn off appliances/equipment that are not being used
Q15d – At home I know approximately how much energy I use

Importance of Energy Use to Business

Q9a – Energy demand is an important issue to BAE Systems
Q9b – Energy use is an important issue to BAE Systems
Q9e – There is a greater focus on reducing energy use and demand at the Samlesbury site compared with other BAE sites

Group 1 – Immediate Work Environment Influences

Q10b – Within my specific work team we are conscious of our energy use
Q10d – Within my work environment energy use and demand are discussed regularly
Q10e – I discuss ways to reduce energy use and demand with my work colleagues
Q10c – Within my specific work team we regularly try to reduce our energy use
Q10h – I would be well thought of by my colleagues if I took action to save energy at work
Q10a – My line manager influences my energy use
Q10g – I would be well thought of by my line manager if I took actions to save energy at work
Q10f – Colleagues within my work environment support the need to reduce energy use

α = 0.889

Group 2 – Employee energy suggestions and feedback

Q9h – If I make a suggestion on how to reduce energy use and demand it will be taken seriously
Q9i – If I make a suggestion I will receive a response detailing any changes or reasons for not implementing the suggestion
Q9j – Employees are encouraged to make suggestions which can reduce energy use and demand
Q9g – If I have a suggestion on how to reduce energy use and demand at work I know who to speak to

α = 0.966

Group 3 – Concern of energy use, demand and cost to business

Q9c – Reducing energy demand should be a higher priority for BAE Systems
Q9a – Energy demand is an important issue for BAE Systems
Q9d – Reducing energy use should be a higher priority for BAE Systems
Q9b – Energy use is an important issue for BAE Systems
Q13a – I am concerned about the cost of energy to the business

α = 0.782

Group 4 – Energy practices

Q14e – At home I always make an effort to reduce energy use
Q14c – At home I always leave electrical goods off at the mains socket when not in use
Q15a – At home I am concerned about rising energy prices
Q14a – At home I always turn lights off after I leave a room
Q13b – I am concerned that rising energy costs will affect my day-to-day tasks
Q15b – At home rising costs have affected my day-to-day tasks

α = 0.889

Group 5 – Workplace Energy Practices

Q12a – At work I always turn equipment, which I personally use, off after I have finished using it
Q12b – At work I always turn equipment off at the end of the day/shift
Q12d – At work I always make an effort to reduce energy use within the workplace
Q12c – At work if I am the only person in an area, I always turn lights off after I leave that area

α = 0.800

Group 6 – Workplace energy reduction knowledge

Q13f – It is clear to me who is responsible for switching off the lights
Q13e – It is clear to me who is responsible for switching machines/equipment off during downtimes
Q13g – If I wanted to turn equipment/machines off in my work area I know where the relevant switches are

α = 0.703

Group 7 – Business approach to energy use

Q8b – I have received enough training on energy saving at work
Q8a – I get enough supervision and guidance on saving energy at work
Q9f – It is clear to me what BAE Systems is doing to reduce energy use and demand
Q8c –I know the amount of energy my team/department use

α = 0.784

Group 8 – SHE INFLUENCE

Q1da – The SHE function influence how I use energy in work
Q1db – I associate energy related topics with the SHE function

α = 0.742

Figure 5:5: Variable grouping results from PCA, with Cronbach's alpha for each group

5.3 Independent *t*-test Results

To address research Objective 4, an independent *t*-test was conducted on the eight new PCA variables. This was done to determine if there was any statistically significant difference between the means of the office and manufacturing areas.

Treatment of Dataset

The eight new variables were examined for outliers in the data. If outliers were found, two independent *t*-tests were run, as recommended by Tabachnick and Fidell (2012), one excluding and another including the outliers to determine whether they affected the results in any way. Table 5:3 presents the results of this process.

Table 5:3: The outliers in each group

Group and area	Outlier case number	Outcome
Group 1		
Manufacturing	5, 12, 49	Box plot showed these were mild outliers. The *t*-test and mean results did not change considerably between the two tests. **Keep outliers in sample**
Group 2		
Office	6, 30, 231, 232	Box plot showed these were mild outliers. The *t*-test and means for the groups did not change (2d.p.). **Keep outliers in sample**
Group 3		
Office	224	Box plot showed these were mild outliers. The *t*-test and means for the groups did not change (2d.p.). **Keep outliers in sample**
Manufacturing	23, 101	
Group 4		
Office	111, 120, 123, 183, 224	The means for this group did change (22.36 to 21.93 with deletion) but the significance of the *t*-test did not. **Keep outliers in sample**
Group 5		
Office	172, 224	The means for this group did change (Office: 17.23 to 17.40 with deletion, Manufacturing: 16.49 to 16.70 with deletion) but the significance of the *t*-test did not. **Keep outliers in sample**
Manufacturing	46, 10, 12, 100	
Group 6		
Office	6, 131, 138, 210	The means for this group did change (Office: 11.21 to 11.00 with deletion) but the significance of the *t*-test did not. **Keep outliers in sample**
Group 7		
Office	8 and 19	Box plot showed these were mild outliers. The *t*-test and means for the groups did not change (2d.p.). **Keep outliers in sample**
Group 8		
Office	6, 223	The means for this group did change (Office: 6.98 to 7.03) with deletion, but the significance of the *t*-test did not. **Keep outliers in sample**

Descriptive Statistics

The sample size for usable surveys was n = 259, with n = 120 from office areas and n = 139 from manufacturing. Descriptive statistics for the eight variables are presented in Table 5:4.

Table 5:4: Potential range of group, mean, standard deviation and standard error of the mean for each of the areas in each of the PCA groupings (2 decimal places).

Group	Area	Potential medium	Potential range of scores	Mean	Std. deviation	Std. error mean
Group 1	Office	24	8–40	23.33	6.16	.56
	Manufacturing			21.68	4.59	.39
Group 2	Office	12	4–20	13.59	2.62	.24
	Manufacturing			12.35	2.51	.22
Group 3	Office	15	5–25	20.80	2.75	.25
	Manufacturing			20.30	2.46	.21
Group 4	Office	18	6–30	21.93	3.92	.36
	Manufacturing			22.06	3.94	.34
Group 5	Office	12	4–20	17.23	2.67	.24
	Manufacturing			16.49	3.03	.26
Group 6	Office	9	3–15	11.01	2.10	.19
	Manufacturing			9.93	2.40	.20
Group 7	Office	12	4–20	11.88	2.72	.25
	Manufacturing			10.15	2.52	.23
Group 8	Office	6	2–10	6.98	1.71	.16
	Manufacturing			6.24	1.56	.13

Potential Range of Scores

Table 5:4 reports the potential range of scores for each question. Each group consists of a different number of questions. In order to interpret the mean values, it is important to consider the potential range. Using group 1 as an example, this variable consisted of eight questions. The potential range of scores for this variable was 8–40, with 8 representing an individual who answered strongly disagree to all questions, and 40 an individual who answered strongly agree. A score of 24 could be obtained if an individual answered neither agree/disagree to all questions. The research acknowledges that a score of 24 does not necessarily reflect an individual answering neither agree/disagree to all questions. However, in order to explain results, the potential median (reported in Table 5:4) of the potential range of scores is taken as neither agree/disagree answers.

Table 5:5: Independent t-test results

Note: Shaded rows indicate a statistically significant difference between means of manufacturing and office areas

Group	Mean difference	95% Confidence intervals of the difference		*t*- Value	Degrees of freedom (D*f*)	Statistical significance (*p*-value)
		Lower	Upper			
Group 1	1.65	.30	3.0	2.402	218	.017
Group 2	1.24	.61	1.87	3.859	252	.000
Group 3	.50	−1.17	1.14	1.522	240.77	.129
Group 4	−1.33	−1.10	.826	−.272	254	.786
Group 5	.75	.05	1.45	2.081	254	.037
Group 6	1.07	.52	1.45	3.82	253.99	.000
Group 7	1.72	1.08	2.37	5.28	254	.000
Group 8	.75	.34	1.15	3.62	244	.000

Results

The results from the independent *t*-test (Table 5:5) identify statistically significant differences in the means of the office and manufacturing areas for the following groups of questions:

- *Group 1: Immediate work environment influences*. This group of questions examined engagement in topics of energy use by immediate work team through questions focusing on awareness of energy use, discussion of energy topics, attempts to reduce energy use, and the judgement of work team on individual behaviour. The means for both areas (Office = 23.33, Manufacturing = 21.68) do not reflect a strongly agreeing or agreeing score for this set of questions. This suggested that the immediate work team (including line managers) are not actively engaged in topics of energy use. However, the higher mean value for the office areas suggests the immediate work environment in this area influences energy use more than in manufacturing areas.
- *Group 2: Employee energy suggestions and feedback.* This variable consisted of questions that focused on bottom-up employee suggestions and whether two-way communication occurs. The questions asked whether suggestions would be taken seriously, whether employees' would receive feedback on suggestions, and whether employees' were encouraged to make suggestions and had knowledge of who to make suggestions to. The office areas have a statistically significant higher mean (13.59) compared with the manufacturing areas (12.35), indicating that they have more

knowledge about who to make a suggestion to about energy topics and that they believe they will receive feedback on suggestions more than the manufacturing areas.

- *Group 5: Workplace energy practices.* The questions that constructed this variable explored workplace energy practices. The questions asked specifically about turning equipment and lights off when employees had finished using them and at the end of the day/shift. Both areas had mean scores that were in agreement with these questions (Office = 17.23, Manufacturing = 16.49), suggesting they both undertake energy-efficient behaviours. However, the results from the *t*-test suggest the office areas participate in these behaviours more than the manufacturing areas.
- *Group 6: Workplace energy reduction knowledge.* This variable explored employees' knowledge of who is responsible for turning lights and equipment off, and if employees know where the switches to turn equipment off are. The mean for the office (11.0) and the manufacturing (9.93) areas indicate that neither area strongly disagrees or disagrees with the statements in this variable. However, the office areas have a more statistically significant agreeing mean than the manufacturing areas. This indicates that the office areas have a greater knowledge of who turns equipment and lights off, and where switches are in their work area.
- *Group 7: Business approach to energy use.* The means for both office (11.88) and manufacturing (10.15) areas indicated a slightly disagreeing view for this variable. This variable is constructed of questions that seek to explore the business approach to engaging employees in energy use. The questions asked about whether employees receive energy-related training, get enough supervision and guidance on saving energy, are aware of what BAE is doing to reduce energy use and demand, and if they know how much energy their team/department uses. The *t*-test results suggest the office areas are more knowledgeable on the business approach to energy use compared with the manufacturing areas.
- *Group 8: SHE influences.* This variable was constructed of two questions focused on the SHE team. The questions asked whether the SHE team influences individuals' energy use, and whether individuals associated energy-related topics with the SHE team. The means of the office (6.98) and manufacturing (6.23) areas reflect a neither agree nor disagree answer. However, the office areas are in more agreement with this variable than the manufacturing areas. This suggests the SHE function has more influence on energy use in the office areas compared with the manufacturing areas.

5.4 Focus Groups and Interviews

The schedule for conducting focus groups and interviews in BAE was impacted by the delays in survey distribution (as reported in Chapter 3). This limited the ability to complete survey analysis prior to conducting interviews and focus groups. As a result, a clear discussion on each of the different variables could not occur. However, a number of themes that cross over the variables were discussed, which provide explanation and validation of the results reported in the previous section. These themes are communication, knowledge of energy use, and some reasons for differences in attitudes across the site. Reference is made throughout this chapter to early reports of differences in areas on site. These findings were obtained from early stages of survey analysis.

Note: As this chapter views the results from Chapter 4 through a different analytical lens, some focus group and interview extract extracts will be re-cited as they provide additional understanding of differences between office and manufacturing areas. All extracts are numbered for identification purposes only. This does not imply an order in which the extracts appeared in the interviews and focus groups.

5.4.1 Communication

The BAE management communications with office and manufacturing staff are very different, due to the nature of the physical environments. Office staff naturally have more interaction with computers compared to the predominantly manufacturing environments, where staff are heavily involved in production processes. These differences in the physical environments produce challenges for communication to staff throughout the business. The following section provides evidence of these challenges and the differences in communication channels in the two areas.

Interview with TM2 and TM3

The main method of environmental communication with all areas across the site is via *Team Briefs*, which are team meetings held once a month. TM2, TM3 or their colleagues chair these briefs and invite supervisors or SHE members from different areas of site to attend. To make these meetings relevant to the attendees, two meetings are held, one aimed predominantly at manufacturing areas, the other at office areas. The meetings take a similar format but present information, figures and suggestions specific to either the manufacturing or office areas.

TM2 stated that the most common method for attendees of Team Briefs to communicate the information to employees in their areas was via daily start-up meetings (DSUMs) and weekly start-up meetings (WSUMs), which often occur around Safety, Quality, Cost, Delivery and Product (SQCDP) boards, which are discussed in more detail in Chapter 6. These are:

> *'… quick fifteen minute stand-up meeting[s] … [for] the shop-floor staff. It tends to be that sort of thing that we'll use to communicate' TM2*
>
> *Extract 1*

Continuing discussions in the interview highlighted that this communication method, in the manufacturing areas, relies on the relay of information from Team Brief attendees to supervisors of different areas, SHE representatives or energy champions, and then to shop-floor staff during the DSUMs and WSUMs. In some instances TM2 and TM3 have directly spoken to shop-floor staff:

> *'we have done it before now, we've been and stood up in front of them and talked to them about stuff, but usually because there's so many of them [employees] to get to, we tend to disseminate it now [through Team Brief and management].' TM3*
>
> *Extract 2*

But, as the extract highlights, there is a large number of manufacturing employees, so it is difficult for TM2 and TM3 to speak to everyone. They rely on other people to disseminate the messages, which further describes and confirms the chain method of communication on site (Martin, 2005; Mullins, 2007). However, as the following extract suggests, this communication method presents many challenges:

> *'I suppose [it's] probably a less effective way of doing it because you can't guarantee [supervisors are] going to do it right … and you can't guarantee they're going to even do it..' TM3*
>
> *Extract 3*

In addition to this chain communication, TM2 also detailed how noticeboards were used to communicate messages to the manufacturing areas. This led to the conversation discussing the ISO 50001 certification:

> *'So as part of the 50001 … there's like an improvement suggestion scheme … they're printed on card so that they [employees] can actually fill [them] out, so we're not relying on like emails and stuff, so they're usually displayed in the areas as well and then they'll get fed back to like the SHE person or the environmental coordinator or whoever in there and then come back up to us that way.' TM2*
>
> *Extract 4*

More details on the ISO 50001 certification are provided in Chapter 6. However, this extract describes how the drive to achieve ISO 50001 is improving the bottom-up methods of communication, where suggestions from shop-floor staff are being transferred to the environmental teams via cards on noticeboards. These noticeboards were previously mentioned in focus group discussions cited in Chapter 4 (Extracts 17–19). The interviews with TM2 and TM3 also described other methods of communication through poster campaigns and web page articles:

> *'we have the web page, so articles will go up on the web page and stuff. All the shop floor do have access, they all have a log-on and stuff for doing online training and things like that, so some of them will log-on on a more regular basis than others, so we'll communicate things through the internal web page, poster campaigns, we've done stuff before, like we did like spraying the pavements didn't we last year' TM1*
>
> *Extract 5*

This extract acknowledges that the website communications only reach a limited audience despite all staff having log-ons. The nature of the manufacturing environment, with employees not having to interact with computers, limits the success of these interventions. The office areas, with more frequent computer access, have greater capabilities to engage with online training and web pages than the manufacturing areas.

During the interview both core team members highlighted how there are many email listings on the Samlesbury site, which inform employees about a range of topics:

> *'We get email updates on all sort of things … charity challenges, and when the National Blood Service are coming.' TM3*
>
> *'Canteen offers, all sorts of stuff' TM2*
>
> *'Health awareness, newsletters, so we get all sorts,' TM3*
>
> *'Union reps as well send a lot of stuff out.' TM2*
>
> *Extract 6*

This extract highlights two points. First, email is used as a method of communication with all staff on site, for a variety of topics. Second, employees can be faced with a lot of emails.

Focus Group with Manufacturing Areas

During the focus group with manufacturing staff, the subject of communication was brought up. Participants were asked if they knew why, or if they had any suggestions as to why, the office areas answered more agreeing comments to the questions in Group 2. The group responded with:

A – 'I think it's probably the fact that, like you say, you're building stuff that is their priority for this facility.'

B – 'Yeah, yeah. I mean I'm guessing, I don't want to put words in your mouth, but I'm guessing, you know, when you have your DSUM it's quite practical and it's you're on this today, you're on that, this is what I need finishing by this time, whereas when the offices have the DSUM they talk more around the flowery stuff like that, you know what I mean, the softer side, like that and they can't do that. I don't know, don't know if that's right because that's my perception, is that?'

Extract 7

Participant A highlights that the different type of work occurring in the two areas and different area priorities may be reasons for the differences in answers. Participant B provides an example of these differences by describing their experience of DSUMs from both manufacturing and office perspectives. Here the participant describes the DSUMs in manufacturing areas as being more structured around tasks that need to be completed, whereas the DSUMS in offices are less structured around specific jobs. The participant specifically uses the term 'talk' for office DSUMs, suggesting a meeting less directed by the manufacturing process and one that may be open for discussions and conversations to occur. These differences in communication are discussed further in Chapter 9.

5.4.2 Knowledge of Energy Use

The group were informed of some of the preliminary survey results. They were told that the manufacturing areas had a larger percentage of agree/strongly agree answers to a question wanting to know how much energy they were using, when compared to the office areas. The researcher asked participants why they thought this was the case. Immediately two members of the group responded with:

'We just care more.'

Extract 8

This triggered other participants to make comments:

A – ' I think that is to do with, because there's constantly people on the shop floor and like not necessarily offices, [they] are always in use. So obviously all these big lights are always on, night shift and day shift.'

B – 'Yeah'

C – ' It's always drummed in through, in the SQCDP, it's cost isn't it? Cost, everything's always about cost. Not about the units but obviously about how much it costs just to make them as well, and I don't think in the office they have as much emphasis on SQCDP … Obviously safety, but I don't I don't think they have as much focus on delivery and stuff. They don't have the boards like the SQCDP boards we have.'

C – 'They mentioned savings, but never really mention energy levels that we're using, and could be reducing.'

B – 'Yeah, lights and all.'

C – 'Never really mention, you know, lights, or anything like that.'

Extract 9

This dialogue suggests several differences between office and manufacturing areas. First, participant A suggests that the nature of the manufacturing environment, which is subject to shift work, may be one of the reasons for this difference. They describe how there are constantly people working in the manufacturing areas, so equipment is often on all the time. They indicate that this awareness of equipment being in constant use may be the reason they want to know more about energy use than those in office areas. Second, participant C builds on this suggestion by describing how the SQCDP process may differ in different areas. They suggest that the boards are visually different, and there is not so much emphasis on the whole SQCDP process in the office areas. The SQCDP boards often form the focus of the DSUMs and WSUMs, so this statement supports comments in Extract 7, which suggests the format of these meetings differs between manufacturing and office environments. The researcher's field notes made from observations while walking around site support the statement in Extract 9 about the focus on SQCDP boards. The SQCDP boards were a main focus near workstations and were often pointed out to the researcher when passing through these areas. However, these boards did not stand out in the office areas, and no member of staff directed the researcher to them. In addition to these comments, it is important to note that the extract comments on 'cost' rather than energy; energy as a topic is being discussed under the 'C' category of the SQCDP boards (this theme is further discussed in Chapter 9). Another interesting point from Extract 9 is that participant C highlights how 'obviously' safety is mentioned in the same way in both office and manufacturing environments. This is also discussed in greater detail in Chapter 6, where the safety culture of the site is described.

5.4.3 Additional Reasons for Differences

Towards the end of the focus group session, the group were asked why they think there are differences between areas on site:

> *'A – 'I think some of it's because we're in a newish building, like 4 Shed.'*
>
> *B – 'Culture isn't it? This is a new building and there's new culture, new build.'*
>
> *C – 'The investment …'*
>
> *B – 'Young people, lots of investment, and 4 Shed is rather old school isn't it?'*
>
> *C – 'Yeah, I think you're right, good choice of words … yeah we're a bit collective like office and shop and, you know, I think if you go somewhere else it's a bit more us and them'*
>
> *Extract 10*

When answering the researcher's question, the participants discussed differences between manufacturing areas rather than focusing on other areas on site. The extract highlights how employees think that the differences in investment and material surroundings can affect differences in attitudes towards energy use. The group describe these differences as a different shed culture, with participant B describing the other shed as being 'old school'. Here the participant is suggesting they are more traditional and less open to changing their ways of completing tasks. Extract 10 also indicates how the focus group think the employees of the buildings can affect attitudes. They comment that newer buildings often have newer and younger recruits, which can affect attitudes. This difference between sheds was echoed during survey distribution, in a conversation with a manufacturing employee. The employee was asking the researcher about the research and the data collection methods. This conversation occurred in 3B, the newer of the two buildings. When it was mentioned that the research had conducted the same tasks in 4 Shed, the participant responded:

> *'you're going to find differences, we've got loads of investment and have orders for the rest of our career here at BAE, they don't know what they're going to be doing in the next few years.'*
>
> *Extract 11*

This conversation suggests that differences may exist between sheds. The focus group extract (Extract 10) also suggests that this manufacturing area may be different to other areas due to the nature of having a mix of office and manufacturing areas. It also reiterates some conversations from the pilot study, which discussed feelings of 'us and them' (Table 3:3).

Participant C in Extract 10 suggests that the mix of office and manufacturing staff in one area reduced the 'us and them' feeling. The use of the 'us and them' terminology in Extract 10 prompted the researched to ask further questions on this theme. Participants were asked if they ever feel an 'us and them' environment, such as they are the offices, and we are the manufacturing, and there is a difference. The first couple of responses were those of uncertainty: 'maybe' and 'not sure'. One participant then responded with:

> *'I think manufacturing can understand what we've got to do as an office, because it's monitors and electricity and so on, I think we, the offices find it harder to grasp what you can turn on and off on the shop floor and what tooling you use and stuff like that, we [office] don't have an understanding of that whereas [manufacturing] can look in an office and grasp pretty quickly what you could do [long pause] we're not, it's not that, [there are] big differences between sheds as well because cost driving more of a saving.'*
>
> *Extract 12*

This participant was based in the manufacturing building, but worked in a more office administrative role, and this is why they refer to the office environment in Extract 12. The first part of this extract suggests that the 'us and them' may come from knowledge on energy savings. They describe how the office environments are much easier to understand in terms of what is using energy, while the manufacturing areas are much more complex. Focus group extracts (Extract 4, 5 and 16 in Chapter 4) have already shown that there is some lack of knowledge on what the most energy-efficient way to treat machines is; that is, whether to turn them off or leave them on. This highlights the added complexity of understanding the manufacturing areas that Extract 12 suggests. All manufacturing environments will look different, which is dictated by the manufacturing processes they are involved in. However, the office areas all look very similar, which is not dependent on the project they may be working on.

> *'I think the other one is when it comes to safety, as well as energy and everything else, like you mentioned the life [of energy savings], if it takes seven years to pay something off, if you're working in a programme that is limited by years, or something like that, or until the next contract starts or whatever, they may be more reluctant to invest for the future, do you know what I mean? It, it all depends on, and that's a business decision sometimes, doing the right thing environmentally, because that's why there's a difference between us and them, and the business.'*
>
> *Extract 13*

This final extract moves away from the 'us and them' differences and goes back to suggesting why there may be differences in energy cultures across the site. It describes the process of gaining jobs and contracts, which is unique to certain work environments. Extract 13, similar to Extract 10, again mentions the safety culture on the site.

5.5 Conclusion

This chapter presents results that can be used to address research Objective 4 'examine the geographies of energy cultures'. It uses the results obtained from the survey, previously presented in Chapter 4, but applies a different analytical method to examine whether differences exist between office and manufacturing areas on site. Prior to conducting an independent *t*-test, which explores the comparison of means of the two areas, the data reduction method of PCA was undertaken. This process suggests the grouping of survey questions into eight new variables, which explore the underlying variance of the survey. An independent *t*-test was conducted on the new variables to determine whether there were any statistically significant differences in the means of the office and manufacturing areas. The results show differences in the following variables:

- immediate work environment influences,
- employee energy suggestions and feedback,
- workplace energy practices,
- workplace energy reduction knowledge,
- attitudes towards business approach to energy use,
- influences of the SHE function.

In all six variables listed above, the office environments answered with more agreeing statements than the manufacturing areas.

This chapter has begun to address research Objective 4 by providing a brief discussion of the differences between the manufacturing and office areas. It has done this by structuring discussions around three themes: communication, knowledge of energy use and additional reasons for differences. Each of these themes provides an understanding of the energy cultures of the office and manufacturing environments. The 'additional reasons for differences' theme has detailed how differing levels of investment, culture and demographics of age can influence attitudes towards energy use on site, and explain differences between office and manufacturing areas. The discussions also suggest that daily and weekly meetings may differ in the office and manufacturing areas, with cost being emphasised more in the manufacturing areas due to the nature of the tasks being completed there. They also showed how conversations on energy use are often linked to the theme of cost in manufacturing areas.

This chapter also found links between safety and energy topics on site. The group discussions have detailed how daily and weekly meetings are held around the SQCDP boards. Chapter 6 provides more information on these boards while also describing how safety is integrated into everyday site activities and into the wider structure of BAE. It argues that safety is a subculture of BAE that influences all activities on site, including energy use. In so doing, it presents a discussion of how the safety culture developed on site.

6 Organisational Cultures and Priorities

This chapter directly addresses research Objective 2:

Detail the evolving nature of organisational priorities and organisational cultures.

6.1 Introduction

Chapters 4 and 5 covered employee attitudes towards energy use and discussed how attitudes differ at the Samlesbury site. The empirical material in the preceding chapters provided many references to the wider safety culture of BAE. Some of these references are given in Figure 6:1. This chapter seeks to provide some context to these references by giving details of the current safety culture of BAE. It does this by examining the evolving organisational priorities and cultures of BAE. This chapter is addresses research Objective 2.

Extract 9: Chapter 4

Researcher: 'Do you think that's different with safety though, in terms of if I said who's responsible for safety?'

Focus Group: 'No, safety's more at a local level' and '*Different issues in different areas, has to be local whereas use of energy is a site one.'*

Survey results: Chapter 4 highlighted that safety is the predominant theme employees associate with the SHE function.

Extract 9: Chapter 5

Focus Group:* 'It's always drummed in through, in the SQCDP, it's cost isn't it? Cost, everything's always about cost. Not about the units but obviously about how much it costs just to make them as well, and I don't think in the office they have as much emphasis on SQCDP… Obviously safety, but I don't … think they have as much focus on delivery and stuff. They don't have the boards … the SQCDP boards we have.'*

Extract 14: Chapter 5

'I think the other one is when it comes to safety, as well as energy and everything else.'

Figure 6:1: References to 'Safety' cited in Chapters 4 and 5

Before outlining the structure of this chapter, an explanation for exploring organisational cultures and priorities is provided. This introductory section also explains what an organisational culture is.

The research did not initially seek to explore wider organisational cultures within BAE. The researcher was very aware of BAE's safety culture, through the various ways in which it is manifested on site (discussed below). However, as is evident from Figure 6:1, it became apparent during fieldwork that energy topics are entwined with the safety culture on site. Consequently, it was determined that any description of an energy culture in the workplace would need to incorporate and acknowledge the wider organisational cultures. As a result, discussions with TM1 regarding safety took place, during which it became apparent that the safety culture was established in the early 2000s, coinciding with the appointment of a new CEO. This prompted the researcher to start exploring questions, such as:

- How did this safety culture develop?
- What were the original drivers?
- What are the current drivers?
- Is this a sustained culture or continually developing?
- How is it engrained in everyday tasks, and has it changed behaviour?
- Could an energy culture develop in a similar way?

Subsequently, these questions formulated the main topics of discussion for the semi-structured interview with TM1. This interview highlighted that in recent years BAE had undergone a change in organisational priorities with regards to energy topics. It was suggested by TM1 that this was a potential reason for some of the challenges experienced during fieldwork. This prompted additional questions, such as:

- How do the changing organisational priorities impact workplace behaviours?
- How can workplace energy research be conducted in large organisations with changing organisational priorities?

Not all of these questions are answered in this chapter, nor were they addressed in the research. However, the questions provide theoretical and methodological discussion points for future research, which are further emphasized in Chapter 10. Articulating these questions also provides the reader with an understanding of why organisational cultures were explored in the research, which predominantly examines energy use.

Chapter Structure

This chapter starts by explaining how the safety culture is manifested on site and how this culture was experienced by the researcher. It also explains what the Safety, Quality, Cost, Delivery and People (SQCDP) boards are, and how they help integrate a safety culture into everyday activities. The chapter then moves on to discuss how the safety culture on site became established, by presenting a commentary from TM1, who has experienced and witnessed a change in top-level management, resulting in the evolution of BAE's safety culture. In so doing, this chapter argues that within the context of BAE, there is a dominant safety culture that influences all site activities, including energy use.

Closely related to any culture in an organisation are workplace priorities. The previous chapters have already indicated that priorities in manufacturing areas, at an employee level, appear to focus around safety, cost and delivery, with energy being mentioned in cost discussions. However, workplace priorities can also be examined at the wider organisational and board levels. During the research, a change in organisational priorities towards energy was observed. This chapter, through extracts from interviews with TM1 and Rob Wallace (UCLan), describes these changes. In doing so, it argues that any research conducted within industry or in a workplace needs to consider how organisational priorities can impact any proposed research schedules and the engagement of participants with the research.

While explaining the change in organisational direction from energy development and research, to energy efficiency and conservation, this chapter also outlines the approaches to improving energy efficiency at the Samlesbury site. It argues that the wider organisational culture and organisational priorities influence how energy is used by individuals, and that both need to be incorporated into any framework examining energy use in the workplace.

Readers' note: This chapter has been reviewed by members of the core BAE team to ensure the researcher had gained a correct understanding of the safety culture. Consequently, some extracts from this feedback have been included in this chapter.

What is an Organisational Culture?

> 'Culture is a complex phenomenon ranging from underlying beliefs and assumptions, to visible structure and practices.'
>
> (Denison *et al.*, 2004:99)

> ‘Culture is a characteristic of the organisation, not of individuals, but it is manifested in and measured from the verbal and/or nonverbal behaviour of the individual.’
>
> (Hofstede, 1998:479)

> ‘Organisational culture, is the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaption and internal integration … a pattern of assumptions that has worked well … to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel.’
>
> (Schein, 1983:14)

These quotations, albeit very different, highlight key elements of organisational culture. They identify the role individuals have in creating and sustaining a culture, through both verbal communications and non-verbal actions. They also highlight that culture is a complex topic to explore, and can be difficult to measure (Denison *et al.*, 2004). Organisational management can affect the organisational culture in both positive and negative ways (Hofstede, 1998), and creating an organisational culture usually involves someone taking a leadership role (Schein, 1983). This leadership role, or ‘founder’ (Schein, 1983:13), determines how the collective actions of employees can accomplish something that an individual could not achieve alone (Schein, 1983). This chapter explores the ‘founder’ of the safety culture at BAE and details how the culture has developed with the organisation’s management.

Within a wider organisational culture, described as a ‘supra-culture’ (Barczak *et al.*, 1987:33) there can be subcultures (Schein, 1996; Parker and Bradley, 2000; Fine and Hallett, 2014). Within BAE’s supra-culture are several subcultures (Figure 6:2). Figure 6:2 does not act as a comprehensive list of cultures in BAE; instead, it details the different subcultures that were experienced by the researcher. These cultures were experienced at different scales in the business, and some are more established and evident than others. This chapter focuses on the culture of safety, with Chapters 7, 8 and 9 discussing aspects of the other cultures. As will become evident in this chapter, these cultures interact with each other at varying scales within the wider BAE organisational culture.

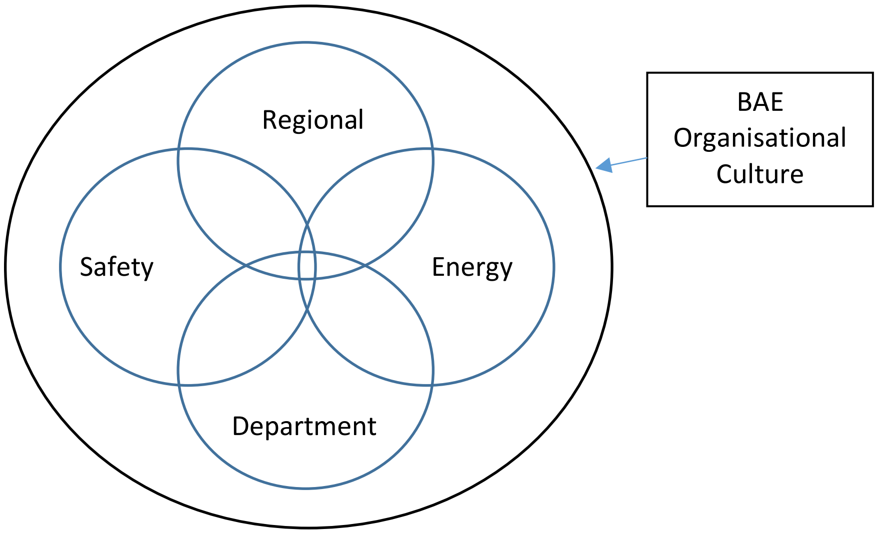


Figure 6:2: Example of the different interacting cultures that exist within the wider BAE organisational culture

6.2 What is the 'Safety Culture'?

BAE has a reputable safety culture (British Safety Council, 2014, 2015, 2016). This culture is engrained throughout the organisation (Table 6:1) and identified within each of the multi-national businesses of BAE (see Figure 1:1). The research does not seek to define what a safety culture is, a task conducted by others (e.g. Cox and Cox, 1991; Eiff, 1999; Hansen, 2000). However, it does describe the many ways in which the researcher observed the safety culture of BAE. First, there is a *Think Safety First* campaign which manifests itself across the site (see Figure 6:3). Think Safety First is a business-wide approach to safety, and provides the foundations for the broader safety culture. Second, there are painted floors across the site. These are a common feature of many manufacturing based sites, as the Health and Safety Executive recommends safe areas for employees using machinery and segregation from traffic (Health and Safety Executive, 2013). These floors display areas safe for pedestrians. Within manufacturing sheds, the different coloured floors show where you can walk with and without safety shoes. These areas, common on industrial sites, present a visual reminder for employees about safety on site. Third, there are many visual safety posters found in toilets, corridors, offices and on information boards, which highlight particular safety practices, as part of the Think Safety First campaign (see Figure 6:4). This again acts as a visual reminder for employees about safety on site. Lastly, the SQCDP boards (more details below) were observed in work areas around site. The purpose of the Think Safety First campaign is to encourage all employees to put safety first in everything they do. BAE's approach is summarised as follows:

> ‘Everyone at BAE Systems must take responsibility for safety – from senior management to the shop floor’
>
> (BAE Systems, 2014)

Table 6:1 Example of how safety is observed at different employee levels in the business (BAE Systems, 2016c)

Senior management	Safety objectives, together with objectives in Diversity & Inclusion and Environment, makes up 10% of the potential incentive allocation for our Executive Committee. Senior managers take a strong role in safety management and take part in site tours and safety audits to get an insight into safety issues affecting employees.
Line managers	Operational line managers are responsible for implementing our safety policy.
Employees	Employees must take responsibility for safety by identifying and reporting risks. Some businesses include safety in the bonus structure for all employees. At Surface Ships, for example, 30% of the incentive scheme for employees depends on the business meeting targets to reduce the number of lost days and implement Safety, Health and Environment (SHE) improvements.
Contractors	Contractors working on our sites must follow the same safety guidelines as employees. They are actively included in many of our safety programmes, such as Ship Repair’s safety incentive scheme and Surface Ships’ safety passport programme.

Picture 1: On a manufacturing shed door.
Picture 2: Large banner outside a building.
Picture 3: Printed on the outside of a building.
Picture 4: On bus shelter.
Picture 5: Moveable boards.
Picture 6: On back of hi-vis jackets used across site.
Picture 7: On lamp posts.
Picture 8: On buildings.
Picture 9: Large banners within buildings.
Picture 10: On identity badges.

Figure 6:3: Examples of how the 'Think Safety First' campaign manifests on site.

Pictures obtained from personal email communications with Lesley Allger and Robert Ward (3rd November 2015)

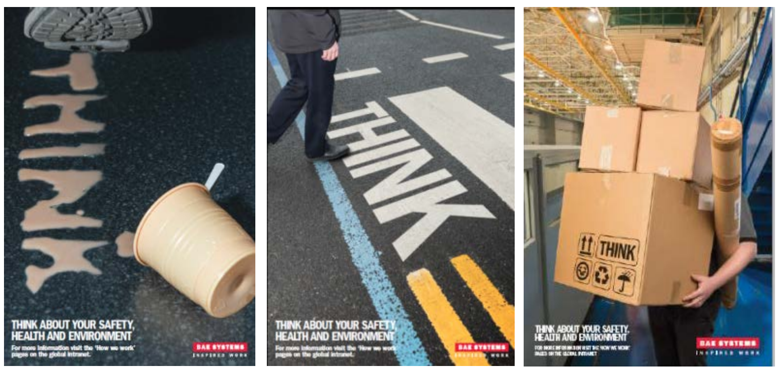


Figure 6:4: Example of the campaigns targeting specific safety practices, within the 'Think Safety First' campaign

SQCDP Boards

SQCDP boards are located in work areas across site. They build on the well-established model of Quality, Delivery, Cost and Morale (an overview is provided by El-Haik and Roy, 2005). The SQCDP boards (Figure 6:5 and Figure 6:6) are intended to act as a prompt for the daily start-up meetings (DSUMs) and weekly start-up meetings (WSUMs). These meetings are held by each team in the various lines of business. They are short daily or weekly meetings that focus on aspects of the SQCDP. They provide opportunities for members to discuss issues related to SQCDP or the work tasks they are completing. As extracts 1–3 in Chapter 5 show, the meetings also form part of the site's chain communications (Martin, 2005; Mullins, 2007), which provide opportunities for supervisors to transfer messages to employees.

Conversations with TM2 and TM3 highlighted how the structure of the DSUMs and WSUMS vary across site, with some teams focusing on one theme of SQCDP per day, and discussing it in detail, while others discussed them all, in less detail, every day. This varied format was noted in the focus group discussion (Extract 7, Chapter 5) where a manufacturing employee suggested the office DSUMs are more 'flowery'. In this extract the participant is implying the DSUMs in the office areas are less structured and more discussion-based, compared with the manufacturing DSUMS. The SQCDP boards also act as a visual reminder for employees in specific work areas of important topics associated with tasks in that area. For example, the Safety, Health and Environment (SHE) function often puts important notices on the SQCDP board for employees to read.

Time for Safety

An additional way safety is manifested on site is through *Time for Safety* sessions. During chapter feedback with TM1, the following example was given:

> *'We also have "Time for Safety" sessions where various prepared scenarios are discussed within teams meetings, to keep the subject "alive".*
>
> *Also every individual has at least one objective related to safety in their performance reviews.'*
>
> *Extract 1*

This extract demonstrates the importance that is placed on safety in the business, and how the intervention of role play (Cabral, 1987) is assisting to sustain the safety culture on site. Extract 1 also highlights how employees' performance reviews have at least one objective that is related to safety. This demonstrates how safety is integrated into the wider organisational structure of BAE.

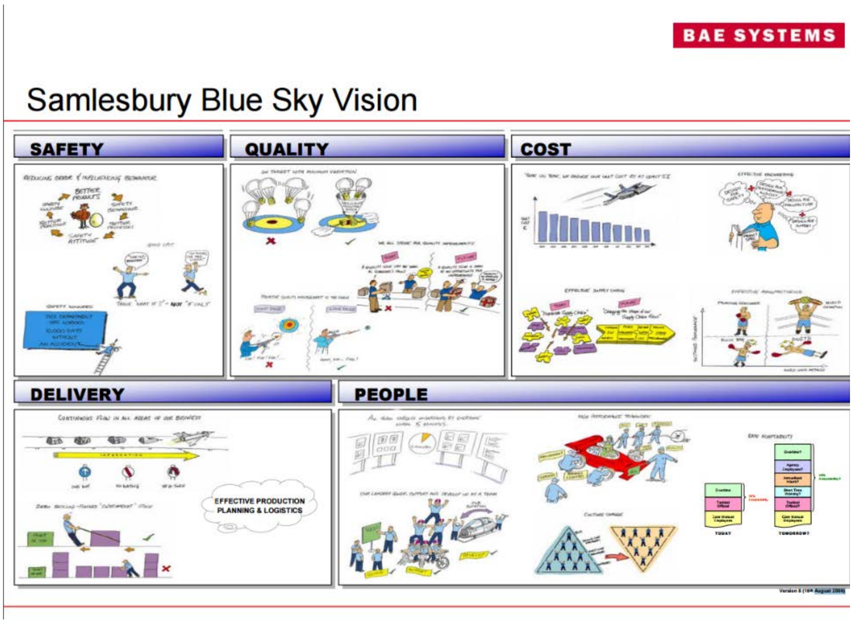


Figure 6:5: Visualisation of an example of an SQCDP board (Hayden, n.d.)

Figure 6:6: Examples of SQCDP boards in the manufacturing areas.

Pictures taken from UK/US Shingo Summit 2009 Presentation (BAE Systems, 2016a)

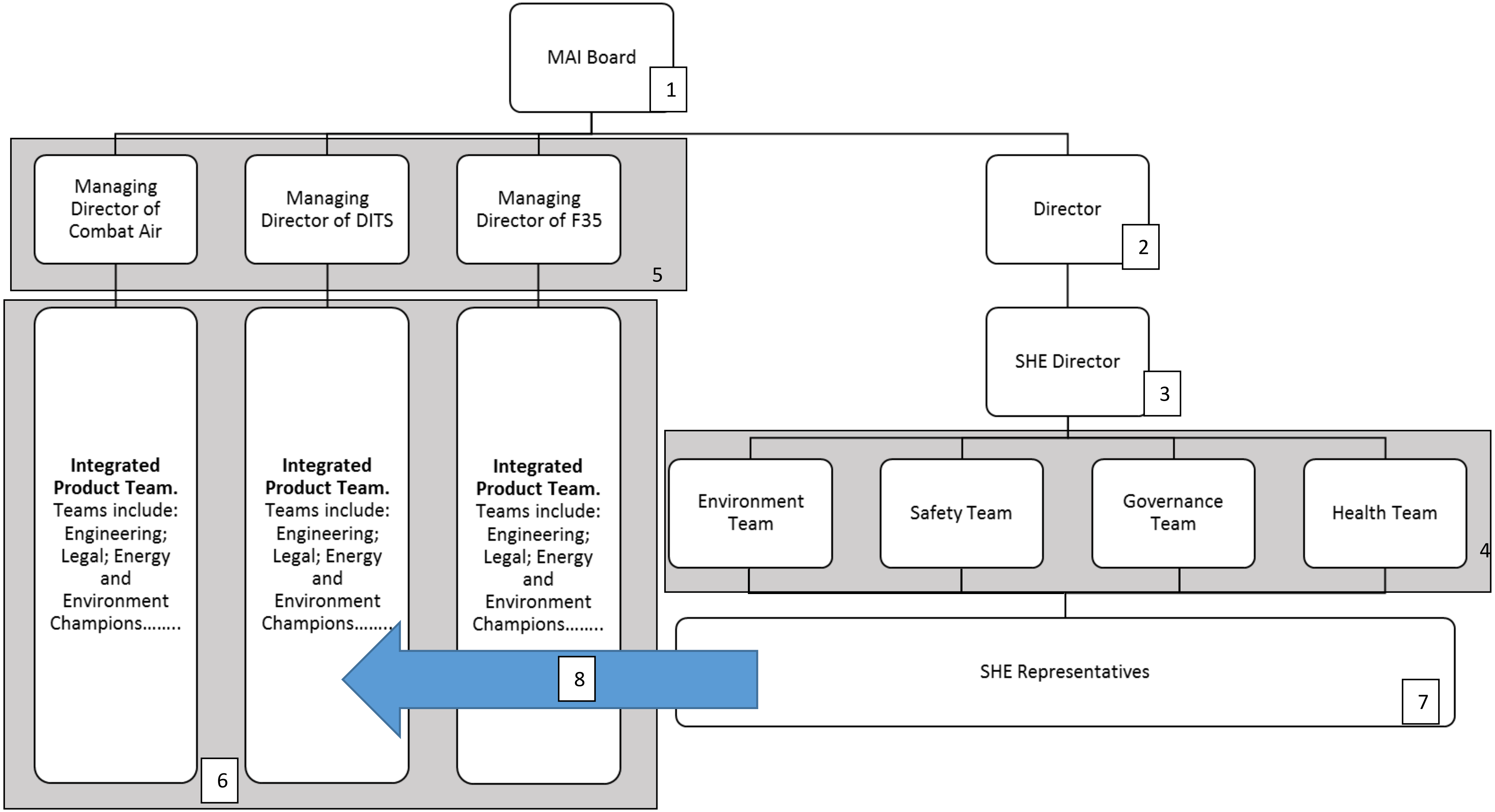


Figure 6:7: Visual representation of the integration of the SHE function into MAI business.

