3. The importance of energy management

> *"Systematic energy management is one of the most effective approaches to improve energy efficiency in industries because it equips companies with practices and procedures to continuously make improvements and capture new opportunities."*
>
> *Energy Management Programmes for Industry: Gaining through saving*
>
> *(Reinaud, Goldberg & Rozite 2012, p. 5)*

3.1 Introduction

Chapter 2 examined the need for a rapid transition to a low carbon energy system. It highlighted the critical role that energy efficiency improvement in organisations can play in reducing greenhouse gas emissions and delivering a wide range of economic, social and environmental benefits. The chapter also introduced the notion of the energy efficiency gap. This notion suggests that, despite the potential benefits that energy efficiency can deliver for organisations and society more widely, cost-effective opportunities to improve energy efficiency in organisations remain underexploited.

Chapter 3 presents a review of the existing academic literature on energy management practices and energy efficiency policy to establish key knowledge gaps in the literature that are associated with the adoption of energy management practices in organisations. It begins by providing key definitions before highlighting how energy management practices have been examined in the existing literature. The aim is to highlight what is known about energy management and, in doing so, to identify gaps in the literature that will be addressed in this thesis. The chapter will highlight that there has been limited empirical research that examines the process by which energy management practices are developed and adopted in organisations over time.

3.2 Key definitions

There is no single consistent definition of energy management that is applied in the literature (Backlund et al. 2012) and there are a number of related terms that are used interchangeably (Thollander & Ottosson 2010). This section of the thesis examines the definitional issues associated with three key terms used in this thesis:

1. energy management
2. energy management systems, and
3. energy management practices.

In doing so, this section establishes the rationale that informs the definitions used in this thesis.

Energy management

According to Kannan (2003, p. 946), energy management is: "the judicious and effective use of energy to maximise profits and to enhance competitive positions through organisational measures and optimisation of energy efficiency in the process". This definition highlights a number of important characteristics associated with energy management.

First, energy efficiency is not a core business objective in its own right. Rather, it contributes to broader organisational goals, such as profitability and competitiveness. From this point of view, and in order to understand the effectiveness of energy management, it is necessary to understand an organisation's broader business objectives.

Second, energy management involves: "organisational measures and optimisation of energy efficiency in the process" (2003, p. 946). The inference here is that managers and personnel can influence the amount of energy used to deliver the business outcomes that they seek. Whilst this may appear to be an obvious statement, there is evidence to suggest that many organisations may perceive energy to be a fixed cost item that they cannot influence. Where managers have this belief (or they are in situations where this is the case), they are unlikely to be motivated to attempt improvements in energy efficiency performance (Greening, Greene & Difiglio 2000).

The literature highlights a number of other characteristics that researchers commonly attribute to energy management. First, energy management is an enduring and ongoing process of improvement in energy use rather than an occasional, episodic activity. Cycles of review, feedback and improvement are, therefore, an integral component of effective energy management (Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006; Jelic et al. 2010; Kannan & Boie 2003). Second, energy management is typically considered to be a multidisciplinary activity incorporating skills covering both technical and general management activities (Kannan & Boie 2003). Third, energy management involves a systematic rather than ad hoc approach to energy efficiency improvement. For example, Jelic et al. (2010, p. 613) describe energy management as reflecting a set of activities that are conducted in an "organised, structured, systematic and permanent way".

Energy management systems

According to the ISO 50001 International Standard for energy management (ISO 2011, p. 2) an energy management system is a: "set of interrelated or interacting elements to establish an energy policy and energy objectives and processes and procedures to achieve those objectives". The purpose of an energy management system is to "enable an organisation to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption" (ISO 2011, p. 2).

The term 'energy management system' is often used interchangeably with the term 'energy management' (Rohdin, Thollander & Solding 2007). Thollander (2008) suggests that one way of distinguishing between the two terms is to consider an energy management system as a tool that can be used to achieve the goals of energy management. This perspective is also reflected by Reinaud, Goldberg & Rozite (2012, p. 10) who define energy management systems as: "a means by which organisations establish the systems and processes necessary to achieve operational control and continual improvement of energy performance."

As described in ISO 50001, the key components of an energy management system are:

- management responsibility
- energy policy
- energy planning
- implementation and operation
- checking, and
- management review.

Table 3.1 lists these components and their associated sub-components. The table illustrates the range of activities that are associated with the implementation of energy management systems.

Table 3.1: Energy management system requirements in ISO 50001

Requirement	Sub-requirement
Management responsibility	None
Energy policy	None
Energy planning	Legal requirements and other requirements Energy review Energy baseline Energy performance indicators Energy objectives, energy targets and energy management action plans
Implementation and operation	Competence, training and awareness Communication Documentation Operational control Design Procurement of energy services, products, equipment and energy
Checking	Monitoring, measurement and analysis Evaluation of compliance with legal requirements and other requirements Internal audit of the energy management system Nonconformities, correction, corrective action and preventative action Control of records
Management review	Input to management review Output from management review

(Source: ISO 2011)

It is important to note that, in some instances, the term 'energy management system' also takes on quite a markedly different meaning to the one discussed here. For example, the International Performance Measurement & Verification Protocol Committee (IPMVPC) defines an energy management system as: "a computer that can be programmed to control and/or monitor the operations of energy consuming equipment in a facility" (IPMVPC 2002, p. 49). This thesis does not use the IPMVPC definition.

Energy management practices

The practices enacted to support the goals of optimising energy use underpin the implementation of energy management and energy management systems. This thesis assumes that groups of people (rather than individuals) influence and 'own' energy management practices. Charles Taylor (1971, p. 27) explains:

> "The meanings and norms implicit in practices are not just in the minds of the actors but are out there in the practices themselves, practices which cannot be conceived as a set of individual actions, but which are essentially modes of social relation, of mutual action."

Consistent with this approach, Zietsma and Lawrence (2010, p. 192) describe practices as: "shared routines or recognized forms of activity". Reckwitz (2002, p. 249) suggests that it is through successive performances of these practices that interdependencies are reinforced between: "forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge".

