Waide Strategic Efficiency

The scope for energy saving from energy management

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The Scope for Energy Savings from Energy Management

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Glossary

AC	Alternating Current
BACS	Building automation and controls system
BEMS	Building energy management system
Capex	capital expenditure
CEM	Clean Energy Ministerial
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CENELEC	European Committee for Electrotechnical Standardisation
CHP	combined heat and power
CO_2	carbon dixoxide
CRC	Carbon Reduction Commitment (UK)
CSC	cost supply curve
CSR	corporate social responsibility
DE	Germany
DIN	Deutsches Institut für Normung (German Standards Organization)
EC	European Commission
ECI	European Copper Institute
EE	energy efficiency
EED	Energy Efficiency Directive
EEG	erneuerbare Energien Gesetz (Germany's renewable energy act)
EEO	Energy Efficiency Obligation (scheme)
EM	energy management
EnMS	energy management system
EnvMS	environmental management system
EnPI	energy performance indicator
EPBD	Energy Performance in Buildings Directive
EPC	energy performance certificate (for buildings)
EPC	energy performance contract
ES	Spain
ESCO	energy service company
ESOS	Energy Supplier Obligation Scheme (UK)
EU	European Union
EU ETS	European Union Emissions Trading Scheme
European standard	A *standard* adopted by a European standardisation organisation.

FM	facility manager
FR	France
GDP	gross domestic product
GWh	gigawatt-hours
HSE	health, safety and environment
HVAC	heating, ventilation and air conditioning
IED	Industrial Emissions Directive (2010/75/EU)
ICT	information and communication technology
IP	intellectual property
IPCC	Integrated Pollution Prevention and Control Directive (2008/1/EC) replaced by IED 2010/75/EU
IT	Italy
IEC	International Electrotechnical Commission
IEA	International Energy Agency
ISO	International Organization for Standardization
ktoe	thousand tons of oil equivalent
kV	kilovolt (i.e., thousand volts)
kVA	kilovolt-ampere
kW	kilowatt
LCC	life-cycle cost
MACC	Marginal abatement cost curve
MEPS	Minimum Energy Performance Standards
MS	Member State (of the EU)
Mtoe	million tons of oil equivalent
$MtCO_2$	million tons of carbon dioxide
MVA	megavolt-ampere
MWh	megawatt-hours
PL	Poland
QM	Quality Management
Opex	operating expenditure
R&D	Research and Development
RE	renewable energy
RED	Renewable Energy Directive
SFEM	Sector Forum Energy Management of CEN & CENELEC
SME	Small and Medium Sized Enterprise
TCO	Total Cost of Ownership

TPF	Third Party Finance
TWh	terrawatt-hours
UK	United Kingdom
W	Watts

EXECUTIVE SUMMARY

Energy management is a structured process through which organisations seek to optimise their energy use and whose definition and practice is codified through standards such as EN ISO 50001. It is an essential tool to deliver systemic level savings in how energy using capital is chosen and deployed but also, and importantly, with respect to how that capital is actually operated and managed. Despite its importance to overcome some of the more intractable barriers to energy efficiency it has received relatively modest attention within EU policy portfolios.

This report presents the key findings from a comprehensive assessment of the potential for savings from broader and more effective adoption of energy management across the EU. Degrees of energy management practice and effectiveness are outlined and the barriers which energy management helps to overcome are discussed. Current levels of adoption of energy management in European organisations and the associated trends are assessed and found to be quite low e.g. just 1.5% of medium to large companies have adopted EN ISO 50001. In contrast, a detailed quantified analysis finds there is a techno-economic optimal savings potential from greater adoption of effective energy management in the EU's industrial and service sectors of 26% of their combined energy consumption by 2035.

The report concludes with an analysis of policies that could help to increase energy management adoption rates across the EU and positions them within the context of the existing EU policy portfolio for energy efficiency. This builds from an assessment of factors that influence (encourage or inhibit) the adoption of effective energy management for each end-user sector and of the degree to which targeted policies can help to influence this. The analysis considers where these measures fit within the broader portfolio of EU energy efficiency policy instruments and concludes with a set of policy recommendations pertinent to the ongoing reviews of the major EU Directives.

Definitions and scope

Energy management has no single definition but can be said to entail the proactive, organised and systematic coordination of procurement, conversion, distribution and use of energy to meet an organisation's requirements, taking into account environmental and economic objectives. In the tertiary and industrial sectors its operation addresses facility management, logistics, procurement, production, planning and control, maintenance and IT. Its implementation requires an organisation to develop an energy management strategy.