Created with TM1 during chapter feedback on 15th September 2015. Note: This is not a comprehensive structure.

6.2.1 SHE function

A vital part of the 'safety first' culture of BAE is the SHE function, which is part of the business structure. The SHE function consists of a team of people who focus on all matters to do with safety, health and environment. The research uses the term 'function' to describe this group, rather than team or department, due to their integration in the business, as explained below. During feedback on a chapter written by the researcher, TM1 stated:

> *'SHE is very much integrated, they don't sit away from the business, well they do and they don't, it does and it doesn't.'*
>
> *Extract 2*

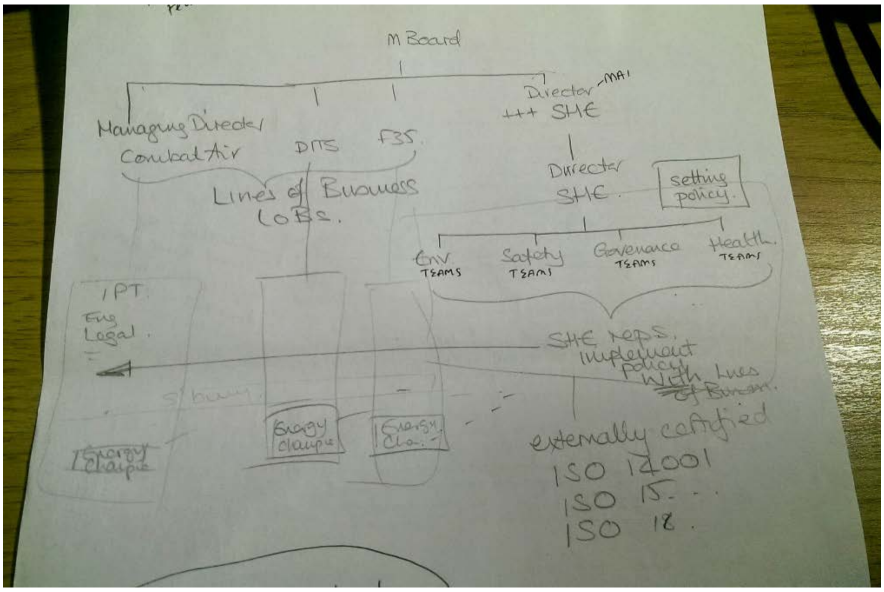


Figure 6:8: Photograph of hand-drawn SHE integration in the business from TM1

After this, TM1 proceeded to draw a diagrammatic representation (Figure 6:8), to assist the researcher in gaining an understanding of the integration of the SHE function into the business. This drawing has been converted into the more detailed, computerised diagram shown in Figure 6:7. The following extract, taken from the chapter feedback session, explains this diagram (Figure 6:7). Numbers have been placed in the extract to distinguish between the different parts of the diagram.

'If you have the main board (1), we have a director there (2) and one of his responsibilities is for SHE, along with a few other things. He then has, appointed to him another director but this time just for SHE (3). And he has safety teams, governance teams … he has environmental specialists and health as well (4) … They are all central people, but over here (5) we will have a managing director for all other lines of the business. Under there, they have loads of people, integrated product teams, engineering, legal (6) and they will have, from that team (7) SHE representatives (8), that are based in the integrated product team. So for all of those [lines of the business], they will have reps in, so these people in the centre (4) set the standards, while those people (8) implement them. So in that way, it really does make sure that safety, health and environment is really embedded in our business. And then there are regular audits, and all of this is externally certified by organisations and international standards.'

Extract 3

This extract and associated figures show how the SHE function is a department that fits into the central shared services business of BAE. This department sets the policy for the lines of business. Information and polices are products of this department and are then implemented via the SHE representatives, who sit in each of the lines of business in MAI. Extract 3 also highlights how the policies are subject to regular internal and external audits, to meet the externally certified requirements of the International Organization for Standardization via ISO 14001, ISO 50001 and BS OHSAS 18001. A summary of these standards is provided in Figure 6:9.

The nature of the name, and the aims of the SHE team (to cover topics of safety, health and environment), means that any safety culture observed within BAE will have close links to subsequent energy cultures. This was observed in the survey results to Q1 (Section 4.8), where participants cited a variety of tasks that they associated with the SHE function.

ISO 14001 – Environmental Management Standard

This standard focuses on the production process and acts as a framework to assist companies to reduce their environmental impact. It 'helps organisations improve their environmental performance through more efficient use of resources and reduction of waste' (ISO, 2005). For applications and an overview of ISO 14001 please refer to Matjaž *et al.,* (2015) and Hillary (2000).

ISO 50 001 – Energy Management Standard (more details provided in Section 6.3.1)

This standard is similar to ISO 14001 but focuses specifically on energy. It provides a framework to assist organisations 'implement an energy policy, and establish objectives, targets and action plans which take into account legal requirements and information related to significant energy use' (ISO, 2011). For an overview of the standard and application please refer to Brown and Desai (2014).

BS OHSAS 18001 – Occupational Health and Safety Management Standard

Similar to the above standards, BS OHSAS 180001 provides a framework to help organisations with occupational health and safety. It differs from the other standards in that it is produced and accredited through the British Standards Institution. The framework can help organisations 'put in place the policies, procedures and controls needed for [an] organisation to achieve the best possible working conditions, and workplace health and safety' (BSI Group, 2016). For an overview of applications of BS OHSAS 180001 please refer to Lo *et al.,* (2014) and Fernández-Muñiz *et al.,* (2012).

Figure 6:9: Overview of international and British standards that BAE implements

6.2.2 Origins of BAE Safety Culture

To explore questions of how the safety culture at BAE became established and evolved over time an interview was held with TM1 on 24th March 2015. TM1 has around 35 years' experience at BAE. They have witnessed changes in the organisational culture, such as the development of BAE from the merger of British Aerospace and Marconi Electronic Systems. They have also seen how changes in business agendas and staffing in the hierarchical structure (e.g. Board of Directors and Executive Boards) have affected the BAE culture. During the interview, TM1 was asked how the safety culture was established, where it emerged from and how it had been engrained into all levels in the business:

> *'Dick Olver was our Chief Executive for a number of years, he was heavily involved with BP whose operations are intrinsically risky if you don't put the correct controls in place. One of the first things he did when he looked around all of BAE Systems was he kept asking people about safety, because it was something, personally for him really, really routed deeply, and I suppose as a Chief Exec you want to make a difference in a company.'*
>
> *Extract 4*

The above extract details how immediately Dick Olver's name was mentioned by TM1. Sir Dick Olver (Richard Olver) was appointed as Chief Executive of BAE Systems in 2004 (BAE Systems, 2014a) stepping down from the BAE board in February 2014 (BAE Systems, 2014). Prior to the appointment, he had worked at British Petroleum (BP) for 30 years in a variety of posts, including as Deputy Group Chief Executive (BP website, 2004). Extract 4 suggests that prior to Dick Olver's appointment, it was not routine for a Chief Executive to ask questions about safety while walking around site.

This new focus on safety is also evident in the BAE Annual Reports. Pre-2003, the first mention of safety in the annual reports appeared approximately a quarter of the way through the document. A review of the reports notes safety references are often situated in the Corporate Social Responsibility section:

> 'Safety of our products is of paramount importance to those who use them; equally important is the creation of a safe working environment in our workplace.'
>
> (BAE Systems, 2003:25)

In contrast, the 2007 Annual Report demonstrates how safety is in the Executive Committee top ten objectives (BAE Systems, 2007:11) and the 2008 report mentions safety in the Chairman's Letter, located at the start of the report (BAE Systems, 2008:3). All subsequent reports mention safety within the first ten pages (BAE Systems, 2009, 2010, 2011, 2012, 2013, 2014, 2015a).

The interview with TM1 further demonstrated this change towards a safety agenda in the business. They detail a change in the top-level management of the business since 2004, by explaining the history behind the Think Safety First campaign:

> *'Right from the top they defined a campaign called 'Think Safety First', and it took a number of years, we had a safety maturity matrix which defined certain parameters of safety, about 5 different parameters and then you would rate yourselves on a scale of 1 to 5, where 1 was a sort of beginner and 5 was excellent performance, and right across the globe, the leaders in each of the bits of the business had personal objectives set by Dick Olver to reach a safety maturity target of 5 which would be audited by a certain point in time. And by the way, your bonus would depend on it.'*
>
> *Extract 5*

TM1 refers to a 'bonus' within BAE. This highlights how the corporate objectives set out by Dick Olver were linked to bonuses. This type of incentive is similar to the monetary pro-environmental incentives described by Geller (2002) and Abrahamse *et al.,* (2005). Anecdotal evidence from various staff members suggests that the bonuses at board level can often be 30–50% of salary, which is a substantial financial incentive. Finance as a driver to changing organisations is a theme that will reappear frequently during this and following chapters.

> *'so that cascaded down, so certainly when you get into MAI [Military, Air and Information], all the board members in MAI they also had personal objectives that reflected it [safety targets] and because of that, it forced [people to say], "what are you doing about it?" So you get a training programme where it was mandated training, depending on if you were a grad engineer you had to [do a] minimum amount of training, if you were a team leader you had more to do, if you were an exec you had even more to do … [at] every function you had to go on this training, we encouraged training to get extra qualifications. There were very strong communications and that's why it worked. It was led from [the] top, reflected in people's personal objectives and their bonus payments and it came right the way down through the structure, and that's why it worked.'*
>
> *Extract 6*

The above extract demonstrates the hierarchal structure that is observed in the organisation, where decisions are made at board level then filtered down through the company. This is a common method of organisational change (Parker and Bradley, 2000). Extract 6 provides an example of decisions filtering down through the MAI business, with the introduction of the Think Safety First campaign and the integration of board personal objectives and subsequent training programmes. Different businesses within BAE may have had different approaches and experiences with creating this 'safety culture' but fundamentally everyone was assessed by the same safety maturity matrix and exposed to the same Think Safety First campaign. This campaign has continued to evolve through the years, with continuing safety maturity matrix assessments.

6.3 Change in Organisational Priorities: Energy

This chapter has so far discussed the safety culture that was observed within BAE. It has shown how the approach towards safety has changed in the last 15 years due to changes in senior management. This section now discusses how a change in the organisational agenda during the PhD affected the focus on energy within BAE. Following this it outlines some of the approaches to energy observed at the Samlesbury site.

Changes in Energy Agenda

In the years prior to the strategic partnership with UCLan, set up in 2009, BAE was engaged with energy in a number of ways, as demonstrated in this extract from an interview with TM1:

> *'at that time we had quite a few business development opportunities, things like the hybrid buses … [we] were really considering getting into wind turbines as well, because the technologies for aerodynamics, composites and performance are all at the heart of what we do in structures and manufacturing … the other really key bit I suppose that pushed us down the energy agenda, we had in the centre at Farnborough a research hub … it would nurture technologies in small groups to a point where they believed if they floated it out of Farnborough, it would be self-sustaining, and an energy business was being formed in there … we had an energy business in the US, and a burgeoning energy business in the UK. In MAI we had business development opportunities, we had hybrid buses in the electronics bit of our business, everyone was going energy, energy, energy.'*
>
> *Extract 7*

This extract shows where energy was fitting into the agenda of BAE circa 2005, at varying scales across the organisation. A strategic partnership was being developed, with the creation of energy businesses in the UK and the US, where BAE was exploring different energy technologies (wind turbines and hybrid buses). However, during the course of the research, a change in the energy agenda was observed, which was explored in the interview with TM1. Here they are talking about a timeframe between 2009 and the start of the research, 2012:

> *'It is interesting that the financial crisis of 2008 was starting to hit big in the business, we stopped all business development on energy.'*
>
> *Extract 8*

TM1 went on to discuss how during the same period government subsidies for renewables also changed, which impacted business energy decisions. TM1 continued by explaining that during this period the US energy business folded, and in the UK the head of the energy business, which was supported by MAI, had to divert their attention away from the energy business and towards site energy use, specifically reducing site energy use.

> *'the energy business in the US was folded, about the same time … within the space of a couple of years from being very pro energy development to a conservative approach.'*
>
> *Extract 9*

In addition to these changes within BAE towards energy, in October 2010 the UK coalition government published a *Strategic Defence and Security Review* (SDSR; HM Government, 2010). This was published at a time when the government was committed to reducing the national budget deficit. One of the purposes of the review was to address a £38 billion overspend on defence (HM Government, 2010:15). The review identified many areas where the UK needed to make savings of at least £4.3 billion over the Spending Review period (HM Government, 2010:31). This review had impacts on BAE, one of the largest being the cancellation of the Nimrod project (HM Government, 2010:27), which was associated with the Maritime business of BAE. This cancellation immediately led to redundancies at several sites, including Warton and Samlesbury (BAE Systems, 2010; BBC, 2010; The Telegraph, 2010). This event was brought up in the interview with TM1:

> *'we just didn't see [it] coming, and so the funding for us as a business (energy business) just collapsed, so where sustainability was high on the agenda and we could devote a little bit of money to that, we no longer could. The impact of the SDSR review was severe and we made a lot of people redundant as a result.'*
>
> *Extract 10*

This extract gives an insight into how quickly the position of energy changed on BAE's agenda. In 2009, a £1m strategic partnership with UCLan was developed, focusing on energy management systems research. However, from 2011 to present day, there have been redundancies, cancellations of projects, closures of sites (e.g. Woodford, Cheshire, which was predominantly involved with Nimrod), cancellation of energy businesses in the UK and US, and a change in focus on energy in BAE. These changes were due to board level decisions, which were strongly influenced by the SDSR and the wider economic climate. They had a large impact on the wider organisational culture, with changes in staffing and structure (closure of sites and cancellation of projects).

Impact on the Strategic Partnership

As the extract from TM1 describes, the strategic priorities of BAE with regards to energy changed during the research. In exploring these changes further, an interview was held with Rob Wallace (UCLan) to consider how these changes would influence the strategic partnership. The primary focus of this interview was to gain further understanding of BAE, from an ex-employee who had approximately 22 years' experience. However, during this interview a further insight into the changing priorities of BAE in terms of energy was gained. Rob Wallace had knowledge of the wider BAE culture, but also had the insight of representing UCLan in the strategic partnership with BAE.

> *'the environment changed, that stopped the partnership being able to be long-term, sustainable, and achieve what it had the potential to achieve, and the key thing that changed was BAE's perspective on how important energy was from a strategic viewpoint.'*

Extract 11

In this extract, Rob Wallace is reiterating the change in priorities in terms of energy that TM1 discussed in the earlier extracts. Expanding on this change in priorities, Rob Wallace reflects on how this altered the strategic partnership relationship:

> *'[BAE] decided that [energy] wasn't a key strategic priority. So effectively, because you were running something like a three-year programme, about halfway through it some of the key players from BAE started reflecting, said "well, we're not that bothered about it now" … so I think that caused an interesting dilemma as we went through … because everyone who was engaged with it was quite happy to carry on and try make it work, and I think everybody was quite pleased with how the partnership was going but it was clear that … the partnership couldn't endure because of that strategic directional change that BAE Systems had made.'*

Extract 12

This extract highlights some of the challenges caused by this change in organisational priorities. Rob Wallace discusses how the strategic partnership continued because the people involved in it were keen for it to carry on, although all parties involved knew that the partnership was not sustainable beyond the contractual programme, due to the change in strategic priorities. In the interview Rob Wallace, went on to discuss the PhDs associated with the strategic partnership:

> *'you're looking at a three-year project, so it's a relatively long project and the, the impact of changes of priorities is a huge thing … how do you deal with things like that as you go forward?'*

Extract 13

Expanding on this further, he offers his view on why the PhDs are continuing:

> *'at the moment you're probably finding that the reason it's carrying on is that you've got some very good individuals who are trying to work with you, and allow you to be successful at the end of this.'*

Extract 14

The extract explains how the research was conducted: the core BAE team are a group of individuals who have an interest in the research and have volunteered to continue working with the researcher. However, the change in strategic priorities for the business poses methodological questions for future research between universities and large businesses: How do you create a partnership that can continue to be successful if the priorities of the business change? And if research is being conducted in the workplace, how can you ensure this is successful? These questions are discussed further in Chapter 9.

Towards the end of the interview, Rob Wallace stated:

> *'priorities have changed and that's something that happens with a business.'*
>
> *Extract 15*

As Extract 15 suggests, business priorities do change (Rosenfeld and Wilson, 1999). As explained in this chapter, it appears that these changes were, in part, a consequence of a political spending review and the wider economic climate. Extracts 4–6 demonstrated the emergence of the safety culture of BAE, particularly the Think Safety First campaign. This is another example of a change in business priorities. The empirical material collected in the research suggests this change in priorities towards a focus on safety created a safety culture on site, and this safety culture interacts with energy use on site. Relating this to energy, has the change in strategic decision making regarding energy affected energy use on site? Chapter 3 discussed how engagement in the research appears to have been varied across the site, for example the unsuccessful distribution of the initial survey, which the core BAE team thought would be successful. This may be a consequence of the change in strategic priorities. As the company experienced redundancies, the focus on site may have been on production rather than volunteering to partake in research. However, it became apparent during conversations with TM1, TM2 and TM3, that energy still appears to be a strategic priority for the business, but, as the interview with TM1 has suggested, the focus appeared to move towards site energy use rather than energy as a product for the business. This chapter now discusses some of the energy infrastructure at the Samlesbury site. In so doing, it further elucidates how energy conservation and efficiency is becoming a site priority.

6.3.1 Energy Infrastructure at Samlesbury

The Samlesbury site is the biggest energy user in MAI and the second biggest in BAE UK (interview with TM2 and TM3). The site has the ability to generate some energy through its own infrastructure. Figure 6:10 provides an overview of this. In addition to the energy infrastructure projects, other energy-related projects that have occurred on site involve the renovation of older buildings, and the construction of building extensions and new highly energy-efficient buildings, with features such as rain water harvesting, biomass boilers, free cooling chillers and solar PV panels on the roof. Two of these projects, the canteen and ISO 500001, are described below. These projects were discussed regularly during the manufacturing focus group and the interview with TM2 and TM3. It is interesting to note that all these projects were developed within the last five years, relating to this change in strategic priorities towards site energy.

The two largest energy generators on site are solar PV (installed in 2015) and combined heat and power (CHP) (installed in 2009). Together with relatively small generators (additional solar PV panels on roofs of buildings and a wind turbine at the entrance to the site), they generate an average 10% of the site's energy use.

The solar PV farm, which is located at the end of a disused runway on site, consists of around 9000 solar panels covering 61,000 m^2. It generates, on average, around 4–5% of the site's total annual energy use; during the day, it can generate about 20% of the site's electricity at peak flow (sunny, clear day). The solar PV is a recent addition to the Samlesbury site, with electricity generation starting in the first quarter of 2015.

Figure 6:10: Overview of energy infrastructure on the Samlesbury site (information obtained from interview with TM2 and TM3 on 30th June 2015)

The Canteen

During the interview with TM2 and TM3, TM3 gave an example of a construction project (a new canteen and occupational health building) that involved building the most sustainable building on site in both construction and running terms:

> *'The centre is … [a good] example because that's all sorts of sustainable sources of materials, all the labour, all the workforce were locally sourced and everything, rather than big national firms, apart from the main building, but even they don't employ their own guys anyway so … the people who put the timber frame up are from down the road and things like that.*
>
> *Got lots of renewables in there, it's got a good sort of low-energy strategy for the building, it's all naturally ventilated (and) naturally lit and things like that.'*
>
> *Extract 16*

The interviewees highlighted that around £0.5 billion has been spent on construction and renovation projects on the site in the last 10 years. Knowing that one person (the CEO) was a driver for a business safety focus, the research was interested in exploring what the drivers were for the improvement in energy infrastructure on the Samlesbury site. The interview with TM1 highlighted one potential driver, which was the change in strategic priorities from energy development to energy demand, which led to staff focusing on site energy. However, the researcher wanted to explore this in more detail with TM2 and TM3, with particular focus on what the driver was for the sustainable building on site:

> *'It was an opportunity to try something different, it was our suggestion, it came from our team, because traditionally our buildings have all been big tin sheds or big concrete boxes and because of the function of the building, [they] needed to be that way. Because [the sustainable building] was just a restaurant and [occupational] health there wasn't a particular need to have it air conditioned and there wasn't a particular need to have it built out of a tin box, so we just sort of said well why don't we try doing it different and making it a beacon project for sustainability? So that, that's the terminology we used but it was, our beacon project and we, we said well we'll see what we can do and, there was still the same financial constraints and timescale constraints, that we have on every project but it worked really well and the project team that we employ, the architects and everything really took it on board.'*
>
> *Extract 17*

In continuing this discussion, TM2 responded with:

> *'Yeah, your director's quite supportive as well in some stuff like that, he's got an active interest.'*
>
> *Extract 18*

TM3 responded with:

> *'Well the Director of Manufacturing Operations, as we are now, he, he's always been very keen on energy efficiency and environment generally, he's always pushed and he's given us plenty of funding to be able to invest in new technologies and stuff like that over the years.'*
>
> *Extract 19*

Extracts 17–19 give an indication of how the idea for the sustainable canteen (referred to as a restaurant in the above extracts) was developed. They also highlight the involvement of the Director of Manufacturing and Operations, who had an interest in energy efficiency and the environment, and give an insight into how, historically, sustainable buildings have not been constructed on site, with existing buildings described as ‘tin sheds’. All major investment projects have to be signed off at MAI board level, so this construction is an example of a bottom-up approach to energy reduction in BAE. This was discussed with TM1, who stated:

> *‘The point is, that even if the ideas were bottom-up, the investment case would still have to show a good return on investment.’*
>
> *Extract 20*

This extract highlights how it was still a board decision to go ahead with this project, re-emphasising the hierarchical structure of BAE. Even though this idea was given the final go-ahead by the board, the idea manifested at employee level, with Extract 17 stating ‘our’ project. The employees knew that their director was supportive of sustainability projects. The interview with TM2 and TM3 highlighted how this director also ran a farm and had explored ideas such as harvesting gas from manure through anaerobic digestion. Employees under this director knew he had an interest in energy-efficiency projects, so would be open to improving site sustainability.

Due to the recent redundancies, in response to the SDSR, the researcher was interested in how this sustainable building was given the go-ahead:

> *‘It was at a time when we were at quite a low as well, a lot of people didn’t really understand how we managed to get the approval to go ahead with it, but it wasn’t a particularly expensive building comparative to the rest of the buildings we put up on site, because it’s only relatively small.*
>
> *But when the business case was signed we’d just started going through a big period of redundancies so there was a lot of job losses but it still went ahead because there was a lot of financial benefits from closing down some very old, very inefficient buildings and co-locating [of services] it was also … a much better location on site and it would bring in more revenue … because the canteen used to be right at the very bottom corner of the site, so people like in these offices and up at 3A16 would never use it whereas now it’s slap bang in the middle so it’s much more accessible for those people.’*
>
> *Extract 21*

This extract indicates that one of the reasons why the project was approved was the financial savings, which supports the comment by TM1 in Extract 20 about all projects needing a good return on investment. The new sustainable build allowed the relocation of several departments from old, inefficient buildings to a more central location. The new building relocated the site canteen, which improved the facilities for more staff, resulting in improved staff well being. This reference to staff well being provides an indication of how a wider occupational health subculture on site is also being considered in infrastructural improvements. Extracts 17, 18, 19 and 21 indicate that this project was approved due to a director with an interest in energy efficiency and sustainability, the project being relatively low cost in comparison with other projects and buildings, and the development making some services more central. This is particularly interesting as it brings aspects of health into decision making regarding improving energy infrastructure.

ISO 50001

The final energy project under discussion is the award of ISO 50001. The site had been implementing some of the ISO suggestions in several of the manufacturing buildings for a number of years, but it was only granted ISO 50001 in early 2015. In exploring why ISO 50001 had not been granted previously, TM3 said:

> *'Basically at a senior level, on the Board, Board level they said right, we're doing this, so they basically forced everyone to comply and it basically meant that people had to actually do something about it.'*
>
> *Extract 23*

This extract again emphasises the hierarchical approach within BAE, with decisions made at board level being successfully implemented at lower levels in the business. Prior to the board supporting ISO 50001 the site had had mixed responses to energy developments. This can be seen when TM2 and TM3 discussed various energy interventions that had occurred on site in the last 5 years:

> *'Well, we've always, had a drumbeat going on haven't we, on around [energy] behaviour … for a long while, and it's had its ups and downs. We've had some real good successes and some years we've had virtually no response and things, so it, more often than not, there are some areas that do really well and some areas that just don't seem like they can be bothered. The best response we've had has been over the last eighteen months because of the drive to achieve ISO 50001.'*
>
> *Extract 24*

This extract shows that the site has had various energy reduction interventions ongoing for a number of years. It highlights how some areas have had greater success than others, indicating possible differences in energy cultures in these areas. The interviewees proceeded to talk about some of the building areas that had experienced varying successes with energy interventions. TM2 states:

'you'll probably find there's one person in there that's like a little bit higher up that pushes it [energy interventions] through … and then you get a really good success.'

Extract 25

This extract suggests that one person is responsible for the success of the energy interventions. This reiterates a common theme in the chapter, that key members of staff drive successful projects, which is discussed further in Chapter 9.

During the interview with TM2 and TM3, it was noticed that when asked about energy interventions on site, both members focused on behaviour-related interventions. There may be various reasons for this: first, as highlighted in Chapter 8, the Samlesbury site is very advanced with approaches aimed at reducing energy use, compared with other sites. It has already established good energy management systems and achieved ISO 50001, which could suggest the site is now exploring employee-focused interventions as another avenue to reduce energy use. Second, both TM2 and TM3 are interested in how people use energy, which is one of the reasons for their involvement in the research. Third, they are very familiar with the research and know that it has an interest in employee energy use and energy cultures. This might explain why they mentioned employee-aimed interventions first.

6.4 Conclusion

This chapter provided details on the organisational safety culture experienced by the researcher. The empirical material presented in Chapters 4 and 5 examined employee attitudes to energy use and provided many references to the safety culture on site. This demonstrated that safety is entwined with the wider influences on energy use. In exploring how this safety culture is manifested on site through semi-structured interviews, this chapter provided an overview of how the safety culture is incorporated into everyday site activities through the Think Safety First campaign, safety objectives and 'time for safety' role plays.

This chapter also detailed how the SHE function and the safety culture are integrated into the wider business structure at all levels. SHE sits alone as its own entity, but also sits within other areas of BAE. However, as detailed in the interview extracts from TM1, this focus on safety developed only in the last 15 years. They have detailed how a focus on safety appeared after the appointment of CEO Sir Richard Olver, who appears to be the 'founder' (Schein, 1983) of this subculture. Establishing the safety culture has involved creating a safety maturity matrix, providing incentives involving bonuses for meeting targets, ensuring each employee has safety objectives, and disseminating fundamental top-down communications from the CEO about the importance of safety. This indicates that the organisational management has created a culture in a positive way (Denison *et al.*, 2004), as it is integrated into day-to-day tasks. A further discussion regarding the evolution of the safety culture is provided in Chapter 9, where some of the research enquiries (detailed in Section 6.1) about whether an energy culture could develop in a similar way to the safety culture of BAE are explored.

In examining the top-down communications and the consequences of board-level discussions further, this chapter explored the change in strategic decision making regarding energy. As stated, BAE appears to have changed from a focus on creating an energy-related product (energy business and energy research) to a business focus on site energy and energy conservation. It has been argued that this may have influenced the success of the methods applied through the research. However, as detailed in this chapter, the strategic focus to explore site energy use has led to several energy developments on the site, which are consequently changing and influencing energy use.

By providing a description of the safety culture of the site, and explaining how it became established and engrained in everyday activities within BAE, this chapter addressed research Objective 4: 'detail the evolving nature of organisational priorities and organisational cultures'. It further met this objective by providing a description of the organisational subcultures in BAE, and demonstrating how changes in strategic priorities can change employee activities. It did this by providing examples of changes in business activities regarding energy use.

One of the main themes of this chapter is how the strategic decision making at board level influences employees' actions. The history of the safety culture demonstrated a successful creation and integration of a culture on site, while the change in strategic focus towards site energy appears to be changing energy use on site. To explore this further, the next chapter uses results (Chapter 4) from the application of an energy culture approach (detailed in Chapter 3), to examine the energy culture of the Samlesbury site. In so doing, it provides an overview of the influences on employee energy use, encompassing the organisational subculture of safety, and the recent ISO 50001 accreditation.

7 Samlesbury Site Energy Culture

This chapter addresses the aim of this research:

Apply an energy culture approach to examine energy use in an industrial workplace.

It uses the empirical material presented in the previous chapters to describe the energy culture of the Samlesbury site.

7.1 Introduction

The previous chapters have detailed how and why the *workplace energy culture framework* was developed (Chapter 2) and how it was operationalised to apply an energy culture approach to examine energy use (Chapter 3). The empirical material obtained from applying this approach was presented in Chapters 4 and 5, and Chapter 6 put forward additional empirical material that demonstrated how wider organisational cultures and strategic priorities interact with energy cultures on site. Each of these chapters has addressed, to varying extents, the four objectives of the research. This chapter contributes to these discussions by describing the energy culture of the Samlesbury site. The research objectives are addressed as follows:

- *Define a framework for informing research on energy cultures in the industrial workplace*: This chapter uses the workplace energy culture framework developed in Chapter 2 as a structure to describe the site energy culture. It also presents a visualisation of the Samlesbury energy culture that is based on the workplace energy culture framework.
- *Detail the evolving nature of organisational priorities and organisational cultures*: The site energy culture description in this chapter contains many references to the wider organisational culture/s. These references reiterate the findings of Chapter 6, which identified the dominant nature of the safety culture of BAE and how it is interwoven with the site's energy culture. This chapter also demonstrates how organisational priorities can change the energy culture of the site.
- *Detail and review employees' attitudes towards energy use*: The empirical material in Chapter 4 provides the foundations for the forthcoming discussions on the Samlesbury energy culture. This chapter demonstrates how the themes presented in Chapter 4 can

be used to describe the energy culture of the Samlesbury site. As a result, this chapter details how an energy culture approach can be used to examine energy use.

- *Examine the geographies of energy cultures*: In describing the energy culture of the Samlesbury site, this chapter argues that energy culture can change with time. It also describes some additional spaces on site where different energy cultures can be observed. These discussions act as an introduction to the more detailed account of geographies of energy cultures in Chapters 8 and 9.

Chapter Structure

This chapter is divided into three sections. The first section is structured into eight themes, which detail the organisational determinants of energy use. These are:

- energy teams on site,
- energy monitoring,
- physical environment,
- energy and environment champions,
- supervisors, colleagues and work teams,
- activities on site,
- training,
- energy-saving targets.

The second section focuses on the individual determinants of energy use and is structured into the following themes:

- socio-demographics,
- energy practices,
- new ecological paradigm (Dunlap *et al*., 2000),
- engagement with energy topics,
- individual energy cultures.

These themes of discussion are directed by the workplace energy culture framework (Figure 7:1). They are examined through the survey data, or have appeared as themes of the interview and focus group discussions.

The final section provides a discussion of the whole Samlesbury energy culture. During this section a visualisation of the energy culture of the site is provided, which uses empirical material presented throughout the thesis. It details how some determinants have a greater impact on energy use than others. It also describes some of the ‘drivers’ to changing the energy culture on site. The research uses the terminology of ‘driver’ to describe a change on site, or in site activities, that leads to a change in the energy culture of the site. By describing these drivers, this chapter argues that energy cultures change with time and space, a theme that is reiterated and discussed further in the remaining chapters.

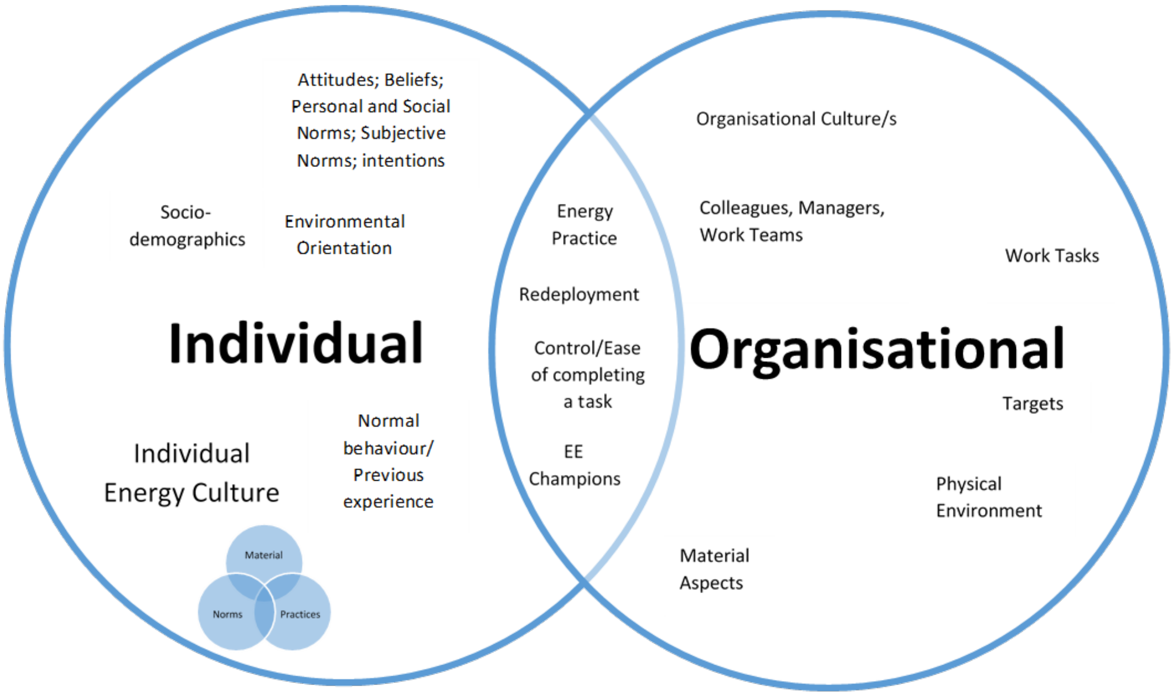


Figure 7:1: Workplace energy culture framework, from Chapter 2

7.2 Organisational Influences

This section provides a description of the organisational determinants of the workplace energy culture framework. It uses empirical material collected from site visits, the results in Chapters 4, 5 and 6, and the experiences of the researcher in the contact she has had with BAE. The following section demonstrates how some of the organisational themes of the framework have more of an influence on employee energy use than others.

7.2.1 Energy Teams on Site

There are two teams on site, who as part of their day-to-day tasks are involved in overseeing site energy use and developing improvements to energy efficiency. TM2 and TM3 are based in these teams. The first team is the engineering team, which focuses on the technical and systems aspects of site energy use. Part of its role is to oversee the monitoring of energy and water on site, and explore potential improvements in site energy infrastructures. TM3 works as part of this team, and Figure 7:2 is an extract from an interview with TM2 and TM3 where TM3 is describing their job role. The extract demonstrates the range of additional activities the engineering team is involved in, such as report writing and the identification of opportunities on the various sites.

'I am responsible for energy management across Warton and Samlesbury … that involves gathering data, producing reports, setting targets, it involves … in conjunction with the SHE department, overseeing the energy management system for MAI. It involves carrying out surveys and producing reports, identifying opportunities. It involves providing technical support to project work and making sure they are meeting minimum standards, generating specifications for our own standards on energy, forecasting energy, producing budgets … in how much energy we're going to use for the next ten years … engagement [with people], supporting, and again supporting the SHE department from a technical perspective, with their work with the businesses … providing a lot of the data for [carbon reporting], and provide all the data for the management reports that go into the Board and things like that … Oh, renewables, we do a lot of surveys and investigations to get involved in trying to validate [them] and check [their] feasibility, if it is feasible, taking it from there [and], writing business cases and passing that on to a project team to deliver.'

Figure 7:2: Extract from interview with TM2 and TM3 where TM3 is describing their job role, within their team

The second team involved in energy on site is the SHE function. TM2 works in this team. Figure 7:3 is an extract from an interview with TM2 and TM3 where TM2 is describing their job role. It demonstrates how the SHE function is involved in ensuring the site continually meets requirements of legislation, regulations and international standards such as ISO 14001 and ISO 50001. The extract also demonstrates how the SHE function and the engineering team work closely together, advising each other on energy topics, and assisting with improving energy efficiency on site. It also demonstrates how the SHE function not only focuses on energy topics but is also involved in occupational health and safety. Further details on the SHE function and its role in the energy culture of the site are presented in the next subsection.

'Technically I'm a SHE advisor but I specialise in occupational hygiene, control of major accident hazards and environment. So the environmental management side of it is supporting the site with 14001, so things like environmental impact assessments, me and [a colleague] do some work on external impact assessments as well, so like oil storage across site … anything that is external to buildings. I work with [TM3] a lot on people engagement, particularly for the significant energy users across site, with the 50001 stuff, shut down plans, things like that … I work with [a colleague] on liaising with the Environment Agency and local authorities, so permit applications, emissions … hazardous substances consent, which we have to apply for, for the chemical processes on site, then I sit in on quite a lot of projects as well from an occupational hygiene point of view, in terms of the health effects, but then I also feed in any energy concerns and things like that to TM3, so we try pick stuff up between us.'

Figure 7:3: Extract from interview with TM2 and TM3, where TM2 is describing their job role, within their team

As Figure 7:3 suggests, the engineering team and the SHE function work closely together. TM2 provides an example of how they might be involved in a site project from an occupational hygiene perspective, but they also report back to TM3 any potential energy concerns. The two teams are also involved in hosting and leading the SHE quarterly meetings, which were described in Chapter 6. These meetings are intended to inform the local SHE representatives based in different buildings on site on all environmental findings, including water, electricity and gas usage figures. During these meetings attendees are provided with up-to-date information on current site projects that focus on waste, energy and water. Attendees are also shown graphs comparing current figures with previous years. The group members also have opportunities throughout the session to provide feedback from their immediate work areas and to ask the hosts questions.

SHE

Chapter 6 has already reported on how the SHE function is integrated into the organisational structure of BAE. It highlighted the central role SHE plays in creating and sustaining the safety culture on site. Energy fits in the agenda of SHE under the 'Environment' part of Safety, Health and Environment (SHE). To explore this link between SHE and energy topics further, from an employee perspective, the survey explored whether the SHE function influences employee energy use and whether employees associate energy-related topics with SHE.

The results from the survey showed that employees generally agree that the SHE function influences their energy use and that they associate topics of energy with the SHE function (Figure 4:20 and Figure 4:21). However, the differences in the distribution of answers for the two questions suggests that some employees associate energy with the SHE function but that the SHE function does not influence their energy use. The qualitative answers provide further details on this. Figure 4:22 reported 114 comments of a total of 1060 potential answers relating to energy and/or environment themes (excluding recycling/waste comments), only 29 of which mentioned the term energy. In contrast to this, there were 681 comments relating to safety topics, and all 261 participants who answered the survey wrote at least one safety-related comment. The positionality of the energy and environmental comments in the list of five answers to Q1a demonstrates how 'safety' is the dominant topic employees' associate with SHE, with energy and environmental comments being positioned third, fourth and fifth in the list.

Some important conclusions about the Samlesbury energy culture can be drawn from this short discussion on SHE and the associated survey results. First, there is a definite overlap between safety and energy cultures on site. The structure of the SHE function to include topics of safety, health and the environment demonstrates this. The qualitative survey results also reveals how employees on site experience and understand this link by writing suggestions on safety, health and environment (Figure 4:22). Second, the positionality of energy-related comments demonstrates how employees' predominantly associate safety topics with the SHE function over any other of its tasks (Table 4:6 and Table 4:7). Third, and relating closely to the previous point, when employees are asked in the Likert scale questions if they associate energy with SHE, and if SHE influences their energy use the majority of participants agree with these statements. However, the survey results presented in Chapter 4 also demonstrate how safety dominates employees' thoughts about energy use, with many employees failing to acknowledge energy in the open-ended questions. This is an example of how qualitative questions can provide richer data when compared with Likert scale questions, which are often restricted by the statement being asked (Bryman, 2012).

The overview of the teams involved in energy at Samlesbury at the start of this section demonstrates how there is not one team on site whose role it is to specialise and explore energy-efficiency potential. The engineering team and the SHE function look at wider environmental matters, such as water and waste, safety and occupational health tasks, and engineering projects, in addition to energy topics. The SHE discussions above and associated results from the survey further support this findings by demonstrating how employees do not see energy topics as the main role of the SHE function.

7.2.2 Energy Monitoring

Over the last decade the Samlesbury site has invested in energy monitoring and sub-metering. This has provided the site with the ability to gain knowledge about the different energy users on site, highlighting the significant energy users (high-intensive energy areas – manufacturing areas) and the less intense energy users (new office buildings). The research found that this ability to categorise areas by energy use, and to monitor energy use, was one of the drivers for some of the energy-focused social and technical interventions on site. Examples include:

- Portable energy monitors have been used on different equipment to identify energy-intensive machines in the significant energy use areas of site. This energy intervention was an outcome of first highlighting the significant energy users. With this categorisation, the site wanted to gain a further understanding of the energy use occurring in these areas, and used portable energy monitors to investigate this. An outcome of these monitors has been trialling of 'ramping down and up' techniques to determine the best way to handle energy-intensive machines (Extract 16, Chapter 4). Once the optimum running speed of the equipment has been calculated, the intention is to reduce equipment to this speed during quieter times or 'down times' to reduce energy, thus leading to a reduction in energy use.
- Painting external flooring of high-energy using buildings to highlight energy usage and act as a prompt to employees to behave in an energy-efficient way. Similar to the previous point, this was in response to improved knowledge of the higher energy users on site. The intervention sought to target specific areas where energy reductions would have a large impact on site energy use.
- Development of a solar farm to reduce energy costs. Knowing how much energy each area uses and being able to identify usage patterns throughout the day assisted with the business case for the solar farm. This information was gained from the sub-metering and monitoring system on site.

Many authors have argued that knowledge alone does not correlate with behaviours (Kollmuss and Agyeman, 2002; Ajzen *et al.*, 2011; Kaufer-Horwitz *et al.*, 2015), but the evidence in the research shows that knowledge can act as a trigger for other interventions, which then result in behaviour change. At Samlesbury, gaining energy use knowledge from sub-metering and monitoring was the first step in the identification of high-energy using areas. This then led to a ripple effect of subsequent energy-focused actions and interventions with the sub-monitoring of equipment, its subsequent ramping up and down, and the painting of external floors of buildings.

In terms of monitoring leading to direct behaviour change, the research agrees with the previously cited studies showing that knowledge alone does not lead to behaviour change. The survey results indicate that employees have limited knowledge on the amount of energy they use within their teams or department (Figure 4:5). However, the energy behaviour results reported in Figures 4.8 and 4.9 describe a workforce that conducts and participates in many energy-saving practices and energy use topics. If employees are not aware of their energy use, as the results suggest, knowledge cannot be influencing their behaviours. Consequently, these results suggest energy knowledge does not influence the energy-efficiency behaviours of employees. As stated above, energy monitoring can lead to energy reduction through interventions that are created after monitoring information has been gained.