The following definition of energy management practices is applied in this thesis.

> "Energy management practices are activities recognised by a community as the legitimate means of coordinating around energy use in accordance with the goals of an organisation."

There are three important dimensions associated with this definition.

First, the definition suggests that in order to define energy management practices it is necessary to define the community or groups of individuals and organisations that

recognise a set of activities.[6] Within the energy efficiency literature, groups are typically categorised by industry sector, country and/or size of organisation. For example, there is a distinction made in the energy efficiency literature between Small and Medium Enterprises (SMEs) (Cagno & Trianni 2013; Fleiter, Schleich & Ravivanpong 2012; Trianni & Cagno 2012) and large energy consuming or energy intensive organisations (Thollander & Ottosson 2010; Trianni et al. 2013).

Second, this definition suggests that energy performance can only be assessed relative to an organisation's broader goals. Therefore, in considering the appropriateness of particular energy management activities, an organisation's goals must be articulated.

Third, energy management practices are dynamic rather than static; that is, they are constantly evolving. Jelic et al. (2010, p. 613) highlight the dynamic nature of changing energy management practices in the following quote:

> "Until recent times, energy management practices primarily consisted in replacing inefficient equipment and then using any number of methods to estimate obtained savings."

Swords also highlights the evolutionary nature of energy management (2008, p. 61)

> "Energy management has evolved from a practice that focused solely on efficient technology to a multidisciplinary combination of the skills of engineering, management and housekeeping."

Summary

This review of key definitions highlights the importance of research that examines energy management practices with reference to the community of stakeholders that have an interest in such practices as well as the goals of the organisations within which such practices are being applied. Further, energy management and its associated practices should be viewed as a dynamic process of change over time

[6] This approach may be characterised as a social constructivist ontology which maintains that knowledge is constructed through people's interpretations of reality. This is discussed further in Section 6.2.1.

rather than a static set of pre-defined activities. These definitional insights will be further reinforced in subsequent chapters as existing literature is reviewed and as it is argued that institutional theory is an appropriate theoretical framework for this thesis. The next section examines the treatment of energy management practices in the existing literature. It reviews the energy efficiency literature as well as related work in corporate sustainability and organisational change.

3.3 Energy management practices in the existing literature

The aim of this section is to highlight the wide scope of practices presented in the energy efficiency and related literatures. A large body of practitioner literature exists that examines a range of energy management practices. This review focuses primarily on scholarly articles and publications. The corporate sustainability and organisational change literatures are examined as these are relevant to energy management and whilst this literature is not reviewed in detail it shows that there is little evidence of integration across the literatures. The section concludes by arguing that empirical research into energy management practices can also contribute to the corporate sustainability and organisational change literatures. This perspective will support the efforts to develop an interdisciplinary model in Chapter 5.

Key practices

Table 3.2 lists the key energy management practices that are described in the energy efficiency literature.

Table 3.2: Energy management practices promoted in the existing literature

Energy management practices	References
Develop top management support.	Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006; Thollander et al. 2013; Thollander & Ottosson 2010.
Develop and implement a long-term energy strategy that incorporates energy policy, goals and targets.	McKane et al. 2008; Rohdin, Thollander & Solding 2007; Thollander et al. 2013; Thollander & Ottosson 2007; Thollander & Ottosson 2010.
Appropriately resource and allocate responsibilities for energy efficiency, including through a dedicated energy management system.	Abdelaziz, Saidur & Mekhilef 2011; Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006.
Inform staff of the importance of improving energy efficiency and involve them in the improvement process.	Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006; Goldstein, McKane & Desai 2011.
Conduct an energy audit, assessment or review[7] to identify energy efficiency measures.	Abdelaziz, Saidur & Mekhilef 2011; Anderson & Newell 2004; Kong et al. 2012; Schleich 2004a; Shen, Price & Lu 2012; Thollander et al. 2013.
Integrate energy into cost accounting and budgeting systems.	Ates & Durakbasa 2012; Giacone, Mancò & Gabriele 2008; Granderson, Piette & Ghatikar 2010; Sandberg 2003; Swords, Colyle & Norton 2008; Thollander & Ottosson 2010.

[7] The terms ‘energy audit’ and ‘energy efficiency assessment’ are used interchangeably throughout this thesis.

Energy management practices	References
Establish appropriate financial criteria for energy efficiency projects.	Sandberg 2003; Thollander & Ottosson 2010; Trianni et al. 2013.
Develop, maintain and analyse energy-use data through an appropriate metering and monitoring system. Allocate costs to users.	Ferreira et al. 2008; Ke et al. 2013; Swords, Colyle & Norton 2008; Thollander & Ottosson 2010; Trianni et al. 2013.
Systematically incorporate energy-efficiency into procurement processes.	Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006.
Implement energy efficiency projects.	Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006.

This listing of energy management practices illustrates that energy management is a multidisciplinary activity involving technical practices (e.g. energy analysis) and practices more closely related to tasks associated with management (e.g. planning) (Christoffersen, Larsen & Togeby 2006; Kannan & Boie 2003). Another broad category of practice relates to informing and engaging staff in the process of energy efficiency improvement (Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006; Goldstein, McKane & Desai 2011). It is important to note that these practices are not exclusive to the domain of energy or environmental management (Corbett & Kirsch 2001; Viadiu, Fa & Saizarbitoria 2006). As Christoffersen, Larsen and Togeby (Christoffersen, Larsen & Togeby 2006) observe, energy management practices are similar to other management approaches, such as environmental management, health and safety management, and quality and production management. In part, this is due to multi-stakeholder efforts to standardise energy management practices.