This study includes:

- an assessment of the current situation by sector – an analysis of levels of deployment of EM by depth of EM and includes an assessment of typical institutional frameworks for EM
- the typical savings potentials by sector (light industry, iron & steel, petro-chemicals, cement, glass etc. and the various tertiary sector building and organisational types)
- the typical cost/benefits of energy management by sector
- the effectiveness and teething issues with energy management and specifically ISO 50001 – experience from the field
- an assessment of the barriers to greater application of EM by sector
- recommendations on how to strengthen good practice and the EU's policy portfolio.

This Executive Summary presents a short summary of the parts of the report that address current practice, barriers to the adoption of energy management, existing policy frameworks, the energy savings potentials, economics and the opportunities to stimulate increased savings from energy management through more proactive policy measures.

Current energy management practice

Current trends

One way of classifying the implementation of energy management is to consider the nature of organisation EM strategies and practices which can be grouped into following cases ranked from least to most proactive strategies:

- no systematic planning; where an organisation only deals with the most essential issues and has no dedicated management process for energy
- short-term profit maximisation approach: where management is focused exclusively on measures that have a relatively short payback period and a high return
- longer-term profit maximisation: where measures with a longer term payback are also implemented
- realisation of all financially attractive energy measures: where all measures are implemented that have a positive return on investment
- climate optimisation strategy: where the organisation is willing to invest in all measures that meet their climate impact mitigation strategy and hence may go beyond purely cost-effective measures

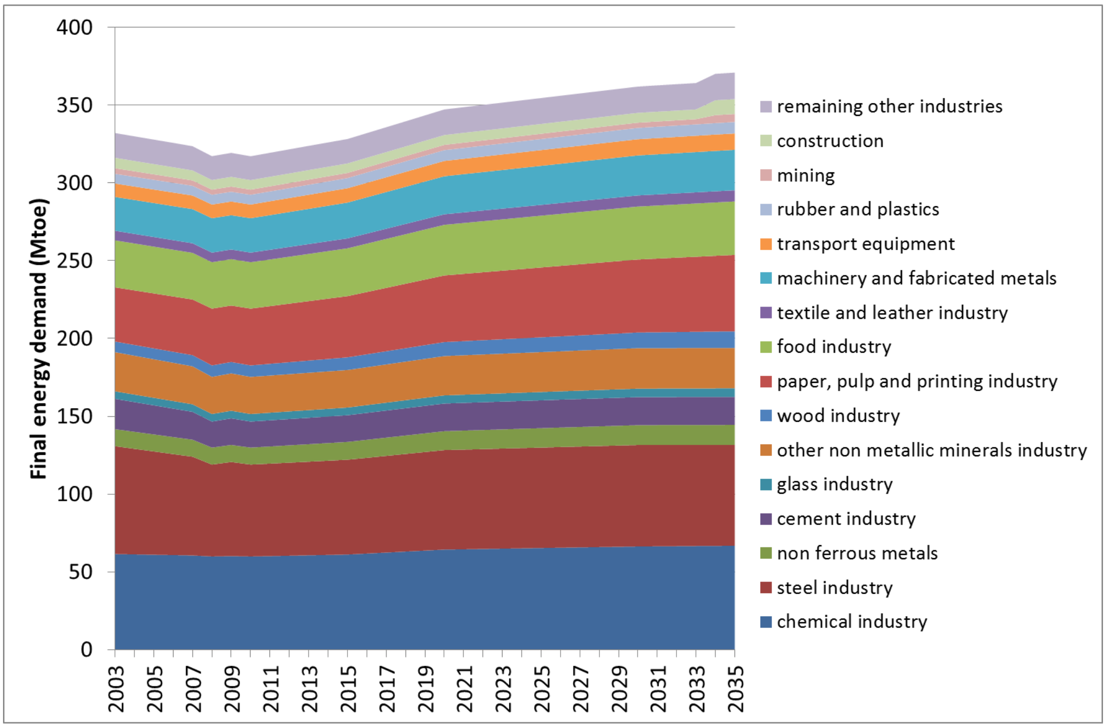
There is no systematic survey of current levels of EM adoption across EU organisations; however, a review of the literature, of case studies and a survey of experts in the field suggest that:

- there is a broad spectrum of behaviours currently seen but on average EM adoption is well below economically rational levels
- (as one would expect), energy intensive and larger organisations are much more likely to have adopted proactive energy management strategies than less energy intensive or smaller organisations
- very few organisations adopt strategies to realise all financially attractive measures and even less to optimise their climate impact
- the case of no systematic planning predominates in SMEs
- short-term profit maximisation is most common in other commercial enterprises such that measures with payback periods of beyond 2 years are seldom considered.

Overall it appears that while awareness of energy management and its significance is increasing most organisations are struggling to implement it effectively. They tend to operate conservative, risk-averse strategies that avoid deflecting time and effort from core business activities for measures that may be seen to be desirable in principle but are perceived to be outside core competences. Given this situation there remains a considerable scope to develop more sophisticated EM strategies that mine the cost effective savings potentials more fully.