Relating to energy knowledge, the focus groups and pilot study results indicate that some employees are aware of their energy use but do not understand these figures (Table 7:1). The extract from the manufacturing focus group in Table 7:1 demonstrates how this participant, a SHE representative, is aware of the figures for the manufacturing shed, but does not fully comprehend what they represent in real-world terms. The pilot study focus group echoes these comments, with participants wanting information to be presented in real-world terms.

Table 7:1: Qualitative extracts from pilot and manufacturing focus groups

Extract details	Extract
Manufacturing Focus Group – 30th June 2015: The researcher had asked the group whether they knew how much energy they use. The majority of the group responded with 'No', apart from this participant.	**Participant:** I do, but I only know it in terms of thousands of kilowatts, I'd love to know, say I'm more interested to know, what they meant.
Pilot Focus Group – 26th April 2014: This short dialogue occurred in response to one participant explaining how on their consumable cabinet (a cabinet that contained items such as bolts, screws, nuts, zip ties, tape etc.), they used to get told what the monthly bills for the items would be if they were to buy them, and they thought this was a good idea.	**Researcher**: So relate [energy figures] to real-world stuff, that you can relate to, and everyone can relate to? **Participants** : Yeah **Participants**: Holiday … a car whatever, especially when you're getting at energy, the amount of money we must use in here in a month, could probably sort all our houses out for a year … you know that kind of stuff.

The way in which BAE is using portable energy monitors (similar to smart meters) is interesting, and has the potential to lead to continuous change in energy efficiency. Day-to-day employees are not required to interact with the monitors, which alleviates the potential for them to be 'backgrounded' (Hargreaves *et al.*, 2013) into everyday activities. Instead, the monitors are used to inform energy behaviours on particular items, which then potentially leads to changes in energy usage on site.

The energy monitoring of individual equipment is a new introduction to the site and was not in place long before data collection, but exploring the success of how the energy monitors change energy practices is an area for future research.

7.2.3 Physical Environment

The size of the site and the activities that take place on site fundamentally direct the amount of energy the site uses, and the way energy is used. The nature of what can and cannot be manufactured on site is partially directed by the manufacturing shed size, equipment and resources. The available space in manufacturing sheds subsequently dictates the available infrastructure options (energy, building and machinery), which will direct and significantly influence the energy use on site. For example, if the site did not have sufficient unused space for the solar farm, this project would not have taken place.

The size of the site also creates challenges for communication with all employees. Members of the core energy teams are unable to see all employees and speak to them about energy usage (Extract 2, Section 5.4.1) due to the size of the site and the number of employees. The site therefore implements a chain communication strategy (Martin, 2005; Mullins, 2007), where information is provided to senior staff in regular meetings and is then transferred to the staff they manage. However, as extract 3 (Section 5.4.1), taken from the interview with TM2 and TM3, describes, there is no guarantee all messages will get transferred.

The physical environment on site also directly influences energy behaviour, further adding complexity to any attempts to reduce energy use. Some examples of this are discussed below.

- First, on a local level within the site the physical environment directs the access employees have to power switches. In Extract 15 (Section 4.3) the participant describes how employees can turn off equipment that they individually use. However, they are unable to turn off the larger equipment because the switches are inaccessible. To turn the machines off, they require maintenance teams to come to the location and switch them off. This and wider focus group discussions suggest a distinction should be made between *shed energy* and *individual energy*, both on site and in any future research. Individual energy is the energy used by personal equipment and includes items such as computers, speakers, radios and spotlights. These items are often low in energy intensity, only benefit employees in the immediate vicinity, and have a fairly low impact if they are turned off. The shed energy category would include the higher energy using equipment and machines that are manufacturing specific, such as machine presses, air lines, chemical baths and ovens. These pieces of equipment would take longer to turn on and off, compared with the smaller appliances, and have a much larger impact on the wider manufacturing processes conducted within the shed. This categorisation was sparked by Extracts 11–15 (Section 4.3) and Extract 30 (Section 4.8), when participants were asked if they knew what to switch off if the site was closing down. An attempt was made during construction of the survey to distinguish between these two types of energy by using the terminology of 'energy use' and 'energy demand'; however, the results suggest the distinction between these two groupings was not clear. This theme is expanded on in Section 7.3.2.

- Second, the size of the site affects energy behaviours in some areas. During the manufacturing focus group discussions, the group mentioned some difficulties in determining who is in certain areas, which can affect decisions on whether to turn lights off or not. This has two points relating to the physical environment. First, the physical layout makes it difficult to visually inspect a working area to determine if any employees are left in a particular space. This then impacts decisions to turn lights off or not. Second, it highlights that light switches are not always area specific and can cover large areas, making it difficult to determine whether an area is empty and lights can be switched off.
- Third, the type of building and the building aesthetics appear to influence attitudes towards energy and energy behaviours on site. The employees in the manufacturing focus group commented that the newness of a building, the aesthetics and the level of investment explain differences in energy attitudes across site (Extracts 10 and 11, Section 5.4.3). If attitudes change, the energy behaviours and response to any energy interventions could change. This is further discussed in Chapter 9, in the section on areas for future research.

- Additionally, newer buildings or recently renovated buildings have more energy-efficient technologies in them compared with older buildings. An example of these technologies is the automated lighting that has been installed in some buildings. This automates control of equipment and aim to improve energy efficiency by limiting the opportunity for having lights on when they are not needed. The type of building and building structure can also influence energy use. Informal conversations with TM2 and TM3 throughout the research explained how some energy infrastructure improvements were unable to be conducted due to the inadequate structure of some of the buildings. For example, some roofs are not structurally strong enough to host rain water harvesting or solar panels.

This section has only discussed three ways in which the research has observed how the physical environment influences energy use: access to switches, difficulties in determining if anyone is still in an area, and how building structure can improve/hinder energy efficiency. The researcher acknowledges that this is not a comprehensive list, but the research is not focusing on the material aspects that are influencing energy behaviour. Instead it seeks to provide an overview of the energy culture of the site, highlighting the variety of influences on energy behaviours.

7.2.4 Energy and Environment Champions (EE Champions)

At the early stages of the research the researcher was made aware of the site having energy and environment champions (EE champions) located in various areas. As a consequence, they were included as a theme of the workplace energy culture framework originally presented in Chapter 2, and survey questions were developed to explore their influence on energy use (all of question 2). The results to Q2c (Figure 4:24), which asked whether the EE champions influence employee energy use, showed a mixed response of agree/strongly agree, neither agree/disagree and strongly disagree/disagree answers. However, 47% of participants who answered Q2c could not write down the name of a champion, which suggests that nearly half of employees do not know who their EE champion is. The qualitative answers to Q2b, which asked participants what they thought the purpose of the EE champions was, also highlighted how there is some confusion about the role of the EE champions. The uncertainty of some employees about the role of the EE champions is further supported by Extract 29 from the manufacturing focus group (Chapter 4), in which employees are discussing how they would like to have a designated contact to discuss energy topics and shut-down plans, but the facility is not available. The EE champions are the appropriate people with whom to discuss such suggestions, but the focus group participants did not seem to connect energy suggestions with them.

7.2.5 Supervisors, Colleagues and Work Teams

The literature presented in Chapter 2 highlights research that has explored supervisors' impact on employees' work behaviours (Ramus and Steger, 2000; Kasim, 2009; Johansson *et al.*, 2011; Schelly *et al.*, 2011; Lo *et al.*, 2012; Robertson and Barling, 2012; Walls and Hoffman, 2012). In addition, it highlights some theoretical models that argue peer opinions can influence energy behaviour (Ajzen, 1991, 2005; Tudor *et al.*, 2008). Due to this, the survey was designed to explore whether the opinions of supervisors, colleagues and work teams affect individual energy use and whether they should be considered for the workplace energy culture framework.

The results from the survey are summarised as:

- employees think their colleagues and line manager would not think differently of them if they took actions to save energy at work (Q10g and Q10h),
- employees feel they do not receive enough supervision and guidance on saving energy at work (Q8a),
- line managers don't influence employee energy use (Q10a).

These results suggest that line managers do not have a significant role to play in influencing energy use in the workplace. This is an important finding in this workplace setting. Chapter 6 has already highlighted the command and control, top-down workplace structure within BAE, which has strong influences on employees' actions, for example the safety culture of BAE. However, this is not the same for energy. Line managers direct the employees they are responsible for in their day-to-day tasks. If line managers are not influencing employees' energy practices, then it is the employees' choice whether energy-efficient behaviours are conducted. This highlights how an individual energy culture, with the associated norms and practices, will interact with the workplace energy culture. It also demonstrates a weak or not very well established energy culture in comparison with the integrated and established safety culture on site. The majority of strongly disagree/disagree and neither agree/disagree results to Q8a suggest employees don't think they get enough supervision and guidance on saving energy at work.

In addition, the responses to questions 10g and 10h, which show that employees believe their colleagues and line managers would not think differently of them if they took actions to save energy at work, lead to the conclusion that the subjective norm aspect of the theory of planned behaviour (Ajzen, 1991, 2005) is not applicable to this work environment. As stated in Chapter 2, Ajzen (1991, 2005) suggests that social behaviours are a function of attitudes towards a behaviour, subjective norms (the perceived social pressure to perform or not to perform), the perceived behavioural control (the perceived ease or difficulty of performing the behaviour) and the intention to perform the behaviour (the willingness/effort to do something). Further research would be needed to explore the other themes of the theory of planned behaviour, as is discussed in Chapter 10. However, the results from the survey imply subjective norms do not influence discussions on energy use in the workplace.

In addition to the above findings, the survey and focus group results from the colleagues and work team actions theme (Sections 4.9) also provide further explanation of where these themes fit into the energy culture on site. The survey results are summarised as:

- energy use and demand were not discussed regularly (Q10d),
- energy use not discussed with colleagues (Q10e),
- mixed results to ‘within my work team we are conscious of our energy use’ and ‘we regularly try to reduce energy’ (Q10b and Q10c)
- unsure results about colleagues supporting need to reduce energy use (Q10f).

These results describe a culture where energy is not a topic discussed regularly in work teams or with colleagues. The manufacturing focus group extracts (Extracts 33–35, Section 4.9) suggest that energy only becomes a point of discussion in teams and with work colleagues prior to holiday shut-downs. This is again very different to the safety culture described in Chapter 6, which demonstrates how safety is discussed in regular meetings (DSUMs and WSUMs).

The results to questions 10b, 10c and 10f show no clear agreement or disagreement regarding work teams being conscious of their energy use, work teams regularly trying to reduce energy, and whether colleagues support the need to reduce energy use. Figure 4:32, 4.34 and 4.35 show how the majority of answers (around 80%) are agree, neither agree/disagree or disagree. From examining Table 4:1, which shows the variety of locations where surveys were completed, it is no surprise that there is variation in the answers given. Some of the areas where the survey was distributed are home to the SHE function. As described in Chapter 6, the SHE function is partially responsible for leading energy-efficiency improvements on site. Consequently, members of the SHE function would be aware of their energy use, or know where to obtain this information, and be aware of how to reduce it. This may influence the survey results.

The results from this theme suggest that supervisors, work teams and colleagues at present do not have a large impact on individual energy behaviour. Consequently, this impacts the larger site energy culture by demonstrating how supervisors, work teams and colleagues are not important influences. However, it does highlight areas that can be targeted to change future energy use.

7.2.6 Activities on Site: Shift Work

As highlighted in Chapter 1, Samlesbury is a large, mixed-use site, consisting of manufacturing sheds and office environments. The previous section highlighted the physical aspects of some of these buildings and how they can influence energy use. This section focuses on the activities conducted on site, specifically shift work and the impact this has on the energy culture.

Shift Work

During the focus group, and site visits, it was noted that in some of the manufacturing areas employees work shifts. The focus group described two types of shifts, one day time and one night time. The shift work on site can be periodic, and is dependent on demand for the manufactured parts and the contract for the aircraft that the shed is working on. This has numerous impacts on the energy culture on the site.

First, shift work requires knowledge transfer between the two shift teams. Section 5.4.1 discussed the methods employed at BAE to communicate with employees. However, an added complexity of the chain communication is the need to transfer knowledge and communicate to various shift managers, who subsequently need to transfer this knowledge to their teams. The majority of non-manufacturing tasks on site occur within the traditional UK working hours of the 37.5-hour week (9 a.m. to 5.30 p.m.). Managerial group meetings such as the SHE quarterly reviews occur during this time. However, often there is only one representative from each area attending, and the timing of the meetings means this would be a day-shift representative. This lengthens the chain of communication, with the day-shift representative needing to transfer information to a night-shift representative, who then needs to transfer it to the employees.

Second, and closely linked to the previous point, shift workers only interact with fellow shift employees while on site. This is important when exploring the Samlesbury energy culture. During the day shifts, employees are able to communicate instantly for information requests via forms of communication such as emails and direct calls to other teams about work practices that directly impact energy use. However, with a limited number of staff on site working night shifts, if employees have a query relating to manufacturing processes or related energy activities they are unable to obtain a prompt answer, with answers potentially taking a few days to come through. This can have implications for energy use during the night shift, with employees not participating in energy-efficiency activities. The SHE function and engineering team (represented by TM2 and TM3), which focus on site energy use, acknowledge these different working hours and the range of employees on site. To try to address this, TM2 and TM3 explained to the researcher that they or their colleagues will often attend shift daily start-up meetings (DSUMs) or weekly start-up meetings (WSUMs) to make messages accessible to all employees.

Third, in a similar way to that described above, the shift workers have less contact with key individuals in the SHE team and will therefore be less aware of the energy interventions in place on site. For example, night-shift employees are less likely to circulate as widely round the site as their day-time counterparts due to facilities such as canteens not being open. Therefore they are not as aware of the painted floors and educational walkways outside buildings. In addition to this, the EE champions exist per area, not per shift. Therefore the EE champions only impact the employees on their shift, with the other shift being unaware of who they are, and their role and responsibilities. The researcher was unable to hold a focus group with any of the shift workers or attend site visits during these times because of BAE's restraints on access for the researcher. Consequently, there is no empirical evidence for these two points. It is important, however, to consider the impacts of night shifts on site energy culture.

Fourth, the activities of manufacturing employees during the day shift vary depending on whether there is a night shift coming in after them. Extract 30 (Section 4.8) from the manufacturing focus group demonstrates how employees' activities are directed by whether a night shift is working after them. During the extract the employee highlights how turning machines and equipment off would have an impact on the next shift. Extract 9 (Section 5.4.2) also comments on how tasks in the manufacturing shed are dependent on the night shift by highlighting how lights are on during day shift and night shift and do not get turned off.

7.2.7 Training

The Samlesbury site energy culture is one where energy-focused training is not a priority. The survey asked two questions regarding training: Q3 'Have you, in the last 6 months, received any energy-related training' and Q8b 'I have received enough training on energy saving at work'. The results (Figure 4:26) revealed how the majority of employees do not think they receive enough training, and over 90% of participants reported they had not received any energy-focused training in the last 6 months. The answers to questions asking participants to provide details of training (Figure 4:27) indicate that the energy training that is available is provided via an online platform called Skillport. They also suggest that the energy training is provided within an environmental module, which also discusses topics relating to water and waste. Only one of the participants detailed training they had had on specific processes that occur in their work environment, 'Shut down process [name of employee] – 2 hours' (Figure 4:27), with another two participants mentioning training that asked employees to 'Turn … off lights and computers' and about general energy use in BAE – 'I believe I did some mandated training approx. 12 months ago covering energy usage in BAE and how we can reduce it'. During the interview with TM2 and TM3, they were asked about what energy-related training was offered by BAE. They described how every employee has a log-on for completing online training which hosts an environmental and energy module (Extract 5, Section 5.4.1).

These results indicate that the Samlesbury site energy culture is not one that is formulated or reinforced through training. This is in contrast to the safety culture on site. As indicated by Extract 1 (Section 6.2.2) often work teams are given safety scenarios which they play out, with the aim of promoting safety discussions and reinforcing the safety culture on site. Scenarios currently do not occur based around energy behaviours.

7.2.8 Energy Saving Targets

The survey sought to explore whether employees were aware of any energy-saving targets set for their work area (Q7) and if they could provide some details of these targets (Figure 4:28). The results show that participants were not aware of targets, with only 22.2% of participants answering yes to Q7. However, when looking at the comments in Figure 4:28, 11 of these participants could not provide any further details about energy targets, and 8 provided details about recycling and waste reduction targets on site. These results show that employees do not know their energy targets. Consequently energy targets cannot be influencing energy behaviours.

During discussion of the dominant safety culture on site (Chapter 6), the thesis stated that within the SHE function, energy fits into the environment theme of SHE. The previous section on SHE also indicated how energy figures are reported within SHE quarterly meetings where, again, other environmental figures are reported alongside energy. The comments in Figure 4:28

indicate that some of the participants who answered the survey attend these meetings and this is how they are aware of the energy-related targets for the site. The comments also suggest that some employees think that energy targets only apply to the energy-intensive work environments, and are not applicable to the office environments.

During an interview with TM2 and TM3, they were asked if there are any energy-saving targets on the Samlesbury site. They explained that the site has targets but these are no longer targets assigned to specific buildings:

> *'The site has a specific target, the building basically doesn't have a target set upon them, they have a number of different measures that they have to meet, which are around the energy management system and in theory if they meet those measures and they're doing it properly, the consumption should reduce or at least be controlled.'*
>
> *(Extract from interview with TM2 and TM3)*

TM2 and TM3 then proceeded to talk about the challenges with assigning targets to specific areas on site:

> *'Because this site's been growing so much, it's just been impossible to manage that, and it's quite difficult because, to normalise it, because they'll run aircraft parts in campaigns or whatever, so some will still run thirty through, the next would be none while they're waiting for stuff to feed in so it's quite hard to then normalise the figures to make sense of them, so what we decided to do a few years ago, we looked at 50001 … and we implemented the measures from that, and then obviously we've decided to formalise and go for the certification this year.'*
>
> *(Extract from interview with TM2 and TM3)*

These two extracts highlight two important points for the research. First, it is difficult for manufacturing workplaces to set targets due to the changeable nature of manufacturing orders. TM2 explains how the site used to set targets for specific areas, but due to the parts manufactured on site being used for various operations, the demand for parts is not consistent. This has consequences for potential site energy interventions. Second, the extract highlights some inaccuracy in the wording of the question in the survey. The question asked participants if they were aware of targets for their area. However, as the extracts suggest, there are no targets for each area; instead, there are targets for the site. This could have led to some confusion for participants. The survey responses are still useful in this present instance as they provide an indication of employees' thoughts on energy targets and also highlight how not everyone on site is aware of a move away from energy targets.

7.3 Individuals

This chapter now proceeds to talk about the individual aspect of the workplace energy culture framework presented in Figure 7:1. In a similar format to the previous section on organisational determinants of energy use, it presents empirical material detailing the individual determinants. During this section some wider individual determinants that were not directly addressed by the research are discussed. The purpose of this is to draw attention to additional individual determinants of energy use that were not examined due to challenges with data collection and access to employees.

7.3.1 Socio-demographics

BAE has a predominantly male workforce, which was observed during site visits. The survey data shows 75% of participants were male (Table 4:2), as were 87.5% of the manufacturing focus group. The research was unable to obtain site demographic information due to security restrictions and the information not being in the public domain, but the results were reported back to the core industrial team, who did not report any differentiating views. The age group results from the survey (Table 4:3) shows a range of ages, with 23.9% of employees who answered the survey being 25–35 years old, and 52.9% being between ages 41–55. These results are important when considering the energy culture on site. Research by Zelezny *et al.,* (2000), Abrahamse and Steg (2009) and Laidley (2013) has shown a link between demographics of people and their receptiveness to the introduction of energy interventions. Any energy interventions BAE introduces needs to consider the employees on site. Exploring energy usage by applying the workplace energy culture framework can assist with this by gaining an understanding of the employees. In terms of the age groups, a lot of research has been conducted exploring 'generation Y', defined as people 'born between 1980 and the early 2000s' (Hopkins and Stephenson, 2014:88). A summary of this research shows that generation Y use technology more on a day-to-day basis (Bolton *et al.*, 2013), are more familiar with it and interact more with social media than other generations (Bolton *et al.*, 2013). Along with a recognition of the material environment where employees conduct energy practices (e.g. frequency of computer access), the varying age groups and generational traits should be considered when introducing any energy interventions. For example, the research cited above suggests people aged between 16 and 35 (approximate age range for generation Y) will be more comfortable with technology and computers, and are faster learners where interaction with these technologies is required. This needs to be considered when introducing energy interventions as some groups will interact and understand interventions better than others.

In addition to the predominantly male workforce with a range of ages, the employment time and length of time in the role of employees completing the survey is an interesting consideration in the energy culture of the site. The results (Figure 4:3 and Figure 4:4) shows that employees tend to stay employed in BAE, but move around the business by having different job roles. This conclusion is supported by the findings of the manufacturing focus group, which revealed that the majority of participants had previous roles within BAE prior to their current position. The movement of employees around the business suggests that employees find BAE a good place to work. The interview with Rob Wallace provides an explanation for staying employed at BAE:

> *'many people are waiting for their pension … and I include people who are in their mid-forties, it's like, they're well paid, it's a good job … People, I think get tied in because they've got their pension and all that sort of stuff that goes with it [staff benefits].'*
>
> Interview with Rob Wallace

Previously Rob Wallace had commented that he was 'not normal' in leaving BAE after 22 years of employment. This extract gives an indication of some of the reasons people remain in employment at BAE – the staff benefits and pension. If people are employed at BAE over long periods of time, the organisational culture will be engrained in how they act. They will also be aware of any previous interventions or ways of doing. This can impact how receptive employees will be to new interventions. An example of this was seen in the pilot study focus group, where a participant described how one of their employees had become disengaged with energy topics because of a lack of response to an energy suggestion (Extract 20, Section 4.5).

The retention of employees within BAE and the movement of employees around the business through obtaining new roles are important findings for the site energy culture. When exploring energy behaviours it is necessary to consider the transfer of behaviours, knowledge and ways of doing from one area to another. McGrath and Argote (2008) discuss the process of knowledge transfer through employment movement, and Akgün *et al.,* (2007) argue for a need for unlearning before new learning, and consequently new behaviours, can occur. When discussing preliminary results with TM2 and TM3, they made numerous comments about how they thought the movement of employees with changing job roles accounted for the varying success with past energy interventions. One example the team provided was of an enthusiastic local SHE employee based in one of the manufacturing sheds. They explained how the success of a recycling programme in a manufacturing shed reduced significantly when this employee moved to another role in the business. Here TM2 and TM3 are demonstrating how movement of a key individual to another location changed the recycling rates in the manufacturing area.

7.3.2 Energy Practices

The survey sought to examine the energy practices theme of the workplace energy culture framework (Figure 7:1) by asking participants to answer four Likert-scale questions on turning equipment and lights off and reporting faults to line managers (Section 4.10). The majority of participants (at least 80%) participate in energy practices that support energy reduction (turning off equipment and reporting of faults) with a slightly lower percentage (68.78%) turning off lights. While the research acknowledges the limitations of exploring self-reporting of behaviours through the method of surveys (Bryman, 2012; De Vaus, 2014), the results give an indication of attitudes towards energy use behaviours from employees, thus providing an overview of the energy practices and subsequent energy culture of the Samlesbury site.

Individual Energy Use and Energy Demand

The survey was designed to explore differences between site energy use and individual energy use by using the phrases ‘energy use’ and ‘energy demand’. Energy use referred to approaches aimed at improving employee energy efficiency while energy demand focused on infrastructure and workplace improvements. Chapter 2 discussed how a lot of businesses and academic research that focuses on energy topics or improving energy efficiency often take a predominantly technically driven approach, such as improving energy infrastructure or changing processes. The aim of distinguishing between energy use and energy demand was to explore whether the site took a predominantly technical or human-centred approach to improving energy efficiency. The survey questions that distinguished between these two concepts reported no difference in the views of the employees. However, the focus group discussions (Extracts 11–15, Section 4.3) highlight how the manufacturing focus group described a work environment where employees have individual work environments (individual energy), within the large manufacturing area. Within these individual environments employees (or their immediate work team) have their own equipment, which includes computers, radios and spotlights. All of this equipment will have no or low consequence for the wider manufacturing area if it is turned off. The focus group discussions pointed out that employees tend to turn off equipment in these individual environments but do not turn off the larger manufacturing shed equipment and lights. The focus group explored various reasons for this, such as access to switches, nature of shift work, equipment warm-up and cool-down times, the effect on other shifts, and the size/layout of the building preventing easy knowledge of who is left in an area to turn lights off.

It is suspected that employees completing the survey did not fully appreciate the differences between the terms energy use and energy demand, even though reminders of each phrase were placed on each page of the survey. This would explain the discrepancy between the survey results, which report no difference in attitudes and energy use behaviours around energy use and energy demand, and the focus group results, which did report differences. As mentioned in Section 7.2.3, improved terminology could include the terms ‘shed energy’ and ‘individual energy’. The results of the research suggest there is a difference in energy actions relating to ‘shed energy’ and ‘individual energy’ by individuals in the workplace, with employees turning off equipment in their immediate work environment (individual energy) and not turning off larger equipment and lights (shed energy). Relating these findings to the energy practices theme of the results in Chapter 4 (Section 4.3), it is thought that when answering these questions, employees were considering their immediate work environment, rather than the wider manufacturing work area.

7.3.3 New Ecological Paradigm Scale

In exploring the energy culture of the site, the research used the NEP scales (Dunlap *et al*., 2000) as a measure to explore the environmental identity of BAE employees. As stated in Chapter 3, Stephenson *et al.,* (2010) also used the NEP scale in their energy cultures framework analysis of New Zealand households. As recommended by Dunlap *et al.,* (2000) principal component analysis was conducted on the results to determine how many scales of answers are appropriate for this population sample. During this process, as detailed in Chapter 5, it was determined inappropriate to use the results from the NEP scale due to large numbers of missing answers. Even though the research does not have empirical material to examine the environmental identity of BAE employees, the wide application of the NEP scales suggests the environmental identify of employees would vary, which would have an impact on how they engage with energy topics. Future research is needed to explore this link further, and to collect empirical material to examine it.

7.3.4 Engagement with Energy Topics

The energy culture on site is one where employees are engaged with energy-related topics; they are aware of who is responsible for switching off lights and machines when the areas are vacant (Figure 4:6 and Figure 4:7) and know the locations of switches to turn off equipment and lights in their work areas (Figure 4:8 and Figure 4:9). Employees also state that they know what to do to save energy within the workplace (Figure 4:10). However, as discussed in Section 7.2.3, the physical environment often directs decisions about turning lights and equipment off. The manufacturing focus group (Extracts 11–15, Section 4.3) discussed what the research has defined as 'shed energy' and 'individual energy'. The employees are aware of how to turn their individual items off, but often the larger equipment in the manufacturing areas needs to be turned off by maintenance. As explained earlier, the building layout prevents the lights being turned off, because employees are not always able to determine whether people are still working in a particular area. Another example of the workforce being engaged in energy-related topics is their concern about the cost of energy to the business (Figure 4:45 and Figure 4:46). However, as Section 4.10 shows, employees are unsure whether the rising energy costs will affect their day-to-day tasks (Figure 4:39). This shows a separation between the rising energy costs to the business and the tasks employees conduct on site.

7.3.5 Individual Energy Cultures

The work by Stephenson *et al*., (2010, 2015) on the energy culture framework argues that each individual has their own energy culture, which is dictated by the interaction between norms, practices and material aspects. The individual in the workplace energy culture framework (Figure 7:1) will also bring with them their own energy culture. It is important to remember this when examining workplace energy cultures. Each employee will have their own views on appropriate behaviours and have distinct energy practices in certain material environments. Authors have argued that behaviours can be transferred from one environment to another and have described this as 'spill-over' behaviours (Thøgersen and Crompton, 2009; Whitmarsh and O'Neill, 2010; Austin *et al.*, 2011). The distinct energy practices of the individual, which can be examined by the energy culture framework (Stephenson *et al.*, 2010, 2015) may 'spill-over' from the home environment to the work environment. The spill-over of behaviours may also move from work to home, with workplace energy practices moving into the home environment where appropriate. This suggests a wider impact of a workplace energy culture in the energy culture of a home.

When examining workplace energy behaviours, an acknowledgment of the variety in individual employees' energy cultures is vital. Individual employees' attitudes and behaviours will naturally vary across the business, which will have implications for the success of any energy intervention strategies. Research has highlighted how people sustain changes in behaviour if they have been given tailored information (Daamen *et al*., 2001; Carrico and Riemer, 2011; Lo *et al.,* 2012); if non-tailored information is used, and provided to the whole site, it may be ignored by employees who already undertake the behaviours being changed. Consequently, employees might not engage in future interventions as they think the information is not applicable to them, even though future interventions and information could be. Organisations that implement any interventions need to be aware of this risk, and the potential consequences for the success of future interventions.

7.4 The Samlesbury Energy Culture

The discussion and empirical material presented in this chapter have provided further explanation of the energy culture of the site. This section presents a visualisation of this energy culture (Figure 7:4). In so doing, it highlights the changes that have been made to the workplace energy culture framework originally presented in Figure 7:1.

The majority of the determinants presented in Figure 7:1 were observed as influencing energy behaviours on site and have already been discussed in this chapter. However, there are five distinct differences between Figure 7:1 and Figure 7:4:

- *Safety culture*: this category has been placed in a circle to represent another organisational culture that is having an impact on the energy culture of the site. As discussed in Chapter 4, and in Section 7.2.1, the SHE function has an important part to play in the energy behaviours on site. However, it does not focus exclusively on energy-related topics, the survey results suggesting its primary task is safety. This has strong links with the established safety culture on site and is the main reason for it being in another circle.

- *Historic nature of the site and energy monitoring*: Physical environment, building characteristics and material aspects were shown to influence energy practices on site. It was therefore deemed appropriate to create another theme, called 'Historic nature of the site', to reflect the information obtained from TM2 and TM3 about energy monitoring. This interview highlighted how the historic nature of the site had caused limitations on the ability to monitor energy. It was deemed appropriate to have an 'energy monitoring' determinant theme in the site culture visualisation as this appears to be a current intervention strategy the site is implementing with the aim of changing behaviours. Thus, it was decided that this theme is influencing, or has the potential to influence, energy behaviours on site.
- *Training and scorecards*: the research was interested in exploring whether training has had an impact on the energy behaviours on site. The results indicate that there is a lack of site-wide energy-related training. The training that does occur is linked to wider environmental-related training. Due to this lack of training, the training theme has been placed outside the energy culture of the Samlesbury site. It was decided to keep this theme on the visualisation as it represents the potential driver for energy behaviour change. One way the safety culture described in Chapter 4 is engrained in everyday activities is through the role play, training and scorecards on site. This demonstrates a successful strategy employed to engrain a particular culture into day-to-day activities of employees. This strategy could be used for future energy training.
- *Environment culture*: similarly to the above SHE and safety culture, the research has shown that the wider environmental culture on site strongly interacts with the energy culture. Throughout the surveys and the manufacturing and pilot focus groups, employees mentioned wider environmental topics such as waste and recycling. Therefore, it was deemed appropriate to include the environmental culture in the framework. It is smaller in size as it is not as established or as well embedded in everyday activities as the safety culture.
- *Black dashed line*: this has been introduced to represent the impact different spaces can have on the energy culture of the Samlesbury site. As indicated in Section 7.2.3, which discusses the physical environment, some of the empirical findings suggest that different sheds may have different energy cultures due to the amount of investment and the manufacturing contracts that they have.

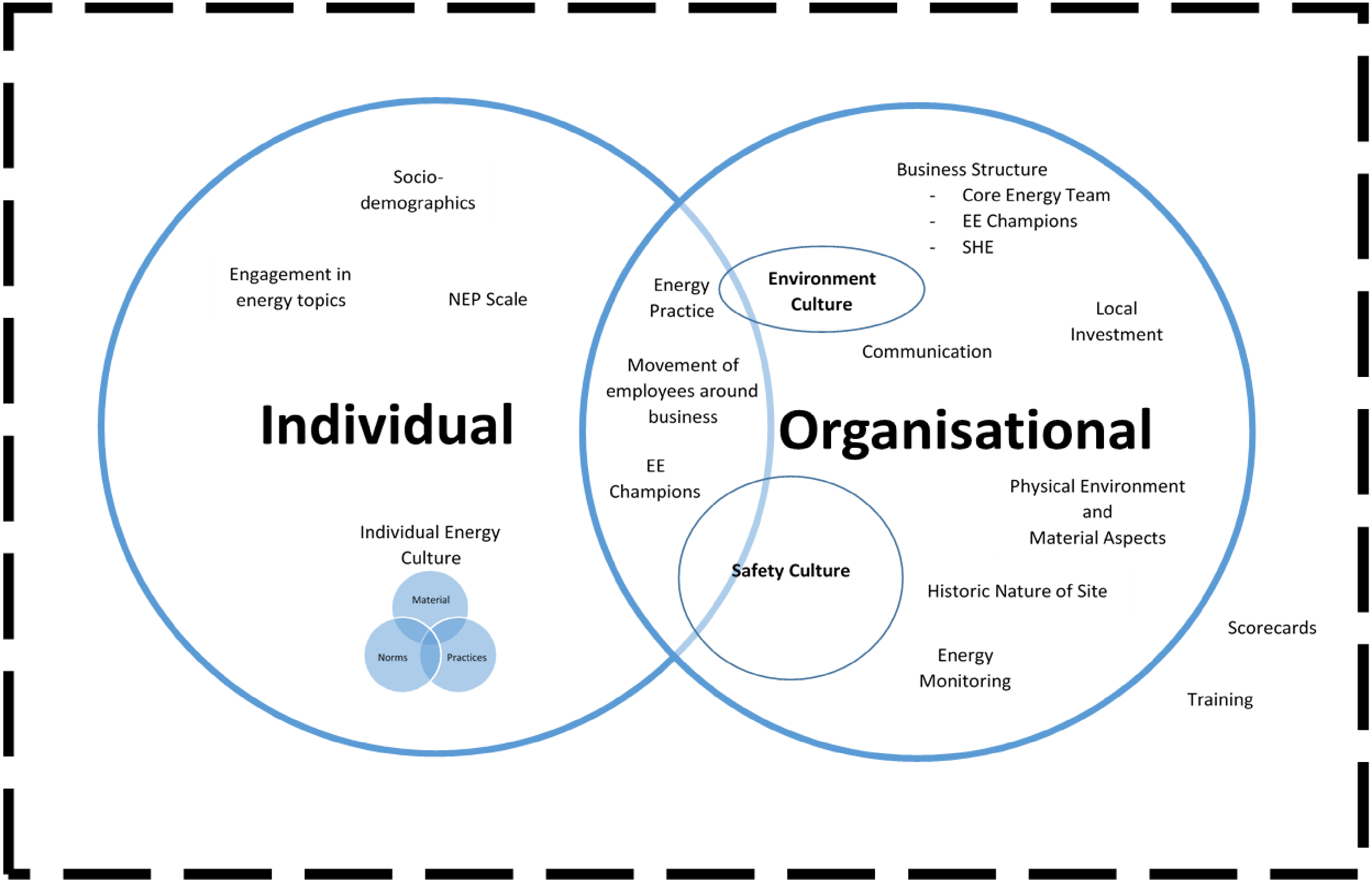


Figure 7:4: BAE Samlesbury energy culture

7.4.1 Drivers of Changing Energy Culture

This chapter has so far discussed the energy culture of the Samlesbury site and neglected to discuss any of the drivers to changing it. The drivers differ from the energy culture determinants as they are factors that can change the organisational theme of the workplace energy culture framework (Figure 7:1). The research did not seek to explore the drivers, but during data collection it became apparent that there are two key drivers of the energy culture – communication and ISO 50001 – both of which are still fundamentally influenced by organisational decisions.

Communication

Communication was not highlighted as being an influence on energy behaviour in the workplace energy culture framework (Figure 7:1), but during the process of data collection, analysing and writing up, it was deemed appropriate to have this as a driver to change energy use on site. Site visits and focus group discussions identified that there are clear differences in communications between employees based in office and manufacturing environments. The manufacturing areas rely on chain communications, while the office environments have additional resources such as internal information services (e.g. webpages and email). Communication as a theme of the workplace energy culture framework is discussed again in Chapter 8, where differences between the two areas (manufacturing and offices environments) are discussed. It is also discussed further in Chapter 9.

ISO 50001

As stated in previous chapters, the Samlesbury site recently achieved ISO 50001 accreditation. Throughout this chapter reference has been made to the ISO 50001 status during survey and focus group comments about energy targets and energy use and demand. In achieving ISO accreditation, the site has to abide by set standards, to meet external site inspections. The ISO 50001 status was obtained during the course of data collection. When reporting survey results to TM2 and TM3, they stated that if the survey were to be completed now, post-ISO 50001 accreditation, the results would differ. An indication of this can be observed in the difference in comments between the pilot and the manufacturing focus groups. During the pilot there was no mention from employees about the ISO 50001 certification; however, in the manufacturing focus group references were made on numerous occasions, such as Extracts 17–19 (Section 4.5), which discussed the new shed comments board, where employees have the opportunity to post their energy suggestions, which are reviewed on a regular basis. In addition, one member of the manufacturing focus group specifically mentioned the ISO 50001 certification and the other impacts it is having on the shed.

7.5 Conclusion

This chapter described the energy culture of the Samlesbury site. In doing so, it presented and discussed data collected from site visits, surveys, focus groups, interviews and all communications with BAE. It demonstrated how the workplace energy culture framework originally presented in Chapter 2, to address research Objective 1, was operationalised (Chapter 3) to enable a description of the energy culture of the Samlesbury site to occur. It used the discussions and results associated with addressing research Objectives 2 (Chapter 5) and 3 (Chapters 4 and 5), to demonstrate how an energy culture approach can be applied to examine energy use in an industrial workplace. It also presented a visualisation of the Samlesbury energy culture in Figure 7:4. Thus, this chapter has directly addressed the aim of the research.

In discussing the Samlesbury energy culture, this chapter described a site culture where certain teams (SHE and engineering teams) are actively trying to make the site more energy efficient. This site has knowledge of its energy use through sub-metering of different areas and it actively engages with energy-generating and energy-saving technologies (e.g. the solar farm, wind turbine, energy monitoring systems and sub-monitoring of equipment). However, the site employees are not all actively trying to make the site more energy efficient in their individual behaviours, and there does not appear to be a culture where energy is a regular topic of discussion. The site has actively engaged with social and technological interventions to expose employees to energy topics, but these have had varying success rates, and have not led to any significant sustained behaviour change. As shown in Figure 7:4, the energy culture on site is interwoven with the overarching organisational structure, the dominant safety culture and the additional environmental subculture. However, the culture is evolving. This chapter has detailed how drivers such as ISO 50001 and key individuals are changing energy behaviours. It has demonstrated how key individuals have in the past been crucial to the success of some recycling campaigns; however, when such individuals move on, the behaviours are not sustained. This chapter also demonstrated how a decision made at board level for the site to seek ISO 50001 accreditation is changing energy use on site.

The thesis now moves on to address research Objective 4. Chapter 8 uses a similar format to this chapter in describing the energy cultures of two US sites, York and Louisville. It demonstrates how the workplace energy culture framework can be operationalised at an international scale, while also exploring differences between the Samlesbury, York and Louisville sites.

8 Geography of Energy Culture: National Scale

This chapter directly addresses Objective 4:

Examine the geographies of energy cultures.

8.1 Introduction

The thesis has so far presented discussions and empirical material to address research Objectives 1, 2 and 3 (Figure 8:1). Chapter 7 demonstrated how empirical material from each of these objectives, and the operationalisation of the 'workplace energy culture framework' have assisted with addressing the research aim 'apply an energy culture approach to examine energy use in an industrial workplace'. It achieved this by presenting a detailed description of the energy culture of the Samlesbury site.

1. Define a framework for informing research on energy cultures in the industrial workplace.
2. Detail the evolving nature of organisational priorities and organisational cultures.
3. Detail and review employees' attitudes towards energy use.
4. Examine the geographies of energy cultures.

Figure 8:1: Objectives of this EPSRC PhD CASE award research

This chapter seeks to move the discussion on to address research Objective 4 by focusing on the internationalisation of the workplace energy culture framework. It presents empirical material collected from two focus groups conducted at the Louisville and York BAE sites in the US and uses it to describe the energy cultures of these two sites. In so doing, it introduces discussions and observations on how energy cultures change with different geographies. Chapter 5 introduced this theme by presenting empirical material examining how energy cultures can change with local geographies. The results presented in Chapter 5 and the discussions in this chapter of how energy cultures change at an international scale are used in Chapter 9, in a final discussion of the geographies of energy cultures.

This chapter starts by introducing why the thesis has explored energy cultures at an international scale. In doing this it provides a brief overview of the academic literature, which has demonstrated how national culture can influence energy behaviours. It then provides an overview of the methodology applied to obtain the empirical material presented here. A description of the two sites is provided, along with details of how the opportunity to conduct the focus groups arose. Sections 8.3 and 8.4 describe the Louisville and York site energy cultures, respectively. These are structured in a similar format to Chapter 7, which described the energy culture of the Samlesbury site. First, a visualisation of the energy culture of the site is presented, which indicates the sections of the workplace energy culture framework that will be described. During these descriptions extracts from the focus groups are presented. A short summary of the energy culture of the site is provided at the end of each section. The chapter concludes by outlining the main similarities and differences observed between the US sites and the Samlesbury site. The conclusion also demonstrates how the findings from this chapter have assisted with further defining the workplace energy culture framework.

It is important to note that the information for both the Louisville and York energy cultures was obtained from focus groups. The option to speak to other employees and conduct surveys on the sites was not available. Consequently the individual element of the workplace energy culture framework was not the focus of discussion.

Readers' note: To protect the identity of focus group participants, when presenting extracts different participants are identified as R1, R2, R3 etc. These labels do not represent each participant in the focus group; they are simply a means to identify different voices in an extract. If only one participant is speaking, they are called R1, but this label does not reflect the same person speaking throughout the session.

8.2 Energy Cultures at an International Scale

The impact of national culture and politics on individual employee behaviours has been highlighted by researchers such as Bock *et al., (*2005). They highlight how different national cultures have an influence on employees' intention to share knowledge. In addition, Chen and Knight (2014) acknowledge the important roles culture, social themes and the organisation can play when applying the theory of planned behaviour (TPB) to examine workplace energy conservation. They argue that differences in their findings, and those of Greaves *et al*., (2013), may be due to cultural variations. This chapter draws on these research findings when exploring the energy cultures of two sites in the US, and in the subsequent comparison to the UK site. The originality of the research is that it explores sites within one organisation, rather than comparing studies or results from different organisations (Chen and Knight, 2014).

The energy cultures of these two sites were explored, first, because BAE categorises them as being predominantly manufacturing, meaning their main use is manufacturing processes with some office tasks, which makes them comparable with Samlesbury. Second, as Chapter 3 explains, the opportunity to conduct focus groups in the US arose from a meeting with TM2, who was aware the researcher was presenting a paper at the International Conference of the Association of American Geographers and suggested conducting research at BAE sites in the US. TM2 put the researcher in contact with members of the SHE function at the York and Louisville sites (Figure 8:2), and focus groups were arranged.

Both sites are located within the Performance and Services (PNS) business of BAE, and are high-energy users, similar to the Samlesbury site. The information provided by the two focus groups gave an indication of how sites in the wider PNS business operate, and allowed a comparison to be made with Samlesbury. In addressing Objective 4, towards the end of this chapter a discussion presents similarities and differences between the energy cultures of the sites. It is important to note that the PNS businesses do not have energy or environment champions on their sites, so the descriptions do not provide details on these aspects of the workplace energy culture framework.