For example, the ISO 50001 International Standard for energy management has been intentionally developed in a format that incorporates similar practices to those which exist in quality standards such as the ISO 9000 family of standards – Quality Management and the ISO 14000 family of standards – Environmental Management. One reason why this development approach has been taken is because it will be

familiar to organisations that already have these other ISO-type management systems. Aligning energy management practices with practices in other areas can facilitate acceptance and to encourage widespread adoption (Goldstein, McKane & Desai 2011; McKane et al. 2008; Perkmann & Spicer 2008; Viadiu, Fa & Saizarbitoria 2006). Ultimately, the foundation for quality systems can be traced back to scholars such as W. Edward Deming and his work on quality management and the introduction of structured tools such as the Plan-Do-Check-Act cycle (Zbaracki 1998).

Goldstein, McKane and Desai (2011) suggest that a key point of difference between the practices promoted in the ISO 50001 International Standard for energy management and other ISO standards is the strong emphasis on a data-driven approach. The focus on data and statistical approaches is also a feature of other operational improvement tools and practices such as Six Sigma, Lean and Cleaner Production (Besseris 2010; Brady & Allen 2006; Stone 2006). This suggests that there may be useful alignment between the introduction of systematic approaches to energy management and operational tools and management practices that are already being applied within organisations.

The next section briefly examines the corporate sustainability and organisational change literatures. It highlights the benefit of improving the linkages between these literatures and the energy efficiency literature.

Perspectives from the corporate sustainability literature

The corporate sustainability literature also includes descriptions of management practices that are appropriate to energy management. For example, Dunphy, Benn and Griffiths (2007) outline six phases that organisations may follow as they progress from a state of 'rejection' of corporate sustainability towards a sixth and final phase of 'ideological commitment' to corporate sustainability. These phases are:

1. Rejection of corporate sustainability
2. Non-responsiveness
3. Compliance
4. Efficiency

5. Strategic proactivity
6. Ideological commitment

Of note is that efficiency is presented as a middle phase in which organisations recognise the benefits of corporate sustainability in reducing costs and therefore improve resource efficiency. However, it is broadly assumed that cost reduction is, in its own right, a sufficient driver for efficiency and that efficiency is 'largely achieved' before an organisation moves on to strategic proactivity (the fifth phase) or ideological commitment (the sixth phase). The relationship between organisational attitudes towards corporate sustainability in the latter phases and the extent to which this influences energy efficiency performance is unclear and is an issue that will be examined in this thesis.

Dunphy, Benn and Griffiths (2007) propose several management practices that support organisations in moving *between* stages, such as from 'compliance/risk reduction' (the third phase) to 'efficiency' (the fourth phase). These, include:

- educating managers
- creating senior roles to drive change
- conducting audits, and
- developing the business case for efficiency and corporate sustainability to engage senior management.

These types of practices appear to be described consistently across the corporate sustainability and organisational change literature in general.

Other corporate sustainability frameworks also encourage the integration of technical approaches with organisational change-related practices to some extent. Examples include:

- The Natural Step model (Robèrt et al. 2002)
- Whole System Design (Stasinopoulos et al. 2009)
- Natural Capitalism (Hawken, Lovins & Lovins 1999), and
- Factor 4 (Weizsäcker et al. 2009).

Of note is that empirical work in the organisational change for corporate sustainability literature is limited. Considering the similarities across this literature

with the energy efficiency literature, the review highlights that empirical research conducted in this thesis will have relevance to the corporate sustainability literature.

Perspectives on organisational change

Over the past 30 years, an extensive body of organisational change literature has developed (Armenakis & Harris 2009). Despite the prevalence of this literature, organisational change programs are widely reported as having a poor success rate (Balogun & Hailey 2004).

Two broad approaches to change in the literature include the:

1. planned model, and
2. emergent model.

Kurt Lewin's Three-Stage Model of organisational change (Lewin 1951) is widely recognised as providing a foundation for the study and implementation of 'planned' organisational change. Lewin's three stages of organisational change are:

1. freezing
2. unfreezing, and
3. refreezing.

The model is based on democratic principles and encourages collaboration and learning among personnel (Benn & Rusinko 2013). By (2005) proposes that three of the most prominent models of planned change are:

1. Kanter, Stein & Jick's Ten Commandments for Executing Change (Kanter, Stein & Jick 1992)
2. Kotter's Eight-Stage Process for Successful Organisational Transformation (Kotter 1996), and
3. Lueckes's Seven Steps (Luecke 2003).

Some scholars have challenged the planned approaches to change because they are seen to be limited in their ability to address the challenges that organisations face in adjusting to continuous changes in their operating environments (Bamford & Forrester 2003). Such changes include technological innovation, globalisation and, often, unpredictable social and demographic trends (Graetz 2000). This has led to a more recent focus on emergent rather than planned models of change.

Characteristics of ‘emergent’ change include a greater emphasis on ‘bottom up’ action in contrast to the ‘top down’ control and comprehensive planning approaches emphasised in models of planned change (Bamford & Forrester 2003). Emergent approaches include process-based change models – the central tenets of which highlight that power and politics are a central component of change and that incremental improvements over time can have significant impacts on an organisation (Dawson 2005).

The intention of this review of the literatures that overlap with and are of relevance to energy management practices is to reinforce the eclectic characteristics of energy management practices. That is, what this thesis refers to as ‘energy management practices’ include practices that cover technical issues such as data, statistical analysis and accounting for the costs and benefits of projects. These are also practices that address the need to educate, engage and motivate a workforce. The review also highlights that efforts to explain the ‘how’ and ‘why’ of change have been relatively neglected. As will be argued in this chapter and Chapter 4, while the actual practices are quite well known, the fundamental challenge is to introduce those new practices into an organisation and then to enact them in ways that lead to improved energy efficiency performance within the context of the organisation’s broader business goals. As has been highlighted in the organisational change literature, attempts to implement change often fail (Balogun & Hailey 2004).Therefore, while this thesis will identify *what* energy management practices organisations have changed over the study period, it is expected that a more significant contribution will be made by providing insights into *how* and *why* new practices are successfully developed and adopted by organisations over time. In particular, Chapter 4 argues that institutional theory (including more recent work on institutional entrepreneurship) is a particularly relevant approach to examine the dynamics of changing energy management practices. To progress the argument, the next section considers the existing research that has examined the *extent* to which energy management practices have been adopted by organisations.