Based on the study’s findings of the trends in levels of EM adoption in the EU’s businesses and public sectors a reference case scenario of energy consumption by end-use to 2035 was elaborated. This scenario is broadly in line with IEA projections (IEA 2012) that assume current policies are implemented and somewhat strengthened over the time period; however, unlike these scenarios the Reference Case scenario disaggregates end-use by industrial and tertiary sector sub-sectors. The energy consumption projected for the industrial sector is shown in Figure ES1.

Figure ES1. Final energy consumption for industry in the EU under the Reference Scenario (RS)



Barriers to greater savings through energy management

There are manifold barriers to the greater adoption of EM and to the adoption of more effective EM. For example, a good summary of barriers faced by industrial energy audits (one element within EM) is provided in ECEEE (2014). While in the buildings sector the barriers that limit the better use of more effective automation and control strategies (a major EM opportunity) are documented in Waide et al (2013). These have a substantial overlap with the broad generic barriers to energy efficiency documented in WEO (2012) in that they include: EE is not visible to end users & service procurers and is usually not measured; limited awareness of the value proposition and opportunity; energy expenditure is a low priority; split incentives e.g. competing account holders for capital and operational budgets; scarce investment capital or competing capital needs; unfavourable perception and treatment of risk; limited staff resources and know-how on implementing energy-saving measures; limited government resources to support implementation; fragmented and under-developed supply chains and services markets. All these factors apply and act to hinder adoption of cost-effective energy management and hence supporting measures are required to help overcome these constraints and enable good practice to flourish. Critically though there is a need to raise the prioritisation of energy management, and not just energy audits, as a strategic objective of organisations (Corremans 2010) and this has implications for the most appropriate focus of remedial policy measures.

Existing policy frameworks

In recent years there have been a number of technical and policy developments in the EU that are providing some support to higher and more effective EM adoption. On the technical level the ISO 50001 series of energy management standards has been issued and revised (ISO 2011) and serves to provide a consistent platform for energy management. While the use of this standard is steadily growing its level of adoption is still quite low and much remains to disseminate its (or equivalent standards) use.

Public policies to promote energy management can broadly be divided into those that target the tertiary buildings sector and those that apply to industrial enterprises and SMEs; however, the measures adopted at the EU level leave some very significant gaps.

In the buildings sector the EPBD (2010) includes some measures and encouragement for EM, however, this is essentially limited to energy performance certificates that can be based on either operational energy consumption or asset energy ratings and hence either give modest or no encouragement to savings through energy management in the operational sense. The majority of the other measures within the EPBD apply to whole building energy performance when assessed as an asset and hence only encourage improvement through new build or major renovation interventions i.e. do not address improvements through improved operation of existing buildings. The exception to this are Articles 14 and 15 which addresses heating and AC system inspections respectively; however, while these could be applied to promote some improvements in energy management it is not well targeted in this respect and so its expected impact will be weak.

The EED (2012) currently requires EU member states to make energy audits mandatory for large enterprises and gives the possibility for such enterprise that have implemented broader energy management schemes such as ISO 50001 to be exempt from the requirement provided the energy management scheme includes audits of a recognised quality. While this is welcome progress compared with previous policy frameworks it leaves several important gaps:

a) it does not oblige affected enterprises to implement an energy management system (just to conduct audits; although this does give mild encouragement to EM adoption) nor does it create an incentive for organisations to adopt EM other than through the findings of the audits
b) it does not oblige or encourage affected enterprises to implement cost effective measures identified in the audits
c) it does not create a system to support the adoption and implementation of energy management systems
d) it only applies to large enterprises

With respect to point b) the EED falls short of the requirements already imposed for example in Japan (Kimura & Noda 2014), Denmark (Togeby et al 2012) and Italy (for energy intensive industries). In the former the strength of obligations on companies to conduct energy audits and implement the measures is related to the companies energy use; however, a large proportion of tertiary sector enterprise and almost all industrial enterprise are required to undertake energy audits and to implement measures with a sufficiently short payback time. Furthermore, the quality of the audits has to be approved by the relevant line ministry. Danish regulations impose similar requirements on the more significant energy using sectors of industry. Nonetheless, while audits are an important technical input and stimulus to action to address energy savings they are one element within energy management and the main deficiency within the EED measures is that they do not address the organisational and institutional policy issues that are also a part of energy management. Nor do they adequately address other barriers, such as competition for investment finance.

The EED also has several measures that are intended to support energy savings in SMEs. These include requiring Member States to:

- develop programmes to encourage SMEs to undergo energy audits and the subsequent implementation of the recommendations from these audits
- set up support schemes for SMEs, including if they have concluded voluntary agreements, to cover costs of an energy audit and of the implementation of highly cost-effective recommendations from the energy audits, if the proposed measures are implemented.