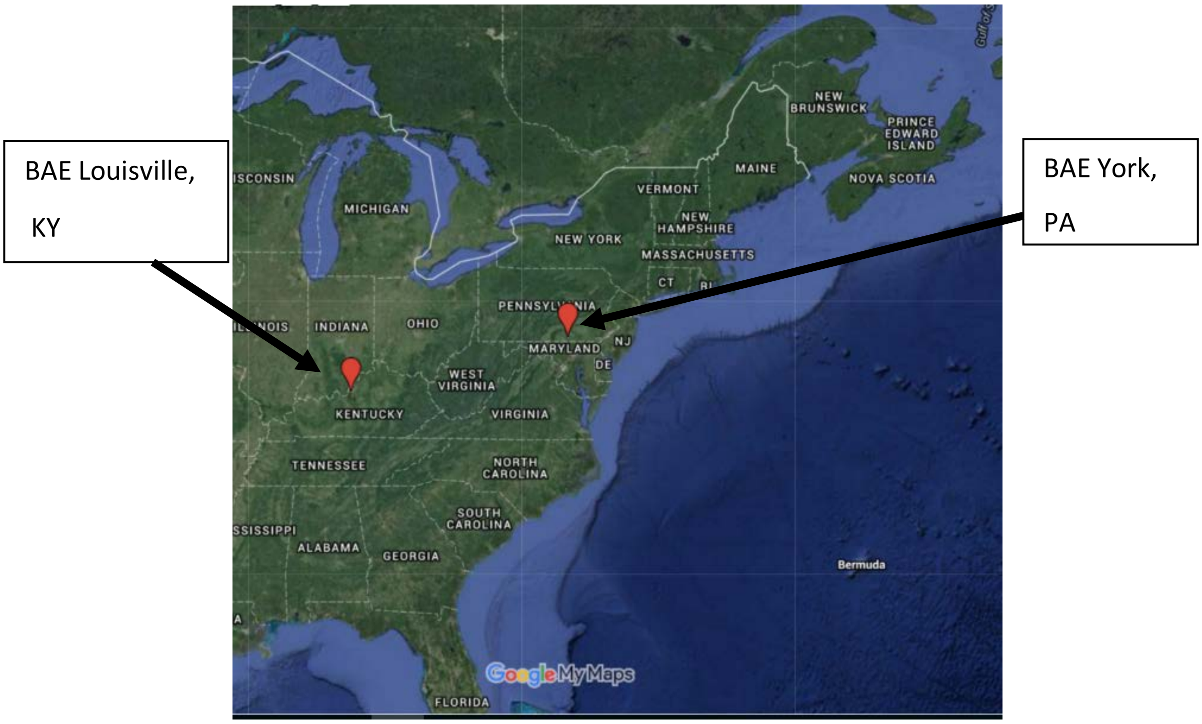


Figure 8:2: Map of the eastern side of the USA showing the locations of the Louisville and York sites

Methodology Overview

The empirical material for this chapter was obtained from two semi-structured focus groups one conducted at Louisville, Kentucky on 17th April 2015 and one at York, Pennsylvania on 28th April

2015. The purpose of the focus groups was to gain an understanding of the energy cultures of both sites and to explore the geography of energy cultures. This was done in two ways:

- Members of the group were presented with two A3 diagrams (Appendices 8 and 9) showing preliminary data analysis of the survey conducted at Samlesbury. One diagram focused on the results from a site perspective, and the other on the differences between manufacturing and office environments. The researcher talked through each of these diagrams, asking participants if they had any comments and whether they thought results would be similar on their site.
- Questions were posed to the group to discuss aspects of the workplace energy culture framework (Appendix 10). During the discussions that followed, the researcher articulated to the group some of the differences and similarities with the Samlesbury site.

Both focus groups lasted for 1–1.5 hours, but had slightly different structures due to how the BAE sites organised the sessions. The York site went through the Samlesbury survey results first, because lunch was provided during the meeting and participants were eating. At the Louisville site the results were discussed towards the end of the session. In addition, a tour of the Louisville site was given by the manager of the site prior to the focus group session.

8.3 Louisville Site Energy Culture

A visualisation of the Louisville energy culture is presented in Figure 8:3. The themes of the energy culture were obtained from the focus group discussions and a tour of the site. Additional themes were explored in the focus group, but as they do not appear to influence site energy use, they do not appear on the visualisation. The blue circles on the outside of the organisational theme indicate influences and drivers outside of the organisation that have a direct impact on organisational processes or the energy culture of the site.

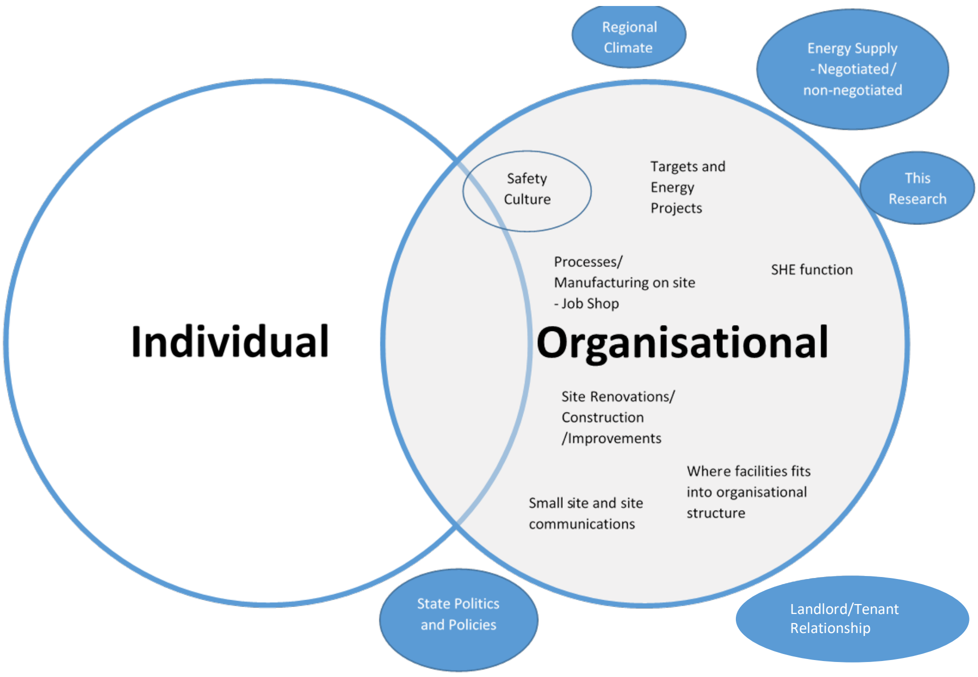


Figure 8:3: Energy culture of the Louisville site

8.3.1 Physical site, Key Features and Energy Infrastructures

The Louisville site is located in the city of Louisville, close to the border with Indiana. The site, with an area of approximately 0.125km^2, is located 7 miles from the centre of Louisville on an industrial estate within the city boundaries (Figure 8:4). Figure 8:5 shows the location of the manufacturing buildings (represented by the letters A, B, C, D, E, Z). During the tour of the site the researcher was shown around buildings A, B and C, and walked around the outside of building D. The researcher also went into building 117, as this building is a high-energy user.

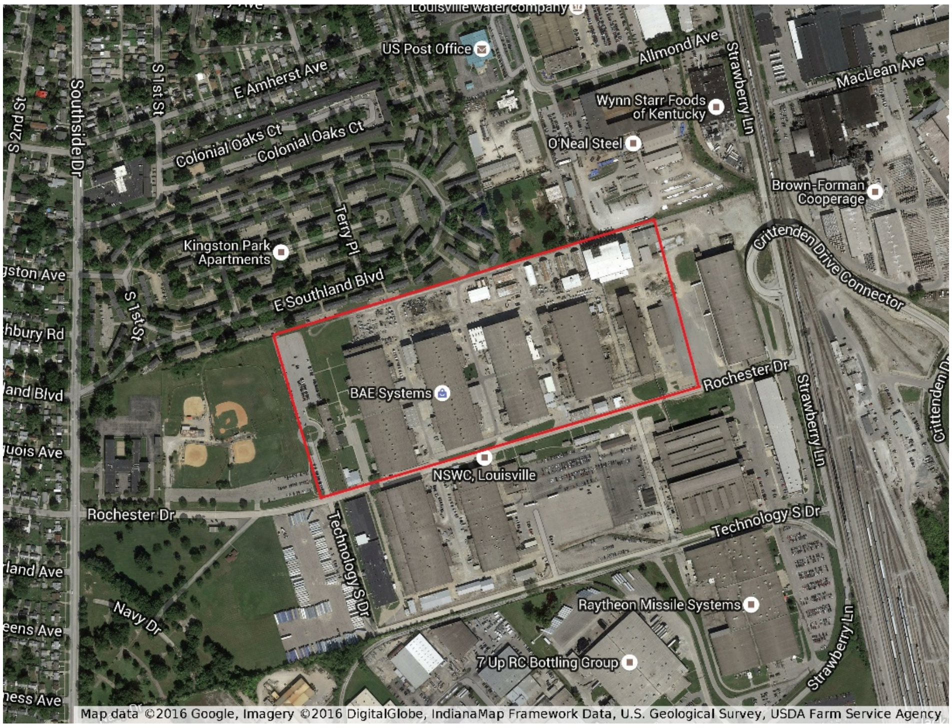


Figure 8:4: Aerial view of the Louisville Site. The Red line shows the approximate boundary of the Louisville site. Imagine obtained from Google Maps, accessed 29th March 2016

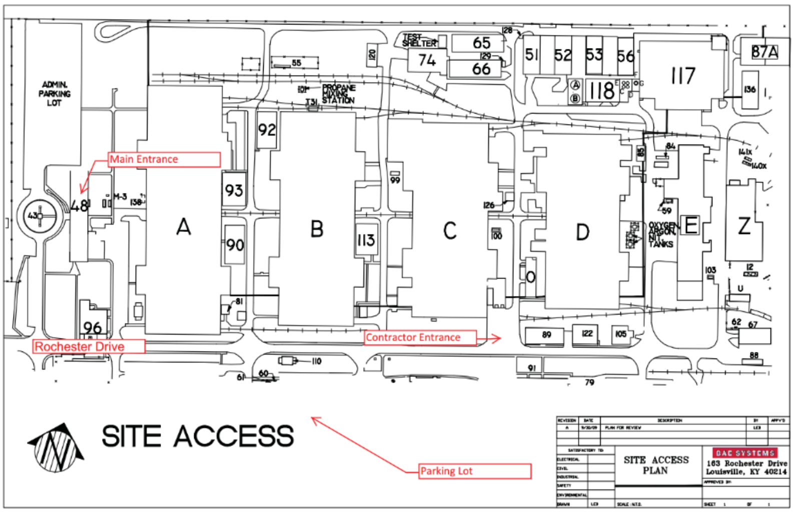


Figure 8:5: Schematic of the Louisville site

Figure obtained from email communications with SHE member. The letters represent the manufacturing buildings. Approximate scale of map: Building A is 200m × 60m

The physical site, as can be seen from Figure 8:4 and Figure 8:5, is much smaller than Samlesbury and York. Another key difference is that it is rented, not BAE owned. This means there is an additional dimension to the energy culture on this site – the landlord. As discussing the tenancy impinged on security issues, the research was not able to explore the landlord–tenant relationship. However, there is a growing body of work exploring how the landlord–tenant relationship can impact energy use, from both domestic and workplace perspectives (Scrase, 2001; Hinnells *et al.*, 2008; Axon *et al.*, 2012; Ástmarsson *et al.*, 2013; Greenough and Tosoratti, 2014; Huebner *et al.*, 2014; Schlomann and Schleich, 2015). It is anticipated that many of the challenges described in the cited research will apply at some scale to this site, for example the challenge of changing site infrastructure, and gaining approval of the landlord. As is explained in Section 8.3.2, the landlord–tenant relationship has also provided the site with some advantages when exploring energy use, for example by having each building sub-metered.

Site Manufacturing Production

This site is predominantly involved in the refurbishment of naval guns, and is one of the most energy-intensive sites in the PNS business. Expanding on this, the focus group explained how their site differs from other sites in the US:

> *'I know our site is unique to other sites in our sector, well at least in the US … we do some things here that requires use [of] a substantial [amount] of energy, and that 'plating' shop [building 117] … is the greatest example … the tanks are tempered … they have to be maintained at a certain temperature, so they are using steam and other sources of energy to sustain that.'*
>
> *Extract 1*

This extract explains one of the reasons why the site is a high energy user, and how the processes conducted on site dictate energy use. The concluding part of the extract highlights that no matter what attempts are made to reduce energy use, the site is still going to be a high energy user due to the need to maintain equipment at a certain temperature.

When providing details of the site, the focus group stated that they were not a 'job shop' or an 'assembly line', which is how they described the Samlesbury and York sites. The group explained that often the site will see up to three different product lines go through the manufacturing areas. This means that the manufacturing employees do not work on the same job on a week-by-week basis. This has important consequences for the energy culture and the energy use of the site, as they will have fluctuating energy use. Both the York and Samlesbury sites are job shops or assembly lines, which means that as long as orders have been received from customers, the site will consume a constant amount of energy due to the repetitive manufacturing process. At the Louisville site, each of the product lines requires a different manufacturing process, which means they have variable processing times, so energy demand will vary. This means energy figures are more challenging to predict compared with those of Samlesbury.

Energy Generation and Supply

> *Interviewer: 'Do you generate your own energy anywhere on site, or is it all from the grid?'*
>
> *R1: 'It's from the grid, it's local.'*
>
> *R2: '… that's almost not true though, we do have emergency generators.'*
>
> *Interviewer: 'So if something goes wrong with the grid, is that when you use the emergency generators?'*
>
> *R2: 'Yes.'*
>
> *Extract 2*

The focus group explained that the site does not generate its own energy, but does have emergency generators as a back-up supply when the grid network goes offline. During the York focus group, it became apparent to the researcher that the electricity grid going offline is a fairly frequent occurrence in the US. The site therefore has emergency generators for safety reasons.

As stated above, the energy for the site is provided by the grid. However, the group discussed how there are differences between the electricity and gas supplies for the site. The site is able to negotiate its gas supply, but the electricity is non-negotiable, and is also subject to a tariff that charges a higher rate for daytime use. The participants explained how their production schedule, and the varying production lines going through the site, limit them to scheduling production to align with the cheaper off-peak prices. The participant describes this as the site not having the 'luxury' in the extract:

> *Interviewer: 'Do you know if you have, in terms of paying for energy, if you have a fixed contract or do you have fluctuating prices?'*
>
> *R1 'Well the national gas is negotiated a year in advance, the rates are. Then the power is based on the electric rates structure, and then depending on the time of day that you use the power it can affect your cost. Generally we don't have the luxury of adjusting our schedules but some industries do, and they look at that … but we are driven more by a pretty rigid production schedule.'*
>
> *Extract 3*

The negotiation of gas prices means the site has the flexibility of a year in which to change any gas-intensive processes prior to any potential financial impact. For example, if the price of gas were to increase suddenly, the site would still be paying the price they negotiated the year before.

8.3.2 Site Energy Monitoring and Shutdown Plans

The description of the energy culture at the Samlesbury site showed how the energy monitoring system evolved over time. The site originally had few substations, limiting the ability to monitor energy at building level; now the site has many substations, enabling energy monitoring of individual buildings, and the use of portable monitors to explore specific machines. During the focus group, the researcher was keen to explore the level of energy monitoring occurring on site, and whether the landlord–tenant relationship affected this monitoring.

> *'What we have done, is with our landlord, each individual building is metered, [and] that's how we pay our bill … [the] energy monitoring system that we installed last year … [has] 4–6 electrical sub-stations … we made the decision … to meter each substation, so that is going to tell us at the 6 points what our usage is, then that could drive it further, you know, sort of one step at a time process … I don't know how this process is going to evolve. If we are going to go further down the line with it … [This] is where we are today, each building has substations metered separately, and it's through software systems where we can see the usage and trends.'*
>
> *Extract 4*

This extract highlights that the site's energy monitoring, similar to that of Samlesbury, has evolved in recent years. It explains how the site is now using a software system to monitor energy usage from various substations in each building. It is interesting to note that the participant calls this the first step; however, they are unsure whether this will evolve into further exploration or monitoring of energy use. Using the Samlesbury site as an example, it is likely that this monitoring process will evolve into further monitoring, and the subsequent exploration of changing energy use levels by changing how machines are used. However, as the interacting nexus of items that make up the workplace energy culture framework highlights, energy monitoring is affected by wider influences, such as energy pricing, energy infrastructure subsidies and grants, BAE structure and jobs.

It is also interesting to note the landlord–tenant relationship, highlighted in the above extract. The participant uses the phrase 'what we have done, with our landlord … ', which suggests the landlord is on board with the site in terms of energy monitoring and changing the energy infrastructure. Research by Scrase (2001) and Axon *et al.,* (2012) has highlighted how this can be an issue for some businesses when trying to improve energy infrastructure.

Site Shutdown Plans

The Louisville site undertakes site shutdowns during holiday periods, with one participant describing a process similar to that of Samlesbury:

> *'We have institutional knowledge here, that when we go through the Christmas shutdown … for 2 weeks, we will go through and shutdown compressors, shutdown everything we can to reduce the power draw, machines we are not using … '*
>
> *Extract 5*

Following this description of the shutdown process, another participant provided further details about how energy monitoring might progress in the future.

> *'I think what we are kinda go[ing] towards, with what I was talking about with this energy monitoring … [is] trying to identify some of these [energy] trends, and then maybe try looking at what we do at the substations, it's using quite a lot of energy right now, can we do something differently over there, so I anticipate this being evolution.'*
>
> *Extract 6*

Similar to the previous section, this participant is giving a further indication that they think energy monitoring might be the first step in an evolutionary process. As described in Chapter 7, Samlesbury initially started energy monitoring from various substations on site, which then evolved to energy monitoring of buildings and more recently to energy monitoring of individual machines. This process led to behavioural changes, with changing use of machines and equipment.

8.3.3 Energy Reduction Interventions on Site

The focus group did not provide any specific details on energy projects, but it became apparent during the session that energy reduction was what they described as a by-product of conducting other projects. When exploring renovation, construction or site improvements projects, the SHE function would determine if there were opportunities for reducing site energy use. Reducing energy use was not the priority of the project; rather, it was a by-product. All the projects that the group mentioned had a technical or engineering focus based on changing equipment or the physical environment on site. The following extract provides details of these projects and was in response to a question which asked what the site does to reduce energy. The participants provide examples of projects such as introducing new machinery, transitioning to LED lighting, tinting of windows and utilising more natural light:

> *'We look at, well there are two different sides, if you look at the facilities side and then the side that [Participants 1 and 2] look at, [they] look at every project that we do with an energy conservation lens. Like if we are putting in VFD drivers, for start-up of the machines, to reduce start-up and voltage surges. Building renovations, we look at things we can do like LED lighting, tinting windows, utilizing ambient lighting where we can, it's more of a by-product of the projects we do …'*
>
> *'We are undergoing this, another reorganisation, from my side (facilities), when … we became BAE Systems, the facilities group was under operations, and managed to circulate in sort of localised [with] how things ran, and then we created the facilities group, [where they have] head of facilities … and we had facilities-wide programmes, and we were trying to look at some of these energy conservation measures, and safety from a national stand point. Now they are reorganising again, [with] facilities going back under operations and they are splitting the sites back up again, so we [will] see how the results of that will be.'*
>
> *Extract 7*

The second part of the extract highlights how this employee has been based in the business for a while, since the merger with BAE Systems in 2005, and has witnessed many restructuring processes where the facilities group has been placed in the wider organisation structure of BAE Systems. The participant does not go into detail about the impact this has had on the work they conduct, but does provide details on how the previous restructuring of the facilities group led to energy projects being looked at across sites in the business. This suggests that the facilities group based on site will liaise with other groups across the business on projects, when previously projects would be site specific.

This discussion highlights how the workplace energy culture framework and the nexus of activities and influences that define it can be analysed in different spaces and at different times. The restructuring of the facilities group would have changed the energy culture on site, with the focus changing from one where the team undertakes site-specific activities, to one where the tasks they conduct are driven by objectives set by those in charge of directing the facilities teams across various sites. This demonstrates a change in organisational structure of the facilities teams from local to more regional/national (business-wide), then, as the above extract suggests, the current restructuring is returning the facilities function back to the local level.

It is also interesting to note that in the above extract, R1 mentioned 'safety'. This begins to demonstrate that the safety culture described in Chapter 6 is not just a dominant culture at site level, but is a culture on a global scale, throughout the business. This reference to the safety culture on site is the reason for including a safety circle in Figure 8:3, which crosses over the organisational and into the individual circles of the energy culture.

Energy Targets

The site is subject to energy targets, with one of the participants stating that they think the current target is for a 3% reduction:

> *'PNS are always looking at energy reduction, I believe our target is like 3% right now, if I remember correctly … you [need] to look at a site, how I think, from a stand point. We were broken up from a facilities stand point [Participant 3] looks at projects that touch on … more environmental, and more on electricity. Then from a SHE departments we're probably looking at the flip side of, ok what are we doing and how can [we] minimise things like waste streams, and other avenues associated with projects that are going on.'*
>
> *Extract 8*

The above extract, along with Extract 7, demonstrates how site energy use is explored from two perspectives: facilities and SHE. This is similar to what the researcher observed at the Samlesbury site. However, from the extract it appears that these two teams work independently, which is in contrast to what was observed at Samlesbury, where frequent reference was made to the two teams working closely together, for example, the interview with TM2 and TM3, their work interaction and interest in the research, and frequent references to both teams in the survey and the manufacturing focus group.

The Louisville site appears to experience challenges with setting energy targets. The interview with TM2 and TM3 highlighted how the Samlesbury site changed from aiming to meet targets due to the variable nature of manufacturing jobs. However, it appears that the Louisville site is still subject to percentage reduction targets, even though the site processes are constantly changing.

> *' Energy reduction targets [are] one of the things that challenges us … since 2011 we have brought manufacturing in from … Minneapolis, [and] other sites, so … basically in the last four years we've brought a hundred thousand square feet of … production space, and bought air conditioning in for environmental control, that's a big energy cost, but it's a requirement of the programme.'*
>
> *Extract 9*

The participants further highlight the challenges of setting targets on a site that is changing by explaining how they have recently started looking at energy:

> *'Yes we look at percentage reduction, but what we kinda shifted on is what we call environmental projects or sustainability projects on factors like moving manufacturing processes and stuff like that. They may force an increase in energy that we can't do a whole lot about, we [have] taken a different approach by saying … how can we focus on reducing energy use on that particular project, versus a more this year as a site across the board we are going to reduce [energy] by about 1% or 2%.'*
>
> *Extract 10*

This extract highlights that the site, in addition to the reduction targets, is currently taking different approaches to reducing energy use by focusing on projects. It is applying an environmental or sustainability lens to the manufacturing processes undertaken on site and asking the question 'how can they reduce energy?' This suggests an evolution of the processes dictating energy use on site from one driven by energy targets, to one where employees are now asking energy-related questions when undertaking projects. The research does acknowledge that the extract does not specifically state whether questions of 'how can they reduce energy' had previously occurred on projects, but the participant does use the phrase 'we [have] taken a different approach', which suggests that this is different to what was previously done on site.

Role of SHE Function

Extracts 9 and 10 highlighted how the SHE function is involved in exploring energy reduction interventions on site, in a similar way to how it operates at Samlesbury. It can also be noted from Extracts 8 and 9, similar to the Samlesbury site, that the site energy culture has a strong connection with wider sustainability processes and projects, through the SHE function. The participant talks about 'minimis[ing] things like waste streams' (Extract 8) when providing examples of what the SHE function does. The question posed to the participants specifically asked about energy use, but the extract demonstrates how energy and sustainability topics are closely linked.

Energy Campaigns and Other Interventions

In addition to the energy targets, the researcher was interested in exploring whether the site had implemented any other campaigns in recent years. Keeping the question broad, the researcher asked whether there were any interventions focusing on sustainability topics and employees. One of the aims of this question was to explore the more individual aspects of the site energy culture and draw the group's attention to the employees rather than the facilities, which had dominated the focus group up to this point. The researcher used the term 'sustainability' because the group had previously mentioned waste reduction techniques, and they had also used terminology of a 'sustainability movement' rather than an energy movement. The group could not describe any energy specific campaigns (Table 8.1).

The participants did, however, provide some examples of waste-reduction campaigns on site:

> *'I think flipping [it] a little into more segregation of waste, recycling and reusing of commodities, we are continuing [to] campaign every couple of months. We have taken efforts in the last couple of years to increase our recycling bins, probably an increase of around 300–400%, we've had multiple initiatives to encourage people to recycle, everything from verbal communications, to putting training materials [together], we are continually sending out communications which talk about the impacts of trying to segregate waste and waste minimisation.'*
>
> *Extract 11*

Later in the focus group, the participants also highlighted how they do not tend to focus on energy-reduction campaigns on site.

> *R1: 'Specifically on electricity um, based on what I'm thinking electrical sustainability, I can't [think of anything] there is not one that pops to mind. No … '*
>
> *R2: 'I don't think we have done anything specifically on the energy side.'*
>
> *Extract 12*

Extracts 11 and 12 suggest that energy is not a priority for the site SHE and facilities teams. As previously stated in Extract 7, energy reduction appears to be a by-product of other activities and projects on site, such as refurbishment. However, the extracts do suggest that the site does focus on the broader sustainability activities of reusing and recycling materials. During the focus group, participants gave specific details about waste sustainability on site, describing the process they go through with weighing hazardous, non-hazardous and recycling materials, while also detailing how they were aware of their quarterly and annual tonnages of waste. This weighing of waste, similar to processes conducted at Samlesbury, appears to be driven by waste-reduction targets of 3% for the site.

Enthusiasm of Staff

Time restrictions and limitations on access to the site prevented the research from exploring whether key individuals had a similar impact on energy use at the Louisville site to that at Samlesbury. However, the extracts above, and comments from other participants in the focus group, showed there are employees who are enthusiastic about energy topics. Taking the Samlesbury site as an example, Chapter 7 highlighted how key individuals were seen to impact recycling rates in their work area. Consequently, the enthusiasm of staff might be an avenue to target to change energy cultures.

8.3.4 Site Energy Priority and Energy Drivers

The previous section indicated that energy targets appear to be one of the drivers for energy reduction on site. The research was interested in further exploring the drivers of energy use at Louisville, and asked participants where they saw energy among the site's priorities. During the question, the researcher explained how she had noted the dominant safety culture within BAE, which appeared to be a focal point for the Samlesbury site, with the Think Safety First campaign. The focus group decided to go around the table and answer the question individually, rather than having a more fluid discussion. These extracts are presented in Table 8:1, where each row represents a different responses. To assist with navigation, some key themes of each extract are presented in the third column.

Table 8:1: Focus group extracts from participants answering questions aimed at exploring site energy priorities and the drivers of energy reduction

Participant (P)	Response	Key themes
1-a	*I think energy is a driver, it's a [pause] it tends to be a driver financially, it's one of the things I've pursued in continuing education, solar, wind, energy, geothermal, and these types of things, and everything has a cost with it. And it's the payback there, it is conserving energy [as a] goal, but if you have to spend $1 million dollars to save $500,000, it doesn't make sense. So everything has to be looked at through a lens of a payback period I would think, along with the environmental impacts. So sometimes those things can work against each other, and can be beneficial from an environmental perspective but the company is going to spend money doing it … if you can get incentives during that, you can offset that cost, there is starting to be more of that in the US.*	• Energy and finance • Payback period • Balance between environment and finance

Table 8:1 (Continued): *Focus group extracts from participants answering questions aimed at exploring site energy priorities and the drivers of energy reduction*

2	*I could definitely see how more incentives and the ability to negotiate would prove more beneficial … and give a person more willingness to move forward. I think from … I can't say a site perspective, but from my experience of working with other industries in the US including BAE, is that if you look at energy usage and you look at occupational safety, occupational safety tends to be more at the front as it's something you visually see, whereas if I am an employee and I just don't turn off the light switch and I just leave, it is not a direct impact. If I am that same employee and I cut my finger today, and I'm not able to perform my job function there are all those other associated impacts … And so from that lens of looking at it from a cultural standpoint, occupational and safety is probably … focused on a little bit higher than than electrical and that sustainability side.*	• Energy use is invisible, low impact • Occupation health and safety are visible and high consequence
3 (worked at BAE for a month)	*So I agree with P1 … I can't speak on BAE terms, but I do know that there are not a lot of tax benefits in the State of Kentucky for you to invest in wind energy, actually in a lot of times … when you do invest in solar energy in this state it will cost way more than … you are going to save, so it costs more to install, the cost, you don't get any tax breaks, tax benefits, tax incentives, anything like that so I think it's not that BAE doesn't want to progress as far as sustainability goes, it's like the state that we are in, is not willing to process, so that's my take on it.*	• Payback period • USA state system • State priorities
4	*So I guess I agree with what P2 said. I don't think in general that SHE gets put to the side as far as priorities. I think we've had a lot of support on anything that we see as a high priority … but I think the primary focus on the priorities is kinda what P2 said, more risk based. So the sustainability, there is no risk factor, so the focus probably does tend to be safety, health and environment, and then sustainability as a lower priority. And I don't think that that's strictly BAE, I would say that that's more of a culture nationwide, the sustainability movement is kicking in and going stronger now, but it is probably an added duty onto compliance and workplace safety … So how thin can you spread the people who are handling, obviously with our site we don't have 10 or 12 people handling the same type of issues, so more priority based I guess rather than looking at sustainability as a payback.*	• Site priorities: safety, health, environment then sustainability • Nationwide culture does not have a strong sustainability movement • Staff allocation to sustainability
1-b	*You know if you look at sustainability … it's also very geographical in nature, if you look at where we are, in a pretty temperate environment we don't really have very bad winters or summers, our solar days are umm can you get a pay back on solar cells? It's not like we are out west where the sun is blazing all week. We have cheap energy with our local utility, actually pretty much the cheapest in the country. So all those things can conspire against you to make a business case, could be different [at a different site].*	• Cheap energy in Kentucky • State and geographical influence and interaction with energy infrastructures

Note: The right-hand column highlights the key themes of each extract. P1-b is the same participant as P1-a but they decided to comment again.

Legislation and Policy – Regional and National

The responses in Table 8:1 provide some interesting findings for addressing Objectives 1 and 4 of the research. P1-b and P3 demonstrate how the wider state legislation and energy costs can heavily influence the payback period of any energy infrastructure. They also suggest that the state dictates the energy costs that the site is subject to, which are currently low. These findings, as highlighted by P1-b, suggest that developing a business case for energy generation on site is difficult when it does not experience high energy costs. This is in contrast to the energy culture of the Samlesbury site, where energy infrastructures appear to be partially driven by rising energy costs. This builds on the workplace energy culture framework, by highlighting a need to think about regional politics and policies.

This geographically defined effect of legislation also prompted a discussion around Objective 4 of the research, which explores how energy cultures change with geography. The extracts from P3, P4 and P1-b (Table 8:1) demonstrate differences between the UK and the US in terms of energy policies, energy costs and the 'sustainability movement'. The comments by P3 and P1-b also indicate that policies and energy costs vary between states. This further demonstrates how the energy culture of a site can change with different geographies, and also how the nexus of influences on both the individual and the organisational themes of the framework can be explored at different scales.

Focusing on the individual, the energy culture of the individual is heavily influenced by what is going on in their immediate surroundings at home (Stephenson *et al.,* 2010). The comment from P3 about the sustainability movement suggests that recycling, energy and sustainability are not as important topics in the US compared to the UK. The lack of attention to recycling or reduction of waste was also noted by the researcher on the trip to the US, where breakfast was often served on a variety of plastic and paper plates, with no segregation of waste streams. The comments by P3 imply that wider national policies and government could heavily influence individual behaviours, demonstrating the influences are not just local, but also national, and potentially global. Focusing on the organisational element of the workplace energy culture framework, state policies are directly influencing energy costs for the site. However, this could also be considered at a national scale, where the government could subsequently change energy policy.

Impact of Site Geography

The comments by P3 and P1-b also highlight how the varying geographical locations of sites can influence business cases for energy infrastructure, for example the comparison of locations in the US for solar farms, which will fundamentally influence the energy culture of the site. Within the UK these discussions may not occur in the MAI business, because of the lower diversity of the UK climate. However, the USA has a varying climate across all the states, with extremes of temperatures witnessed across the country. When making business cases and discussing feasibility, the PNS business will compare sites to determine where to locate any future installations or improvements in order to reap the greatest benefit.

Home and Workplace

P2 makes an interesting comment about the occupational health and safety aspects of the site. The participant highlights how occupational health and safety has a much larger impact on individual work and home lifestyles, while energy topics are perceived as fairly low consequence on site, due to the inability to visualise energy. This echoes research by Hargreaves *et al.,* (2010), which states that there is a need to 'make energy visible', and the following comment from TM1 during Chapter 6 feedback:

> *'I wonder whether the ability to connect to the impact of poor safety as potentially an immediate risk to human life makes people generally more engaged than all energy or environmental risk.'*
>
> *Extract 13*

This extract, and the research by Hargreaves *et al., (*2010), illustrates the difference between safety and energy on site. Safety and the consequences of unsafe behaviour can have an immediate impact on individuals and their lifestyles. However, as energy is often invisible, undertaking non-energy-efficient behaviours has low consequence for the individual. Further discussion of this difference between safety and energy is provided in Chapter 9.

8.3.5 Site Communication

As one of the notable points in describing the energy culture in Chapter 7 was communication, the research was interested in exploring whether communication methods were similar at the US sites. The group were asked how they communicate with the manufacturing employees. The researcher said she had noted at the Samlesbury site that as manufacturing employees were often not required to use computers as part of their day-to-day tasks, and so may not check emails regularly, chain communication methods were implemented. The researcher asked the group if this was similar for the Louisville site:

> *'Fairly similar here, we have multi tracks of communication here from what they call senior leadership team meetings, where core individuals get together [and] have a meeting and that information is then passed down. There is a percentage of shop-floor staff that have email, and within that group a lot of them have designated … team leaders or leaders for those work cells … and often … information is communicated through them.'*
>
> *Extract 14*

In addition to these communication channels, the researcher observed during a site tour that there were television screens in the manufacturing areas. The focus group stated that messages were put on the television screens in a slideshow format, so there were continually repeated. In addition to these screens, one of the SHE participants stated that:

> *'If we're looking to ask a question about a particular machine starting up or shutting, we're out there on the shop floor. [The site is] not large [so] we can do that, we have fewer employees so it makes it more possible.'*
>
> *Extract 15*

In Extract 15, the employee is describing how the size of the site and the smaller number of employees (compared with Samlesbury) allow the teams to move around and question employees easily. This will have a significant impact on the energy culture of the site: messages are not require to be transferred from SHE, to supervisor, to employee, but instead they can be transferred directly from the SHE function to the employee.

8.3.6 Discussion of Survey Results

During the second part of the focus group, the researcher fed back the results from preliminary analysis of the survey to the group. The purpose of this was to determine if the group thought the same would apply to the Louisville site, and to assist with determining whether there were differences between the two sites. These discussions highlighted some further similarities between the two sites:

- *Key individuals*: when providing initial results about some differences between office and manufacturing groups (Appendix 9), the focus group provided details of how one employee used to drive energy use in office areas by approaching people who had left lights on. This sparked a further discussion with the group, where they talked about differences between manufacturing and office environments.

- *Office vs manufacturing areas*: one participant commented, *'office areas are easier to understand … the production areas are different … the lights in the bay, there are 100 people working out there, half of those probably don't even know where the light switches are because they are on when they come in*'. Providing further details on this, the participant continued by stating how he thinks people in the production environment would have an opinion of, '*I'm not going to turn the lights off when I walk out because somebody somewhere surely is working out there'.* This extract is similar to the discussion in Section 7.2.3, where the nature of the physical manufacturing environment limited the ability to see whether people were still working in an area.

In addition to these comments, the group suggested that if the survey was conducted on their site, they would expect a similar response rate:

> *R1: 'I think if we did the survey here, I think we would see a similar percentage of response here.'*
>
> *Extract 16*

Expanding on this comment, the group were interested in exploring how the researcher had conducted surveys in the manufacturing areas. Upon hearing about the challenges of getting completed surveys from the manufacturing area, and hearing the method the researcher applied, the group laughed and joked about how they thought that would be the only way to get surveys completed in their manufacturing areas.

Some of the concluding focus group comments suggested that the discussion around the preliminary survey results may change the energy culture of the site:

> *'It was very very fascinating, it kinda gives me an insight into things that you have [seen] actually done … that would be beneficial to our site … particularly when we start getting the data back as part of this new system.'*
>
> *Extract 17*

8.3.7 Evolutionary Nature of Energy Culture

One of the concluding comments of the focus group was about the political policies that the site has to conform with. Here the participant uses the term 'code' to refer to various building standards and policies implemented by Kentucky.

'Whether you like it or not, we are naturally going to be dragged into it, with energy coming from natural resources, so a lot of this stuff is becoming codified over here, so we are under Kentucky building code … and we are under the energy conservation code which covers everything, so we renovate this building you are sitting in, about 7 years ago, and it had to go under a sort of comms check … that's why we've got the automated light switches, it's a requirement … that didn't exist 10 years ago.'

Extract 18

This extract highlights how the changing policies of Kentucky may force the site to change some of its processes or procedures. Consequently, you can see how Kentucky policies could be drivers for potential energy efficiency technologies on site. This echoes some of the findings from Chapter 6, which highlighted how the ISO standards appeared to be driving some of the energy-saving behaviours now implemented on site.

The extract also highlights how these policies are changing in Kentucky. The participant specifically recalls how these were not in place ten years ago. This shows that even without focusing on the organisational and individual aspects of the energy culture framework, there are other influences that affect how energy is being used in the workplace, in this case the state policies the business has to comply with. It also shows that with changes in time, the energy culture of the site will change.

8.3.8 Louisville Site Overview

The Louisville energy culture has many similarities with that of Samlesbury, both sites being energy intensive and primarily manufacturing sites. In addition, they both have substation energy monitoring, which allows energy usage figures for each building to be determined. They also both have holiday shutdown plans. The focus group discussions also demonstrated how the site has a similar structure to the Samlesbury site, with a SHE function and a facilities team that are responsible for monitoring site energy use. However, the focus group also demonstrated some distinct differences between the sites. The Louisville site is currently not seeking to develop the energy monitoring techniques employed. Currently, monitoring is to building substation level and the site has no portable monitoring equipment for individual machines. Nor does the site have any initiatives aimed at targeting energy-efficiency improvements. This is in contrast to Samlesbury, which has run many information campaigns, such as the painting of external floors and poster campaigns. The Louisville site is much smaller than Samlesbury. This has a positive effect on chain communications, with the SHE function being able to speak to staff with ease of accessibility.

Along with the similarities and differences between the Louisville and Samlesbury site energy cultures, the focus group discussions provided details of the determinants that can influence the organisational element of the workplace energy culture framework. These include the landlord–tenant relationship, which can impact infrastructure developments, with the site having to work with the landlord before commencing any major projects. This can be seen in the energy monitoring developments on site. Other determinants of the organisational influence on site energy culture are state politics and regional climate. These are discussed in greater detail in the conclusion of this chapter, along with the impact of the research on potential site energy culture.

8.4 York Site Energy Culture

This section now describes the energy culture of the York site (Figure 8:6). The themes were identified from focus group discussion. During this session the group made many references to the wider PNS business; consequently, this section provides details on the wider business energy culture. The experience of conducting the focus group at York was very different to site visits to Louisville and Samlesbury, with the researcher feeling uncomfortable during the session. Site access was not granted to the researcher and the focus group was conducted in a meeting room, which housed some computer server coolers, on the perimeter of the site. No site tour was conducted. The focus group had a very different group dynamic compared with the other sessions. The participants were more hesitant in answering some questions, and at numerous points during the session the participants stated they could not answer some questions as they impinged on national security.

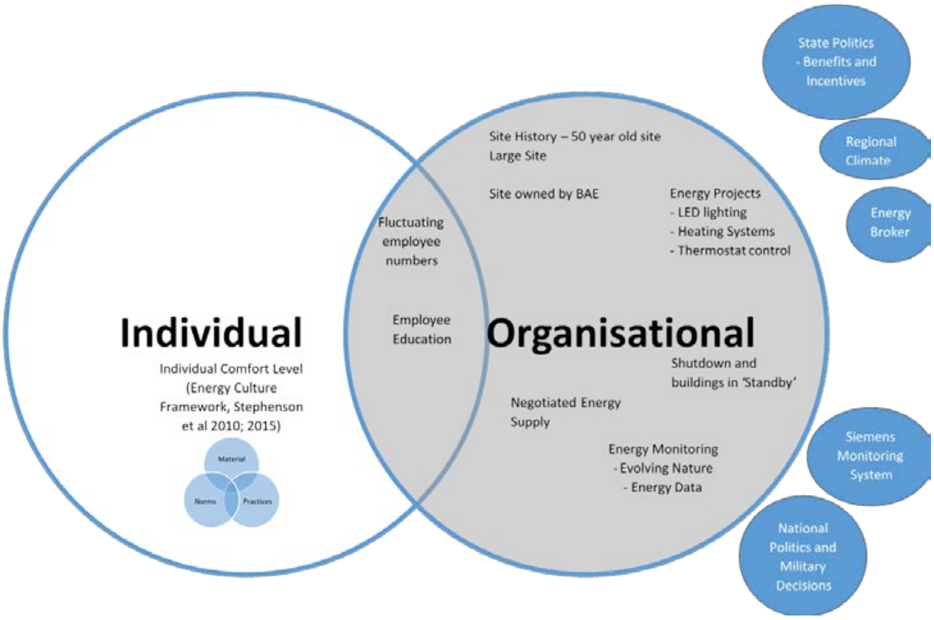


Figure 8:6: Energy culture of the York site

8.4.1 Physical Site, Key Features and Energy Infrastructures

The York site is located 8.2 miles from the city of York in the state of Pennsylvania. As Figure 8:7 shows, the surrounding area of the site is predominantly rural with a small dwelling to the west and southwest of the site. The site, approximately 0.56 km^2 in size, currently employs around 300 manufacturing employees, and around 600–700 office-based staff. However, as an extract below indicates, this figure does fluctuate.

Figure 8:7: York Site and surroundings. Image obtained from Google Maps, accessed 29th March 2016

This site is much larger than the Louisville site, with many more buildings. Due to the inability to gain a site tour, the ratio of office to manufacturing buildings is unknown. However, there are thought to be more manufacturing buildings than office buildings as BAE categorises this site as 'predominantly manufacturing'. The site is similar in size to the Samlesbury site, is owned by BAE and is over 50 years old, with various construction phases and renovations occurring during its history.

Site Manufacturing Production

The site is involved in the manufacturing of military all-terrain vehicles. During an explanation of what the site manufactures and its size, the group highlighted how the demand for goods changes the employee numbers and shift patterns.

> *'In like 2006–2008, we had the height of like the Gulf war and the Iraq wars, we had about three thousand employees on site, three shifts, twenty four hours a day, seven days a week, and the production lines. Wars have obviously backed away [since] then, now we're down to one shift and [that's] Monday through Friday.'*
>
> *Extract 19*

This is an interesting extract for the workplace energy culture framework, because it highlights how wider national and international politics influence energy use on site. The decision to be involved in wars overseas drove production on site, meaning a greater than threefold increase in the number of employees. This increase in production and employee numbers would have increased energy use at all levels in the business. The change in employee numbers also highlights how the site is very diverse and can have a high turnover of staff, depending on the different contracts the site has for manufacturing. In terms of creating a culture on site, which the employees of the focus group talked about on many occasions, the continually changing employee base is a challenge.

The majority of manufacturing contracts the site receives are through the US army and it does not participate in any commercial work. This is in contrast to the Samlesbury site, which manufactures equipment for overseas customers (e.g. Saudi Arabia and the USA).

Energy Generation and Supply

The focus group explained how the site, like Louisville, does not generate its own energy. During this discussion they also highlighted how none of the sites in the wider PNS business generate energy:

Interviewer: Do you generate your own energy?

R1: Nowhere.

R2: Nowhere in the company.

R3: Nowhere within PNS.

R2: We do have the capabilities … there's still some coal plants over east.