Research that examines the adoption of energy management practices

A number of researchers have examined the extent to which organisations adopt particular energy management practices. In this section of the thesis key studies are reviewed. Then, the strengths and weakness of these studies are analysed and the implications for the thesis are made.

Three key studies are as follows:

1. Christoffersen, Larsen and Togeby (2006) conducted a survey in Denmark of 304 manufacturing organisations, each with more than 19 employees and concluded that between 3–14% of firms practice energy management.
2. Thollander and Ottosson (2010) found that – of the 50 foundries and mills surveyed in their research – 40% of the foundries and 25% of the mills may be considered to have sufficient energy management practices.
3. Ates and Durakbasa (2012) examined 40 energy intensive organisations in Turkey (six iron/steel companies, nine cement companies, seven paper companies, eight ceramics companies and 10 textile companies) and concluded that 24% of the surveyed companies actively practiced energy management.

The researchers established between three and six energy management practices that they considered essential for energy management (marked as ‘primary’ in Table 3.3). In the case of the Christoffersen, Larsen and Togeby (2006) and Ates and Durakbasa (2012) studies, ‘secondary’ energy management practices were also considered. That is, researchers considered that an organisation practices energy management when they exhibited all primary practices together with three out of four secondary practices. Table 3.3 lists the energy management practices that each of these studies examined.

Table 3.3: Energy management practices examined in key studies

	Christoffersen, Larsen & Togeby 2006	Ates & Durakbasa 2012	Thollander & Ottosson 2010
Management support			
Energy policy	Primary	Primary	
Energy efficiency target or implementation goals	Primary	Primary	
Strategy			
Have an energy strategy of three years or longer			Primary
Resourcing			
Have an official energy manager		Primary	
Having a staff awareness program in place to encourage energy conservation and efficiency		Primary	
Seek to actively involve the employees in the work of energy saving by informing, motivating and educating them	Secondary	Secondary	
Clearly allocated responsibilities and tasks	Secondary		
Monitoring of energy use			
Meter the energy consumption of main production processes (e.g. motor, pump, steam and process heat systems)		Primary	
Allocating costs based on sub-metering			Primary

	Christoffersen, Larsen & Togeby 2006	Ates & Durakbasa 2012	Thollander & Ottosson 2010
Procurement			
Systematically make energy-efficient purchases according to a specified procedure	Secondary	Secondary	
Financing			
Pay-off periods for energy efficiency investments of two years or more			Primary
Implementation			
Projects are implemented	Primary	Primary	

The findings from each of these studies suggest that there is a significant untapped potential for increasing the extent to which organisations adopt energy management practices in order to improve energy efficiency outcomes. Review of these studies highlights some important directions for future research.

First, while these studies provide information about the extent to which energy management practices are adopted, they do provide limited insights into *how* and *why* various energy management practices are developed, selected and implemented. Further, it is not clear from the research whether the respondents consider the energy management practices selected by the researchers to be appropriate to their particular circumstances. Also, conceptualising energy management practices as a state that either 'is' or 'is not' implemented within an organisation at a particular point in time provides limited insight into the varied levels of adoption of energy management practices within organisations and the factors that may influence such variability.

Studies that examine change over time may build on and complement these existing studies by providing insights into the evolution of management practices and how organisations select, develop and adopt such practices. For example, a number of authors suggest that senior management support and energy audits are a first step in

energy management (Price & Lu 2011; Thollander & Ottosson 2010). However, there is little empirical evidence that organisations can enhance their energy management performance by introducing energy management practices in a particular order. Further, organisational constraints, such as access to resources, may limit the options available to organisations and, therefore, the energy management practices that they may pursue at a particularly point in time. To address these limitations further research could examine the way in which energy management practices change over time. This approach could also provide important perspectives on the process by which organisations introduce energy management practices into organisations. This is important as it could have a significant impact on the effectiveness of particular energy management practices. Kannan and Boie (Kannan & Boie 2003, p. 957) highlight the importance of examining the way in which organisations introduce energy management practices. They observed that:

> "During the energy auditing, when observing housekeeping practices, the operators felt that they were being observed all the time, and it caused fear/resentment among the operators. This could be overcome by giving adequate training, and awareness should be created with dedicated support of top management. Besides, additional incentives would motivate them to conserve energy."

This thesis will treat energy management practices as a dynamic phenomenon that involves a continuous process of change. The approach aims to build on and complement existing research which has provided important insights into the extent to which particular energy management practices have been adopted by organisations at a particular point in time.

Section summary

This section of the thesis has examined existing research to identify knowledge gaps in the energy efficiency and related literatures. It has found that key energy management practices in the literature include:

- developing and implementing long-term energy strategies
- developing energy policies, targets and goals
- conducting energy audits, and
- developing energy information systems to support the identification and

measurement of improvement options.

The breadth of these practices shows that energy management is a multidisciplinary activity involving both technical practices (e.g. energy analysis) and practices that are more closely related to management tasks (e.g. planning) (Christoffersen, Larsen & Togeby 2006; Kannan & Boie 2003). Further, these practices are not exclusive to energy management (Corbett & Kirsch 2001; Viadiu, Fa & Saizarbitoria 2006). Rather, they are similar to other management approaches, such as environmental management, health and safety management, and quality and production management. There is also a significant crossover with the practices described in the corporate sustainability and organisational change literature.

Important research has been undertaken that examines the extent to which energy management practices have been adopted by organisations in particular industry sectors. This suggests that there has not been widespread adoption of energy management practices (Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006; Thollander & Ottosson 2010). However, it does highlight that there is significant potential to improve the energy efficiency performance of organisations by accelerating the adoption of effective energy management practices.

This academic literature can be further developed to explain:

- the motivations driving the adoption of energy management practices within organisations, and/or
- the process by which organisations identify, develop and implement effective energy management practices.

The next section examines the literature on government energy efficiency policies. It seeks to understand the rationale and extent to which the research has shown that such policies increase the adoption of energy management practices in organisations.