- bring to the attention of SMEs, including through their respective representative intermediary organisations, concrete examples of how energy management systems could help their businesses.
- encourage training programmes for the qualification of energy auditors in order to facilitate sufficient availability of experts.

All these measures are laudable but they are mostly quite open-ended with respect to how they are defined, implemented and with respect to their scale of implementation. As the nature and scale of requirements is left unspecified Member States have considerable freedom to do rather little in this domain while still technically meeting the legal obligations i.e. of having done something, no matter how modest. Inspection of the activities mentioned in national energy efficiency action plans reveals that many are exercising this freedom.

Critically none of the provisions in the EED require Member States to develop dedicated finance mechanisms or subsidies to support savings through energy management measures. Rather the Directive simply states:

Without prejudice to Union State aid law, Member States may implement incentive and support schemes for the implementation of recommendations from energy audits and similar measures

The EU emissions trading scheme (EU ETS) and the integrated pollution prevention and control (IPPC) Directives also provide some indirect encouragement to greater adoption of effective energy management within major industries but these are poorly focused as far as energy management is concerned and hence will only weakly stimulate greater levels of adoption.

Thus in summary, the existing EU policy frameworks are helpful but insufficient to stimulate more than a part of the fully economically rational savings potential from energy management.

Savings potentials

In order to clarify the value proposition from broader adoption of effective energy management a series of scenarios were developed and modelled using specifically designed energy capital stock models which treat each energy use sector individually. For each tertiary and industrial sector three scenarios were developed:

- a Reference Scenario that considers the energy use by sector that is anticipated with a continuation of current trends
- a techno-economic Optimum Scenario that considers the energy use by sector that would be expected were all cost-effective energy management options to be adopted as rapidly as is technically feasible
- a Recommended Actions Scenario that explores what savings might be achieved through energy management were the specific recommendations in the study to be implemented across the EU.

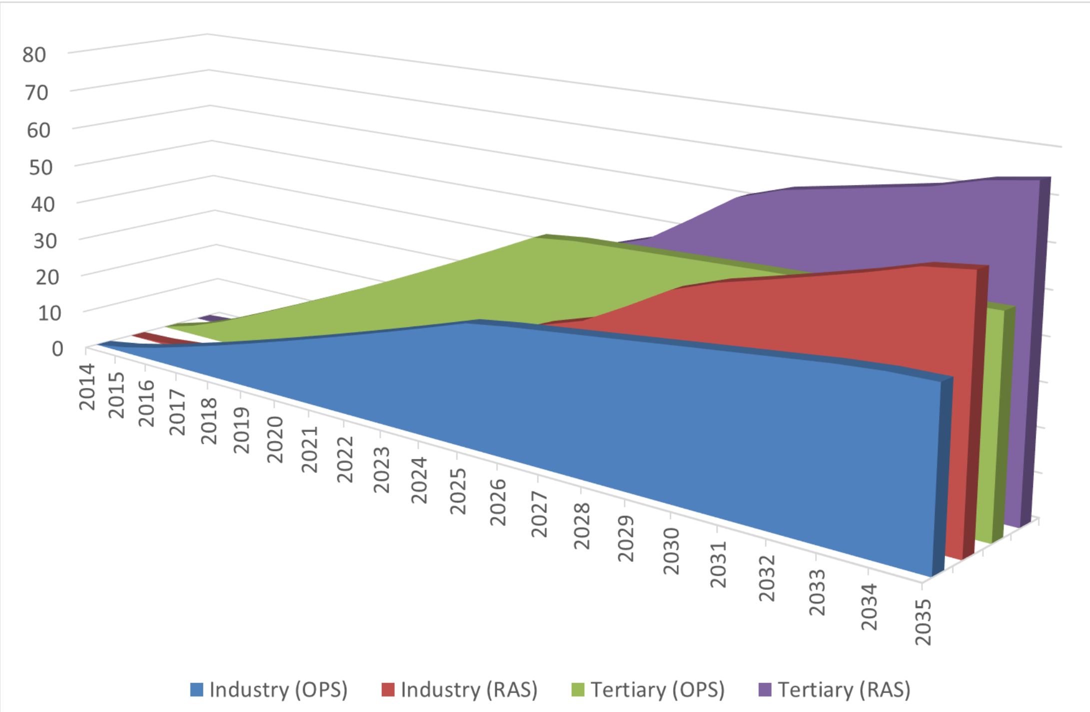
These scenarios are informed by the findings from the detailed literature review, numerous case studies and interviews with specialists in the field. They are also based on a thorough evaluation of the likely costs and benefits of broader adoption of specific energy management measures and the expected uptake in response to a more proactive policy portfolio. The results are presented separately in the report for the industrial and tertiary sectors and also for each of the sub sectors within these e.g. the industry sectors presented in Figure ES1 and the following tertiary sectors: retail, education, health, office, hotel/restaurant, other.