Extract 20

However, it is interesting to note that the group highlights how some sites do have the capabilities to generate energy, with coal plants on the east coast of the USA. The focus group provided further details on these capabilities later in the session:

***R1**: Our California facility can create energy and put it back to the grid through our dinalabs, our dinalab can create and become self-sufficient, put energy back into the grid.*

***R2**: But they're not doing it.*

***R1**: No, because there's no protocol, not doing any testing, we have that capability to go and do that.'*

***R3**: They should but.*

***R2**: We won't.*

Extract 21

This shows how the PNS business of BAE has the potential to generate energy. However, as the above extracts suggest, the PNS business does not utilise this capability, and – as discussed below in Extract 22 – there appears to be no financial incentive or business benefit to make generating energy a viable business decision

Similar to the Louisville site, the focus group provided some details on the reasons for not pursuing energy generation developments. All these comments relate to financial payback or lack of incentives.

R1: There's still no financial payback.

R2: Payback's like ten, eleven years.

R1: We just did one, we just approved one for Sweden, it's still a six year payback, [here we] can't get it down to be viable, we looked at …

R1: There's only five states in the United States that offer incentives to go the green installations.

R1: … renewable energy just doesn't make sense in America right now.

Extract 22

This demonstrates a very different energy culture for the site, compared with Samlesbury. It shows how the site and the wider American PNS business are not seeking to explore renewable or alternative methods of energy generation. The group highlighted that there are some sites with the ability to generate energy, but they have chosen not to run these processes.

Energy Supply

Similar to Louisville, the site uses grid energy, but is able to negotiate both gas and electricity supplies for the site.

> ***Interviewer****: Do you have any sort of fixed contracts [for energy], or do you pay fluctuating prices?*
>
> ***R1****: It depends on [the state]. In the US you have what's called regulated and deregulated states, in the states [which are] deregulated, we have the option to purchase in … the energy. We have a corporate agreement.... there's only a couple of sites within PNS to, that we actually hedge, the York site is one … currently right now we are 80% hedged on our natural gas and 40% on our electricity.*
>
> ***R2****: Who negotiated? Is it us or the broker?*
>
> ***R1****: We use a broker and we're part of it as a team, so [a colleague] up in ES is the lead, I'm second, for signing the contracts, [we conducted] analysis, we do the Monte Carlo simulations.*
>
> ***R1****: Yeah.*
>
> ***R2****: And we go through trigger points, so we have two [simulation] paths over on [a] trigger for hedging … if we start to see any rises.*
>
> *Extract 23*

The participants use the terms 'hedging' to describe how the site agrees a fixed or capped cost for energy use with the supplier. The 'Monte Carlo simulation' is a process of running a computerised simulation to assist with determining the probability of energy costs and energy supply for the site.

The above extracts have important implications for the energy cultures on site. First, as the site is able to negotiate energy prices for both electricity and gas, it means it will not be affected by energy price fluctuations or any immediate rising energy prices. As noted from the focus group at the Lousiville site, and by Statista (2016), US energy prices are fairly low compared to the UK. The discussion of the energy culture of Samlesbury suggested on several occasions that financial costs associated with energy have driven changes in energy usage on site. Second, the extracts above highlight how the site uses a broker to assist with the negotiations on energy prices. As

Stephenson *et. al.* (2010, 2015) say, it is important to consider the external influences on energy culture, which can subsequently dictate and drive energy usage on site. This chapter has already described how government and state regulations can influence, through incentives or lack of incentives, whether businesses decided to install energy infrastructures such as solar and wind power. The broker works on behalf of BAE to negotiate energy prices, but they may have their own energy culture, priorities and organisational structure, which may affect the energy culture of the site. This adds another dimension to the energy culture of the site, where external businesses, with their own energy cultures, interact with the existing culture of BAE and the site. In the York energy culture this is demonstrated by the external business bubbles, which overlap the BAE culture and the wider space elements.

The last thing to note from the above extract is the dialogue between participants. It shows that members of the group are being educated about site and wider PNS energy use. All the members of the group were in some way involved with site energy usage, but, as the extract suggests, not all participants were aware of their energy supply. This finding does not appear to have a direct influence on energy usage but it does demonstrate that the energy supply does not appear to be a driver for energy use on site. If this was the case it would be expected that employees would be aware of changes in energy supply or prices.

8.4.2 Site Energy Monitoring and Shutdown Plans

The energy monitoring system at York is very similar to that at Louisville. Table 8:2 presents the focus group discussion. As this focus group extract is long, the researcher has assigned some key words to the various dialogues. These words assist with further explanation of the focus group key discussions, which follow the table. The table shows how the group start the discussion about the purpose of the monitoring, which is to understand potential savings that could be made on site. Following this, they discuss specific details of the monitoring and what they can observe from the data. Concluding this explanation, they discuss the levels of monitoring they use; currently they only monitor per substation.

Table 8:2: Focus group extract where participants are discussing the energy monitoring systems on site

Participant	Extract	Key summary words
R1	*… part of our monitoring [is] to help [us] understand our savings that we're going to focus at …*	Financial costs Understanding
R2	*… so this site being fifty plus years old, through multiple substations we have no idea of what building uses what, we just do calculations assuming it was, where it was at. We've gone through and we … electronically … monitor by building, where our energy drivers are, to understand it.*	Site history Energy monitoring Understanding
R1	*… and what time of day, so you can literally see when we power up a machine, you can see how, what time, and you can see the spikes, and where the energy consumption is happening.*	Energy monitoring
R2	*… and it gives us the alerts that we need to see, so we can do it over a snapshot or we have ability to log in directly to the system and see it real time, to a four second delay, but it also doesn't [just] worry about measuring the utilities, because it also understands our power factor conditions, which gives into penalty clauses to make sure overall consumption [does not] exceed our load analysis, so we have power, we have power factor, then you have your load consumption, you can't go above a certain spike … we get alerts on those*	Energy monitoring and measurements
R1	*… and monitor degree days and weather aspects as well and....I know when we have an especially cold area.*	Energy monitoring
R3	*… and we eliminated, locked out some doors so people weren't exiting and entering on the cold or the wind side of the building, so actually changed all our forklift drivers away, to maintain the heat in the buildings.*	Changing energy usage
Interviewer	*Is that down to building level or a different level?*	
R1	*Right now it goes down to where our substations are, it serves one to multiple buildings … so it's for us to understand what feeds what … we can take it to the next level but we haven't seen a need to go spend that cost yet, before you start the macro, we worry about getting the micro.*	Financial costs Level of energy monitoring Understanding site energy
Interviewer	*So you're not looking at the moment to go down to maybe portable metering, that you can put on particular machines?*	
R1	*No because the financial savings now are still at the macro level. We need to get it within the building to understand the drivers, we can go off and use another one of our corporate providers to come in and put Bluetooth metering to understand [the different] lines.*	Financial costs Evolving energy monitoring
R2	*Would you say we have a good level of our fixed and variable usage for now?*	Employee education during the focus group
R1	*We're getting better at it, I think we have a real good foundation for that now, where five years [ago] we didn't have a clue.*	Evolving energy monitoring Understanding site energy
R1	*I think we're farther along than we have ever been on understanding where our energy consumption is at this site and so much data has taken a long time for us to, one, change our thinking, changing our culture, and how we attack things, and then we have so much data, how do we digest it?*	Evolving energy monitoring Changing energy usage Evolving energy culture

Key summary words from each participant are provided in the right-hand column

The focus group dialogue in Table 8:2 highlights several key themes from this discussion. First, the monitoring is changing energy use on site, as demonstrated in the example provided by the group, in which monitoring enabled them to see the colder areas inside and outside of the buildings, allowing the site to gain an understanding of how the regional climate affects energy use. The monitoring provided information that assisted with changing site energy usage by preventing employees from using doors on the colder side of the building and changed work practices within the sheds (forklift usage) to work on the other side of the buildings. Second, monitoring appears to be an ongoing, evolving process. Throughout the extracts in Table 8:2, participants not only demonstrate how monitoring is allowing them to gain an understanding of site energy use, but also suggest this is the first step of a process that will evolve into a more micro understanding of energy usage (e.g. looking at individual lines or machinery). More details of this evolving process are provided in Table 8:3.

The extracts in Table 8:2 also demonstrate how energy monitoring is driven or closely linked with financial costs to the business. The decision on what level to take energy monitoring to is driven by financial costs. The last comment is also very interesting: it demonstrates an evolving energy monitoring process but, importantly for the research, the participant specifically talks about changing the culture of the site. This demonstrates how energy monitoring is a vital ingredient in the energy culture nexus of items that influence energy use.

Table 8:3 gives further comments from the group on how energy monitoring is leading to a change in energy use in, while also demonstrating an evolving energy monitoring process.

Table 8:3: Focus group extracts showing how energy monitoring is changing energy use and attitudes towards energy use on site

Participant	**Extract**	**Key summary words**
Interviewer	*I suppose [you're] working out what the trends are? What is normal and what is abnormal?*	Stage one
R1	*Exactly, so that's what we're working through, with understanding the different climates. We did have a couple of, several problems internally when we lost the data, so we're still working through that …*	Stage one Technical issues
Interviewer	*So is that just what you're concentrating on at the moment?*	
R1	*I see the next five years will drive [energy monitoring] to the next levels of the buildings and machines, and understand where our next usages are, once we pinpoint and get the, understanding, how do we reduce from the natural gas that we spend to do steam boiler heat to hot water heat, that has less than two years payback, so driving this cost down, and THEN you start the next, you've got to pay for monitoring, so there's no value in paying for that first.* *It's initial investment to get our heads around, understand where our costs are, and that's again about communicating and educating … but [we] don't understand how far we need to go …*	Stages two and three in energy monitoring Evolving energy monitoring Financial costs
R1	*So we use [energy monitoring data], because the next part is around the culture, when you have, what you call your demand load, the main load, so when no one's here you should be at, probably 30%, 28%, the average of demand when no one's here, that's your fixed cost, we're still high, so now we have to get that [fixed cost] down, so you don't need to do it individually but you take it to each place.*	Stage three in energy monitoring Area specific energy Evolving energy monitoring

To assist with understanding how energy monitoring is evolving with time, key words of stages one, two and three have been assigned to each of the extracts in Table 8:3. Stage one shows how the monitoring is helping the site understand its energy use and its relation to the regional climate. The group proceeded to talk about 'stage two', an evolution of the energy monitoring process, in which they anticipate the site will start to explore the individual buildings and machines. They show how this leads to stage three, which is about communicating, educating, changing culture and exploring the base load of the site, and how they might change this level.

Later in the focus group, one member provided a further example of how energy monitoring is changing energy use:

> *'Thinking about Siemens system [i.e. the site's energy monitoring system], a couple of months ago one of the supervisors … called me and says "we have a pump problem down here". I do? Usually we're the ones that detect we have problems, we get all the maintenance, they picked it up on your Siemens.'*
>
> *Extract 24*

The group provided a further example of how the energy monitoring system informed them of another electrical fault:

> *' The parking lot lights … we had a ground problem there as well, and up on the hill one of the light ballast has a failure … so it goes back to our system and we get immediate texts and alerts.'*
>
> *Extract 25*

These extracts demonstrate how the Siemens system is helping to change energy usage, by alerting members of staff of loss of power in certain areas on site, which suggest equipment faults. The teams are then able to locate the fault and fix it. As extract 24 suggests, the fault was picked up before the employees in the immediate area were aware of a problem.

Energy Monitoring and Site Energy Culture

This discussion about energy monitoring has some important findings for the energy culture of the York site. First, York is in the early stages of changing energy usage, and energy monitoring is helping it to understand site energy use. Second, the site is not as far along with energy monitoring as Samlesbury. It is important to note that during this discussion the participants were very enthusiastic when talking about their ability to monitor energy, and there was what can be described as a sense of pride about the achievement of site-wide energy monitoring. This, along with the extracts in Table 8:2 and Table 8:3, show that monitoring energy is a new process for the site.

The enthusiasm of the participants provides an indication that this is an achievement for the site, and something that they are proud of. It is not known how the energy monitoring will actually evolve; however, what is apparent from these extracts is that it is already becoming a discussion point for staff, meaning they are already becoming more engaged in energy topics. It is not in the realms of the research to explore how energy topics fit into the wider agenda at York, but the site is at the start of what could be described as an evolving energy culture over time. Finally, the energy monitoring system is changing the response to equipment faults on site, which subsequently changes energy use on site. Equipment faults often mean the equipment has abnormal energy use. If these faults are spotted quickly the energy use will be steady and within the normal parameters for the site.

Site Shutdown Plans

The group were asked about whether the site had shutdown plans similar to Samlesbury. They did not provide a clear answer, although they did give details about some issues with shutdown of equipment:

> ***R1**: Well long time versus just overnight or weekends is the first one, I'll talk about demand, if you get into long term, there's still a cultural and technology understanding … it's a belief, I don't want to do that because it's a restart. The same thing we have with our computers, you go to the engineers or you talk to IT [who] don't turn their computers off at night because we need to do software upgrades.*
>
> ***R2**: And they all [don't] turn [their] machines off because you leave the oils to cool, down and you change the volumetric performance of the machine, because when you restart it, then it has to circulate and heat back up before you can use it.*
>
> *Extract 26*

Here the participants are discussing the challenges with some of the manufacturing and office environments on site. In the office environment, people generally do not turn their computers off because of advice from IT about needing to perform upgrades, while in manufacturing there are challenges with turning machines off and the potential change in performance this causes. Such challenges were also reported at Samlesbury, which demonstrates some similarities with the energy cultures of the two sites.

The extracts above also highlight how you can look at shutdowns at various time scales: overnights, weekends or longer term. The group continued the discussion by talking about a building that is in a longer term shutdown:

> ***R1**: We've done blackouts on facilities, like a part of a facility [that] is no longer need[ed in] production, we did it in building ten or twelve a couple of years ago.*
>
> ***R2**: Yeah, we have turned the temperature down to one hold, so the plates don't freeze and [we] turned the lights out. So we've idled areas, we power them down.*
>
> *Extract 27*

The 'standby mode' or 'idled' area is currently not in use but is kept running at what appears to be a minimum energy running cost, to enable the area to be brought back online if required. The group describe how turning all the equipment off would lead to plates freezing, meaning there would be problems or costs involved with using the machines in the future. This is not something that was noted at either Samlesbury or Louisville.

8.4.3 Energy Reduction Interventions on Site

The focus group were asked what approaches they apply to reduce energy use on site. In the following extract the participants discuss both technical and more socially driven approaches. However, they start by talking about the more technical approaches, followed by discussing how they can engineer behaviours (thermostat settings), and finally considering social approaches of energy education:

> ***R1****: [We] do a lot of lighting projects, for converting a lot of our lights to LEDs, we're looking at some heating systems, revise heating systems, update heating systems. We heat all of our factory space, most of [it] with steam blowers or hot water boilers, so we're looking to replace those … that's primarily what we're looking at.*
>
> ***Interviewer****: So more on the facilities side?*
>
> ***R1****: Yeah, and we're trying to implement across the board, thermostat settings but we need some better controls there, because people can still get in and adjust thermostats themselves.*
>
> ***R2****: But we've also put in automated switches.*
>
> ***R1****: We've done a number of employee educations about turning off lights, and turning down things when you're not using them.*
>
> ***R3****: Closing our red doors in factories.*
>
> ***R1****: Closing doors.*
>
> ***R2****: The business approach is to engineer savings out first versus the cultural programme, back to the old saying you can't teach an old dog a new trick, so it's about how we engineering the savings out first.*
>
> *Extract 28*

Similar to the Louisville site, the York participants talk about 'projects'. These are the more technically driven approaches to reducing energy that they are implementing (e.g. changing existing lighting to LED lights and changing heating systems). The focus group highlight how the human element of energy use is challenging, by providing a comment about how the site needs better controls to stop people adjusting thermostats.

When exploring the energy culture, it is clear that the site is attempting to reduce energy usage on various levels. Similar to what was observed at Samlesbury and Louisville, the primary approach at York appears to be to engineer energy reduction, for example through LED lights, with the final participant specifically stating that 'the business approach is to engineer savings out first versus the cultural programme'. This phrase is of particular interest to the research as the participant specifically refers to a cultural approach. The researcher took care not to describe the research as exploring energy cultures. This phrase demonstrates how within BAE, the term 'culture' is used often within the organisation.

The group did not provide any further details on 'employee education', although they did discuss some of the more technical aspects. Similar to Louisville, the York site has an energy monitoring system, which the group described.

Energy Interventions and the Individual

During the discussions, the focus group provided an example of an energy intervention they applied which resulted in some complaints. They make reference to the differences between the home and work environments:

> ***R1****: I don't really think you understand the impact [at work] … where the energy costs go … and it's part of our overhead.*
>
> ***R2****: A perfect example for this site specifically is that at home, I think most people would set their [heating] thermostat to like fifty eight during the winter … we knocked it back here … two years ago, to what fifty eight?.... and we had so many complaints.*
>
> *Extract 29*

These extracts show the important role the individual has in the energy culture on site. The organisation may decide to back an intervention to change energy behaviours, but without the individual being on board, complaints occur. The extract above demonstrates this process: here the employees were not happy with the change in temperature, which led to the facilities team receiving complaints. This example links to the example in the work by Stephenson *et al.,* (2010), in which they found each individual has an expected comfort level. In the workplace setting this could be translated to different individuals (employees) having different expected temperature settings within the workplace, which could affect the energy culture of the area.

Energy Targets

When the group were asked about energy targets they stated that the PNS business decided to move away from energy-based targets and start focusing on projects:

> ***R1**: This year the American business as a whole went away from energy reduction targets to energy projects.*
>
> ***R2**: We still [monitor energy, water and waste] but we don't set targets to them … they weren't sustainable, so the production lines change or energy changed.*
>
> ***R1**: So as a whole … this site went to projects, so we were monitoring LED projects and solar projects and stuff like that.*
>
> *Extract 30*

It is interesting to note the differences in response between York and Louisville. Both sites are within the PNS business, but York highlighted how the business no longer works towards targets, while the Louisville participants said they had to meet a 3% reduction in energy usage alongside the energy projects. It is thought that the York participants were correct, because of the more senior position of the members of the focus group; however, this demonstrates how the staff involved in energy matters on sites within PNS are not aware of what is going on in the wider business. This could provide some indication of where energy fits into the current PNS business. Using the safety culture and its evolution as a comparison, if energy were a top priority for the business this message would be communicated efficiently and effectively throughout the PNS business. However, as demonstrated previously, the Louisville site highlighted how they are working towards a 3% reduction.

8.4.4 Site Communication

Similar to the Louisville site, in order to explore the energy culture of the site in more depth, the researcher was interested in the methods used on site to communicate to employees at all levels in the business.

> ***R1**: … communications … I think it's got a lot better over the [last] couple of years … we communicate what projects we're doing and communicate our usage.*
>
> *I guess to your question about energy production targets, we still communicate the energy use and we, show over year energy, how we're using it.*
>
> ***R2**: … we put that out on a monthly basis with the safety statistics too.*
>
> *Extract 31*

Providing further details on how the site communicates to the different employee groups, the participants state:

> ***R1**: [in] the manufacturing site, we call them safety white boards, and every department has a, at least a weekly safety white board, and that's a set time, set day, so if there is environmental or energy reduction type things that need to be discussed, that's how the manufacturing side gets it, they don't have emails here … but they get [all] information that the office side's going to get, and probably actually more here at York, the manufacturing side gets, I would say more information than the office side does.*
>
> ***R2**: … [the] supervisor gets, we'll send the information to the supervisor and then it's up to the supervisor to kind of disseminate that information out to the manufacturing employees.*
>
> *Extract 32*

The participants describe a very similar method to the one applied at Samlesbury, where employees meet around the SQCDP boards to discuss each of the themes. At the York site, these boards are called safety white boards, and are the main opportunity for manufacturing employees to receive information.

8.4.5 Discussion of Survey Results

At the start of the focus group, the researcher talked through the preliminary survey results obtained from Samlesbury.

Office vs Manufacturing

The participants were told that preliminary results had suggested the manufacturing areas of Samlesbury were more engaged with energy topics as they wanted to know how much energy they used, in real-world terms, and more supervision and guidance on energy topics. Upon hearing this, the participants agreed with the comments and suggested that if the survey was conducted at the York site, they would expect similar results. Expanding on this, one participant said:

> ***R1**: Manufacturing is one of the most measured parts of the business, so the employees are programmed to say 'give me the data, tell me how I influence this' … the office employees are, 'we're creative process, we're the engineer or the finance, this is the environment, we can't really contribute or control it', so I think … that's how we program employees.*
>
> *Extract 33*

This extract provides an interesting commentary about manufacturing employees. The participant is suggesting that BAE 'programs' employees. This reiterates a point raised in Chapter 4, when discussing some of the organisational cultures of BAE, which suggested that BAE had a traditional hierarchical top-down, command and control type structure. The above extract suggests this can also be applied when exploring the energy culture on site.

Relating to this comment, the participants provided further details of how the researcher might find differences between the manufacturing and office environments, if they explored the site's energy use:

> ***R1****: I think our workforce in the factory have a better idea where shut-off [switches] are and so forth, the office don't care, 'off, well I don't know where they are'.*
>
> *They see them [switches] but they just ignore them.*
>
> ***R2****: Because they always think somebody else is in the area they're going to [turn lights off] … that's what they feel, the janitors or guards are supposed to do it.*
>
> *Extract 34*

Expanding on this later in the focus group, another participant provided a specific example of how the manufacturing employees were engaged with energy on site:

> ***R1****: Several months ago up on the hill, one of the guys up there took it upon himself to show me where all the light switches were, and he knew where everything was, like [in] our paint shops, where the fan, the fan cut-offs, they know how to report air leaks, because their compressors are expensive, [it all] gets reported in.*
>
> ***R2****: I think it's fair to say that the office know about what we're trying to do but don't actually take it into their hands to do it, whereas manufacturing may not know everything that we're, all the projects that we're working on, but they will do those simple things like turning lights off.*
>
> *Extract 35*

These two extracts suggest that the manufacturing employees are more engaged with energy topics than the office employees. The last extract is interesting as it compares the attitudes and knowledge of the office and manufacturing staff, suggesting that the office environments may be more aware of what the site is trying to achieve but do not conduct the energy reduction and conservation behaviours that are seen in the manufacturing areas. This suggests that the energy culture on site changes with different groups.

8.4.6 York Site Overview

The York energy culture, similar to that at Louisville, has similarities and differences with the Samlesbury energy culture. The similarities include the ability to monitor energy use at substation level. However, this is at a very different scale to the Samlesbury site. The York site does not have the capability to monitor energy use per building, with substations providing information on areas rather than buildings. Additional similarities include the site being involved in manufacturing processes, which makes it energy intensive. The organisational structure of the site is similar to Samlesbury, with SHE and facilities management teams that examine and explore energy efficiency on site. The site also applies similar communication methods to Samlesbury, by using 'safety' boards as a method of communication with manufacturing employees.

Similar to Louisville, the York focus group provided details on the determinants that influence the organisational element of the workplace energy culture framework. They detailed how site energy prices are determined by an energy broker. The information provided to the site by the broker determines the decisions made on the price of energy, which will have an influence on energy use on site. Additionally, the site energy culture is entwined with the Siemens energy monitoring system. The site gets information about energy use and is able to determine spikes, which helps to identify faults in equipment. This influences energy use of the site. The focus group also identified that national politics have a direct effect on the manufacturing processes on site. If the USA decides to participate in military campaigns, the site will see an increase in production; similarly production reduces when the level of military action declines. This demonstrates further differences between Samlesbury and York, with the York site having buildings in 'standby' mode, where machinery is running at the lowest possible rate to ensure it can be used in the future if required. These differences are related to the different product lines of the manufacturing areas and the difference in customers of the sites. Further information on this is provided in the following section.

8.5 Chapter Conclusion

This chapter provided a description of the energy cultures of the Louisville and York sites. The empirical material presented here revealed the similarities and differences between the energy cultures of Louisville, York and Samlesbury. One noticeable difference is the evolution of the site energy culture. Both Louisville and York are in the early stages of energy monitoring and are still gaining an understanding of how their sites use energy. Currently neither site is using this information to create or drive any human-centred energy-efficiency improvements. This is in contrast to Samlesbury, which uses energy monitoring information to assist in the development of initiatives to improve energy efficiency. The York site mentioned how evolved the UK sites were with energy and environment topics and suggested that in the future they would need to act in a similar way.

This chapter introduced discussions on the determinants of the organisational elements of the workplace energy culture framework, such as state and national politics, military decisions, energy brokers and landlord–tenant relationships. These are 'drivers' that can change the organisational elements of the framework, and the site energy culture. The focus group discussions detailed how each of the determinants influences organisational decisions regarding energy use, which has an impact on the site energy culture. Both the York and Louisville sites explained how low energy prices and a lack of renewable incentives have a direct influence on organisational determinants. These then affect the energy culture through decisions surrounding the level of energy monitoring, investment in renewables and the site's agenda for energy-efficiency programmes.

By exploring the differences between the three sites, this chapter explored the geographies of energy culture at an international scale, and addressed research Objective 4. Bock *et al.,* (2005) highlighted how national culture and the unique characteristics associated with them may influence individual actions surrounding knowledge sharing. The research confirmed that the characteristics of national cultures are entwined with wider political structures and directly influence site energy cultures. This chapter demonstrated this, by showing how national and military decisions directly influence production at the York site. It also showed how state politics and a lack of government incentives for renewable technologies influence energy decisions on site. Furthermore, the Louisville site made connections between the 'sustainability movement' and attitudes of individuals towards energy and the environment. The York site did not mention this, but did say that they regarded the UK as being ahead of the US with respect to energy and environment decisions. This demonstrates some distinct differences between site energy cultures across global BAE sites, with many participants suggesting this is due to wider US cultural beliefs and attitudes towards renewables, which includes a lack of incentives, which impacts payback time. These findings of differences in energy cultures at site level suggest an evolution of the workplace energy culture framework is needed, to acknowledge the variety of spatialities at which energy cultures can be observed. This is discussed in the next chapter.

9 Application of an Energy Culture Approach

This chapter provides an opportunity to reflect on the application of the workplace energy culture framework and the results of the thesis. In doing so, it readdresses research Objective 1:

Define a framework for informing research on energy cultures in the industrial workplace.

At the same time, it demonstrates how the overall research aim has been addressed:

Apply an energy culture approach to examine energy use in an industrial workplace.

9.1 Introduction

The preceding chapters provided empirical material that demonstrates the application of a cultural approach to examine energy use in an industrial workplace. This material was collected from applying the workplace energy culture framework that was presented in Chapter 2. This chapter revisits this framework and discusses its suitability in light of the findings and discussions presented in earlier chapters. Section 3.9 detailed how it was anticipated that during the research process, and in light of research findings, the workplace energy culture framework would evolve. This chapter presents a revised framework, which incorporates the key findings from the research, and suggests how it can be used to assist future research on energy use in an industrial workplace.

This chapter is split into the following sections, which detail an evolution and application of the workplace energy culture framework:

1. *Revisiting the workplace energy culture framework*: this section has three purposes. First, it acts as a reminder as to why a cultural approach was applied to examine energy use. Second, it details how the energy culture framework has evolved throughout the research and highlights some of the key findings, which suggest further modifications of the framework are required. Third, it demonstrates by the use of a figure, and detailed discussion, how the results of the thesis could be incorporated into the energy culture framework of Stephenson *et al.,* (2010, 2015). The associated discussion highlights how the key themes of the research can be categorised into 'characteristics' or 'systemic influences' of a BAE energy culture.

2. *Geographies of energy cultures*: this section discusses the various spatialities at which energy cultures have been observed in the thesis. In doing so, it presents two figures proposing modifications to the energy culture framework (Stephenson *et al.,* (2010, 2015). These evolutions of the framework detail the multi-scalar nature of energy cultures and the various interacting characteristics and systemic influences, across multiple scales.
3. *Energy cultures and time*: following the discussion on spatiality, this section focuses on time. It discusses some of the results of the thesis that suggest energy cultures can change over time.
4. *Methodological findings*: this section discusses the application of the framework in an industrial setting. It identifies some of the methodological challenges associated with the research, and the changes in strategic priorities of both university and business. It argues that these can have significant impact on research time scales.

Why Apply a Cultural Approach?

The literature reviewed in Chapter 2 highlighted how little academic attention has been devoted to exploring energy use in the workplace (Dixon *et al.*, 2015; Andrews and Johnson, 2016). Due to this, research focusing on pro-environmental behaviour was incorporated into the development of the framework for the research. As detailed in Chapter 2, there appeared to be two dominant approaches to pro-environmental behaviour or energy use in the workplace: exploring (a) the individual/agent, incorporating elements of psychological models (e.g. Scherbaum *et al.*, 2008; Zhang *et al.*, 2013, 2014; Chen and Knight, 2014), or (b) themes controlled by or associated with the organisation, and its given structure (e.g. Schleich, 2004; Hasanbeigi *et al.*, 2010; Dixon *et al.*, 2014). In an attempt to find frameworks incorporating both themes (Andrews and Johnson, 2016), social practice theories (SPT) and the work by Tudor *et al.,* (2008), Unsworth *et al.,* (2013) and Ucci *et al.,* (2014) were reviewed. As explained in Chapter 2, these frameworks were deemed inappropriate for exploring influences on energy use in the workplace, and the workplace energy culture framework was developed.

The thesis proposed that applying a cultural approach could provide valuable insights into the influences on energy use that other research had not achieved. The empirical material presented in the thesis built on previous cultural approaches (Lutzenhiser, 1992; Aune, 1998; Stephenson *et al.*, 2010, 2015) by focusing on the workplace, and incorporating both individual and organisational cultural influences. One of the arguments of the thesis is that every workplace has a unique energy culture, built on individual and organisational influences. This argument aligns with Sovacool's third definition of culture, as 'how groups of practitioners or professional groups come to form their own internal culture' (Sovacool, 2014:18–19). More details on this theme are given in Section 9.3.

Culture is a common term used in organisations to define particular groups, activities or assumptions (Barczak *et al.*, 1987; Schein, 1993; Parker and Bradley, 2000; Fine and Hallett, 2014). The research demonstrated through the examination of the safety subculture in Chapter 6 and the focus group discussions (Extract 37, Chapter 4; Extract 10, Chapter 5; Table 8:3) that employees are familiar with the term culture, and it is frequently used in organisations. The thesis argues that this is one of the reasons why a cultural approach to examining energy use in the workplace is beneficial.

9.2 Revisiting the Workplace Energy Culture Framework

Throughout the thesis, the discussions of the energy cultures at the Samlesbury, Louisville and York sites have all been directed by the workplace energy culture framework (originally presented in Chapter 2). This framework has evolved throughout the thesis to include determinants such as organisational culture and subcultures, strategic decision making, investments and redeployment, which were not highlighted in Chapter 2. Additionally, towards the end of Chapter 7, the Samlesbury energy culture visualisation suggested a dotted black line be placed around the framework to acknowledge the various geographies at which energy cultures can be examined. A reminder of this evolved framework is presented in Figure 9:1.

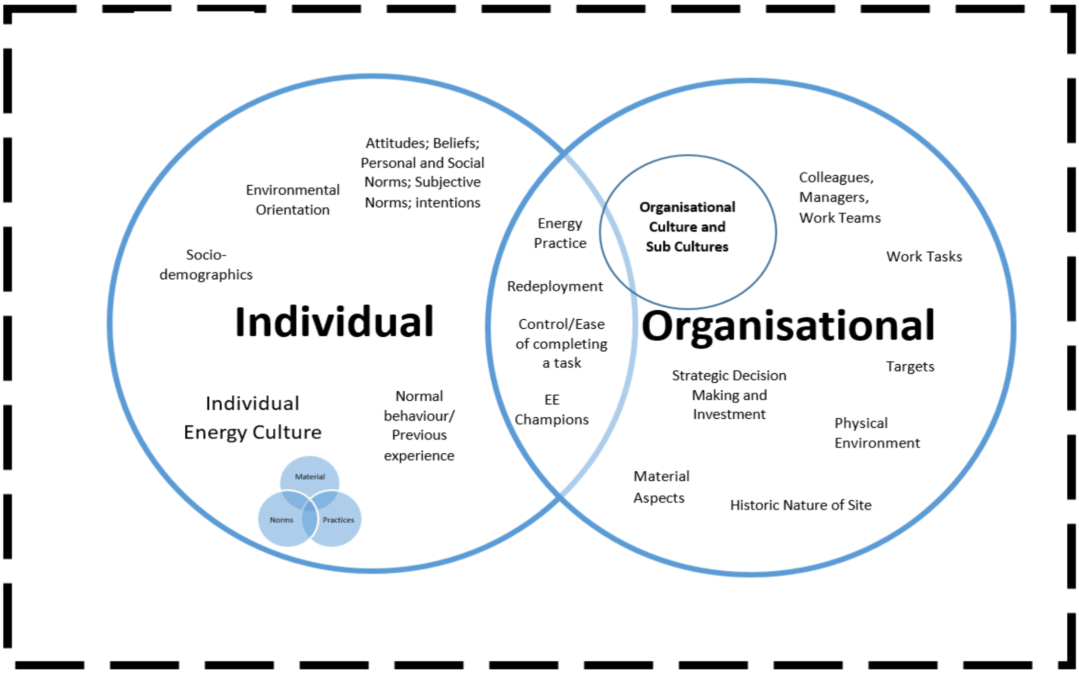


Figure 9:1: Workplace energy culture framework used in the research, with key findings annotated

Originally (Chapter 2), the thesis argued that the individual and organisational elements (Andrews and Johnson, 2016) were not easily identifiable in the original energy culture framework (Stephenson *et al.*, 2010, 2015). However, by reflecting on the results of the thesis and the suitability of the workplace energy culture framework, it has become apparent that the key findings can be incorporated into Stephenson *et al.*'s energy culture framework (2010, 2015) through a series of adaptations. These adaptations are presented in this chapter through a series of figures that talk the reader through:

1. how the results of the thesis can be incorporated into Stephenson *et al*.'s energy culture framework (2010, 2015) (Figure 9:2);
2. how the multi-scalar nature of workplace energy cultures can be incorporated into the energy culture framework (Figure 9:4);
3. how Figure 9:4 can be further developed to demonstrate the interlinking nature of various energy cultures in an organisation, and how it can inform future research (Figure 9:6).

Accompanying each of these figures are detailed discussions explaining the key components of each figure, and some of the key findings of the thesis.

Note: Throughout the thesis the terminology of 'determinant/s' has been used to describe the various influences on the individual and the organisation in the workplace energy culture framework. As this chapter reflects on this framework and seeks to incorporate the findings into the framework developed by Stephenson *et al.*, (2010, 2015), the terminology used by these authors is used here. As is explained, themes previously referred to as 'determinant/s' are referred to as 'characteristic' or 'systemic' influences in a similar way to how Stephenson *et al.,* (2010, 2015) describe their energy culture framework.

The Energy Culture Framework and the Workplace Energy Culture Framework

Stephenson *et al., (*2010) describe how material culture, norms and practices interact together to form the core of the energy culture framework, with each theme having a strong effect on the others. By applying the energy culture framework, one can explain the energy culture being examined by exploring the characterising themes of the material culture, practices, and norms.

Figure 9:2 describes the energy culture of BAE. It demonstrates how the results of the thesis, which were previously categorised as either individual or organisational determinants, can be visualised and incorporated into Stephenson *et al*.'s (2010, 2015) energy culture framework. The black dots represent themes that are specific to the individual, which were previously displayed in the individual theme of the workplace energy culture framework. The grey dots represent themes influenced by the organisation, previously displayed in the organisational theme of the workplace energy culture framework. For the sake of simplicity, a selection of the findings from the Samlesbury, York and Louisville energy cultures are annotated on the figure. Each of the themes in the figure are briefly described in Table 9:1, which lists where in the thesis each theme was discussed previously.

In addition to the themes of material culture, practices and norms, application of the energy culture framework provides opportunity to examine the wider systemic influences on energy behaviour. Stephenson *et al*., describe this as a 'contextual soup' (Stephenson *et al*., 2010:6124) of influences on material culture, practices and norms. They argue that by examining these wider systemic influences, one can highlight areas that fundamentally influence the energy culture, and can be targeted to change it. In Figure 9:2 these wider systemic influences are highlighted by the dashed text boxes. The arrows depict which of the three core energy culture themes they can influence. As many of these themes have not previously been discussed, more detail is provided in the following sections, along with descriptions of how they can influence the energy culture. The next section also draws attention to how many of the systemic influences are interlinked with other influences. For example, strategic decision making and ISO 50001 are interlinked: working towards ISO 50001 accreditation would have been a strategic decision, and being awarded ISO 50001 could influence further strategic decision making on some sites. The following discussions do not represent a finite list of ways in which each systemic influence can change the energy culture of a workplace; they act as examples observed in the research.

In Figure 9:2 the spatiality dimension of the framework was ignored for simplicity of explaining how the findings of the research fit in with the framework of Stephenson *et al. (*2010, 2015). This chapter brings the discussion back to the spatiality dimension through the presentation of Figure 9:4 and the associated discussion.

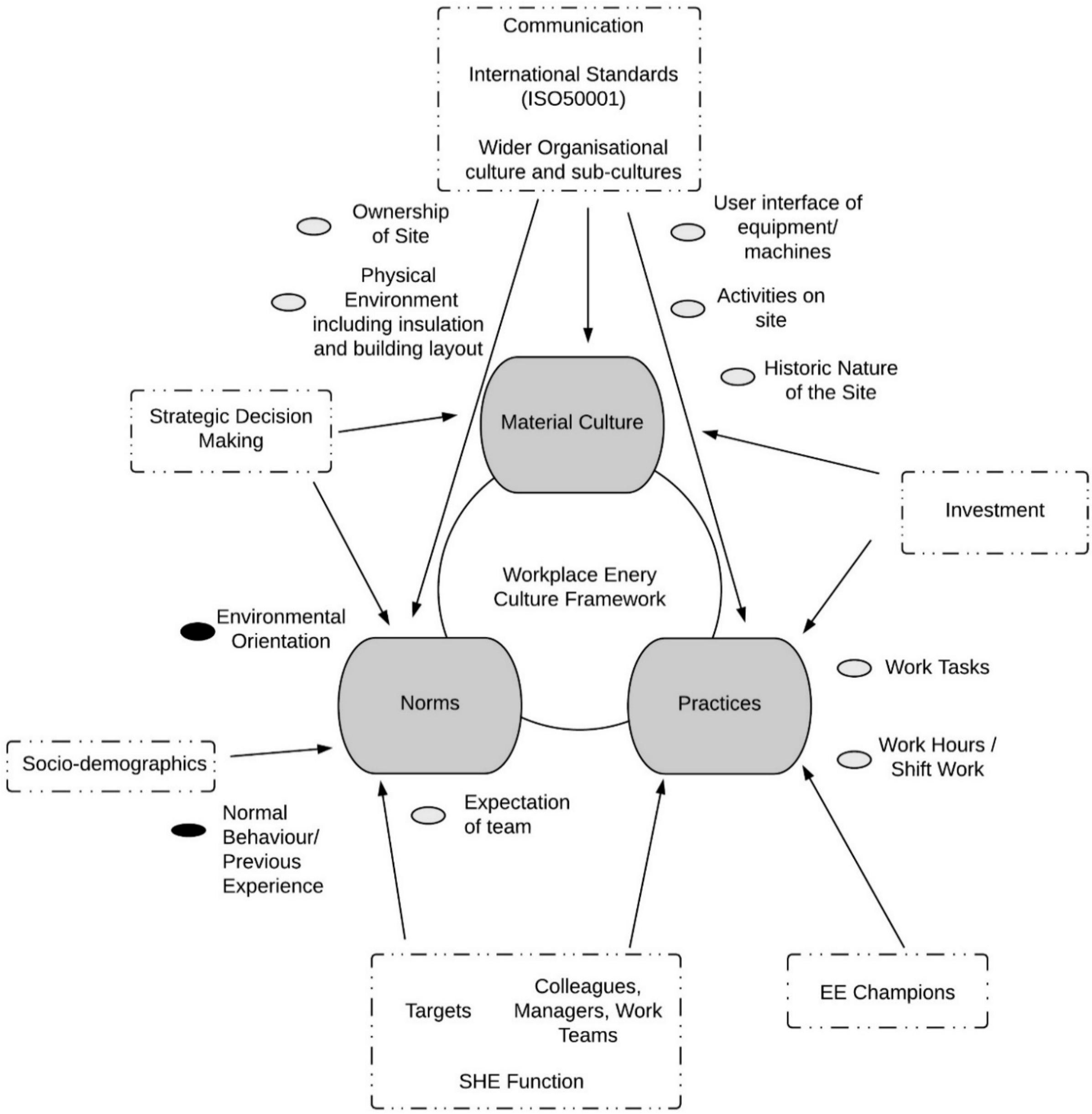


Figure 9:2 Revised workplace energy culture framework using the framework developed by Stephenson et al., (2010)

***Note**: The black and grey dots refer to themes previously classified as 'individual' or 'organisational'* influences, respectively, in *Figure 9:1. The dots and associated themes represent the characteristic of each theme of the energy culture. The themes in the dashed boxes represent the wider systemic influences on the energy culture. The arrows illustrate which energy culture theme is affected by the systemic influence. The framework is discussed in detail in the remainder of this chapter*

Table 9:1: Characteristics of the material culture, norms and practices of Figure 9:2

	Theme	Brief description	Reference to discussion point in thesis
Material Culture	Ownership of site	The research identified that the Samlesbury and York sites are owned by BAE, but BAE is a tenant of the Louisville site. The Louisville focus group detailed how the site worked closely with their landlord to ensure each building was sub-metered to ensure the site could accurately pay their utilities bill. Research by Scrase (2001) and Axon *et al.,* (2012) demonstrates how landlord–tenant relationships can be problematic. This is why this is an important consideration for future energy culture research.	Section 8.3.2
	Physical environment, including insulation and building layout	Throughout the thesis reference has been made to the physical environment. The size of the site affects the ease of communicating with staff, with contrasts seen between the three sites. The thesis has also drawn attention to how the physical appearance and aesthetics of the building can influence energy use.	Section 7.2.3 and associated Extract 15 (Section 4.3) and discussion in Section 8.3.5
	User interface of equipment/ machines	There are many occasions where the thesis has referred to the challenges for employees when turning off equipment or lights due to the interface of equipment/machines.	Extract 14 and 15 (Section 4.3) and discussion in Section 7.2.3
	Activities on site	The activities conducted on site influence the material culture. They direct decisions on building layouts, structures and sizes, along with the type of machines and length of time machines are required to be on.	Section 8.3.1 Section 8.4.1
	Historic nature of the site	All three sites referred to their history and how this provides challenges for efforts to improve energy efficiency; for example, in the ability to monitor energy use, and renovations being affected by building structures.	Section 7.2.2 Section 7.4 Section 8.3.2 Section 8.3.3 Section 8.4.2 Table 8.3

Table 9:1 (Continued): Characteristics of the material culture, norms and practices of Figure 9.2

Practices	Work tasks	Linked with the material culture theme of activities on site, work tasks fundamentally influence the energy used on site. The thesis has shown how the Louisville site was not a 'job shop' or a site based on assembly lines, in contrast to the York and Samlesbury sites. This leads to the Louisville site using large amounts of energy, with no continuity and consistency between different jobs.	Section 8.3.1
	Work hours/shift work	Both Samlesbury and York highlighted how shift work and variability in hours worked affects the energy used on site. York highlighted how fluctuating levels of staff and work significantly affect energy use, and Samlesbury also highlighted how this can affect knowledge transfer between shifts.	Section 7.2.6 Section 8.4.1
Norms	Expectation of team	Results from the Samlesbury survey showed that supervisors, work teams and colleagues currently don't impact the energy decisions of employees. However the top-down structure of BAE suggests if a supervisor told an employee to turn machines off after each use, they would do this. There does seem to be an expectation to participate in events such as shut-down periods which will influence the energy use on site.	Section 4.4 Section 4.9 Section 7.2.5
	Environmental orientation*	The results of the NEP Scale failed to determine whether environmental orientation affects the energy culture. However, Stephenson *et al., (*2010) identify that environment concern can influence norms so this theme is included in the framework.	Environmental orientation*
	Normal behaviour/ previous experience*	The Louisville site spoke about the wider national culture and the attitudes towards energy use. At the Samlesbury site, the survey data specifically examined home and workplace energy behaviours. Reference to the home was made at numerous points during the focus groups and interviews at Samlesbury.	Normal behaviour/ previous experience*

** Themes associated with the individual, as depicted by the black dots in Figure 9:2*

9.2.1 Communication

The theme of communication was introduced at many points in the thesis, but not discussed in detail. The survey directly explored bottom-up communication with employees (Q9g–Q9j), and employees' knowledge of energy use and energy efficiency strategies on site (Q8c and Q13c–i), with results presented in Chapter 4. In addition, the site energy communication strategies were explored during the interview with TM2 and TM3, and the focus group with manufacturing employees, with results presented in Chapters 4 and 5. Communication also appeared as a theme in Chapter 6, with TM1 suggesting BAE's safety culture became established and engrained in everyday activities through top-down communication strategies. This section provides an overview of these findings, while also discussing how communication can influence characteristics of the material culture, norms and practice of Figure 9:2.