3.4 Policy approaches influencing the adoption of energy management practices

> *"It is noteworthy that most energy efficiency policies and measures are not used in isolation, but are often part of policy packages. Furthermore, the introduction of one policy does not necessarily imply the removal of pre-existing policies applied to the same entities. These aspects demand attention to policy coherence to maintain overall efficacy and cost-efficiency."*
>
> *(Tanaka 2011, p. 6535)*

3.4.1 Introduction

This section examines the range of government policies that have been developed that aim to directly and indirectly influence energy management practices in organisations. It is important to examine these policies since government policies and programs are one of the major drivers for change in energy management practices.

Governments have been developing policies that aim to unlock the energy efficiency potential in organisations since the energy crisis in the 1970s. The energy crisis highlighted the vulnerability of economies to disruptions in energy supply when oil prices rose rapidly and dampened economic growth in countries around the world (Hamilton 2011). Subsequently, governments viewed energy efficiency as an important measure in improving energy security. With the more recent emergence of climate change as a significant issue, governments have renewed their focus on improving energy efficiency in organisations as it typically provides the lowest cost option to reduce greenhouse gas emissions (IEA 2013). At the same time, and as described in Chapter 2, energy efficiency can deliver multiple benefits at the organisational level which then flow out into society, reaping wider societal benefits such as increased productivity, reduced local pollution and the creation of employment opportunities (Ryan & Campbell 2012).

Policymakers face a number of challenges in designing and implementing effective policies. For example, variables that affect the extent to which organisations

implement energy efficiency measures include:

- the design of energy markets
- changing economic environments
- business circumstances, and
- managerial priorities (Tanaka 2011).

A wide range of implementation barriers have also been identified (Trianni & Cagno 2012; Tuominen et al. 2012). This means that there is typically no 'one size fits all' policy that will be effective in all circumstances (Christoffersen, Larsen & Togeby 2006). Addressing this diverse range of conditions has led policymakers to develop a range of distinct (yet related) policies that aim to improve energy efficiency.

The term 'policy packages' is used to describe the use of multiple complementary policies that aim collectively to encourage energy efficiency improvements (Jollands 2009; Tanaka 2011). Each measure within a policy package can address the particular barriers that are experienced by different industry groups and stakeholders (Greening & Jefferson 2013; Ürge-Vorsatz & Metz 2009). Governments can enhance the effectiveness of policy measures by combining them in ways that support synergistic effects (Levine et al. 2007). This approach of multiple policies is widely accepted in the literature (Bernstein et al. 2007; Kounetas & Tsekouras 2008; Mallett, Nye & Sorrell 2011; McKane, Price & Can 2007; Price et al. 2005; Tanaka 2008; Worrell et al. 2009; Zhou, Levine & Price 2010).

Since energy policies can play a central role in influencing energy management practices – it is important to understand the different policies that governments may employ. As the analysis reveals – the range of policies do not simply work in isolation to influence practices – rather they interact with one another. Therefore it is important to account for such interactions when examining the factors that influence changes in energy management practices.

The aim of this section of the thesis is not to examine each type of policy mechanism in detail. Rather, it is to explore the scope of government policy options presented in the academic energy efficiency literature and to consider the extent to which different policy measures influence energy management practices directly or

indirectly. For example, policies may require organisations to conduct energy audits or to implement an energy management system to meet particular requirements. Such policies will have a direct impact on energy management practices because organisations are required to undertake specific activities.

An example of an indirect policy influencing energy management practices is a government policy that provides a grant for the implementation of an energy efficiency project. To be eligible for the grant, the government may not require the organisation to implement specific practices. However, due to the incentive offered by the grant, the organisation may improve their energy management practices voluntarily and in the manner that the organisation considers most beneficial.

3.4.2 Policies that aim to directly influence energy management practices

Energy audit policies and programs

Energy audit policies and programs are one of the most common energy efficiency policy measures implemented around the world (Anderson & Newell 2004; Schleich 2004a; Tanaka 2011). The policy rationale for requiring firms to conduct energy audits is based on the idea that if managers do not have all the information they need on energy efficiency options, including the approximate cost and benefit of such options and how to deploy them, then it is reasonable to assume that they may have difficulty deciding to invest in these projects (Garnaut 2008). Governments may consider this to be a market failure for which intervention is justified. However, it is generally accepted that such justification should only occur when the cost of implementing the policy is less than the expected benefit (Brown 2001). In particular, a lack of or incomplete information may pose a particular challenge for smaller businesses with limited resources where information may be less readily available (Anderson & Newell 2004; Kounetas, Skuras & Tsekouras 2011).

The complexity of energy efficiency improvement options, including projects that involve significant capital expenditure through to low and no cost operational improvements, present an informational challenge for managers. Furthermore, delivering energy efficiency improvements may require the purchase of products and services that are relatively unfamiliar to managers within a particular firm. Such purchases may come from multiple suppliers and intermediaries. Information

asymmetries may occur between purchasers and suppliers and across the supply chain. For example, it can be difficult for a purchaser to verify the claims made by the suppliers of energy efficient equipment without targeted monitoring systems and analysis that accounts for the different variables that may affect the energy efficiency performance of a particular product (Sorrell et al. 2004). Frequently, managers have greater confidence in the information associated with upfront capital costs than information about operating costs. This situation creates an incentive to adopt less efficient options upfront where such options require less upfront capital (Eyre 1997).

An energy audit involves a systematic examination of energy consumption to identify improvement options. The level of detail obtained may vary from 'walk through audits', which aim to identify the most obvious energy saving opportunities, through to detailed and comprehensive reviews of energy use across a facility to identify, evaluate and provide financial information on the costs and benefits of particular energy efficiency measures (Shen, Price & Lu 2012). The widespread application of government energy auditing programs is illustrated in an international review conducted by Price & Lu (2011). The review covered 22 energy audit programs across 15 countries (i.e. Australia, Canada, Denmark, Finland, France, India, Ireland, Japan, the Netherlands, Norway, Portugal, Sweden, Switzerland, the United Kingdom and the United States) and one region (i.e. the European Union). Although the focus of the review was the industrial sector, many of these programs also covered the commercial sector as well. The researchers compared the design components of the programs across a number of criteria, including the cost of energy audits, use of standardised manuals and tools, training and certification of energy auditors, databases of energy audit results, post-audit follow-ups and case studies (Price & Lu 2011).