The analysis finds the potential energy savings from greater and more effective use and deployment of energy management are vast. The total techno-economic optimal savings potential as expressed through the Optimal Scenario is estimated to reach 26% of combined tertiary and industrial sector energy consumption by 2025 and to maintain that level thereafter; however, this is predicated on a rational and perfectly functioning market without serious constraints to effective service delivery. A more realistic depiction of the potential to deliver additional savings beyond the Reference Scenario (business-as-usual case) is offered by the Recommended Action Scenario. In this case, savings ramp up progressively over the scenario period to reach 19% of the Reference Scenario energy consumption by 2031 and remain relatively constant thereafter (Figure ES2).

The Optimal Scenario leads to some 1 728 Mtoe of cumulative energy savings from 2015 to 2035 compared to the Reference Scenario for industrial and service sectors combined (Figure ES2), of which 807 Mtoe of savings are in industry and 931 Mtoe of savings are in the tertiary sector. This equates to estimated cumulative CO_2 savings of 4.8 gigatonnes over the same period, with annual savings of 124 million tonnes of CO_2 in 2020 and 383 million tonnes in 2035.

By contrast, the Recommended Action Scenario leads to some 1 184 Mtoe of cumulative energy savings from 2015 to 2035 compared to the Reference Scenario for the industrial and service sector combined (Figure ES2), of which 560 Mtoe of savings are in industry and 624 Mtoe of savings are in the tertiary sector. This equates to estimated cumulative CO_2 savings of 3.3 gigatonnes over the same period, with annual savings of 76 million tonnes of CO_2 in 2020 and 295 million tonnes in 2035.

Figure ES2. Energy savings from Energy Management under the Recommended Action Scenario (RAS) and Optimal Scenario (OS) for European tertiary and industry sectors compared with the Reference Scenario



Over the Recommended Action Scenario period (2015–2035), some €91 billion of extra investments in equipment and related services are needed to deliver these savings, at an average of €4.6 billion per year. Large as these incremental investments are, they are over twelve times less than the value of the resulting savings in energy bills, which total €1 154 billion over the period, at an average of €58 billion per year.

The details of the analysis behind these figures including the breakdown of savings estimates by sector and fuel type as a function of current levels of EnMS adoption are discussed in depth in the full report. In general though savings potentials are slightly higher for electrical end-uses than thermal end-uses and tend to be higher in percentage terms for less energy intensive sectors and for smaller enterprises. This is logical as it reflects the relative importance of managing energy savings and the capacity to do so by economic sector. Nonetheless substantial savings opportunities from EnMS exist in all sectors, regardless of their energy intensity.

Recommended actions

Given the pressing need for the EU to improve its energy security (especially with respect to natural gas imports) and make deep cuts in the carbon intensity of its economy it is appropriate to countenance more proactive stimuli to promote systematic energy savings than have hitherto been adopted. This is especially the case for the savings that require systemic and organisational level savings such as are accessed through energy management. The full report includes an extensive set of recommendations supported with a carefully articulated rationale. The principal recommendations are summarised below.

Following review of the EED the Commission and Member State (MS) should consider amending the articles which currently exclusively concern energy audits to:

- introduce MS level targets for the share of enterprises that have adopted EM and where the targets are set based on the proportion of enterprises of a given size and energy intensity within each MS
- consider amending the EED energy audit obligations to become an obligation to adopt full energy management for enterprises using more than a minimum prescribed energy consumption or energy intensity level and above a minimum size
- set MS targets for the number of certified energy managers, wherein the targets are proportional to the economy's size and energy intensity and increase with time
- support the development of EM standards and tools which are targeted to each sub-sector and which are designed to be less burdensome and more relevant for SMEs and less energy intensive enterprises

Independently of developments in the EED MS should also consider:

- providing fiscal incentives for EnMS either in the form of direct tax incentives for companies are certified for EnMS or in the form of tax incentives to participate in a Long Term Agreement to improve energy intensity via EM
- providing incentives on energy efficiency capital expenditures for those organisations that adopt relatively advanced EnMS, wherein the total scale of the incentives provided by each Member State is commensurate to a proportion (say a quarter) of the value of expected energy savings to be achieved over the lifetime of the investment. Financing of these incentives could be integrated within national energy efficiency obligation schemes imposed on energy utilities under the provisions of Article 7 of the EED. Develop common EU methodologies to account for and evaluate energy savings produced via EnMS to facilitate funding through Energy Efficiency Obligations (EEOs) and similar market mechanisms.
- supporting awareness raising and knowledge transfer regarding EnMS through then establishment of sector level EnMS learning networks, or Long Term Agreements or similar mechanisms
- establishing and promoting benchmarks of energy performance in the industrial and tertiary sectors that are tailored for relevance to each specified industrial or tertiary sector activity (including SMEs) and require or encourage companies and organisations to benchmark their energy use and share the results in an anonymous format with public authorities
- developing and providing free energy management support services to SMEs targeted at those with poor benchmarked efficiency levels (note this would include but not be limited to energy audits) - consider obligating the poorer performers to implement highly-cost effective measures

- developing extensive capacity building programmes to train organisations in the development and implementation of EM policies and to build and support the energy services sector.