On the theme of energy communications the research found:

- *Employees are generally not aware of the amount of energy their team or department use* (Figure 4:6). The interview with TM2 and TM3 demonstrated how the site is aware of these figures, while Extract 1 (Chapter 4) showed that some individual employees were also aware, but the information does not appear to be is communicated to all employees (Extract 3, Chapter 4).
- *Energy figures communicated to employees are often difficult to interpret.* Extract 1 (Chapter 4) showed that the SHE representatives of the manufacturing focus group were aware of the energy figures but did not fully understand them. This reiterates comments from the focus group, which appear in Extract 2 (Chapter 4), where employees wanted figures to be presented in terms they could relate to; for example, in relation to material objects, like cars, or holidays.
- *The physical environment and size of the site affect energy communications.* The focus group held at the Louisville site demonstrated how the SHE team directly communicates with manufacturing employees, informing them about and making enquiries regarding energy topics (Extract 13, Chapter 8). This is possible due to the small size of the site. In their interview, TM2 and TM3 said they occasionally speak to manufacturing employees, but the size of the site limits this communication method (Extract 2, Chapter 5). Consequently they rely on chain communication methods to transfer energy messages. These two extracts demonstrate how the size of the site affects the communication methods implemented by the SHE function.
- *BAE manufacturing sites implement chain 'communications methods'* (Martin, 2005; Mullins, 2007). TM2 and TM3 explain how this is implemented at the Samlesbury site (Extract 3, Chapter 5) with Extracts 13 and 32 (Chapter 8) providing details of the chain communications at Louisville and York. However, there are limitations with these communication methods, as identified in Extract 3 (Chapter 5), with messages not necessarily being transferred to employees correctly. Another limitation of this method was highlighted in Extract 27 (Chapter 4), where the SHE coordinator commented that it can often be difficult to determine what the important messages to communicate to employees are.

- *Communication strategies that involve the distribution of energy information through email, internal internet and chain communications.* The interview with TM2 and TM3, along with Extract 32 (Chapter 8), provides details of electronic communications on site. The Samlesbury site also distributes energy communications via a website, although TM2 and TM3 acknowledge that some employees access it more frequently than others (Extract 5, Chapter 5) with manufacturing areas not having regular computer access.
- *Manufacturing areas provide additional challenges for teams to engage in energy topics.* As detailed in Chapter 7, manufacturing employees are often not required to use a computer as part of their day-to-day tasks, and consequently may not check their emails regularly (Extract 25, Chapter 4). This means that energy communications via email to these areas may not be appropriate in BAE. This theme is further addressed in Section 9.3, where differences between office and manufacturing energy cultures are discussed.
- *Lack of effective bottom-up communications and feedback can lead to employees disengaging from energy topics.* The pilot study highlighted how a lack of feedback from bottom-up communications had negative consequences (Extract 20, Chapter 4). During this extract, a manufacturing supervisor is explaining how one of his employees made a suggestion regarding energy savings. The employee received no feedback about why it would not be implemented, resulted in that employee being unwilling to make any further suggestions. This is an example of how lack of feedback can lead to negative consequences, with employees becoming less engaged in making energy suggestions.
- *Tailored communications and feedback do not occur frequently at the Samlesbury site, but it appears this is changing.* Extract 21 (Chapter 4) demonstrates how this employee does not think the Samlesbury site is very good at providing feedback, and often people do not follow up on commitments to provide feedback. However, this situation appears to be changing. Boards are being placed in manufacturing areas to act as a means of gathering suggestions from employees regarding energy topics (Extract 4, Chapter 5).
- *Workplace priorities can interfere with bottom-up communications and the success of chain communications.* Extract 27, Chapter 4 describes how the SHE coordinator finds it difficult to manage various work priorities and energy/environment initiatives. Unsworth *et al., (*2013) define this as 'goal conflict', and propose numerous conflicts with pro-environmental behaviour, such as performance and safety goals. They argue that employees will complete the most focal goal first, and often in organisations this is not the pro-environmental goal (Unsworth *et al*., 2013). The findings from Extract 27,

Chapter 4 support Unsworth *et al.*'s (2013) suggestion. The descriptions of the energy culture framework (Chapter 7) and the safety culture (Chapter 6) demonstrate how safety goals, and manufacturing goals will often take priority over energy-related tasks.

These findings lead to important considerations with regards to the energy culture on site. The academic literature suggests that one way to change behaviour and to sustain that change is to provide groups with tailored information (De Young, 1993; Abrahamse *et al.*, 2005; Steg, 2008). However, in order to provide tailored information, a suitable communication strategy is required to ensure employees receive it. Strategies such as providing tailored information via email (Carrico and Reimer, 2011) would be inappropriate in the manufacturing areas as employees do not access emails regularly. Improving communication methods could directly impact the practices implemented on site.

In terms of changing the norms of the energy culture, Chapter 5 provided details on how the safety culture in BAE was created, developed and sustained. One of the key findings of Chapter 5 is the identification that a top-down communication strategy was implemented within BAE, and this helped to create the safety culture. This communication strategy came from board level, with the CEO, Sir Richard Olver, leading the Think Safety First campaign. This demonstrates how communication can play an important role in changing the norms of a culture.

Communication can also change aspects of the material culture. Section 5.4.1 and Extracts 17–19 in Chapter 4 highlight how physical notice boards are being introduced to help with bottom-up communication of energy-efficiency strategies. Some of the suggestions from employees are being implemented on site by the SHE function and energy teams. For example, TM2 and TM3 detailed how a member of a manufacturing shed had used these boards to communicate a suggestion on how to improve energy efficiency by changing how the air lines were used. This led to a change in the physical environment and infrastructure, to switch off air lines when not in use, or when employees usually working in these areas were off.

9.2.2 International Standards (ISO 50001)

The thesis identified that the Samlesbury site had recently achieved ISO 50001 accreditation, which is having a direct impact on the energy efficiency of the site, and also links with the previous section about communication. Throughout Chapters 4 and 7 reference was made to ISO 50001 and its implication for and impacts on improving the energy efficiency of the site. One example of how the accreditation has driven a change in energy culture is the use of portable energy monitoring equipment to gain an understanding of energy-intensive machines, thus improving the energy monitoring system at Samlesbury.

The ability to monitor energy use is leading to a direct change in the practices theme of the energy culture framework by changing how and when machines are used, and the experimentation with ramping up and ramping down of machines. It is also changing the norms of the energy culture. Employees understand the monitoring, as demonstrated by the numerous references made to it in the focus group, and it is becoming the norm for them to utilise portable energy monitoring devices on a daily basis and to trial changes in machine use. It is anticipated that once the experimentation is complete, and an optimum running speed or temperature is found, this will be implemented; consequently, the norms of how employees use machines and undertake tasks will change. The ability to communicate energy data is also changing norms on site, with some employees being aware of the energy the buildings use, or beginning to understand they can get access to energy data. Linking to the section above, it is also changing the norm of employees being able to engage in energy-efficiency suggestions, with the notice boards that were discussed earlier.

9.2.3 Wider Organisational Culture and Subcultures

By conducting research within BAE the researcher became aware of the wider organisational cultures and subcultures of the organisation and site. As detailed in Chapter 6, the researcher became aware of the safety culture through references made during focus group discussions, survey results and through exploring these topics in interviews with TM1 and Rob Wallace.

On the theme of organisational cultures/s, the research found:

- *A dominant safety culture is present in BAE.* Chapter 6 provided details on the safety culture, and demonstrated how it had developed and evolved. This culture is integrated into everyday activities at all levels of the business through a safety matrix, safety objectives, 'time for safety' sessions, SQCDP boards and the 'Think Safety First' campaign. However, it is important to note the flexibility of the safety culture on site, with supervisors able to make decisions on how to integrate safety discussions into their work areas. Extracts 1–3 (Chapter 5) and Extract 7 (Chapter 5) detail differences in how SQCDP boards are discussed, with some areas focusing on a topic a day, and others covering all topics. The SQCDP boards form part of the safety culture, with 'S' representing safety topics. Section 4.3.2 demonstrated how safety is seen as the responsibility of each employee, whereas energy is regarded differently.

- *Safety culture influences energy decisions.* The thesis demonstrated how the safety culture on site is engrained in day-to-day activities. Consequently, it is entwined with the energy culture on site. The nature of the Think Safety First campaign directs employees to first think about safety in all activities on site, so this will be prioritised over energy activities.
- *Additional subcultures exist on site, such as occupational health.* During the interview with TM2 and TM3, where TM3 provided details on the site canteen (Extracts 16 and 17, Chapter 6), it was noted that occupational health and the well-being of staff were considerations in the construction of this sustainable building. This insight into the decision making of the business highlights how 'return on investment' (TM1 Extract 20, Chapter 6) does not always translate to direct financial returns on investment. In this example, the wider occupational health culture was considered along with staff well-being, when making a decision regarding a return on investment.

As Chapter 6 and the first two bullet points have detailed, the safety culture is very much integrated into the business structure of BAE. The founder of the safety culture, who established the 'Think Safety First' campaign and associated safety maturity matrix, was the CEO of the business. The introduction of Chapter 6 questioned whether an energy culture could become as established and integrated into everyday activities as the safety culture. The empirical evidence collected throughout the research has detailed how decisions that change behaviour at BAE appear to come from board level. Consequently, the researcher does not believe an energy culture could become as established and engrained into everyday activities as the safety culture unless it came from board level. The research disagrees with Endrejat *et al.,* (2015), who argue that bottom-up approaches are required for organisations. The research argues that a mix of bottom-up and top-down approaches is required in an organisation like BAE.

These findings highlight how the various subcultures observed within an organisation appear to interact with energy-use decisions at various scales. At an employee level, the safety culture directs attitudes on how to conduct tasks, and takes priority over energy behaviours on site. At site level, additional cultures such as occupational health appear to be considered alongside energy usage when determining the feasibility of infrastructure projects.

9.2.4 Investment

Within BAE there appears to be a connection between energy and finance topics across a variety of scales in the business. Consequently this was identified as a systemic influence on the energy culture of BAE. These findings show:

- *Wider political decisions and financial crises affect strategic priorities.* When exploring changes in strategic priorities, it became apparent that wider political decisions can impact BAE. The interview with TM1 (Chapter 6) indicated that the strategic defence review (HM Government, 2010) and the subsequent termination of the Nimrod project was unexpected, and led to site closures and redundancies at BAE. This defence review, along with the financial crisis, led to changes in the strategic priorities of BAE, where the business could no longer provide financial support for sustainability and energy projects. The focus appears to be on making their products more competitively priced, with many references appearing throughout the thesis to a 'competitive market' (e.g. Extract 41, Chapter 4). The strategic priorities appear to have changed from actively investing in energy through energy technologies and businesses, to energy conservation methods aimed at improving site energy efficiency, reducing costs and making the business more competitive. More details on strategic priorities are provided in the next section.
- *Bonuses have been linked to changing cultures.* During Chapter 6, TM1 described how one of the methods of implementing the safety culture in BAE was through safety objectives linked to senior executive bonuses (Extract 5, Chapter 6). This demonstrates an intervention method associated with monetary reward (Mizobuchi and Takeuchi, 2013; Lanzini and Thøgersen, 2014) at a senior executive level of the business.
- *Cost is mentioned at all levels in the business.* Cost appears to be a subject of board level discussions, and the manufacturing focus group highlighted how cost is part of the SQCDP discussions that occur in DSUMs and WSUMs (Extract 9, Chapter 5). This extract details how these discussions involve the cost of a product, and the cost involved in manufacturing, which often involves discussions on savings. The group identified how the amount of energy used is not directly discussed, but potential energy savings are. The focus groups conducted in the US also provided examples of cost being linked with energy. On many occasions the 'payback' periods of energy infrastructures were mentioned (Table 8:1 and Table 8:2 Extract 21, Chapter 8), which also led to discussions on wider US state subsidies.

- *Cost indirectly affects energy use.* The focus groups at both Louisville and York discussed energy monitoring. They explained how both sites are now able to monitor energy use in great detail through infrastructure changes which have seen a greater number of substations on site, which are all monitored. However, when the groups were asked whether they would look at further improving energy monitoring to building level, or by using portable energy monitors, both sites responded with answers relating to the cost involved and the payback. Tables 8:1, 8:2 and 8:3 examine this macro level of monitoring and consider whether micro levels would occur in future. Table 8.2 demonstrates how energy monitoring has led to behaviour change.
- *Weak links between costs, energy and jobs.* The survey results demonstrated how employees were concerned about the cost of energy to the business, but unsure whether rising energy costs would affect day-to-day tasks, with a mix of neither agree/disagree and strongly agree/agree answers (Q13a and Q13b). The focus group discussions (Extracts 40 and 41, Chapter 4) supported these findings, by demonstrating some weak links between energy efficiency, reduction in cost and keeping jobs. However, goal conflict means energy is often an afterthought when completing tasks (Extract 40, Chapter 4), and there is a suggestion that energy efficiency does not directly benefit the individual, even though employees are aware that lowering energy use reduces costs and makes the business more competitive (Extract 41, Chapter 4).

The results of the thesis suggest that one of the reasons for improving energy efficiency is the potential cost saving for the business. This may be a reduction in overhead costs or production costs, which consequently makes the business more competitive. The research finding supports Hasanbeigi *et al.,* (2010), who found a similar result. As a consequence, investment is a systemic influence on workplace energy culture. Investment can directly change characteristics of the material culture by changing infrastructure, providing funds for energy projects and affecting the longevity of work on site. It can also directly change aspects of the practice theme of the energy culture framework by influencing characteristics such as working hours and shifts.

9.2.5 Targets

Within BAE, targets seem to be part of the day-to-day tasks for employees. Section 6.2 described how safety targets were integrated into all levels of the business as a means of engraining a safety culture into day-to-day activities. In addition, Sections 7.2.8, 8.3.3, 8.4.3 and 8.4.4 all showed how targets are integrated into the Samlesbury, York and Louisville sites. As these sections explain, the way energy targets are measured have changed in recent years at Louisville and York but they still appear to be a driver to creating an energy-efficient culture on site. Chapter 6 provided details on how targets have changed the norms, practices and material culture on site. The sections on targets in Chapters 7 and 8 demonstrated the varying degrees of success they have had for creating an energy-efficient culture, along with discussing some of the challenges with measuring energy use. However, by using the safety culture as an example, targets can act as a drive to change the characteristics of a culture. Subsequently, targets have been included in Figure 9:2 as a wider systemic influence.

9.2.6 Colleagues, Managers and Work Teams

At many points throughout the thesis, reference was made to the role of key individuals and managers, and the influence they have on activities within BAE. At a site level, the Director of Manufacturing Operations has a personal interest in energy efficiency and partakes in numerous pro-environmental activities (Extracts 18 and 19, Chapter 6). This active interest leads to encouragement for his staff to explore improvements in energy-efficiency technologies and to approach him with proposals. Extract 17 (Chapter 6) from the interview with TM2 and TM3 demonstrates how the idea for the sustainable canteen on site came from TM3's team. This idea was then put to the Board, who decided it would provide a good return on investment (Extract 20, Chapter 6) and the idea became reality. This new building is now influencing the material aspect of the energy culture and subsequently changing the wider site energy use. This research finding supports Roberston and Barling (2012), who found a leader's energy-efficiency behaviours were positively correlated with workplace employee pro-environmental behaviour.

TM2 and TM3 also gave a further insight into how key individuals can influence energy use. During their interview they explained how the site has had varying success rates with interventions focusing on reducing energy use and recycling. They suggest that the varying success rates of particular buildings were due to key individuals in these areas driving recycling rates. However, they recount (Extract 25, Chapter 6) how within 6 months recycling rates changed, with behaviours not being sustained. They suggested this was due to the movement of a key individual (Section 7.3.1, Chapter 7). Argote and Ingram (2000) acknowledge that knowledge transfer can occur with movement of employees around site, through member–member and member–task networks. It appears that this is occurring at the Samlesbury site.

Reiterating this theme of key individuals in work areas, Section 8.2.6 provides details of how a key individual in the office area at the Louisville site would change colleagues' behaviours by questioning their energy activities, such as leaving computers on. This demonstrates how the norm and practice of the energy culture framework can be altered by colleagues.

The survey explored the role of managers on employee energy use through Q10g. Employees provided a mixed response when answering 'I would be well thought of by my line manager if I took action to save energy at work' (Q10g), with approximately 40% answering neither agree/disagree and 40% answering strongly agree/agree, suggesting that managers currently do not play an important part in employees' energy use. These results also provide an explanation for answers to Q10d, which stated: 'within my work environment energy use and energy demand are discussed regularly'. The majority of employees disagreed with this statement. These results suggest that managers are not actively engaged in energy topics, which reflects the strategic priorities of the wider organisation. Lo *et al.,* (2012) detail how management is an important element in improving pro-environmental behaviour, and this research argues that this is applicable to energy-efficiency behaviours. The discussion around BAE's safety culture (Chapter 6) highlights how all members of staff are engaged in safety topics, and this appears to be achieved from a mix of management targets, campaigns and top-down communications. However, one of the key elements of this culture was management engagement.

Key individuals also play a role in knowledge transfer. They can act as gatekeepers of knowledge, and consequently this theme is closely related to the communication theme discussed above. During the focus group at York, the dialogue presented in Extract 22, Chapter 8 demonstrates how participants are being educated during the session. One employee appears to be more knowledgeable on energy topics compared with the others in the group. A similar scenario occurred in the manufacturing focus group at the Samlesbury site, where the SHE advisor was better informed about energy topics than the others in the group.

A final example of the influence of key individuals on energy use is in the success of the strategic partnership with UCLan. Extracts 12 and 14 (Chapter 6) detail how the strategic partnership with UClan and this research owed their success to key individuals who were enthusiastic and interested in the research being conducted. This example is not directly related to energy use on site, but it demonstrates how key individuals can drive projects.

This overview of research findings demonstrates how key individuals can drive energy cultures in the areas where they work, and in some cases this can have an impact on the wider energy culture of a site. This overview stresses the importance of the norms theme of the energy culture framework (Stephenson *et al*., 2010, 2015) and the active role individuals play in reducing energy use. Future work could build on the research finding and the work by Ucci *et al., (*2012), to develop a benchmarking tool to assess whether individuals have energy leadership qualities to drive energy use in certain areas on site. More details on this, and the sub-energy cultures that appear on site, are provided in Section 9.3.

9.2.7 SHE Function

A focus of the surveys distributed at the Samlesbury site was the SHE function. These results, discussed in Section 4.8, revealed how the majority of employees associated topics of safety and health with the SHE function. This demonstrates how currently the SHE function is not a significant influence on the workplace energy culture. However, as Section 6.2.1 discussed, it does play an important role in creating, sustaining and engraining the safety culture of BAE. When describing the safety culture in Chapter 5, it can be seen that the SHE function influences the material culture, practices and norms of the safety culture. Sections 4.8, 6.2.1, 7.2.1 and 8.3.3 describe the roles of the SHE function at Samlesbury and Louisville. They also outline the role SHE plays in energy topics on site. At the Samlesbury site, as discussed in Section 7.2.1, the SHE function is involved in ensuring the site meets the requirements of legislation, regulations and international standards such as ISO 500001. This further demonstrates the interrelated nature of the systemic influences of the energy culture in Figure 9:2.

9.2.8 Strategic Decision Making

The thesis identified many examples where changes in hierarchical decisions impacted workplace behaviours. Chapter 6 detailed how prioritising safety was a board decision and this translated through the business and became engrained in everyday activities, changing the practices and norms. Similar examples were found when focusing on energy use. During the interview with TM2 and TM3, it was noted that the decision was taken to implement ISO 50001 at board level, and compliance filtered down through all levels. This demonstrates how the change in strategic focus from energy as a product to energy efficiency at site level is being implemented at Samlesbury, and, as discussed above, this strategic decision is changing the norms, practices and material culture of areas of the site.

The interviews with TM1 and Rob Wallace (Chapter 6) gave details on a change in strategic priorities with regard to energy at BAE. These interviews detail how BAE moved away from developing energy businesses and sustaining strategic partnerships with UCLan, to a focus on in-house energy efficiency. Extract 9 (Chapter 5) demonstrates how the energy focus on site appears to be linked with manufacturing costs, with energy often being discussed in the 'cost' theme of SQCDP. This also illustrates the close link between strategic decision making and investment, demonstrating how some of the systemic influences being discussed can be interlinked.

9.2.9 EE Champions

The thesis described how BAE has energy and environment champions (EE champions). The survey results showed that these teams of employees currently do not appear to have a significant impact on employee energy use, as detailed in Section 7.2.4. However, as the literature in Chapter 2 highlighted, role models (Higgs and McMillan, 2006) and knowledge transfer between individuals (Argote and Ingram, 2000) can influence pro-environmental behaviour and energy use. This demonstrates the potential impact EE champions could have on the various characteristics of the energy culture of BAE identified in Figure 9:2.

Some employees' answers to questions in the surveys highlighted how the EE champions influence their recycling habits, which demonstrates the potential for impacting the practices of employees in the energy culture framework.

9.2.10 Socio-demographics

The link between socio-demographics and energy use was discussed in detail in Chapter 2 and Sections 7.3.1. Stephenson *et al.,* (2010) identify demographics as a systemic influence on the energy culture of a household, which influences the norms of the energy culture. Figure 9:2 uses the term socio-demographics to provide an opportunity to include sociological characteristics such as household size, income, interests and values, in addition to demographics such as age and gender. The thesis has not examined all these themes, but Chapter 2 and Section 7.3.1 provide references to literature demonstrating links between socio-demographics and energy use. Due to this, Figure 9:2 has included this as a systemic influence for the norms of the energy culture framework.

9.3 Geographies of Energy Cultures

The previous section demonstrated how the findings from the research can explain the workplace energy culture through the use of Stephenson's *et al.,* (2010, 20115) energy culture framework. However, Figure 9:2 ignored the findings of this research, which demonstrated the importance of spatiality when examining energy cultures.

As Chapter 1 stated, the disciplinary background of the researcher is geography, and geographers explore topics of space and place, as explained by Clifford *et al.,* (2000), Thrift (2002) and Pasqualetti and Brown (2014). The research applied this disciplinary interest to examine how energy cultures change with geographies. The following section uses the terminologies 'spatiality' and 'multi-scalar' to describe how energy cultures can be experienced at varying scales across an organisation. At a local level, Chapter 5 provided results of *t*-tests demonstrating the difference in energy cultures of two work areas at the Samlesbury site. At an international level, Chapter 8 discussed differences between the site energy cultures of York and Louisville in the US, and compared these with the Samlesbury energy culture. This section seeks to draw attention to the multi-scalar nature of energy culture and provide a more detailed discussion of the various geographies at which energy cultures have been observed. Following this, an evolution of Figure 9:2 is presented which demonstrates how a spatiality element can be incorporated into the energy culture framework.

9.3.1 Local

The independent *t*-test results presented in Chapter 5 showed significant differences in the means of the office and manufacturing energy cultures for a number of groups of questions (Figure 9:3). In each of these groups the office areas were more in agreement than the manufacturing areas. This section discusses these findings by detailing how some of the wider systemic influences and characteristics of Figure 9:2 can explain the results.

Group 1: Immediate work environment influences
Group 2: Employee energy suggestions and feedback
Group 5: Workplace energy practices
Group 6: Workplace energy reduction knowledge
Group 7: Business approach to energy use
Group 8: SHE influences

Figure 9:3: Groups with a statistically significant difference in mean values, as indicated by the independent t-test results

Communication

The communication of information via email could explain some of the differences between manufacturing and office areas in Figure 9:3. Extract 25 (Chapter 5) explains how all employees have an email address, but due to the nature of the physical environment and differences in day-to-day tasks, office employees are required to interact with computers more regularly than those in manufacturing areas. This lack of regular computer interaction could explain the differences in groups 2, 7 and 8:

- *Group 2* explored knowledge of who to make suggestions to and the process of making suggestions about energy reduction in the workplace. Within the office environments, where computers are used regularly, it is much easier and more convenient for employees to find out for themselves who to make suggestions to, and to email the suggestion. The nature of email makes it easier to transfer messages between the employee making a suggestion and the recipient. Even though all employees in the manufacturing areas have logons and email access, Extract 25 (Chapter 4) suggests that not everyone will access them. Many manufacturing employees rely on the relay of suggestions via supervisors.
- *Group 7* focuses on employees' knowledge of the approaches taken by the business to explore energy use. The questions focused on training, amount of supervision and guidance, knowledge of team/department energy use and knowledge of what BAE is doing to reduce energy use and demand. TM2 and TM3 gave details of an intranet page with information about current campaigns (Extract 5, Chapter 6). Additionally, some of the office survey results stated that employees know where to access information about the energy use of their building online (Box 2, Chapter 4). If manufacturing employees do not routinely interact with computers, they will not access the intranet page regularly, if at all, so will only get information if it is transferred to them via DSUMs or WSUMs. These points are also applicable to *Group 8*, which is about the SHE function.
  Much of the training is online, which could also explain why the office environments answer in a more agreeing way for this variable. Extract 5, Chapter 5 says everyone has a logon for completing online training, butTM2 highlights how some people log on more regularly than others. The differences in the physical environments, and differing numbers of computers, could explain these differences.

Another explanation for the differences between these two areas was provided by the manufacturing focus group describing the format of the DSUMs and WSUMS, and the locations where these meetings are held. One participant described the office-based meetings as 'flowery' (Extract 5, Chapter 5), suggesting more of a discussion format rather than a meeting focused on specific jobs and/or tasks. Another participant suggested that the location of the DSUMs and WSUMs impacts the structure of meetings. In the manufacturing areas, meetings are held by the SQCDP boards (Extract 1, Chapter 5), which assist with the structure of the meetings. If the office areas do not hold their DSUMs and WSUMs by the SQCDP boards, the structure of the meetings may be subject to change, meaning more opportunity to discuss energy- and sustainability-related topics with the immediate work team and colleagues. As detailed in Chapter 5, there are a variety of methods of energy and sustainability communications, but unlike safety, which is the 'S' in SQCDP, there is no set opportunity for employees to discuss energy topics. These differences in format and ability for discussions could explain the results for Group 1, which consisted of questions on colleagues'/work teams' energy actions and perceived pressure from line managers and colleagues, and Group 8, which focused on SHE influences (Figure 9:3).

Group 8 questions focused on the SHE function within BAE. Messages that are distributed in the DSUMs and WSUMs around environmental topics often come from the SHE function. The communication section above highlighted the chain communication method (Martin, 2005; Mullins, 2007) implemented on site, and the limitations of this method. These limitations could explain the difference in results in Group 8. One consideration is that the manufacturing areas may not be aware of where the messages are coming from. SHE function decisions and messages may be influencing manufacturing energy use, but employees might not be aware of the messages' origin, and consequently may have answered with disagree/strongly disagree for the questions in this group. This differs from the office environments, which receive email communications in addition to the information transferred in the DSUMs and WSUMs.

Physical Environment

The workplace energy culture framework in Figure 9:1 identifies how energy use can be heavily influenced by the physical environment. The descriptions of the energy cultures of the Samlesbury (Chapter 7), York and Louisville sites (Chapter 8*)* have further shown how the physical environment changes energy use. When looking at explanations for the differences in responses from the office and manufacturing areas, the physical environment was considered. This section focuses on how differences between the two environments contribute to the differences in energy cultures.

The questions that constructed *Group 5* explored the energy practices of employees. One explanation for the noted differences is the ability to determine who is left in an area so lights and equipment can be turned off. The Samlesbury and York focus groups both commented on how the physical environment in the manufacturing areas means it is more challenging to determine who is left in a building. The majority of offices are open plan, which makes determining if anyone is left in a building easier; manufacturing areas are more difficult due to layout. Employees in manufacturing areas describe their work areas as 'constantly [having] people on the floor … so obviously all these big lights are always on' (Extract 9, Chapter 5), which suggests they do not routinely switch lights off. The nature of the shift work patterns in manufacturing areas also heavily influenced answers in this variable. As Extract 30 (Chapter 4) states, turning machines off would impact the following shift, so it is not appropriate to do so.

Another explanation for the office environments having more agree/strongly agree answers could be the lack of complexity of the equipment in those areas. The manufacturing environment is much more complex. For example, turning a large machine off may have an impact on the production process and the wider manufacturing shed population, with long shutdown/cool-down and reboot/warm-up times. Compare this to a computer or photocopier, which have quicker shut-down and reboot times and less impact on the wider work population if turned off. Another example that highlights the differences in the level of complexity of the two environments is provided in Extract 12, Chapter 5. Here the participant comments on how the majority of people could venture into an office and turn equipment off due to their familiarity with the type of equipment, for example, through having computers at home. However, the same user behaviour cannot be applied to the manufacturing environment, as stated above, because there are greater consequences from turning equipment off. This complexity in turning equipment off could also explain some of the answers to questions in *Group 6*. This variable explored who is responsible for switching off lights and equipment, and knowledge of where switches are. Extracts 10, 14 and 15 (Chapter 4) highlighted how in some manufacturing areas, employees do not have the ability to turn machines off and they require maintenance to do this. This would explain the lower number of agreeing answers when compared with the office areas.

The final comment on the physical environment relates to the type of activities that were based in the office locations, which could influence some of the answers in the office areas. The two main office buildings, 608 and 609, host the sustainability team, along with other teams, while Mellor House (predominantly office based) hosts the SHE function. Both these teams are heavily involved in reducing site energy use, so would naturally be more engaged with discussing topics of energy use with work colleagues.

The physical environment of buildings 608 and 609 may also influence discussion of energy use topics. They are the newest office buildings on site, and are extremely energy efficient. The participants in these buildings may discuss their physical surroundings with colleagues more often, as they are still getting used to the buildings and their energy-efficient features.

9.3.2 International

The empirical findings in Chapter 8 described how energy cultures can change within an organisation, at an international scale. The thesis found many similarities between the energy cultures of the Samlesbury, York and Louisville sites relating to organisational structure, communication methods, interaction between safety and energy, and challenges of the physical environment and surroundings. However, there were also many differences. These differences are discussed through the wider systemic influences and characteristics of the energy cultures – organisational priorities, ISO 50001 and energy monitoring, individual cultural norms and wider national cultural influences.

The most noticeable of the differences between the sites was the level of energy monitoring occurring. The interview with TM2 and TM3 described how the level of energy monitoring at Samlesbury had improved over the past 10 years, to the extent that it now has the ability to monitor to building level. The level of energy monitoring occurring at York and Louisville is very different, with the Samlesbury site being much more advanced. Chapter 8 details how both the York and Louisville sites only monitor down to substation level, with multiple buildings on one substation. When exploring if there were plans to increase the level of energy monitoring, both focus groups were unsure, and made reference to the payback period, and whether it was financially viable to do this.

During the York focus group, one participant commented that the British sites were more advanced in understanding energy use on site and incorporating environmental sustainability topics into site activities. This participant concluded by saying:

> *'… we don't have [an environmental sustainability team], so I'm interested [in] this, that these facilities guys and Dave, let's create an environmental sustainability team here, seeing what's happening in Britain, [and] knowing that it's going to be pushed down to us.'*
>
> *York Focus Group Extract 1*

Chapter 8 described how the facilities and SHE functions at the Louisville and York sites appear to be less integrated, and do not seem to work closely, compared to what occurs at Samlesbury. The extract above supports this finding, while also demonstrating how the York participants view the British sites as being more advanced, in terms of environmental sustainability. The participant also comments that he thinks what is happening in the UK will be 'pushed' on the York site in the future. This extract, and the empirical findings of the research in Chapter 8, detail how advanced the Samlesbury site is, compared with York and Louisville.

At the Samlesbury site the focus on improving energy efficiency appears to be from both social and technical perspectives. However, when the York and Louisville sites were discussing how energy use could be reduced, both provided technical approaches, with the researcher needing to direct attention to whether any social interventions occurred. The social approaches at the York and Louisville sites appear to target waste campaigns rather than focusing on energy reduction.

The thesis argues that the Samlesbury site has a more established energy efficient energy culture compared to York and Louisville, and the empirical material has provided various explanations for this:

- *ISO 50001*: The Samlesbury site was recently ISO 50001 accredited. In achieving this, both technical and social approaches to improving energy efficiency have been adopted. From a technical approach, the site has a more detailed energy monitoring system. Portable energy monitors are being used to assist with gaining an understanding of how the amount of energy being used by energy-intensive machines can be reduced. From a social perspective, suggestion boards have been introduced to improve bottom-up communications. Samlesbury also draws attention to shutdown plans at all levels on site, and has energy and environment champions based in all areas.
- *Energy costs*: The US appears to have lower energy costs than the UK. Section 9.2.2 and Chapter 6 detail the changes in strategic priorities of BAE, with a move to focusing on site energy. This focus on site energy was observed at all three sites, but to varying degrees of success. The above section discussed the different levels of energy monitoring observed at the three sites, which demonstrates a move towards exploring site energy use. The more evolved nature of the Samlesbury site may be due to the impact of higher energy costs.

- *National cultural norms*: The cultural norms of the individual may also explain the different energy cultures on site. The US has very different cultural norms to the UK. The focus groups at Louisville and York discussed these by describing how the 'sustainability movement' is less established in the US than in the UK. Section 9.2.6 gave an overview of how key individuals can influence energy infrastructure developments and group energy behaviours. If these key individuals are less enthusiastic than their UK counterparts, or if they do not have the same opportunities to develop ideas, the energy cultures of the sites could be very different. This is very speculative, and there is no empirical evidence to support it, but it is using the energy culture of the Samlesbury site, and the workplace energy culture framework, to compare differences in the individual and organisational elements.

Sovacool (2016) found energy cultures to be influenced by national cultures, and he argues that national cultural influences on energy culture are not fixed but represent an interplay of geographic, economic and political factors that extend beyond the individual country. While the research by Sovacool (2016), as stated in Chapter 2, does not explore energy cultures in the same way as this research, the links he found between energy use and national culture are particularly relevant for the energy cultures of the sites.

The impact of national culture on workplaces has been examined by several authors (e.g. Hofstede, 2001; Taras *et al.*, 2011) but little academic work has focused on the impact of different cultures on energy use (Sovacool, 2014). Models such as Hofstede's (2001) cultural model explored the role of employees' national cultures, and research has found that 'people had different and sometimes directly opposing, values and beliefs depending upon their country of origin' (Taras *et al.,* 2011:191). The research by Hofstede (2001) and authors who have applied his framework demonstrates the important role individuals play in the workplace energy culture framework. The research did not have an opportunity to explore the individual elements of the workplace energy culture framework at an international scale. However, the research by Hofstede (2001) demonstrates the potential differences in individuals' values and opinions at international and regional scales. This links to the 'national culture norm' bullet point earlier, where focus group participants describe different cultural values towards the sustainability movement.

9.3.3 Micro Scale and Evolutionary Energy Cultures

In addition to the international and local geographical scales that the research has explored, the manufacturing focus group at Samlesbury indicated another spatiality at which energy cultures may vary – the micro scale:

> *A: 'I think some of it's because we're in a newish building, like 4 Shed.'*
>
> *B: 'Culture isn't it? This is a new building and there's new culture, new build.'*
>
> *C: 'The investment …'*
>
> *B: 'Young people, lots of investment, and 4 Shed is rather old school isn't it?'*
>
> *C: 'Yeah, I think you're right, good choice of words … yeah we're a bit collective like office and shop and, you know, I think if you go somewhere else it's a bit more us and them.'*
>
> *(Extract 10, originally presented in Chapter 5)*

The participants were asked why differences are found across site. In the extract they think there are differences between two manufacturing sheds. They explain how this is due to multiple factors such as young people, investment, activities taking place in the different buildings and the newness of the building. During survey distribution one employee enquired about the research. The researcher commented that one line of enquiry was exploring differences between attitudes across site, to which the employee commented 'it's all about investment'. Here the employee is reiterating a comment made in the extract above regarding investment levels. Continuing the conversation, the participant linked investment with job security and knowledge of how many years remained on the contracts for the various product lines.

The design of the survey distributed as part of the research did provide opportunity to explore the geographies of energy cultures at a more micro scale than what has previously been discussed. However, the challenges with survey distribution led to poor sample sizes from individual areas on site. Consequently this research avenue was not pursued.

9.3.4 Evolution of the Energy Culture Framework

The above discussions have demonstrated the importance of spatiality when examining workplace energy cultures and highlighted the multi-scalar nature of such cultures. The thesis has identified scales of the micro level – different buildings or work teams – and the more macro scale – such as the type of process employees may be involved in, whether manufacturing or office based, or at site level. To illustrate the spatiality dimension of energy cultures, Figure 9:4 was developed, demonstrating the multi-scalar nature of workplace energy cultures. This figure takes inspiration from the multi-level perspective applied by Geels (2002).

For simplicity, only a selection of systemic influences and characteristics are annotated. Unlike Figure 9:2, this illustration does not have arrows highlighting how the systemic influences affect the material culture, norms and practices of the energy culture. These have been excluded for ease of visualising the diagram. If an energy culture at any of the spatial scales in Figure 9:4 were examined in detail, the framework presented in Figure 9:2 could be applied. Doing this gives an opportunity to examine the characteristics and wider systemic influences of the energy cultures at each level of Figure 9:4.

The annotation of some of the systemic influences and characteristics in Figure 9:4 and Figure 9:6 also highlights their cross-cutting nature. For example, communication can be a systemic influence on each of the energy cultures in Figure 9:4. The annotation of these themes is not intended to act as an exhaustive list, but as a demonstration of their ability to cut across multiple energy cultures. As these themes have been discussed in detail previously in this chapter, Table 9:2 provides a very brief description of the cross-cutting nature of each theme. It is important to note that Figure 9:4 suggests each systemic influence and characteristic is stand-alone. However, often these are entwined with other systemic influences and characteristics. For example, communication is as a cross-cutting systemic influence, but the impact of communication methods can be entwined with employee targets and bonuses. Chapter 5 showed that safety targets were interrelated with bonuses. This is then interlinked with the communication methods that are implemented to achieve a safety culture on site.

An important development of Figure 9:4 is the inclusion of the individual energy culture. Throughout the thesis, the Samlesbury, York and Louisville energy culture frameworks acknowledged that every individual will have their own individual energy culture, which will influence their wider decisions on how to use energy in the workplace (see Section 7.3.5 for more details).

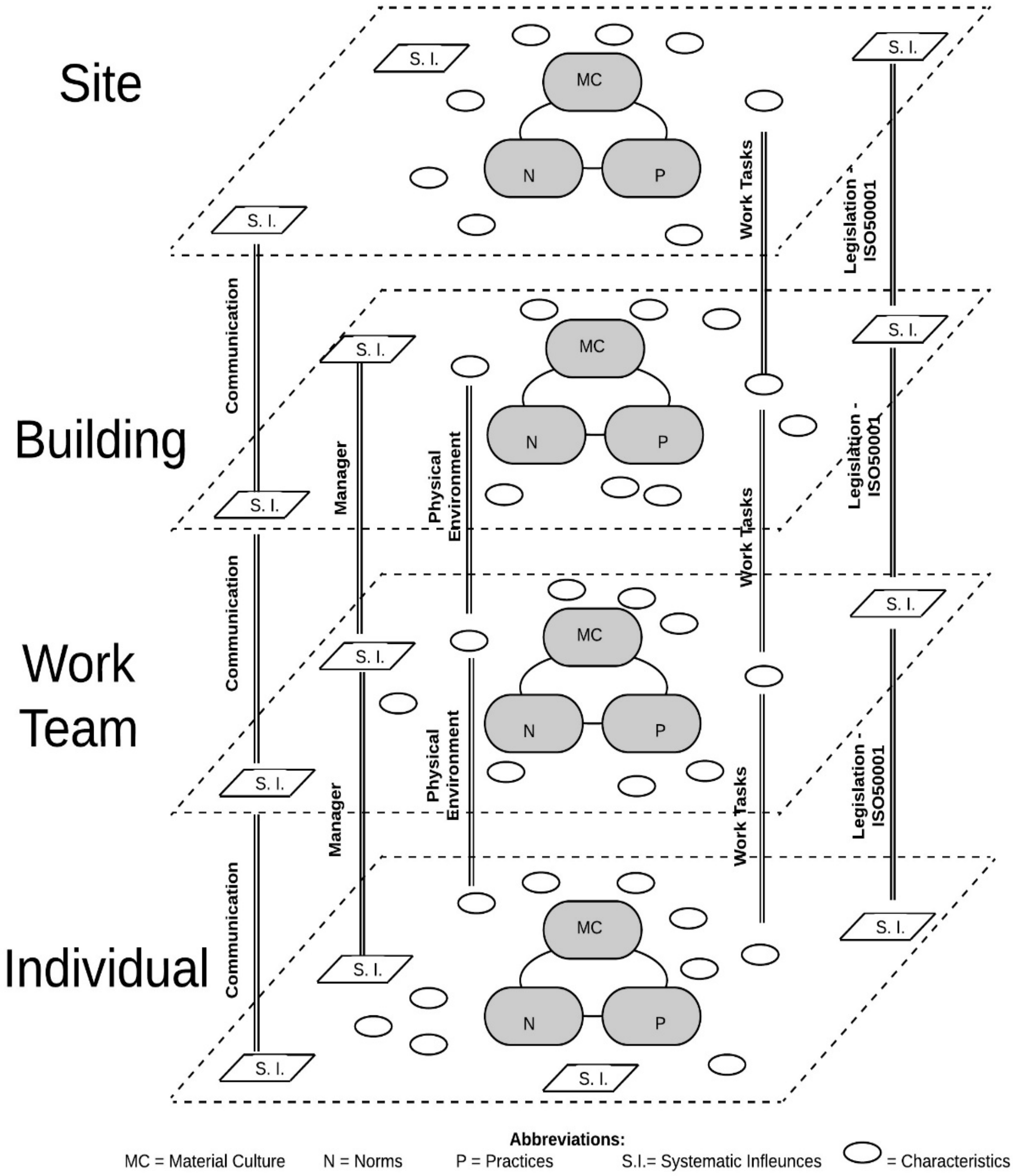


Figure 9:4: Inclusion of a spatial dimension in the energy culture framework.

Note: Horizontal double lines demonstrate how some systemic influences and characteristics can impact energy cultures at varying scales throughout the organisation. More details are provided in Section 9.3.4.