Some countries have had energy auditing programs over a number of decades. For example:

- In Australia, there have been various energy auditing programs over the past 20 years. The Entreprise Energy Audit program which commenced in 1991 (Harris, Anderson & Shafron 2000) and has been followed by a number of national and state-based energy audit programs, including the Energy Efficiency Best Practice Program, the *Energy Efficiency Opportunities Act*

2006 (Cth) and the NSW Government's Energy Savings Action Plan (Crittenden & Lewis 2011).

- China has had some form of industrial energy auditing program during the last three decades (Price & Lu 2011; Shen, Price & Lu 2012).
- The Mongolian Government is currently developing energy efficiency audit legislation for large energy consuming businesses (Ernedal & Gombosuren 2011).
- In the United States, the U.S. DOE Industrial Assessment Center (IAC) program has been providing energy assessments (at no financial cost) to small and medium-sized manufacturers since 1976 (Anderson & Newell 2004).

In one major study of the outcomes from energy audits in the United States, Anderson and Newell (2004) examined over 39,920 projects from over 9000 manufacturing plant energy reviews listed on the U.S. DOE IAC program database between 1981–2000. The researchers found that firms adopted around 40% of the recommended projects. In commenting about the effectiveness of the program, the authors stated that: "overall, one can view the glass as either half full or half empty" (Anderson & Newell 2004, p. 32). In other words, researchers and policymakers may perceive the program to be a success because of the large number of projects that have been adopted. However, they may also consider the results as relatively poor because the organisations involved did not implement the remaining 60% of cost-effective projects. This example reflects a common difficulty associated with examining the outcomes of energy efficiency audit programs (i.e. determining whether organisations have obtained all the cost-effective benefits identified in the energy audit). This work highlights the need for further research on the effectiveness of energy efficiency assessments and the factors that influence the outcomes achieved, including the underlying energy management practices adopted to conduct the audits (Anderson & Newell 2004; Larsen et al. 2006; Schleich 2004a, 2009). Shen, Price and Lu (2012, p. 354) describe one of the major challenges:

> "Mandated energy audits were sometimes seen by enterprises as a government function rather than as business activity. As such, enterprises somewhat felt that energy audits were an administrative burden as well as a means for exposing problems rather than a process for helping them to become more competitive. As a consequence, enterprises are reluctant to undertake extensive efforts to go beyond their targets and energy auditors often only recommend quick fixes to help the enterprises to meet their obligations."

The potential consequence is that the focus in such organisations shifts to administrative expediency; that is, completing the energy audit in a way that reduces disruption and costs. As a result, the researchers found that the energy auditors involved in the program frequently recommended quick fixes in order to meet a companies legislative obligations, rather than proposing projects that might deliver more substantive business benefits. This finding is consistent with Ates and Durakbasa (2012) who found that organisations that were required to have energy managers were in charge of administrative positions and typically approached the implementation of such programs as administrative compliance tasks, rather than seeking energy performance improvement. Researchers have identified that they need to understand how organisations respond to mandatory government energy audit programs and the potential unintended consequences of such programs (Ates & Durakbasa 2012; Shen, Price & Lu 2012).

Government energy audit programs often require organisations to use accredited energy efficiency assessors to conduct energy efficiency assessments (Lu & Price 2011; Vine 2005). The expectation is that a skilled technical expert is required to identify all cost-effective energy efficiency projects. However, Helcke et al. (1990) compared energy audits conducted by four different private companies and found a high degree of variation in the results. In other research, Schleich (2004a) undertook a survey of firms in the small industrial enterprises and commercial buildings in Germany and found that the quality of audits undertaken by engineering firms was more effective than those carried out by utilities or industry sector associations. These results reinforce the need for further research examining the factors that influence such variability in outcomes (Anderson & Newell 2004). An important

focus in this thesis is on the energy management practices associated with energy auditing in organisations. This is particularly relevant due to the:

- broad application of energy audit programs globally (Lu & Price 2011; Price & Lu 2011)
- role that energy audits play in identifying and establishing the relative cost-effectiveness of energy efficiency projects, and
- call for further research on the effectiveness of energy efficiency assessments (Anderson & Newell 2004; Larsen et al. 2006; Schleich 2004a, 2009).

Energy management policies and programs

Reinaud, Goldberg & Rozite (2012, p. 10) define energy management programs as: "policies and initiatives that encourage companies to adopt energy management". Policymakers typically consider energy audits as one component of a broader set of activities classified as energy management (Price & Lu 2011). For clarity, Table 3.4 highlights the key distinctions between energy audits and energy management programs.

Table 3.4: Distinction between energy audits and energy management

	Energy audit	**Energy management**
Objective	Establish a costed list of energy efficiency measures for decision-makers to consider	Encourage the implementation of systems and processes that support a continuous focus on energy performance
Timeframe	Distinct activity with a start and finish (e.g. three days to three months), typically undertaken on an episodic basis (e.g. once every three to five years)	Permanent and continuous activity associated with ongoing cycles of implementation, review and improvement
Skills required	Technical skills associated with identifying and evaluating potential energy efficiency improvement opportunities	A range of management skills is required, from policy development through to the communication of energy management across an organisation

As governments have sought to encourage the application of energy management systems within organisations, they have developed a set of protocols and standards that define the activities and outcomes associated with energy management. The benefits of the standardisation of management practices may reduce variation in the application of particular management practices, facilitate comparison within and across firms, allow for third party certification to provide assurance as to whether standards have been met and structure product and service offerings of consulting firms (McKane, Price & Can 2007; Price, Wang & Yun 2010). The standardisation process involves transforming a set of loosely described practices into a more closely defined set of generally accepted rules for the way in which a particular management practice should be applied (Perkmann 2008). Companies themselves, industry groups, governments or international bodies (e.g. the International Organization for Standardization (ISO)) may initiate and support the standardisation process.