More detailed recommendations are provided in section 7 and a summary of these is given in Table ES1.

Table ES.1 Summary of recommended actions at EU and MS levels

Measure	Mechanism	Form
MS obligations	Dynamic EM adoption targets	Set by economic sector, enterprise size and enterprise energy intensity - increasing target with time
Incentives for EM	Fiscal incentives	Either: LTAs with fiscal incentive
		Or: Direct fiscal incentives for EM
		Also consider: Carbon trading EM schemes for non EUETS sectors – à la UK CRCEE
	Other incentive mechanisms	EEOs
		Direct state incentives (least preferred choice)
EM obligations for enterprises	Expand from audits to certified EM for enterprises >€50m turnover and with high energy intensity	impose on EUETS obligated as well as un-obligated parties
		introduce in a staged manner as a function of an enterprises energy intensity/energy use
	Consider obligations/incentives to implement cost effective savings	tailored and staged to the target sectors under consideration, to ensure they are appropriate and that sufficient qualified capacity is in place to implement the measures
Clarify value proposition	Targeted awareness campaigns	Sector networks and peer groups
		Awareness through LTAs
		Greater promotion of CSR
Benchmarking	Promotion and incentives	electricity consumption benchmarking for buildings
		energy consumption benchmarking for buildings
		process benchmarks by industry sector
		output benchmarks by industry sector
EM quality	MS dynamic targets for certified energy managers	Targets proportional to economy size and energy intensity, increasing with time
Standardisation and tools	EM standards and tools targeted to each sub-sector	Less burdensome and more relevant EM standards and methods for SMEs and less energy intensive enterprises
	Developed at EU and MS levels	

Conclusions

Strengthening the practice of energy management is a key need if public and private sector organisations are to access the large reserve of energy savings that are not directly addressed through other instruments. In the tertiary sector while measures addressing the energy performance of buildings are partially captured through the provisions of the Energy Performance in Buildings Directive and to a lesser extent the Energy Efficiency Directive these measures leave a substantial proportion of the systems- and operational-level savings potential untouched. This is the domain where energy management can make a significant difference. Similarly, in the industrial sector existing European policy instruments such as the EU ETS and the IPPC directive only provide weak stimuli to encourage the savings that are only accessible through energy management. Not least because the value of carbon credits has plummeted while the energy efficiency specifications within the IPPC are rather loose and have considerable freedom in their interpretation leading to diluted implementation. This leaves a policy vacuum that measures which promote stronger energy management could help to fill.

In this context the development of effective energy management across EU organisations should be viewed as a strategic opportunity and priority. About 11% of all EU energy consumption can be economised cost-effectively through the adoption of more effective energy management and most likely this potential will be “renewable” as more sophisticated technologies and techniques are developed in the future.

A variety of policy and programmatic recommendations have been proposed which can help to realise a large part of this savings potential. These build principally on strengthening the design of the Energy Efficiency Directive and its implementation at the Member State level. Critically realisation of these savings will require efforts at a major scale supported by very substantial financial resources and incentives; however, as the value of the benefits outweigh the costs by an average of twelve to one over the lifetime of the measures this constitutes a highly cost-effective investment and one that merits greater policy attention than it has received thus far.

1. Introduction – why does energy management matter?

1.1 What is energy management?

Energy management has no single definition but can be said to entail the proactive, organised and systematic coordination of procurement, conversion, distribution and use of energy to meet an organisation's requirements, taking into account environmental and economic objectives. In the tertiary and industrial sectors its operation addresses facility management, logistics, procurement, production, planning and control, maintenance and IT. Its implementation requires an organisation to develop an energy management strategy as the key tool to implement its energy policy.

In general energy management can be described as having five distinctive steps – each containing a number of smaller steps[1]. The five steps are implemented iteratively and repeatedly during the lifetime of the system.