Table 9:2: Explaining the cross-cutting themes of Figure 9:4

Cross-cutting theme	**Description and example of where it was observed**
Communication	Communication can be a systemic influence for various characteristics of the energy culture at each scale. The thesis has provided examples of top-down communications helping to create and sustain a safety culture on site (Chapter 5). Similar communications could be used to develop more energy-efficient energy cultures at each scale in Figure 9.4. Additionally Sections 9.2.1 and 9.3.1 have shown how differences in communication methods could explain the different energy cultures experienced at a local level, between the office and manufacturing areas; this same principle could explain differences in work teams. At an individual level, the top-down, command and control nature of BAE (as described in Chapter 5) suggests that any messages coming from the top of the business (board level) are adhered to at individual levels, and are often at the forefront of people's minds. An example of this is the shut-downs that operate during extended holiday periods.
Legislation, regulations etc. (e.g. as ISO 50001)	The results from the Samlesbury site suggest that ISO 50001 is altering the energy culture on site, at a variety of scales, to make it more energy efficient. There are many references throughout Section 9.2.2 and Chapters 4 and 7 to ISO 50001 and the changing energy practices taking place on site. At a site and building level, infrastructure has changed, which enables the monitoring of energy use to at least building level. This is changing individual and work team energy practices through the experimenting with ramping up and ramping down of machinery. The York and Louisville sites (Chapter 7) also made many reference to building regulations and legislation that impact their energy renovations and subsequently change the way energy is used on site.
Work tasks	Work tasks associated with the business will directly impact the amount of energy used on site, and dictate many aspects of an energy culture. The tasks associated with the work of BAE provide the business with an income. For example, Chapter 7 detailed how the Louisville site was different to the York and Samlesbury sites as it was not a 'job shop'. The energy use of the site was directed by what work they had on at any particular moment in time, and this had an impact on their attempts to control or regulate energy use. Similar to the physical environment characteristic detailed below, the tasks an individual or work team need to complete will directly affect the amount of energy being used, and consequently the energy culture.
Managers	Section 9.3.1.6 explained how managers and key individuals can have an impact on energy cultures. The top-down, command and control nature of BAE suggests that employees do what their managers suggest, and managers can have an impact on the energy practices of buildings, work teams and individuals.
Physical Environment	Energy cultures are fundamentally influenced by the physical environment. At building, work team and individual levels, the machines and infrastructure, such as access to switches, can directly influence energy practices and the ability to turn on/off machines, lights and equipment. Section 9.3.1 gave details on how the physical environment could explain differences between office and manufacturing environments.

One of the problems with Figure 9:4 is the appearance of a hierarchical structure of the various energy cultures of an organisation. Figure 9:4 can be interpreted as showing the individual, who is included in the work team energy culture, which is then included in the building energy culture and then the organisation energy culture, implying that the individual only has the ability to be part of one work team energy culture, and only has the potential to impact or change one work team energy culture. However, this is not the case. Elzen *et al.,* (2012) acknowledge this issue with the presentation of frameworks as a hierarchical structure of multi-level perspectives, and propose a multi-level process (Figure 9:5).

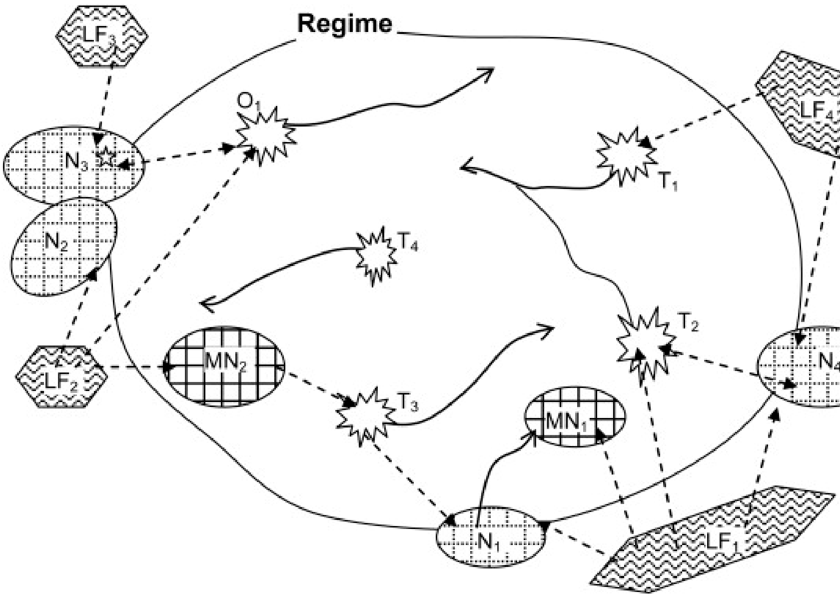


Figure 9:5 Multi-level processes in systems innovation (Elzen et al., 2012:5)

Figure 9:5 incorporates elements of the multi-level perspective but illustrates them in as a landscape of interacting 'niches' and 'regimes'. This figure achieves a presentation that does not suggest a hierarchical structure. Elzen *et al., (*2012) acknowledge the interacting nature of different levels (the niche and regimes, in their terminology). They argue that:

> ' … linking is an active process, involving translation, and not a matter of simply transferring socio-technical practice from a niche to a regime or vice versa.'
>
> (Elzen *et al.*, 2012:3)

This is of relevance to the research, where themes such as the physical environment may be characteristic of many energy cultures of the business. However, a certain theme might direct energy use in one area more than another. For example, office environments might have easier access to switches to turn equipment off than manufacturing areas.

A workplace is full of individuals (employees) each with their own unique energy culture, which is influenced by experiences outside the workplace. In some cases these individuals will be part of a wider work team energy culture, and possibly building energy culture. However, depending on the role of the individual, this might not be the case. For example, a chief executive might work on his/her own and not spend much time in an open-plan office, and so not participate in a building energy culture. In addition, an individual can be a member of multiple energy cultures, which might be at the same scale. For example, a manufacturing manager might be a member of multiple building energy cultures. Figure 9:4 fails to illustrate the variety of interactions between energy cultures. To help explain the interacting nature of energy cultures, Figure 9:6 was developed. It draws on the work of Elzen *et al.,* (2012).

Figure 9:6, along with Table 9:3, demonstrates the various interactions of energy cultures within an organisation. Chapter 10 refers to this figure to discuss areas for future research. As Table 9:3 shows, an important feature of Figure 9:6 is the illustration of how one individual can have an impact on other energy cultures. The table suggests how an individual, such as the chief executive, can have a significant influence on the site energy culture, and consequently on the building and work team energy cultures. This pinpoints how the framework incorporates the debates surrounding the dualisms of structure and agency. The framework provides an opportunity to examine both structure and agency, along with the various intersections between these dualisms.

The example of the role of the chief executive demonstrates how one energy culture can be a systemic influence on other energy cultures. If one were to examine an energy culture of an organisation by applying the framework in Figure 9:2 at the desired scale for investigation, an appreciation that wider energy cultures may interact with the one under investigation would be needed. Figure 9:6 begins to unravel this complexity of interacting energy cultures from the data produced in the thesis. Further research is needed to examine these interactions further, a theme that is expanded on in Chapter 10.

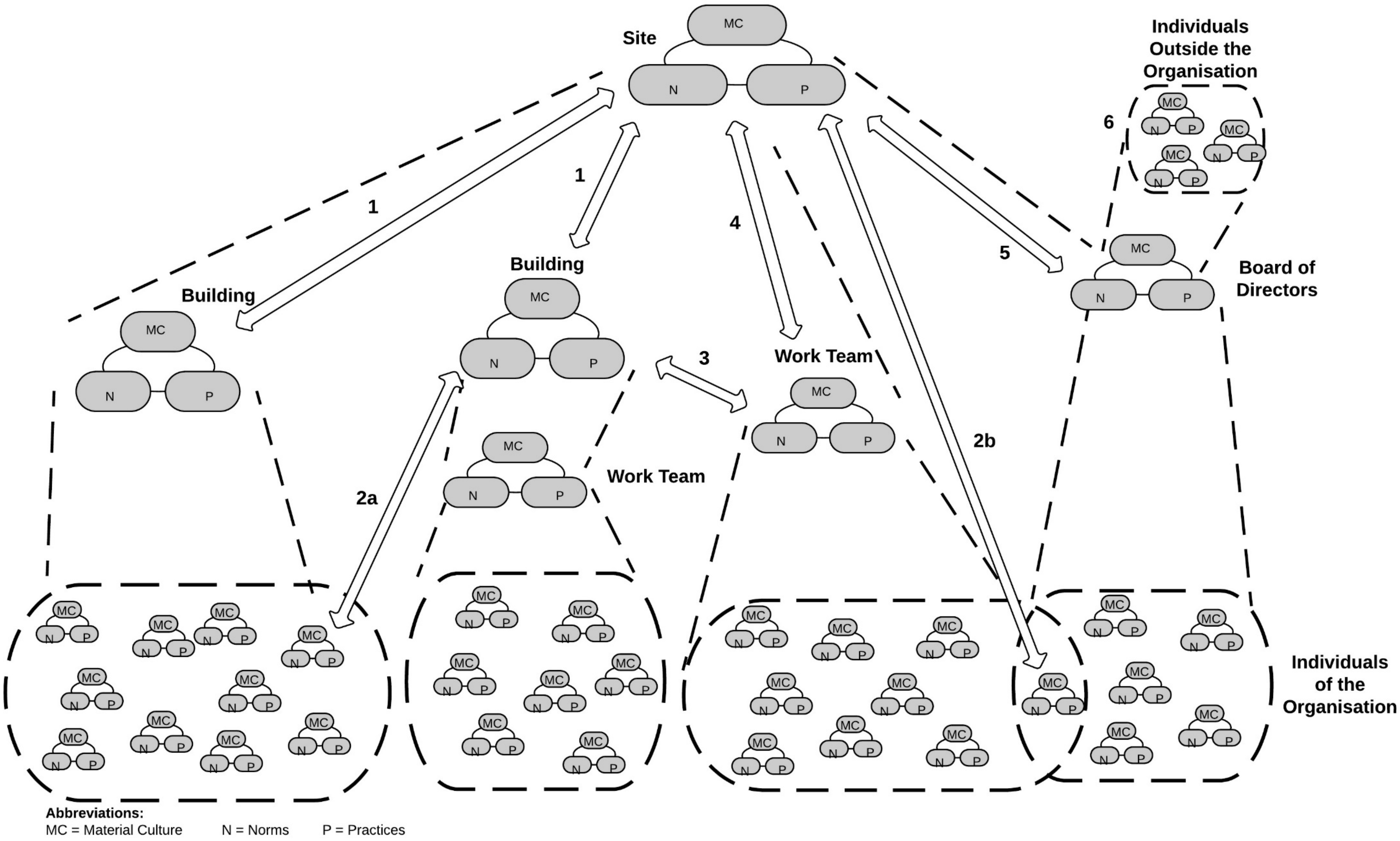


Figure 9:6: Interaction of the energy cultures at varying spatial scales. Please refer to Table 9:3 for details on the labelled arrows.

Table 9:3 Explanation of the annotated labelled arrows in Figure 9:6

Annotated labelled arrow	**Description**
1	Demonstrates the connection between a site and a building. A building sits within a site, so will be impacted by any wider site energy culture. However, a building could also influence a wider site energy culture. At the Samlesbury site, energy-efficiency measures are trialled in a specific building first, and if successful are rolled out to other buildings. An example of this is the trialling of ramping up and down of machinery, which was successful in one building and is now being implemented elsewhere.
2a	Demonstrates how an individual can be a member of multiple energy cultures. The example in Figure 9:6 suggests how an individual could be a member of multiple building energy cultures. They can also influence multiple energy cultures. For example, an individual, such as a head of business, might be responsible for multiple buildings. The decisions they make can have an impact on several energy cultures.
2b	Similar to 2a, an individual is a member of the overall site energy culture, but could also significantly impact the wider site energy culture and the energy practices occurring on site. For example, a head of site will have their own individual energy culture, and may be part of the energy culture of the building they work in, but can significantly affect the wider site energy culture through the decisions they make.
3	Demonstrates how work teams can have their own energy culture, but can also be part of wider building energy cultures. They might adhere to the norms of the building energy culture or have their own energy-efficient culture, which might have an impact upon building energy cultures.
4	Similar to 3, a work team may not be part of a building energy culture. A work team could work in isolation from the rest of the building, and not have contact with other work teams. However, they may be part of a wider site culture. Again, this could be a two-way interaction. For example, if this work team is the SHE function, the suggestions they make and implement can have impacts on the wider site energy culture.
5	This link is explained further in Chapter 10 when considering areas for future research. It suggests that the board of directors might have their own energy culture, which will have an impact on the wider energy culture. The board of directors is composed of a number of individuals who each have their own energy culture, which will contribute to the wider energy culture of the board. This energy culture, and how board members prioritise energy use, will have a direct impact on the site, and consequently on the energy culture of the site. Additionally, the energy culture of a site might influence the decisions made at board level, and the energy culture of the board. Organisational cultures can take time to develop (e.g. the safety culture described in Chapter 5), so decisions made by the board will need to consider the impact on the site, and how they can be implemented.
6	The annotation seeks to identify how the individuals who make up the board, but who might not be BAE employees, might have individual energy cultures that are influenced by their experiences, and by other organisations that they have worked in. More details on this topic are provided in Chapter 10 in the discussion of areas for future research.

9.4 Energy Cultures and Time

'For geographers, time cannot be studied independently of space.'

(Taylor, 2003:152)

The above section explained how the energy culture framework (Stephenson *et al.*, 2010, 2015) can be modified to include the variety of spatialities at which energy cultures can be examined. However, as the above quotation suggests, geographers see time and space as intertwined, and consequently have an interest in the concept of time (Dodgshon, 2008). This section acknowledges this entwined nature of space and time by discussing the interaction of energy cultures with time.

During focus groups and interviews at the Samlesbury, York and Louisville sites it became apparent that the energy cultures of the sites are changing with time, to become more energy efficient. This is not surprising considering the range of influences on energy use, which the thesis has already indicated can change. This section does not present a discussion of changes of energy culture by site; instead, it focuses on the cross-cutting themes of energy monitoring, physical environment, policy and standards. In so doing, it provides examples specific to each site, while also detailing what the research determines to be the key drivers for an energy-efficient culture in industrial work environments.

Energy Monitoring

The Samlesbury, Louisville and York sites all have energy monitoring systems, as discussed in Chapters 7 and 8. It was noted that these monitoring systems were recent installations and the level of monitoring varied between sites. The Louisville and York sites installed their energy monitoring systems in the last five years and only currently monitor to substation level. The Samlesbury site has more metering zones and has been metering for the last 10–15 years. Samlesbury currently monitors individual machines using portable monitors. All three sites detailed how the level of monitoring had changed in recent years. At Samlesbury, TM2 and TM3 stated:

'When I first joined, I think there were seven electricity zones on Samlesbury site, there's now twenty five … [some buildings have] metering inside on the presses and ovens and things like that … some of [the] individual bits of kit use more [energy] than some of the other buildings on site … '

TM2 Extract 2

This extract demonstrates how Samlesbury has increased the level to which they can monitor energy use. Similar developments were noted at York and Louisville, where energy monitoring systems were installed in the last 5 years. The focus group participants saw this as the start of an evolving process of energy monitoring, with one Louisville participant commenting, 'I anticipate this being an evolution', and someone from York stating, 'I see the next five years will drive energy monitoring to the next levels' (originally cited in Chapter 5).

Within BAE, energy monitoring appears to result in changes in site energy use. The comments from York show how the monitoring system had provided the group with the ability to detect faults with electrical equipment, and to understand temperatures inside and outside buildings. This understanding of site energy use has consequently changed energy use on site through the way machinery is used (e.g. changes in the way forklift trucks are being used) and the closing of large manufacturing doors, to reduce energy wastage. At the Samlesbury site, the manufacturing and pilot focus group, along with TM2 and TM3, described how the site is exploring the 'ramping up and down' of energy-intensive machines to determine the optimum power level to leave the machines at when they are not in use. These examples provided from the qualitative results at each site suggest that knowledge obtained from monitoring results in changes in site energy use. It is also changing attitudes to energy use on site: prior to the energy monitoring data, employees did not explore ramping up and down of machinery or how they could reduce energy use by closing doors. Consequently the energy monitoring data is changing energy use on site, and is also leading to employees examining their activities to determine whether they could be more energy efficient. The thesis argues that knowledge from energy monitoring is leading to changes in energy culture. The extracts from the York and Louisville site presented above demonstrate how they anticipate monitoring will evolve in the near future, which suggests changes in the energy culture will be observed with the changes in energy monitoring.

Physical Environment

The manufacturing sites are continually changing due to customer demand, which has a direct impact on energy use. Figure 1:6 illustrates how the Samlesbury site has experienced several construction phases over the past 77 years. The interview with TM2 and TM3 demonstrates they have experienced construction on site:

'... we've had... one, two, three, four, five, six, six new buildings, I think go up.'

TM3 Extract 3

Here TM2 and TM3 are explaining how six buildings have been constructed on site in the past 10–15 years, which will have increased the energy use of the site. The buildings provide new physical environments where employees interact with equipment, and as Janda (2011) observes, 'People use energy not buildings'. The increase in buildings demonstrates the business's commitment to investment on the site. Extract 10, Chapter 5 suggested that new buildings and the investment associated with them create different cultures on site. This suggests that changes in energy cultures over time may be observed with new buildings on site, new investment and the change of employees who work in these new areas.

The Louisville and York sites had similar experiences with continual changes, resulting in changes in energy use and, the thesis argues, a change in energy culture. For example, facilities from the Minneapolis site moved to the Louisville site in recent years (Extract 9, Chapter 8), and consequently site energy use increased. The employees were required to interact with new machinery and equipment, which they may have been unfamiliar with. The facilities and SHE teams also needed to gain an understanding of the new equipment and processes involved. A new piece of machinery can change the day-to-day tasks of employees, which can lead to changes in the energy culture of the site. York provided an example related to changes in the physical environment by describing how fluctuating demand for products can change employee numbers on site, which changes energy demand. This is discussed in the next section as it involves wider political decision making.

Politics, Policies and Standards

The descriptions of the three sites in Chapters 7 and 8 provided examples of how changes in political decisions, policies and standards appear to change energy demand on site. These are discussed here, demonstrating how they can change energy cultures over time.

The York focus group said they experience fluctuations in employee numbers, which appeared to be related to wider national political decisions. Extract 19, Chapter 8 explains how between 2006 and 2008 the site had around three thousand employees. The site's energy demand will have increased during this period, and the wider energy culture will have changed. An increase in employees will have changed the individual elements of the energy culture framework, with a range of 'spill-over' behaviours (Austin *et al*., 2011; Whitmarsh and O'Neill, 2012) from other environments. The way energy is used on site will also have changed, with employees not being required to switch lights or machines off at the end of their shift, because another shift would be coming in straight after them. This example demonstrates how the York site energy culture is interlinked with wider national politics. The main customer for the York site is the US government, and, as Extract 19, Chapter 8 suggests, US involvement in the Gulf and Iraq wars increased demand for the site's products, which increased the number of employees on site, affecting the dynamics of the energy culture framework and consequently the energy culture of the site.

Fluctuating employee numbers can also have an impact on intervention strategies aimed at changing energy use. The description of the Samlesbury site energy culture demonstrates that the site uses a range of intervention methods. One of these is reiterating messages through visual reminders such as posters, painted floors and campaigns. However, if employee numbers are fluctuating, with employees not being employed on site for long periods of time, intervention campaigns which act as reminders to employees may not be successful. This means the energy culture of the site could change. New employees of the site will not be exposed to the intervention strategies for as long as current employees and may not undertake the associated energy-efficiency behaviours.

Another example of how energy cultures change over time was provided by the Louisville site, where the focus group discussed state policies that have changed aspects of site energy use:

> *'Whether you like it or not, we are naturally going to be dragged into it, with energy coming from natural resources, so a lot of this stuff is becoming codified over here, so we are under Kentucky building code … and we are under the energy conservation code which covers everything, so we renovated this building you are sitting in, about 7 years ago, and it had to go under a sort of comms check … that's why we've got the automated light switches, it's a requirement … that didn't exist 10 years ago.'*
>
> *Participant in Louisville Focus Group, Extract 4*

The extract uses the term 'code' to refer to the various building standards and policies that Kentucky State is implementing. It highlights how the changing policies of the state appear to be a driver of some energy-efficiency technologies that are being introduced on site. This demonstrates how wider political decisions are changing the physical environment on site, including the design of buildings, which will change the energy culture on site.

The final example of how energy cultures can change over time was observed at Samlesbury. When presenting TM2 and TM3 with preliminary survey results, they commented that they thought if the survey were to be completed again, in the same areas, they would expect different results. This comment was in response to the increased site efforts to achieve ISO 50001 accreditation in the period between survey distribution and the interview. Further reference to ISO 50001 has been presented throughout the thesis, with Extract 4, Chapter 5 detailing how it is changing the bottom-up communication methods, with an improved suggestions scheme where employees can write suggestions on cards. TM2 and TM3 also said in Extract 24, Chapter 6 that ISO 50001 was the most successful intervention applied on site to improve energy efficiency, and this was noticed over the past eighteen months. The site achieving ISO 50001 accreditation appears to have directly changed the energy culture of the site, with changes in bottom-up communications, a renewed focus on energy topics, base level reduction targets, and reinforcement of the importance of site energy efficiency from board level.

The empirical material collected at Samlesbury shows how ISO 50001 is directly changing energy use on site, and changing the energy culture of the site. This supports the theme of this section that energy cultures can change with time.

9.5 Methodological Findings

Undertaking the research provided a methodological insight into conducting research in an industrial workplace. Along with this, the researcher gained an understanding of how an EPSRC CASE award studentship can evolve over the course of a research project, with changes in university and organisational strategic priorities. These findings and experiences are a by-product of this energy culture research. The researcher did not seek to contribute knowledge to the research area during research design. However, during reflections and writing of the thesis, it became apparent that the experience of conducting research as an EPSRC CASE award student in an industrial environment could provide a valuable insight for future researchers conducting similar research.

Collaborations between industry and university are on the increase (Ankrah and Al-Tabbaa, 2015), and the relationship between these two types of entity has attracted academic attention focusing on topics of intellectual property, knowledge transfer, income generation, relationships and the type of partnership (Rappert *et al.*, 1999; D'Este and Patel, 2007; D'Este and Perkmann, 2011; Perkmann *et al.*, 2011, 2013). However, in a recent review of articles exploring industry and university relationships, it was noted that more research is needed to gain an understanding of the consequences of academic engagement with industry (Perkmann *et al.,* 2013; Ankrah and Al-Tabbaa, 2015). When reading around these topics, the researcher noted that there does not appear to be any research exploring changes in strategic priorities and the impact they can have on research partnerships. This section begins to address this by presenting a discussion of the experience of conducting research in an industrial workplace.

There is a growing need for academics to disseminate their research to non-academic audiences to improve Research Excellence Framework (REF) scores (Parker and van Teijlingen, 2012; Jarman and Bryan, 2015). Consequently, it is anticipated that partnerships between industry and academia will continue to grow (Perkmann *et al*., 2013). The thesis argues that researchers need to be aware of potential challenges (e.g. access, goal conflict, access to participants) when conducting research in a workplace environment, and should understand that a strategic partnership with industry does not provide solutions to these challenges. From an industrial perspective, the researcher agrees with Perkmann *et al., (*2013), who recognise that industry needs to be 'skilled in initiating and maintaining' collaborations (Perkmann *et al.,* 2013:433), and recommends greater attention be paid to the structure of CASE awards from the organisational perspective. Researchers also need to be aware that changes in strategic priorities of both academic institutions and industry can alter engagement levels in research projects.

As detailed in Chapters 1 and 6, the research was in association with the Centre of Energy and Power Management. The centre was established from a £1 million five-year strategic partnership between UCLan and BAE, and the researcher was appointed in 2012, which was three years into the partnership. The vision for the partnership was for the Centre to become a centre of excellence for energy research by 2017 (UCLan, n.d.). However, during the course of the research, the researcher experienced changes in both UCLan's and BAE's strategic priorities. Chapter 6 narrates how strategic priorities changed within BAE, from a business seeking to explore the development of energy products, to a focus towards site energy and improving energy efficiency. It was suggested by the core BAE team that some of the methodological challenges associated with getting surveys completed and engaging employees with the research may be associated with a change in strategic priorities at BAE.

The strategic priorities of UCLan also changed during the course of the research. The university underwent a restructure of departments, and change in Vice-Chancellors. With these changes and the partnership with BAE ending, the Centre of Energy and Power Management disbanded, and members of staff, including members of the supervisory team, moved to other universities.

A variety of factors influence the success of any research conducted from an industry and academic partnership. Ankrah and Al-Tabbaa (2015) categorised them into the following seven groupings: capacity and resources, legal issues and contractual mechanisms, issues relating to the technology or research, political issues, social issues, other issues such as risk and geography, and management and organisational issues. They identify within the management and organisational grouping factors such as communication, leadership and top-management commitment, organisational structure and culture (Ankrah and Al-Tabba, 2015). Their review article suggests the experience of the researcher during this EPSRC CASE award is not uncommon. However, early career researchers, with no experience of managing industrial partnerships and/or large research projects, may not be aware of these factors influencing successful projects, and may be naïve about the whole process. From reflecting on the research undertaken during this EPSRC CASE award, improvements in the management of the research from the perspectives of the researcher, university and BAE could have been made. The research suggests that researchers should be aware of factors that could influence the success of a research project, with the aim of preventing them from becoming issues. The researcher argues that this could be achieved through education programmes or literature directed from research councils involved in CASE partnerships.

In addition to changes in strategic priorities affecting research and research methods, the nature of how CASE award studentships are established and conducted needs reconsidering. From a student's perspective, they are highly attractive as they offer a studentship, access to equipment, funds for attending conferences and for equipment, and a valuable opportunity to work with industry. However, they do not appear to be as structured from an industrial perspective. As detailed in Section 9.2.6, the core BAE team involved in the research were all volunteers, with an interest in energy topics. TM2 and TM3 were not directly assigned to this PhD, and their assistance with the research was in addition to their day-to-day tasks, and was often conducted during their spare time. During the course of the research there were many delays in the schedule (detailed in Chapter 3) due to unanswered emails, and difficulties in obtaining completed surveys and gaining access to employees to conduct research. The researcher considers this to be due to goal conflict of work tasks and not out of a lack of interest in the research. All the core team were extremely apologetic when tasks were not completed on time and the research would not have been conducted without them. However, the thesis argues that improvements could be made to the structure of CASE studentships from an industrial perspective. It suggests that improvements of time allocation to research could assist employees with goal conflict and ensure colleagues and line managers are supportive of research.

9.6 Conclusion

This chapter has focused discussions on the evolution of the workplace energy culture framework. It has demonstrated how the key findings of the thesis, presented in earlier chapters, can be incorporated into Stephenson *et al.*'s (2010, 2015) energy culture framework. However, in explaining this incorporation, it has highlighted how an appreciation of the multi-scalar nature of energy cultures in the workplace is required. Consequently, this chapter used Stephenson *et al.*'s (2010, 2015) energy culture framework as a foundation to examine energy use. Building on this foundation, this chapter presented Figures 9.4 and 9.6 to illustrate the multi-scalar nature of energy cultures and the interacting links between them.

Figure 9.4 acknowledges the limitations of Stephenson *et al.*'s (2010, 2014) energy culture framework, and demonstrates how spatiality can be incorporated into it. It also demonstrates how some of the characteristics and systemic influences of an energy culture can cross-cut multiple energy cultures. Acknowledging the hierarchical structure of Figure 9:4, Figure 9:6 and the associated table were presented to demonstrate the interconnected nature of energy cultures within a business.

This chapter has acknowledged some of the challenges with presenting frameworks, and how they can often articulate hierarchical structures. In an attempt to overcome this challenge, figures have been presented, along with detailed discussions that demonstrate the multi-connected nature of energy cultures.

Along with focusing on the evolution of the workplace energy culture framework, and presentation of a framework to inform future research on energy cultures in the workplace, this chapter has also discussed some methodological findings. These discussions are valuable for future industry and academic collaborations, particularly those involving early career or inexperienced researchers.

10 Conclusion

This chapter describes how the research aim:

Apply an energy culture approach to examine energy use in an industrial workplace

and objectives:

1. *Define a framework for informing research on energy cultures in the industrial workplace,*
2. *Detail the evolving nature of organisational priorities and organisational cultures,*
3. *Detail and review employees'- attitudes towards energy use,*
4. *Examine the geographies of energy cultures*

have been addressed throughout the thesis.

This concluding chapter provides an overview of the main findings of the research, while also detailing how the research aim and objectives were addressed. It also reflects on the results of the thesis to provide some recommendations for BAE and other organisations wishing to improve or create an energy-efficient energy culture. The chapter concludes by highlighting some limitations of the research and suggesting some areas for future research.

10.1 Addressing the Research Aim and Objectives

The overall aim of the thesis was to apply an energy culture approach to examine energy use in an industrial workplace. This was done through the presentation and description of the Samlesbury (Chapter 7), Louisville and York (Chapter 8) energy cultures. To achieve this aim, and to assist future research, four research objectives were created that directed the research.

Research Objective 1: Define a framework for informing research on energy cultures in the industrial workplace

One of the main narratives of the thesis was the development of an energy culture framework. Chapter 2 explained why a cultural approach was taken to examine energy use and proposed a workplace energy culture framework to inform the research in the thesis. The framework was established from a thorough review of the wider energy and pro-environmental literature, and frameworks applied to examine energy and pro-environmental behaviours. By applying the energy culture framework, the thesis has detailed the energy cultures of Samlesbury, York and Louisville.

After reflecting on the application of the workplace energy culture framework and the multi-scalar nature of the energy cultures observed in the thesis, it was determined that the empirical results could have been obtained by applying the framework proposed by Stephenson *et al.,* (2010, 2015). Chapter 8 detailed this development and demonstrated how the key findings of the thesis can be incorporated into the energy culture framework. However, during this reflective process, it became apparent that a modification of Stephenson *et al.*'s (2010, 2015) framework was required to demonstrate the multi-scalar nature of energy cultures. Chapter 9 presented this modification in Figure 9:4 and Figure 9:6, which highlighted how Stephenson *et al.*'s (2010, 2015) energy culture framework could be applied to inform future research on energy cultures in an industrial workplace. A discussion on how this framework could be further developed is presented in the next section.

Research Objective 2: Detail the evolving nature of organisational priorities and organisational cultures

Chapter 6 directly addressed this objective. It described the safety culture of the site, along with a discussion of the changing organisational priorities in relation to safety and energy. This description detailed the dominant nature of the safety culture on BAE sites and how it is engrained into the business structure and everyday tasks. Chapter 6 also provided details on how the safety culture evolved with a change in CEO and became engrained in day-to-day activities through top-down communications, employee objectives, role play and the 'Think Safety First' campaign.

When exploring the evolving nature of organisational priorities, the research highlighted how changes in strategic priorities can influence activities on site. Along with showing how safety became a business priority, Chapter 6 also detailed how wider economic and political decisions can change and influence strategic decision making. During the course of this PhD research changes in strategic priorities in BAE, from a focus on energy as a product for developments and a business opportunity, to improving energy efficiency as a means of cost saving for the business, were observed. The research demonstrated how this changed energy use on site, and how a more energy-efficient culture at the Samlesbury site developed.

Chapter 8 also looked at how evolving organisational priorities can have methodological implications for research. It detailed how changes in the strategic priorities of UCLan and BAE impacted the research. This provided a valuable insight for future research involving lengthy interaction with businesses, and is expanded upon below.

Research Objective 3: Detail and review employees' attitudes towards energy use

Chapter 3 described how a survey was designed to address key themes of the workplace energy culture framework presented in Chapter 2. The results of this survey, the manufacturing focus group and the interview with TM2 and TM3 (presented in Chapter 4), directly address this research objective. An overview of the findings follows. The majority of employees on site:

- do not know how much energy their team or department use; employees who do know these figures often struggle to understand and relate to them
- know who is responsible for switching off lights, machines and equipment and where the switches are
- know what to do to save energy within the workplace. However there appears to be a distinction between immediate workplace equipment and wider shed equipment, with employees turning off immediate workplace equipment, including personal items such as radios, computers and individual work lights, but not wider shed equipment;
- think line managers and colleagues do not influence their energy use
- know who to speak to about suggestions regarding energy savings but are unsure whether their suggestion will be taken seriously, and whether they will receive feedback. There was a mixed response of agree and neither agree/disagree answers on whether employees are encouraged to make suggestions. As discussed in Chapter 9, it appears this may be changing with improved suggestion boards driven by the ISO 50001 initiative
- think energy is an important issue for BAE
- are unsure or do not think they receive enough supervision and guidance on saving energy at work
- do not think they receive enough training on energy saving in the workplace
- do not think their line managers influence energy use
- do not discuss topics of energy use regularly with work teams or colleagues
- regularly conduct energy saving practices and make an effort to reduce energy use in work
- are concerned about rising energy costs for BAE and think energy should be a higher business priority. However, they do not think these costs will affect their day-to-day tasks
- are unsure what BAE is doing to improve energy efficiency.

The results also demonstrated that energy and environment champions do not appear to influence how employees use energy. Employees do associate the SHE function with energy topics, and SHE influences employees' energy use. However, safety topics are often associated with the SHE function before energy topics. Research also highlighted how some work teams are more conscious of their energy use, and conduct more energy-saving practices compared to others.

Research Objective 4: Examine the geographies of energy cultures

The geographies at which energy cultures were examined in the thesis are at the local level, exploring differences between office and manufacturing areas, and at an international level, exploring the energy cultures of different BAE sites. The thesis has also indicated how energy cultures may exist on site at more micro levels of individual work teams. This led to the evolution of the energy culture framework to include an appreciation of the geographies at which energy cultures can be examined, as described in Chapter 8.

At a local level, as presented in Chapter 5, an independent *t*-test found differences between the office and manufacturing areas for the following themes:

- immediate work environment influences, which included questions exploring the influence of work teams, colleagues and line managers
- employee energy suggestions and feedback, which consisted of questions exploring employees' ability to make suggestions and receive feedback on these suggestions;
- workplace energy practices, which explored the way employees use equipment in work
- workplace energy reduction knowledge, which focused on employee knowledge about turning equipment, machines and lights off
- attitudes towards business approaches to energy use, which included questions exploring supervision, guidance and BAE approaches to reducing energy use
- influence of the SHE function, which included questions on how the SHE function influenced energy use of employees.

Chapter 8 presented a discussion focused on the systemic influences of communication, physical environment and key individuals, which begins to explain the differences between the themes above.

At an international scale, Chapter 7 detailed the energy cultures of the Louisville and York sites. The discussions in this chapter showed how the Samlesbury site has a more evolved energy-efficient culture than the York and Louisville sites. Samlesbury has a more evolved site energy monitoring system, and has begun to integrate this information into the SHE function and the energy and environment champions.

10.2 Recommendations for BAE Systems and Other Organisations

The thesis concludes by reflecting on the results and outlining a number of recommendations for BAE and other organisations that want to develop an energy-efficient culture. The thesis has argued that every business will have an energy culture, and there may be, as experienced within BAE, multiple energy cultures existing at different scales of the business. However, these energy cultures may not be energy efficient. To create or develop an energy-efficient culture, the thesis argues that an appreciation of the current energy culture is needed. The thesis proposes that any organisation seeking to develop an energy-efficient culture needs to investigate and acknowledge the existing energy culture. To do this, organisations should apply the energy culture framework (Stephenson *et al.*, 2010, 2015) and develop a list of characteristics and systemic influences for the existing energy culture. As Figure 9:4 and Figure 9:6 demonstrate, organisations also need to acknowledge that different areas of the business can have different energy cultures, with some being more energy efficient than others, and that energy cultures are interlinked.

The research proposed that a review of the existing energy culture, in a format similar to an audit, needs to occur. Ideally, this process should involve someone outside the organisation, such as an academic. This is to ensure that no characteristics or systemic influences are ignored. It was noticed during field work that the researcher would acknowledge numerous themes that employees of BAE did not. There is a chance that employees of a business, especially those who have been employed for many years, can be so involved in the wider organisational culture that they might not acknowledge or appreciate the various systemic influences which could assist with developing an energy-efficient culture. Completing an audit and developing a picture of the existing energy culture will provide an organisation with a list of characteristics and systemic influences, which can then be targeted for change. Changing the systemic influences will have an impact on characteristics of the energy culture, and consequently change the energy culture. If an audit has been completed initially, then subsequent audits can take place to monitor the change in energy culture. This has the potential to allow organisations, over a period of time, to understand patterns of organisational culture change, and to determine how changing certain activities can change the wider energy culture.

By undertaking audits regularly, patterns of change and targets can be created. The production of targets could then be used as a means to develop an energy-efficient culture. Chapter 5 highlighted how during the creation of the safety culture at BAE, a combination of top-down communications from the chief executive and senior-level targets, which were related to bonuses, was implemented. These interventions assisted in driving change and creating a safety culture.

In addition to auditing and creating targets, the thesis has identified the following specific ways in which an energy-efficient culture may be created at a site or business level:

- *Implementing ISO 50001*: the thesis has shown how a drive to achieve ISO 50001 status and meet the ISO auditing requirements has changed the way energy is thought about and used at Samlesbury. The research recommends that other BAE sites, and other organisations, should seek to achieve ISO 50001 accreditation, to develop an energy-efficient culture.
- *Top-down communications*: in an organisation similar to BAE where a command and control culture exists, top-down communications about energy use can help create an energy-efficient culture. Chapter 5 demonstrated how top-down communications assisted in creating a safety culture at BAE. A similar process could be implemented to create an energy-efficient culture.
- *Energy monitoring*: increasing the ability to monitor energy use on site can assist in creating an energy-efficient culture, as seen from the sites examined in the research. This energy monitoring may be partially driven by top-down communications, where sites have been asked to reduce running costs, but all the sites examined have increased their ability to monitor energy in recent years. This has contributed to them all being more knowledgeable about their energy use, and to some changes in site energy practices.

At a local level, the thesis has found that the enthusiasm of key individuals is invaluable in creating a local energy culture. An example of this can be seen in Chapter 5, where colleagues of TM3 knew their manager was on board with energy efficiency and green infrastructure, so they approached him with ideas to improve the energy efficiency of the site. If businesses want to improve energy culture at a local level, the enthusiasm of key individuals should be encouraged. One method to implement this would be to develop a survey similar to that produced by Ucci *et al*., (2012), which could create a score to determine the energy culture of individuals, in a similar way to the NEP scale (Dunlap *et al*., 2000). By developing a survey and creating a score, an organisation could gain an understanding of their employees and appoint enthusiastic individuals to areas where they wish to develop a more energy-efficient culture. This technique is partially implemented in BAE, with the EE champions. However, as this is a voluntary role, there is no audit of how energy efficient or 'green' the members of staff are. From conversations with TM2 and TM3, it is hoped that the individuals have a genuine interest in the environment; however, as employees are paid for their time, some may take on this role for the monetary rewards. Auditing how energy efficient or 'green' a potential EE champion is could help improve the current EE champions arrangements.

Recommendations for BAE Systems

After visiting three BAE sites, it was acknowledged that knowledge transfer across the business was limited. Employees at York and Louisville were not aware of some of the techniques implemented at the Samlesbury site, and vice versa. The thesis recommends a space where members of the SHE functions and energy teams can discuss best practice and challenges they have experienced. This space could take the form of a physical conference/meet-up, or a virtual space such as a forum or virtual conference where members could communicate with each other. The thesis acknowledges some of the challenges in engaging employees with virtual practices (Leonard, 2011; Cebrián *et al.,* 2015) but if the business wants this to happen, directs employees to participate, and provides them with time in their day to participate, the researcher believes it could be a success. The SHE members of staff that the researcher came into contact with were all engaged in trying to improve energy efficiency. Each member of staff was interested in hearing more about the various sites and the different approaches being implemented to improve energy efficiency. It is anticipated that, if an opportunity arose and time was allocated, each of these members of staff would participate in teleconferences with other SHE functions in different businesses. It appears that, within the different businesses of BAE, knowledge is shared between SHE functions, but does not appear to be shared with other businesses.

10.3 Limitations and Areas for Future Research

The above recommendations and suggested steps for BAE and other organisations wishing to develop an energy-efficient culture hint at areas for future research. This section expands on these. It also highlights some limitations of the research and explains how future research could address these. These limitations and areas for future research are discussed under the following themes: empirical applications, methodological advances and theoretical developments.

Empirical Applications

The thesis applied an energy culture approach to examine energy use in one industrial workplace. Applying this approach to other work environments would be beneficial to gain a greater understanding of how organisations use energy. Andrews and Johnson (2016) call for a need to examine sector-specific research, and the researcher agrees with this call, but also argues for a need for cross-sector research and comparison projects exploring similarities and differences between sectors. Lo *et al*., (2012) provide a similar call for future research by outlining how little research exists that examines more than one organisation in their research sample. The results from research addressing these calls could then inform research on energy-efficiency policies and interventions.

Future research could also examine in detail individual energy cultures, and the connection with how energy is used at home. The research has only partially examined individual energy cultures through surveys and focus groups. It attempted to examine differences between home and workplace energy behaviours through a group of questions in the survey, but the main aim of the survey was to understand the energy culture of BAE, and the individual was not the focus of the research. As highlighted in Chapter 2, many authors have argued for 'spill-over' of behaviours from one environment to another. By applying an energy culture approach to examine the individual, the differences and similarities between the domestic and workplace environments could be recognized. This information, along with further research on these differences, could inform policies that seek to improve energy efficiency in the UK.

Additional empirical applications also include the examination of different job roles and the variety of energy cultures at different spatialities. If similarities in energy cultures are found between different groups, or job roles, then workplaces could use this information to tailor interventions to change energy use. Research by Steg (2008) and Abrahamse *et al.,* (2005) has demonstrated that interventions tailored towards different groups appear to have more success at changing behaviour than non-tailored techniques. This application of the framework, to assist with tailoring interventions, builds on the work by Ucci *et al.,* (2014), who attempted to develop a questionnaire-based benchmarking tool to assess behaviour change potential in office and manufacturing environments. If this can be achieved, they argue, tailoring information to different groups can assist with behaviour change. By applying the energy culture framework, this furthers the work by Ucci *et al.,* (2014) as it acknowledges the wider systemic influences and characteristics, which can then be targeted to change behaviour.

Theoretical Developments

The thesis has taken a predominantly geographical approach to examining energy cultures in an industrial workplace. However, in the development of Figures 9.4 and 9.6, it was acknowledged that other disciplinary backgrounds could contribute to the energy culture framework and provide different viewpoints. Building on the research, academics from a variety of backgrounds, such as those interested in economics, history, politics, anthropology, sociology and organisational studies, could examine and apply the energy culture framework to other workplaces. It is anticipated that by doing this the energy culture framework would evolve further. Disciplines such as economics and organisational studies could add an understanding of how an organisation functions, and is driven or restricted by economics and finance.

The application of the energy culture framework in the research has hinted at how a disciplinary background in history and/or politics may assist with gaining an understanding of an energy culture and how it may have developed. Each site or organisation is entwined with the history of the business, and the history and politics of the country or region where it operates. The thesis has already highlighted how historic developments at a site can hinder energy infrastructure developments, with some buildings at Samlesbury not able to host some new infrastructure developments. The Louisville site also suggested that the history and politics of the wider region and country significantly impact the energy culture of the site. Being based in the US, where sustainability topics are not as prominent as in the UK, they argue, hinders some of the interventions they try to implement on site, because the wider national culture is not focusing on sustainability. This links with how the disciplines of sociology and anthropology could provide valuable insights into future energy culture framework developments. It is anticipated that with an interdisciplinary perspective, a framework could be developed that demonstrates in more detail the complex interactions with wider cultures and subcultures, both internal and external to the organisation. This would assist with future empirical applications of the framework, and with gaining an understanding of how energy is used.

Each characteristic and systemic influence identified in the thesis in the Samlesbury, York and Louisville energy cultures provides a topic area where future research could be conducted. The research has only scratched the surface of how detailed the discussions could be on the themes in Figure 9.3. Gaining a more detailed understanding of how each of the systemic influences and characteristics of the energy culture framework are created, interact with each other, and influence the wider energy culture would prove valuable for developing future energy-efficient cultures. The research could also contribute to policies and legislation that seek to reduce energy use within workplaces.

An additional theoretical development could see further research into the links and connections between the multiple scales of the revised energy culture framework (Figure 9:4 and Figure 9:6). As highlighted in Chapter 9, Elzen *et al.,* (2012) have discussed how the connections between different levels can break down and new connections form. Elzen *et al.,* (2012) argue that these breakdowns do not always lead to changes in the various interacting levels, and the same actions can occur. A theoretical example of this could be if a BAE site failed to achieve ISO 50001 accreditation, and attention was given to another strategic priority. If the link (ISO 50001) between different energy cultures broke down, would the current energy practices developed as part of ISO 50001 stop or continue? Future research should examine these linkages in greater detail to answer questions such as: What are the linkages between different energy cultures? What impact do the various systemic influences have on different energy cultures? Are they static, continually evolving or overlapping with other influences? And what happens to an energy culture if the linkage is broken?