Researchers have identified a number of limitations and unintended consequences associated with government programs and the standardisation process. For example, McKane, Scheihing and Williams (2008) argue that technical specialists (e.g. in-house engineers and external energy consultants) are typically the main personnel involved in identifying and implementing energy efficiency projects. Limitations of this approach include the following:

- Non-technical staff in an organisation may not understand the approach since they do not have the requisite technical expertise.
- These practices and technologies penetrate the market slowly.
- Once individuals leave the organisation, the motivation for and expertise to progress energy efficiency may be lost.

The authors suggest that energy management projects and associated energy management systems be developed through a consensus approach by involving the personnel that are required to implement the system in the design of the system itself. However, it is unclear how organisations might accomplish such consensus once a standardised framework is already established. That is because once energy management systems are standardised, there is a risk of personnel viewing the standardised practices as a prescriptive form of compliance. This highlights an important tension between standardisation and engagement.

This unintended consequence of standardisation is similar to the observation made by Shen, Price and Lu (2012) regarding the 'administrative' response by Chinese organisations to the requirement to conduct mandatory energy audits. Organisations may aim to implement an energy management system to a minimum standard to meet compliance requirements; however, organisations may achieve better results where they view energy management systems as an opportunity to achieve wider business benefits.

There has been an extensive multi-stakeholder process to develop the new energy management system standard ISO 50001 (ISO 2011; McKane et al. 2008; Reinaud, Goldberg & Rozite 2012). However, despite the widespread support for the new energy management system standard, limited evidence exists which indicates the extent to which such approaches are successful.

If we look to the considerable research undertaken for the implementation of environmental management systems and the international standard ISO 14000 – Environmental Management, we can obtain some useful insights into potential issues that may arise with the wider implementation of energy management systems. For example, Nawrocka & Parker (2009) examined 23 studies that aimed to identify the link between environmental performance in firms and the implementation of environmental management systems. They were unable to identify a clear link, which suggests that there is wide variation in the effectiveness of systems across different firms. Könnölä and Unruh (2007) suggest that a major limitation of standardised management systems such as ISO 14000 is that they are likely to encourage incremental improvement, but may have the unintended effect of limiting the identification and implementation of more radical improvements in environmental performance. Yin and Schmeidler (2009) found wide variability in the implementation of ISO 14000 and suggest that differing implementation approaches may account for the wide variation in environmental performance across the firms involved in the study. These findings highlight the importance of research that examines the extent to which government-directed energy management programs, in encouraging organisations to conduct an energy audit or to adopt a standardised energy management system, are effective. One way to achieve this is to examine the energy management practices organisations apply that have successfully

demonstrated energy efficiency improvement. This is an approach that will be discussed further in Chapter 6 of this thesis.

3.4.3 Policies that aim to indirectly influence energy management practices

Since the oil crisis of the 1970s energy efficiency policies have evolved. The following section incorporates a brief review of these policies. It is not intended to be a complete review or critique. Rather the wide scope of the different policies further reinforce the complexity of the policy challenge associated with improving energy efficiency improvements. Table 3.5 presents a list of key policies and associated authors.

Table 3.5: Energy efficiency policy mechanisms

Policy instrument	Key references
Control and regulatory mechanisms	
Appliance standards	Garcia et al. 2007; Park et al. 2009; Tenbrunsel et al. 1997; Wiel & McMahon 2003.
Building codes	Iwaro & Mwasha 2010; Nelson 2012.
Labelling and certification programs	Dixon et al. 2010; Dixon, Keeping & Roberts 2008; IEA 2010a.
Energy efficiency obligations and quotas	Bertoldi et al. 2013; Bertoldi et al. 2010; Rosenow 2012.
Financial and market-based instruments	
Energy performance contracting/ Energy service company (ESCO) support	Painuly et al. 2003; Vine 2005.
Energy efficiency certificate schemes	Bertoldi et al. 2010.
Kyoto protocol flexible mechanisms	Lee et al. 2013.
Taxation (on CO_2 or fuels)	Klok et al. 2006; Lu, Tong & Liu 2010.
Tax exemptions/reductions	Bjørner & Jensen 2002.
Capital subsidies, grants, subsidised loans	Olmos, Ruester & Liong 2012.
Support, information and voluntary action	
Voluntary and negotiated agreements	Paton 2001; Price, Wang & Yun 2010.
Education and information programs	Anderson & Newell 2004; Matisoff 2013.

Control and regulatory mechanisms include the development of appliance standards (Park et al. 2009), building codes (Nelson 2012), labelling and certification programs (IEA 2010b), and energy efficiency obligations and quotas (Bertoldi et al. 2013). With regard to energy management practices in organisations, there is a risk that control and regulatory mechanisms encourage organisations to focus on minimum

standards and compliance, rather than ‘good or excellent performance’ (Garcia et al. 2007). From the perspective of energy management practices, this raises questions about whether such standards encourage minimum performance or encourage continuous improvement (Shen, Price & Lu 2012; Wiel & McMahon 2003).

Financial and market-based instruments aim to modify the financial costs and benefits associated with energy efficiency projects (Fischer & Newell 2008). For example, governments have introduced a price on greenhouse gas emissions in some countries. In Australia, this has taken the form of a fixed price period of three years in which the cost of one tonne of carbon dioxide equivalent will be an inflation-adjusted AUD23/tonne. However, as Lo and Spash (2012) argue, the design of the scheme is unlikely to achieve its purpose due to ongoing subsidies to polluters. They highlight that the political process has contributed towards a significant modification of the design. Indeed the political nature of this policy continues to be challenging and at the time of writing the Australian Government led by Prime Minister Abbott is attempting to repeal the carbon price legislation. Other fiscal policies include grants, subsidies, loans and tax relief (Price et al. 2005).