> ENERGY POLICY The energy policy defines the overall guidelines for the efforts to achieve greater energy efficiency. It is established and maintained by the top management of the organisation.
>
> PLANNING The organisation reviews all energy aspects to form an overview of the significant energy consumption i.e. the machinery, equipment and activities which account for the highest energy consumption or which offer the most considerable potential for energy savings. The review forms the basis for determining the order of priority of the energy saving efforts. Concrete energy targets are set complying with the overall energy policy. To achieve the targets the company elaborates action plans.
>
> IMPLEMENTATION AND OPERATION The organisation involves the employees in the implementation of the objectives and makes sure better use of energy becomes a part of their daily routines. This includes introducing procedures for energy conscious purchasing, operation and maintenance of equipment with significant energy consumption, energy efficient design activities etc.
>
> CHECKING AND CORRECTIVE ACTIONS The organisation monitors and measures the significant energy consumption and all activities with a significant impact on energy aspects. Corrective and preventive actions are taken in case of non-conformance e.g. when the energy targets have not been achieved within the specified time limit.
>
> MANAGEMENT REVIEW The top management periodically evaluates how the implementation of plan, objectives and operational control is proceeding to ensure its continuing suitability. The management review must address the possible need for changes of the elements of the energy management system, in the light of the commitment to continual improvement

Ideally these steps are implemented iteratively and repeatedly in a process of continuous improvement (see Figure 2.1).

The implementation of energy management is facilitated by specific techniques and tools. The key techniques are energy audits, monitoring and benchmarking while the key tools are energy management and related standards. These are discussed in section 2.2.

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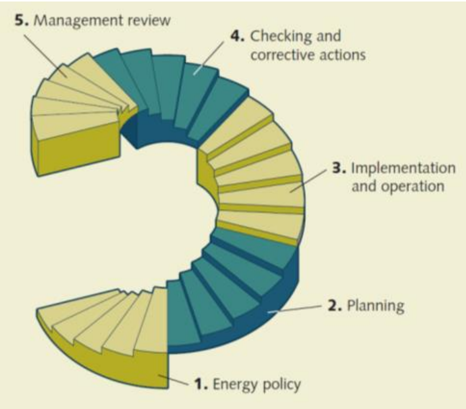
[1] From: *Energy Management In Industry – Danish Experiences*, Danish Energy Authority http://www.ens.dk/sites/ens.dk/files/dokumenter/publikationer/downloads/energy_management.pdf

Energy management is broader than the simple conduct of diagnostic activities such as energy audits and/or benchmarking, as crucially it entails an organisational level commitment and structured process to act on the information provided through such diagnostics.

1.2 Leading energy management protocols and tools

The objective of an energy management standard or protocol is to provide guidance for organisations and facility managers on how to integrate energy efficiency into their management practices. A common aspect is the use of the "plan-do-check-act" framework to structure the steps within the process and via iterative implementation of this process build a culture and system of continuous improvement. The Danish DS 2403:2001, Energy Management-Specification standard provides an early example of this, Figure 1.1.

Figure 1.1. The iterative steps within energy management



Source: DEA (2002)

The most well-known energy management standard is EN ISO 50001:2011 *Energy management systems - Requirements with guidance for use.*

This standard is derived from the CEN standard EN 16001:2009 of the same name, which was developed at the behest of the European Commission and drew upon a synthesis and adaptation of a set of earlier European energy management standards including the: Danish DS 2403:2001 standard, the Swedish SS62 77 50:2003 standard, the Irish IS 393:2005 standard and EnMS specifications in Germany and the Netherlands.

EN 16001:2009 was further developed to be entirely compatible with the ISO standards series for quality management (ISO 9001:2000) and environmental management (ISO 14001) and this has been inherited by the EN ISO 50001: 2011 standard that replaced it.

Typical features of an energy management standard include:

- a strategic plan that requires measurement, management, and documentation for continuous improvement of energy efficiency;
- a cross-divisional management team led by an energy coordinator who reports directly to management and is responsible for overseeing the implementation of the strategic plan;
- policies and procedures to address all aspects of energy purchase, use, and disposal;
- projects to demonstrate continuous improvement in energy efficiency;
- creation of an Energy Manual, a living document that evolves over time as additional energy saving projects and policies are undertaken and documented;

- identification of key performance indicators, unique to the company, that are tracked to measure progress; and
- periodic reporting of progress to management based on these measurements.

In addition, there are likely to be:

- the establishment of an energy baseline against which improvement can be measured (this is related to the KPIs)
- commitment to respect legal requirements and the organisation's policies.

The key steps an organisation would need to follow to abide by the requirements of the EN ISO 50001:2011 standard are set out in Appendix A.

Other standards exist to help support the EN ISO 50001 framework. These include the following sets of standards.

Standards for audits

While the term energy audit is commonly used they are essentially energy assessment or diagnostic activities. They entail a systematic inspection and analysis of energy use and energy consumption of a system or organisation with the objective of identifying energy flows and the potential for energy efficiency improvements. Energy audits are considered to be the standard first step for an organisation, of whatever size or type, that wants to improve its energy efficiency.