Related to the above theme, a further research avenue could examine whether an energy culture could develop in a similar way to the safety culture encountered in the research. The thesis identified in Chapter 5 how a safety culture developed and became engrained into everyday activities. Safety is similar to energy use, in that employees do not seek to use energy; instead, they perform activities that use energy. As Hargreaves *et al*., (2013) state, energy is invisible. Similarly, safety is invisible. Due to the similarities between safety and energy, future research could explore whether an energy culture, or any other subculture, could become as established and engrained in everyday activities as the site's safety culture. The thesis acknowledges that underlying every safety culture or safety agenda is the well-being and safety of employees, making sure they are not injured or even killed during work activities. There are direct consequences to employees if they act in unsafe ways and the researcher is aware that the same ethos cannot be applied to energy activities. However, an integration of energy cultures with safety cultures may be an avenue to develop the energy efficiency of cultures in the workplace. More research is needed to examine the interaction of energy cultures with other cultures in the workplace.

Methodological Advances

To assist in the application of the energy culture framework, researchers could seek to develop a survey that easily examines an energy culture in a workplace. Linking to the earlier recommendations for business, creating a survey would assist with the auditing process. It would also make auditing the energy culture of a business, at whatever level is being examined, an easier process for organisations.

In addition to the future methodological applications of the energy culture framework, another methodological advance that the thesis has acknowledged is the need for a greater understanding and awareness of academic and industrial partnerships. The thesis has highlighted how changes in strategic decisions in a university and business can impact research agendas. To assist future researchers involved in similar projects, especially early career academics, research councils and universities could develop guidelines to make students and supervisors aware of potential challenges. Making students and supervisors aware of potential challenges and suggesting ways of overcoming them could improve the PhD CASE award experience for numerous researchers, while also ensuring the success of future research projects.

Limitations

In addition to some of the limitations previously mentioned, which have developed into calls for future research, the researcher acknowledges certain other limitations. First, the case study approach provides some limitations for the use of results derived from the thesis (Bryman, 2012). The researcher has acknowledged this limitation and has been cautious not to make concluding statements that have no application to other work environments. The previous section has also highlighted a call for future research to examine other workplaces.

Second, many of the results presented in the thesis came from a survey of employees at Samlesbury. As is common with surveys, the results may be subject to survey bias (Bryman, 2012), where surveys may be completed by a particular group of people, or people interested in the research. For example, Carrico and Riemer (2011) found that people who completed their survey were highly concerned about energy conservation. The survey used in the thesis attempted to explore this theme by including the NEP scale (Dunlap *et al.*, 2000) to determine individual environmental orientation. However, a poor response and a large number of missing answers prevented these questions from being examined. To overcome the limitation of survey bias, future research could apply different sampling techniques of employees. This would require access to employees' data from the organisation, which was not possible in this work environment. Linked with the previous point, another limitation of the research is the restricted validation of results through interviews and focus groups. As stated in Chapter 3, the research initially planned to conduct more qualitative data collection, but methodological challenges and problems with access to the site prevented this from occurring.

10.4 Conclusion

This chapter has detailed how the aim and objectives of the research were addressed in the thesis. It has also presented details on some limitations and has suggested areas for future research. The thesis has demonstrated how a cultural approach can be successfully applied to explore employees' workplace energy use. It has proposed a modification of the energy culture framework (Stephenson *et al.*, 2010, 2015), which identifies the multi-scalar nature at which energy cultures can be examined. By doing so, the thesis has detailed the important interplay of space, place and time on energy cultures. It has argued that researchers and organisations need to acknowledge these factors when gaining an understanding of how energy is used in the workplace.

In addition to the findings presented in this chapter, the thesis has demonstrated an evolution in the researcher's skills and abilities to conduct research. At the start of this EPSRC CASE award the researcher had no previous experience with managing industrial relations, conducting a multi-method research project, managing a large research project, writing and managing a large document, and software packages such as Endnote, SPSS and NVivo. This PhD research has also taught the researcher a lot about reflective thinking, critical evaluation and her individual learning/working challenges and abilities. In addition to the theoretical, methodological and empirical findings presented in this chapter, the thesis has also detailed a journey of learning new skills and maturing as a researcher.

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12 Appendices

Appendix 1:

Survey Consent and Information Sheets

Note: Original distribution was on A4

SECTION 1

In this section you will be asked questions focusing on the SHE (Safety, Health and Environment) function.

1) Are you aware of a SHE function within BAE Systems? *(Please mark the appropriate box)*

Yes ☐ No ☐ **If no please proceed to section 2**

a. Name 5 things you associate with the SHE function? *(If you are unable to write 5 things please write down as many as you can)*

1.
2.
3.
4.
5.

b. In the past year, name 3 impacts the SHE function have had on your work? *(If you are unable to write 3 things, please write down as many as you can)*

1.
2.
3.

c. Thinking of <u>your specific work environment,</u> have the SHE functions made any suggestions as to how to improve energy efficiency and reduce energy demand in your workplace?

Yes ☐ No ☐

i. Please give details of the suggestion?

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d. Please rate these statements by marking the relevant box

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
The SHE function influence how I use energy in work					
I associate energy related topics (monitoring, training, energy conservation) with the SHE function					

SECTION 2

In this section you will be asked questions focusing on energy/environment champions.

2) Are you aware that BAE Systems have energy/environment champions at the Samlesbury site? *(Please mark the appropriate box)*

Yes ☐ No ☐ **If no please proceed to section 3**

a. Are you aware of any energy/environment champions within your workplace? *(Please mark the appropriate box)*

Yes ☐ No ☐

i. If you are, please state the name(s) of the energy/environment champion(s)

b. What do you think is the purpose of energy/environment champions?

c. Please rate this statement by marking the relevant box.

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
The energy/environment champion/s influence how I use energy in work					

SECTION 3

In this section you will be asked questions focusing on your work environment and how energy is used. Definitions of 'energy use' and 'energy demand' are given below, the distinction between these is important so please read them carefully;

Energy use - how you personally use energy e.g. situations where you have the option to turn equipment/lighting on and off for a task to be completed.	**Energy demand** - processes which are vital for completing your day-to-day tasks which you have no direct control over e.g. heating, shop floor/office lighting. It is the amount of energy required to run specific equipment.

3) Have you, in the last 6 months, received any energy related training?

Yes ☐ No ☐

a. If you answered yes, please give details of the training e.g. what was the focus of it, who conducted it, how long did it last, when the training occurred. If you have received various training sessions please state as many as you can.

4) Are you aware of any current campaigns/activities/change in infrastructure aimed at changing **employee energy use** and/or **site energy demand** across the Samlesbury site?

Yes ☐ No ☐

b. If you answered yes, please give details of these current campaigns/activities/change in infrastructure.

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Energy use - how you personally use energy e.g. situations where you have the option to turn equipment/lighting on and off for a task to be completed.	**Energy demand** - processes which are vital for completing your day-to-day tasks which you have no direct control over e.g. heating, shop floor/office lighting. It is the amount of energy required to run specific equipment.

5) Are there any areas/processes where you feel more attention could be made to reduce **site energy demand**? Please be specific where possible.

Yes ☐ No ☐

a. If you answered yes, please give details

6) Are there any areas/processes where you feel more attention could be made to reduce **employee energy use**? Please be specific where possible.

Yes ☐ No ☐

a. If you answered yes, please give details

7) Are you aware of any energy saving targets for your area?

Yes ☐ No ☐

a. If you answered yes, please give details of what you know about the targets e.g. what the targets are, who is responsible for them, how you are made aware of the targets.

8) The next set of statements focus on training, supervision and energy targets. Please rate these statements by marking the relevant box.

		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
a	I get enough supervision and guidance on saving energy at work					
b	I have received enough training on energy saving (reducing energy use and energy demand) at work					
c	I know the amount of energy my team/department use					
d	**If you answered neither agree/disagree, disagree or strongly disagree please answer this question**. I would like to know the energy use of my team/department					

9) The next set of statements focus on BAE Systems and their approach to energy use and demand. Please rate these statements by marking the relevant box. Here is a reminder of the definitions;

Energy use - how you personally use energy.

e.g. situations where you have the option to turn equipment/lighting on and off for a task to be completed.

Energy demand - processes which are vital for completing your day-to-day tasks which you have no direct control over.

e.g. heating, shop floor/office lighting. It is the amount of energy required to run specific equipment.

		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
a	Energy demand is an important issue to BAE Systems					
b	Energy use is an important issue to BAE Systems					
c	Reducing energy demand should be a higher priority for BAE Systems					
d	Reducing energy use should be a higher priority for BAE Systems					
e	There is a greater focus on reducing energy use and energy demand at the Samlesbury site compared with other BAE sites.					
f	It is clear to me what BAE Systems is doing to reduce energy use and demand					
g	If I have a suggestion on how to reduce energy use and demand at work I know who to speak to					
h	If I make a suggestion on how to reduce energy use and demand, it will be taken seriously					
i	If I make a suggestion on how to reduce energy use and demand I will receive a response detailing any future changes or stating reasons for not implementing the suggestion					
j	Employees are encouraged to make suggestions which can reduce energy use and energy demand					

10) The next set of statements focus on energy use and demand within your specific work area. Please rate these statements by marking the relevant box.

		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
a	My line manager influences my energy use					
b	Within my specific work team we are conscious of our energy use					
c	Within my specific work team we regularly try to reduce our energy use					
d	Within my work environment, energy use and energy demand are discussed regularly					
e	I discuss ways to reduce energy use and demand with my work colleagues					
f	Colleagues within my work environment support the need to reduce energy use					
g	I would be well thought of by my line manager if I took actions to save energy at work					
h	I would be well thought of by my colleagues if I took action to save energy at work					

Please continue onto Section 4

SECTION 4

This section asks for information surrounding your employment at BAE Systems. These questions are immensely valuable for this study. They will assist in determining any background factors which may influence how energy is used in the workplace.

Please tick one of the following groups which your job fits into:

Managerial ☐ Skilled/Trade/Shop Floor ☐ Professional ☐

Building ☐ **Section** ☐

How long have you been in your current role? ☐

Length of time employed at BAE System: ☐

Gender: ☐

Age Group: Under 25 ☐ 25-30 ☐ 31-35 ☐ 36-40 ☐ 41-45 ☐
46-50 ☐ 51-55 ☐ 56-60 ☐ Over 60 ☐

SECTION 5

In this section you will be asked questions focusing on reducing energy use within your work environment.

> **Energy use** - how you personally use energy
>
> e.g. situations where you have the option to turn equipment/lighting on and off for a task to be completed.

11) Do you contribute to reducing your energy use within your work environment?

Yes ☐ No ☐

a. If you answered yes, please explain all the ways you contribute to reducing energy use. This research is in interested in finding out about all contributes, however big or small.

12) The next set of questions focus on how you use energy in your work environment. On a scale of 1 – 5 please circle how you rate following statements (1 = Strongly Disagree, 5 = Strongly Agree)

	At work………………	Strongly Disagree				Strongly Agree
a	I always turn equipment, which I personally use, off (where possible) after I have finished using it	1	2	3	4	5
b	I always turn equipment, which I personally use, off (where possible) at the end of the day/shift	1	2	3	4	5
c	If I am the only person in an area, I always turn lights off (where possible) after I leave that area	1	2	3	4	5
d	I always make an effort to reduce energy use, within the workplace	1	2	3	4	5

13) The next set of questions focus on how you use energy in your work environment. Please rate these statements by marking the relevant box.

		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
a	I am concerned about the cost of energy to the business					
b	I am concerned that rising energy costs will affect my day-to-day tasks					
c	If I notice a fault with equipment I am using, I always report this to my line manager					
d	I am more conscious of energy use than my work colleagues					
e	It is clear to me who is responsible for switching machines/equipment off during downtimes (when work areas are unoccupied e.g. Christmas)					
f	It is clear to me who is responsible for switching off the lights					
g	If I wanted to turn equipment/machines off in my work area, I know where the relevant switches are					
h	I know where the relevant light switches are to turn the lights off in my work area (if you have automated lights please ignore this question)					
i	I know what to do to save energy within the workplace					

Please continue onto Section 6

SECTION 6

In this section questions will focus on energy use within your home environment and your individual opinions on topics relating to energy use and the home environment.

14) On a scale of 1 – 5 please circle how you rate following statements (1 = Strongly Disagree, 5 = Strongly Agree)

	At home………………	Strongly Disagree				Strongly Agree
a	I always turn lights off after I leave a room	1	2	3	4	5
b	I always leave electrical goods on standby when not in use	1	2	3	4	5
c	I always turn electrical goods off at the mains socket when not in use	1	2	3	4	5
d	I always unplug my phone charger when not in use (If you don't have a phone please leave this question blank)	1	2	3	4	5
e	I always make an effort to reduce energy use	1	2	3	4	5

15) On a scale of 1 – 5 please circle how you rate following statements (1 = Strongly Disagree, 5 = Strongly Agree)

	At home……………….	Strongly Disagree				Strongly Agree
a	I am concerned about rising energy prices	1	2	3	4	5
b	Rising energy costs have affected my day- to-day tasks	1	2	3	4	5
c	I go around my home and turn off appliances/equipment that are not being used	1	2	3	4	5
d	I know approximately how much energy I use	1	2	3	4	5

Please continue to the last question

16) This question lists statements about the relationship between humans and the environment. This is an established environmental scale within the academic literature[1]. Please rate the following statements by marking the relevant box.

		Strongly Disagree	Mildly Disagree	Unsure	Mildly Agree	Strongly Agree
a	We are approaching the limit of the number of people the Earth can support					
b	Humans have the right to modify the natural environment to suit their needs					
c	When humans interfere with nature it often produces disastrous consequences					
d	Human ingenuity will insure that we do NOT make the earth unliveable					
e	Humans are severely abusing the environment					
f	The Earth has plenty of natural resources if we just learn how to develop them					
g	Plants and animals have as much right as humans to exist					
h	The balance of nature is strong enough to cope with the impacts of modern industrial nations					
i	Despite our special abilities humans are still subject to the laws of nature					
j	The so-called 'ecological crisis' facing humankind has been greatly exaggerated					
k	The earth is like a spaceship with very limited room and resources					
l	Humans were meant to rule over the rest of nature					
m	The balance of nature is very delicate and easily upset					
n	Humans will eventually learn enough about how nature works to be able to control it					
o	If things continue on their present course, we will soon experience a major ecological catastrophe.					

[1]Dunlap, R. *et al.* (2000). Measuring endorsement of the new ecological paradigm: a revised NEP Scale. *Journal of social issues.* 56 (3). Pp. 425 –

Thank you for completing this questionnaire.

Appendix 6

Correlation Matrix from Principle Component Analysis

Correlation Matrix[a]

		MEDIAN(Q1da,ALL)	MEDIAN(Q1db,ALL)	MEDIAN(Q8a,ALL)	MEDIAN(Q8b,ALL)	Q8c_1	MEDIAN(Q9a,ALL)	MEDIAN(Q9b,ALL)	MEDIAN(Q10a,ALL)	MEDIAN(Q10b,ALL)	MEDIAN(Q10c,ALL)	MEDIAN(Q10d,ALL)	MEDIAN(Q10e,ALL)	MEDIAN(Q10f,ALL)	MEDIAN(Q10h,ALL)	MEDIAN(Q12c,ALL)	MEDIAN(Q12d,ALL)	MEDIAN(Q13a,ALL)	MEDIAN(Q13b,ALL)	MEDIAN(Q13e,ALL)	MEDIAN(Q13f,ALL)	MEDIAN(Q13g,ALL)
Correlation	MEDIAN(Q1da,ALL)	1.000	.591	.276	.259	.156	.123	.117	.156	.158	.228	.163	.107	.154	.282	.045	.179	.101	.110	.224	.189	.071
	MEDIAN(Q1db,ALL)	.591	1.000	.280	.261	.113	.117	.132	.202	.144	.207	.096	.123	.095	.270	.070	.097	.087	.036	.207	.165	.112
	MEDIAN(Q8a,ALL)	.276	.280	1.000	.738	.357	.162	.167	.303	.266	.331	.319	.238	.277	.213	.179	.205	.181	.028	.343	.317	.227
	MEDIAN(Q8b,ALL)	.259	.261	.738	1.000	.334	.151	.159	.287	.237	.288	.320	.223	.237	.199	.148	.223	.155	.003	.342	.320	.172
	Q8c_1	.156	.113	.357	.334	1.000	.024	.082	.298	.295	.267	.532	.375	.197	.237	.018	.154	.096	.114	.172	.155	.032
	MEDIAN(Q9a,ALL)	.123	.117	.162	.151	.024	1.000	.736	.001	.009	.083	.060	.016	.121	.123	.145	.186	.299	.102	.111	.121	.023
	MEDIAN(Q9b,ALL)	.117	.132	.167	.159	.082	.736	1.000	.057	.045	.126	.097	.074	.160	.200	.209	.228	.284	.171	.099	.109	.091
	MEDIAN(Q10a,ALL)	.156	.202	.303	.287	.298	.001	.057	1.000	.575	.529	.525	.480	.346	.472	.125	.218	.075	.285	.247	.250	.127
	MEDIAN(Q10b,ALL)	.158	.144	.266	.237	.295	.009	.045	.575	1.000	.765	.556	.552	.486	.464	.099	.209	.163	.201	.200	.219	.179
	MEDIAN(Q10c,ALL)	.228	.207	.331	.288	.267	.083	.126	.529	.765	1.000	.509	.517	.529	.405	.161	.284	.181	.174	.239	.269	.178
	MEDIAN(Q10d,ALL)	.163	.096	.319	.320	.532	.060	.097	.525	.556	.509	1.000	.653	.417	.443	.027	.257	.195	.266	.220	.155	.198
	MEDIAN(Q10e,ALL)	.107	.123	.238	.223	.375	.016	.074	.480	.552	.517	.653	1.000	.449	.436	.087	.246	.218	.237	.240	.208	.213
	MEDIAN(Q10f,ALL)	.154	.095	.277	.237	.197	.121	.160	.346	.486	.529	.417	.449	1.000	.551	.184	.290	.349	.243	.155	.236	.255
	MEDIAN(Q10h,ALL)	.282	.270	.213	.199	.237	.123	.200	.472	.464	.405	.443	.436	.551	1.000	.202	.274	.293	.259	.154	.196	.211
	MEDIAN(Q12c,ALL)	.045	.070	.179	.148	.018	.145	.209	.125	.099	.161	.027	.087	.184	.202	1.000	.559	.141	.147	.232	.410	.161
	MEDIAN(Q12d,ALL)	.179	.097	.205	.223	.154	.186	.228	.218	.209	.284	.257	.246	.290	.274	.559	1.000	.291	.292	.249	.323	.161
	MEDIAN(Q13a,ALL)	.101	.087	.181	.155	.096	.299	.284	.075	.163	.181	.195	.218	.349	.293	.141	.291	1.000	.486	.190	.152	.205
	MEDIAN(Q13b,ALL)	.110	.036	.028	.003	.114	.102	.171	.285	.201	.174	.266	.237	.243	.259	.147	.292	.486	1.000	.089	.069	.077
	MEDIAN(Q13e,ALL)	.224	.207	.343	.342	.172	.111	.099	.247	.200	.239	.220	.240	.155	.154	.232	.249	.190	.089	1.000	.642	.351
	MEDIAN(Q13f,ALL)	.189	.165	.317	.320	.155	.121	.109	.250	.219	.269	.155	.208	.236	.196	.410	.323	.152	.069	.642	1.000	.328
	MEDIAN(Q13g,ALL)	.071	.112	.227	.172	.032	.023	.091	.127	.179	.178	.198	.213	.255	.211	.161	.161	.205	.077	.351	.328	1.000
	Q9f_1	.293	.317	.495	.517	.409	.189	.255	.390	.409	.443	.472	.350	.333	.326	.169	.392	.311	.202	.302	.225	.202
	MEDIAN(Q9g,ALL)	.030	.104	.133	.045	.409	.018	.088	.277	.116	.130	.213	.101	.135	.147	.067	.154	.146	.137	.096	.065	.047
	MEDIAN(Q9c,ALL)	.073	-.035	-.010	.018	-.043	.422	.348	.031	.047	.025	.094	.080	.170	.129	.138	.223	.277	.260	.035	.004	-.032
	MEDIAN(Q9d,ALL)	.145	.027	-.007	.008	-.040	.376	.354	.052	.036	.059	.100	.055	.118	.147	.137	.254	.296	.224	.088	-.008	-.046
	MEDIAN(Q12a,ALL)	.233	.115	.125	.077	.145	.181	.202	.103	.032	.122	.043	.101	.083	.165	.398	.546	.116	.158	.183	.162	.098
	MEDIAN(Q12b,ALL)	.190	.059	.103	.066	.151	.192	.211	.099	.059	.123	.061	.102	.125	.126	.350	.509	.158	.096	.167	.250	.052
	MEDIAN(Q9h,ALL)	.038	.089	.082	.016	.338	.059	.148	.282	.112	.149	.215	.077	.137	.189	.054	.112	.142	.151	.160	.135	.119
	MEDIAN(Q9i,ALL)	-.006	.023	.050	-.039	.293	-.011	.076	.265	.057	.059	.168	.038	.086	.148	.054	.070	.068	.150	.093	.067	.049
	MEDIAN(Q9j,ALL)	.054	.096	.147	.093	.343	.050	.122	.325	.142	.166	.216	.083	.101	.152	.043	.112	.128	.188	.141	.115	.085
	MEDIAN(Q10g,ALL)	.225	.290	.327	.301	.271	.084	.140	.505	.417	.374	.398	.428	.451	.780	.159	.190	.221	.235	.215	.228	.224
	MEDIAN(Q13c,ALL)	.087	.100	.030	-.045	.017	.065	.018	.205	.088	.101	.068	.132	-.006	.123	.034	.123	-.021	.185	.065	.050	.148
	MEDIAN(Q13d,ALL)	.028	-.004	.080	.008	.157	.018	-.015	.120	.187	.150	.176	.269	.151	.104	.148	.285	.170	.210	.079	.029	.155
	Q9e_1	.193	.136	.088	.072	.066	.180	.196	.124	.151	.203	.183	.093	.194	.184	.105	.257	.133	.155	.158	.102	.191
	Q14a_1	.253	.099	.068	.039	.088	.162	.156	.047	.083	.096	.056	.114	.104	.193	.273	.284	.133	.241	.062	.077	.056
	Q14b_1	-.003	.001	-.105	-.043	-.098	-.155	-.096	.047	.051	-.040	-.027	-.013	-.096	-.047	-.125	-.155	-.117	-.094	.001	-.036	.080
	Q14c_1	.101	.088	.050	-.021	.022	.018	.048	.135	.089	.081	.097	.170	.105	.043	.155	.262	.071	.269	.020	.054	.084
	Q14e_1	.116	-.004	.038	.021	.067	.137	.138	.107	.054	.102	.076	.176	.152	.094	.253	.375	.215	.355	.007	.082	.083
	Q15a_1	.157	.042	-.066	.009	.115	.188	.216	.048	.027	.025	.109	.115	.126	.102	.082	.220	.262	.281	.030	.020	-.060
	Q15b_1	.131	.017	-.111	-.100	.019	.018	-.016	.187	.158	.134	.205	.150	.127	.041	-.010	.082	.178	.346	.041	.061	.136

a. Determinant = 4.515E-11

		Q9f_1	MEDIAN(Q9g,ALL)	MEDIAN(Q9c,ALL)	MEDIAN(Q9d,ALL)	MEDIAN(Q12a,ALL)	MEDIAN(Q12b,ALL)	MEDIAN(Q9h,ALL)	MEDIAN(Q9i,ALL)	MEDIAN(Q9j,ALL)	MEDIAN(Q10g,ALL)	MEDIAN(Q13c,ALL)	MEDIAN(Q13d,ALL)	Q9e_1	Q14a_1	Q14b_1	Q14c_1	Q14e_1	Q15a_1	Q15b_1
Correlation	MEDIAN(Q1da,ALL)	.293	.030	.073	.145	.233	.190	.038	-.006	.054	.225	.087	.028	.193	.253	-.003	.101	.116	.157	.131
	MEDIAN(Q1db,ALL)	.317	.104	-.035	.027	.115	.059	.089	.023	.096	.290	.100	-.004	.136	.099	.001	.088	-.004	.042	.017
	MEDIAN(Q8a,ALL)	.495	.133	-.010	-.007	.125	.103	.082	.050	.147	.327	.030	.080	.088	.068	-.105	.050	.038	-.066	-.111
	MEDIAN(Q8b,ALL)	.517	.045	.018	.008	.077	.066	.016	-.039	.093	.301	-.045	.008	.072	.039	-.043	-.021	.021	.009	-.100
	Q8c_1	.409	.409	-.043	-.040	.145	.151	.338	.293	.343	.271	.017	.157	.066	.088	-.098	.022	.067	.115	.019
	MEDIAN(Q9a,ALL)	.189	.018	.422	.376	.181	.192	.059	-.011	.050	.084	.065	.018	.180	.162	-.155	.018	.137	.188	.018
	MEDIAN(Q9b,ALL)	.255	.088	.348	.354	.202	.211	.148	.076	.122	.140	.018	-.015	.196	.156	-.096	.048	.138	.216	-.016
	MEDIAN(Q10a,ALL)	.390	.277	.031	.052	.103	.099	.282	.265	.325	.505	.205	.120	.124	.047	.047	.135	.107	.048	.187
	MEDIAN(Q10b,ALL)	.409	.116	.047	.036	.032	.059	.112	.057	.142	.417	.088	.187	.151	.083	.051	.089	.054	.027	.158
	MEDIAN(Q10c,ALL)	.443	.130	.025	.059	.122	.123	.149	.059	.166	.374	.101	.150	.203	.096	-.040	.081	.102	.025	.134
	MEDIAN(Q10d,ALL)	.472	.213	.094	.100	.043	.061	.215	.168	.216	.398	.068	.176	.183	.056	-.027	.097	.076	.109	.205
	MEDIAN(Q10e,ALL)	.350	.101	.080	.055	.101	.102	.077	.038	.083	.428	.132	.269	.093	.114	-.013	.170	.176	.115	.150
	MEDIAN(Q10f,ALL)	.333	.135	.170	.118	.083	.125	.137	.086	.101	.451	-.006	.151	.194	.104	-.096	.105	.152	.126	.127
	MEDIAN(Q10h,ALL)	.326	.147	.129	.147	.165	.126	.189	.148	.152	.780	.123	.104	.184	.193	-.047	.043	.094	.102	.041
	MEDIAN(Q12c,ALL)	.169	.067	.138	.137	.398	.350	.054	.054	.043	.159	.034	.148	.105	.273	-.125	.155	.253	.082	-.010
	MEDIAN(Q12d,ALL)	.392	.154	.223	.254	.546	.509	.112	.070	.112	.190	.123	.285	.257	.284	-.155	.262	.375	.220	.082
	MEDIAN(Q13a,ALL)	.311	.146	.277	.296	.116	.158	.142	.068	.128	.221	-.021	.170	.133	.133	-.117	.071	.215	.262	.178
	MEDIAN(Q13b,ALL)	.202	.137	.260	.224	.158	.096	.151	.150	.188	.235	.185	.210	.155	.241	-.094	.269	.355	.281	.346
	MEDIAN(Q13e,ALL)	.302	.096	.035	.088	.183	.167	.160	.093	.141	.215	.065	.079	.158	.062	.001	.020	.007	.030	.041
	MEDIAN(Q13f,ALL)	.225	.065	.004	-.008	.162	.250	.135	.067	.115	.228	.050	.029	.102	.077	-.036	.054	.082	.020	.061
	MEDIAN(Q13g,ALL)	.202	.047	-.032	-.046	.098	.052	.119	.049	.085	.224	.148	.155	.191	.056	.080	.084	.083	-.060	.136
	Q9f_1	1.000	.257	.146	.167	.238	.223	.222	.154	.259	.303	.090	.198	.274	.055	-.066	.099	.090	.063	.033
	MEDIAN(Q9g,ALL)	.257	1.000	.038	.077	.138	.166	.873	.836	.856	.117	.078	.123	.049	.021	-.050	.090	.082	.094	-.050
	MEDIAN(Q9c,ALL)	.146	.038	1.000	.793	.221	.203	.076	.030	.062	.074	.028	.153	.154	.243	-.032	.120	.205	.297	.005
	MEDIAN(Q9d,ALL)	.167	.077	.793	1.000	.231	.195	.102	.078	.070	.087	.044	.141	.178	.240	-.115	.159	.203	.274	.020
	MEDIAN(Q12a,ALL)	.238	.138	.221	.231	1.000	.806	.142	.094	.133	.103	.210	.115	.182	.383	-.092	.221	.235	.254	.128
	MEDIAN(Q12b,ALL)	.223	.166	.203	.195	.806	1.000	.137	.098	.125	.027	.126	.153	.161	.343	-.062	.185	.240	.245	.077
	MEDIAN(Q9h,ALL)	.222	.873	.076	.102	.142	.137	1.000	.915	.902	.162	.076	.054	.056	-.001	-.030	.061	.052	.096	-.001
	MEDIAN(Q9i,ALL)	.154	.836	.030	.078	.094	.098	.915	1.000	.894	.115	.083	.064	.043	-.036	-.055	.107	.044	.060	.008
	MEDIAN(Q9j,ALL)	.259	.856	.062	.070	.133	.125	.902	.894	1.000	.148	.125	.018	.045	.035	-.034	.114	.070	.062	.003
	MEDIAN(Q10g,ALL)	.303	.117	.074	.087	.103	.027	.162	.115	.148	1.000	.103	.068	.080	.136	.049	-.022	.041	.144	.073
	MEDIAN(Q13c,ALL)	.090	.078	.028	.044	.210	.126	.076	.083	.125	.103	1.000	.119	.043	.166	.026	.183	.110	.070	.092
	MEDIAN(Q13d,ALL)	.198	.123	.153	.141	.115	.153	.054	.064	.018	.068	.119	1.000	.100	.141	-.004	.100	.207	.127	.090
	Q9e_1	.274	.049	.154	.178	.182	.161	.056	.043	.045	.080	.043	.100	1.000	.135	-.105	.217	.198	.222	.250
	Q14a_1	.055	.021	.243	.240	.383	.343	-.001	-.036	.035	.136	.166	.141	.135	1.000	-.090	.381	.572	.409	.139
	Q14b_1	-.066	-.050	-.032	-.115	-.092	-.062	-.030	-.055	-.034	.049	.026	-.004	-.105	-.090	1.000	-.216	-.176	-.087	.024
	Q14c_1	.099	.090	.120	.159	.221	.185	.061	.107	.114	-.022	.183	.100	.217	.381	-.216	1.000	.575	.298	.277
	Q14e_1	.090	.082	.205	.203	.235	.240	.052	.044	.070	.041	.110	.207	.198	.572	-.176	.575	1.000	.449	.201
	Q15a_1	.063	.094	.297	.274	.254	.245	.096	.060	.062	.144	.070	.127	.222	.409	-.087	.298	.449	1.000	.405
	Q15b_1	.033	-.050	.005	.020	.128	.077	-.001	.008	.003	.073	.092	.090	.250	.139	.024	.277	.201	.405	1.000

Appendix 7

Outcomes of PCA

Scree Plot and Total Variance Explained

PCA

Table 5 shows the initial SPSS output suggesting 10 components from the PCA. However when examining Figure 1 it was decided that it was more appropriate to have 8 components.

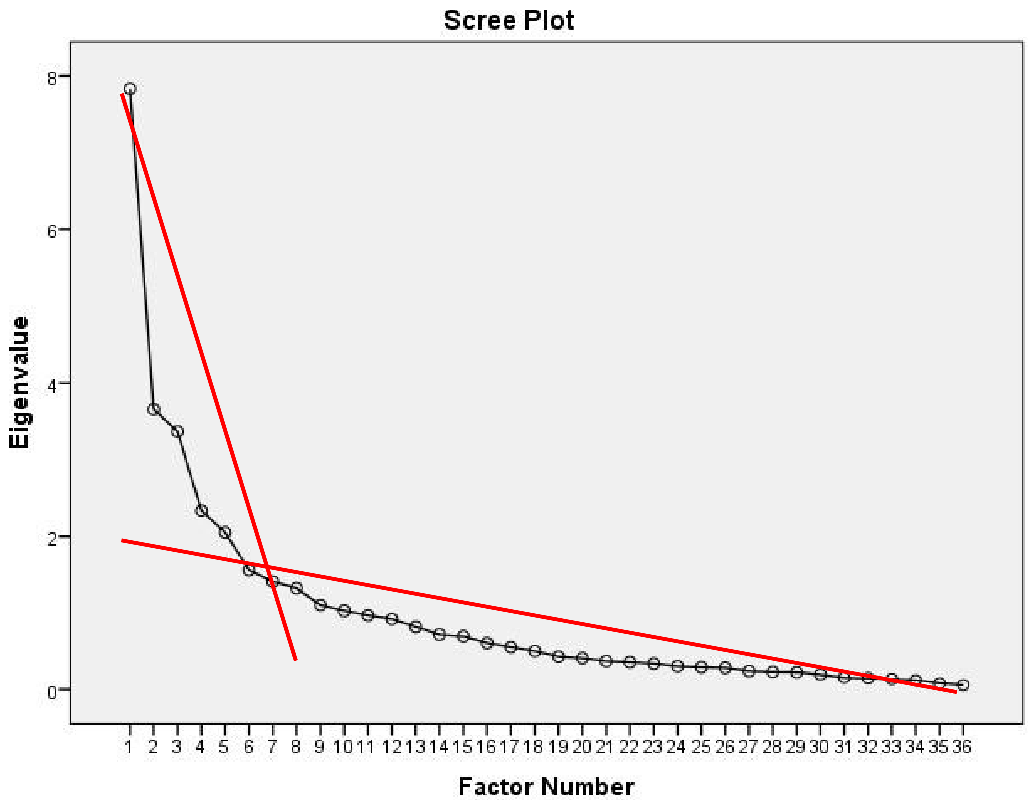

Figure 1: Scree Plot produced from PCA with Varimax Rotation for all variables excluding NEP (2 Variables), 9c, 13c, 13d and 14b. Note: red lines reflect visual indications

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.833	21.759	21.759	7.455	20.708	20.708	4.510	12.529	12.529
2	3.657	10.157	31.916	3.346	9.295	30.004	3.725	10.346	22.875
3	3.370	9.361	41.277	3.161	8.781	38.785	2.457	6.824	29.699
4	2.339	6.496	47.773	1.929	5.358	44.142	2.200	6.111	35.810
5	2.054	5.705	53.478	1.730	4.806	48.949	1.804	5.012	40.822
6	1.564	4.345	57.823	1.121	3.115	52.064	1.702	4.727	45.549
7	1.413	3.926	61.749	1.018	2.829	54.892	1.639	4.554	50.102
8	1.327	3.686	65.435	.956	2.654	57.547	1.558	4.327	54.429
9	1.107	3.074	68.509	.746	2.072	59.619	1.417	3.937	58.366
10	1.034	2.872	71.382	.701	1.947	61.565	1.152	3.199	61.565
11	.973	2.703	74.084						
12	.926	2.573	76.657						

Table 1: Total Variance Explained table showing Components with Eigenvalues over 0.9. PCA with Varimax rotation

Appendix 8

Site Level Preliminary Analysis Information Sheet

Note: Original distribution was on A3

SD/D: Strongly Disagree/Disagree **NA/D**: Neither Agree/Agree **SA/A**: Strongly Agree/Agree

Site Level
Energy Culture
BAE SYSTEMS

SHE

Employees associate Energy with SHE – 53.76% SA/A

Less people think SHE influences how they use energy in work – 43%

97% aware of SHE
2% Not
1% Other

Energy/Environment Champions

66% aware of energy/environment champions 34% not

Champions only influence around a 1/3 of employees energy use
29% SD/D: 39% NA/D: 32% SA/A

Less well known than SHE

Of these 'nots'
31% - 430
24% - 2Shed
15% - 3A
10% - 609
9% - 1 Shed
10% - other

Training/Supervision/Team -department Energy Use

Employees don't think they receive enough training on saving energy at work (47 % SD/D Q8b)

Employees don't know the amount of energy their team/department use (78.25% SD/D Q8c)

Mixed attitudes towards receiving enough supervision and guidance on saving energy at work
38% SD/A: 38% NA/D: 24% SA/A Q8a

Employees would like to know the amount of energy their team/department use (66.51% SA/A Q8d)

Attitudes and Influences

Employees are concerned about the cost of energy to the business SA/A 69% Q13a

BUT concern does not appear to be related to rising energy costs affecting their day-to-day tasks SA/A 41% and a higher % of SD/D Q13b)

Employees know who is responsible for switching machines/equipment off during down times **and** who is responsible for switching lights off. (50% SA/A; 25% NA/D and 25% SD/D Q13e and 13f)

Employees know where switches are to turn equipment/machines off and where light switches are (70 & 80% SA/A Q13e and f)

Employees report to a line manager when they notice faults with equipment (80% SA/A Q13c)

Employees are indifferent to being more conscious of energy use than colleagues (65% NA/D Q13d)

BAE Influences – Energy use/demand priority, feedback, encouragement

Employees believe energy use and energy demand are important issues to BAE Systems (94% and 92% 9a & b)

But they believe reducing energy use and demand should be a higher priority (80% and 83% 9c &d)

Employees were indifferent to 'there is a greater focus on reducing energy use and demand at Samlesbury

Employees were indifferent to the question on whether they would receive feedback on any energy conservation suggestions.

Employees don't really know what BAE Systems are going to reduce energy use and demand. Mixed response 38% SD/D; 34% NA/D; 28%SA/A

Employees generally know who to speak to if they have a suggestion on how to reduce energy use and demand at work. 52% SA/A; 18% NA/D: 30%

Mixed attitudes towards if I make a suggestion if it would be taken seriously. 15% SD/D; 38% NA/D; 41% SA/A

Individual energy use in work

Employees turn equipment which the personally use off after I finished with it **AND** at the end of day/shift (87% and 93% SA/A Q12a and b)

Employees turn lights off (where possible) after they leave an area **AND** they always make an effort to reduce energy use within the workplace (70% SA/A Q12c and d)

Influences on individual energy use in work

Line managers don't influence employees energy use (51% SD/D Q10a)

Mixed views on if work teams regularly reduce their energy AND work teams being conscious of their energy use. Around 40% SD/D; 24% NA/D: 34%

Energy use and energy demand are not discussed regularly (68% SD q10d)

Energy use and energy demand are not discussed with work colleagues (65% SD q10d)

Mixed responses to question about colleagues support the need to reduce energy use **AND** similar response to whether they would be well thought of by my line manager if I took actions to save energy at work. (20% SD/D; 40-45% NA/D; 35-37% SA/A Q10f and G)

Employees are indifferent to question about 'I would be well thought of by my colleagues if I took action to save energy at work. (53% NA/D Q10h)

Mixed views on whether employees are encouraged to make suggestions on reducing energy use and demand
22% SD/D; 32% NA/D; 46%SA/A

Appendix 9

Comparison of Office and Manufacturing areas Preliminary Analysis Information Sheet

Note: Original distribution was on A3

KEY: **SD/D**: Strongly Disagree/Disagree **NA/D**: Neither Agree/Agree **SA/A**: Strongly Agree/Agree

Note – The manufacturing areas are predominantly manufacturing buildings but also have office staff located within them.

If over 10% differences in answers then included on this sheet

Differences between Office and Manufacturing areas

SHE function influence how employees use energy in the workplace **MORE** in office areas than manufacturing areas. Office areas have 20% MORE SA/A answers – 1da

Office areas associate energy related topics with SHE Function **MORE** than manufacturing areas – 20% MORE SA/A answers. – 1db

Both areas had a higher % of SA/A answers to the questions on associating energy related topics with SHE functions.

Lower % SA/A to SHE influencing how individuals use energy.

Training/Supervision/Team-department Energy Use

Manufacturing areas don't think they receive enough supervision & guidance on saving energy at work – around 50% SD/D compared with 26% SD/D office - 8a

Manufacturing areas want to know how much energy their department/team use **MORE** than office areas – 75% SA/A compared with 59% from office areas.-8d

Manufacturing areas don't think they receive enough training on energy saving at work – around 60% SD/D compared with 36.4% office – 8b

BAE Influences – Energy use/demand priority, feedback, encouragement

Manufacturing areas think Energy Demand should be a higher priority **MORE** than the office areas. 87% SA/A compared to 72% from offices – 9c

Office areas are **MORE** aware of what the business is doing to reduce energy use & demand 39% SA/A compared with 18% manufacturing. Manufacturing 16% more SD/D – 9f

Office areas are **MORE** aware of who to speak to if they want to make a suggestion to reduce energy use/demand 62% SA/A compared with 42% from manufacturing areas. Manufacturing more SD/D - 9g

Offices areas have **MORE** people agreeing to their suggestion being taken seriously 57% SA/A compared with 38% manufacturing – Manufacturing more SD/D & NA/D - 9h

Influences on individual energy use in work

Office areas work teams are **MORE** conscious of energy use. Office 44% SA/A compared to 27% - Manufacturing more SD/D & NA/D – 10b

Office areas agree **MORE** with discussing ways to reduce energy use & demand with work colleagues 22% compared with 10% - More SD/D answers in manufacturing areas - 10e

Office areas try to reduce energy use in work teams **MORE** than manufacturing. Office 40% SA/A compared to 26% Manufacturing more SD/D and NA/D – 10c

Office areas have **MORE** SA/A answers for questions on if they would be well thought of by manager <u>and</u> colleagues if they took action to save energy at work. Manufacturing areas more SD/D – 10g & h

Attitudes and Influences

Office areas know what to do to save energy within the workplace **MORE** than the manufacturing areas 73% compared with 58% Manufacturing areas more SD/D & NA/D – 13i

Office areas know where to turn machines/equipment off (excluding lights) **MORE** than the manufacturing areas 79% SA/A compared with 67% Manufacturing more SD/D – 13g

Office areas are **MORE** aware of who is responsible for switching machines/equipment off during downtimes 59% SA/A compared with 40%. Manufacturing more SD/D & NA/D – 13e

Office areas are **MORE** aware who is responsible for switching off lights 66% SA/A compared with 40% Manufacturing more SD/D & NA/D – 13f

Manufacturing report faults to manager **MORE** than office areas 86% compared with 75%. Manufacturing areas more SD/D & NA/D – 13c

Office areas are **MORE** concerned with cost of energy to the business 76% SA/A compared with 64%. Manufacturing areas more SD/D & NA/D – 13a

Individual energy use in work

Office areas turn lights off after they leave an areas **MORE** than the manufacturing areas. 75% SA/A compared with 64%. Manufacturing areas more SD/D & NA/D – 12c

Office areas agree **MORE** than the manufacturing areas to always making an effort to reduce energy use in the workplace 81% compared with 63% Manufacturing area has more neither agree/disagree – 12d

Appendix 10:

York and Louisville Question Prompts for Researcher

Questions Prompts for the Researcher in the Focus Groups at Louisville and York Sites

- Introduction of participants in the session
- Gain an understanding of what happens on site?
    - What do they manufacture? Who are their customers? Whole process of construction or parts of construction?
- Do the site generate their own energy? Or do they use grid energy?
- Is the energy supply fixed contract? Or fluctuating price?
- What approaches do the site take to reduce energy use?
- Does the site have energy/environment champions?
- Where do the group see energy on the site priorities? BAE priorities? Do these differ?
- Do the group know how much energy is used on site?
    - Do they conduct energy monitoring? If so to what level? – Building, area, individual machines?
- Who is responsible for reducing energy use?
- As a site do they go for any environmental awards?
- How does the site communicate with manufacturing areas?
- Are there any drivers for improving energy efficiency on site?
- Where does energy fit into the structure of the site? – Part of SHE? Or a specific group?

Also go through the preliminary results from the Samlesbury survey – hand out A3 printout to each member of the group.