Support, information and voluntary action policies and programs aim to increase awareness of energy efficiency projects. Programs include educational workshops, training programs, advertising and the development of case studies and material that describes energy efficiency opportunities and particular energy management techniques (Anderson & Newell 2004; Matisoff 2013). Governments typically combine information and voluntary programs with other measures. For example, Denmark has combined taxes on greenhouse gas emissions with energy efficiency agreements in which companies are required to undertake energy audits and implement all projects that have payback periods of less than four years. The companies receive subsidies of 30–50% of the cost of energy efficiency investments (Price et al. 2005). However, organisations still need to be able to have identified the potential projects and to make time available to apply for and take-up the loans and grants on offer. This underscores the important linkage between policies intended to influence energy management practices and policies that operate more directly in the market.

While a full analysis of the policies that indirectly influence energy management practices is beyond the scope of the review presented in this thesis, the intention of this brief overview is to highlight the complexity of energy efficiency policies that form a part of energy efficiency policy packages. Researchers have highlighted that there are challenges in differentiating between the relative influence of each individual policy, and that there is an important need to examine the way in which policies interact together to influence energy management practices and energy efficiency outcomes (Bernstein et al. 2007; Jollands et al. 2010; Tanaka 2011).

3.4.4 Section summary and conclusions

This review of existing literature on energy efficiency policies illustrates the importance of considering how energy efficiency policies interact in order to encourage improved energy performance in organisations. Governments may design policy measures to influence energy management practices directly through energy audits and energy management system programs. Other policies have less direct influence on actual energy management practices. There is a knowledge gap associated with our understanding of how individual policy measures interact to, on the one hand, encourage firms to adopt more effective energy management practices and, on the other, to improve their energy efficiency performance. Therefore, the research that is undertaken in this thesis into *how* and *why* energy management practices change will also include consideration of the way in which multiple energy efficiency policies interact to encourage the adoption of effective energy management practices. See section 5.8 for further information on how this informs the research approach.

3.5 Chapter summary and conclusions

This chapter aimed to present a review of the existing literature to identify what is known about energy management practices and to highlight knowledge gaps in the literature. As mentioned previously, this review established the definition of energy management that will be applied in this thesis. That is:

> "Energy management practices are activities recognised by a community as the legitimate means of coordinating around energy use in accordance with the goals of an organisation."

The review found that key energy management practices promoted in the literature includes:

- developing and implementing long-term energy strategies
- developing energy policies, targets and goals
- conducting energy audits, and
- developing energy information systems to support the identification and measurement of improvement options.

The breadth of these practices illustrates that energy management is a multidisciplinary activity involving both technical practices (e.g. energy analysis) and practices that are more closely related to management tasks (e.g. planning) (Christoffersen, Larsen & Togeby 2006; Kannan & Boie 2003). These practices are not exclusive to energy management (Corbett & Kirsch 2001; Viadiu, Fa & Saizarbitoria 2006) and are similar to other management approaches, such as environmental management, health and safety management, and quality and production management. There is also a significant crossover with the practices described in the corporate sustainability and organisational change literature.

Important research has been undertaken that examines the extent to which energy management practices have been adopted by organisations in particular industry sectors. This suggests that there has not been widespread adoption of energy management practices (Ates & Durakbasa 2012; Christoffersen, Larsen & Togeby 2006; Thollander & Ottosson 2010). On the positive side, this suggests that there is significant potential to improve the energy efficiency performance of organisations by accelerating the adoption of effective energy management practices.

This academic literature can be further developed to explain:

- the motivations driving the adoption of energy management practices within organisations, and
- the process by which organisations identify, develop and implement effective energy management practices.

These issues (i.e. understanding the process by which more effective management practices are developed and adopted within organisations), are common challenges

identified in the broader management and practice literature (e.g. corporate sustainability, environmental management, organisational change). Therefore, examining the case of changing energy management practices is valuable in highlighting ways in which the gap between actual and optimal energy use in firms can be addressed to reduce greenhouse gas emissions and deliver a range of other economic, environmental and social benefits *as well as* providing greater insight into the development and spread of new energy management practices more generally. Thus, this review suggests that an appropriate research question is: *How* and *why* do energy management practices change?

Based on the findings, this review has argued that, to better understand how policymakers and organisational practitioners can accelerate the adoption of effective energy management practices, energy management practices should be examined as a dynamic phenomenon. Further, the review of the energy policy literature has highlighted the many complexities associated with designing and implementing policies and programs that aim to encourage energy efficiency improvement in organisations. Due to this complexity, policymakers typically develop policy packages in which multiple measures target different energy end uses, industry sectors and organisational types. This review has also highlighted that it can be difficult for policymakers to establish *how* such policies interact and the extent to which policies and programs influence the successful adoption of energy management practices. For example, many governments have developed energy audit programs, yet organisations do not implement around half of the seemingly cost-effective energy efficiency projects available to them. An unintended consequence of energy efficiency policy may include organisations viewing such policies as an impost. This can lead organisations to adopt an administrative response rather than viewing energy efficiency as an opportunity to improve their profitability and competitiveness. Further, multiple stakeholders external to organisations influence the extent to which effective energy management practices are adopted. These include energy managers, energy consultants and the government departments developing and implementing energy efficiency policies. These findings further reinforce the relevance of examining the dynamic process by which organisations develop and implement energy management practices. They also inform the three research sub-questions:

1. Who are the key organisational stakeholders that have an interest in energy management practices and how do they interact and influence the development and adoption of these practices?
2. How do corporate personnel with responsibility for energy efficiency improvement (referred to as ‘corporate energy practitioners’ in this thesis) influence the disruption, development and maintenance of energy management practices?
3. How does the organisational and organisational field-level context influence individual decision-making on energy efficiency projects?

The next chapter (Chapter 4) reviews the existing literature with regard to the barriers to energy efficiency improvement in organisations. The review will inform the development of an appropriate theoretical perspective that this thesis will apply to the primary research question and three sub-questions.