In response to the Mandate M/479 "Standardisation in the field of energy audits (decision D139/C016)" issued by the European Commission, the European standards bodies, CEN and CENELEC, have developed the EN16271 multi-part standard on energy audits. This comprises:

EN16247-1: 2012 - Energy audits. General requirements

EN16247-2: 2014 - Energy audits. Buildings

EN16247-3: 2014 - Energy audits. Processes

EN16247-4: 2014 - Energy audits. Transport

EN16247-5: 2015 - Energy audits. Competence of auditors

These standards have since been internationalised through ISO within the 50002 standard on energy auditing, as follows:

ISO 50002:2014 Energy audits -- Requirements with guidance for use

ISO 50002:2014 specifies the process requirements for carrying out an energy audit in relation to energy performance. It is applicable to all types of establishments and organizations, and all forms of energy and energy use. ISO 50002:2014 specifies the principles of carrying out energy audits, requirements for the common processes during energy audits, and deliverables for energy audits. ISO 50002:2014 does not address the requirements for selection and evaluation of the competence of bodies providing energy audit services, and it does not cover the auditing of an organization's energy management system, as these are described in ISO 50003. ISO 50002:2014 also provides informative guidance on its use.

The standard ISO 50002 doesn't comply with the requirements of the Commission's Mandate M/479 to CEN and for the time being is not adopted in Europe to comply with the EED.

Guidance standards for the implementation of an EnMS

ISO 50004:2014 Energy management systems -- Guidance for the implementation, maintenance and improvement of an energy management system

ISO 50004:2014 provides practical guidance and examples for establishing, implementing, maintaining and improving an energy management system (EnMS) in accordance with the systematic approach of ISO 50001. The guidance in ISO 50004:2014 is applicable to any organization, regardless of its size, type, location or level of maturity.

ISO 50004:2014 does not provide guidance on how to develop an integrated management system.

While the guidance in ISO 50004:2014 is consistent with the ISO 50001 energy management system model, it is not intended to provide interpretations of the requirements of ISO 50001.

Standards for baselines and energy performance indicators

ISO 50006:2014 Energy management systems -- Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) -- General principles and guidance

ISO 50006:2014 provides guidance to organizations on how to establish, use and maintain energy performance indicators (EnPIs) and energy baselines (EnBs) as part of the process of measuring energy performance.

The guidance in ISO 50006:2014 is intended to be applicable to any organisation, regardless of its size, type, location or level of maturity in the field of energy management.

Standards for MV&E of the energy performance of organisations

ISO 50015:2014 Energy management systems -- Measurement and verification of energy performance of organizations -- General principles and guidance

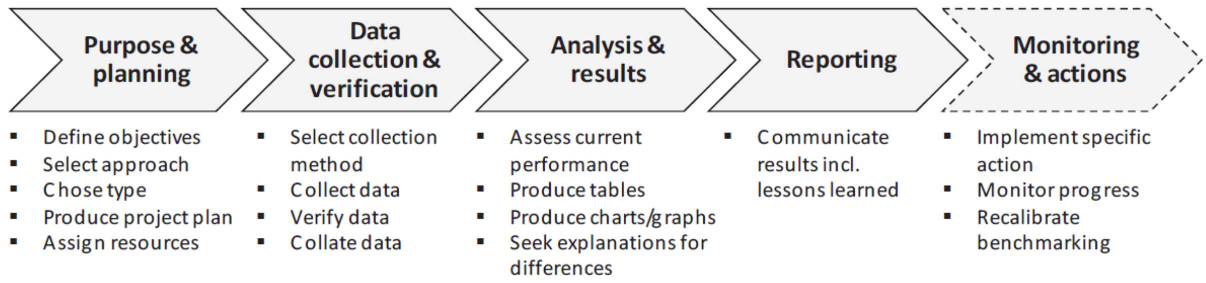
ISO 50015:2014 establishes general principles and guidelines for the process of measurement and verification (M&V) of energy performance of an organization or its components. ISO 50015:2014 can be used independently, or in conjunction with other standards or protocols, and can be applied to all types of energy.

Standards for benchmarking the energy performance of organisations and activities

EN 16231:2012 Energy efficiency benchmarking methodology

This European Standard specifies requirements and provides recommendations for energy efficiency benchmarking methodology. The purpose of energy efficiency benchmarking is to establish the relevant data and indicators on energy consumption, both technical and behavioural, qualitative and quantitative in comparing performance between or within entities. Energy efficiency benchmarking can be either internal (within a specific organisation) or external (between organisations including competitors). This standard describes how to establish the boundaries of what is being benchmarked, including for example facilities, activities, processes, products, services and organisations. This European Standard provides guidance on the criteria to be used in order to choose the appropriate level of detail for the data collection, processing and reviewing which suits the objective of the benchmarking. This European Standard does not itself state specific performance requirements with respect to energy use. For all activities related to the continual improvement cycle (such as the Plan-Do-Check-Act methodology) reference shall be made to management systems in the organisation.

Figure 1.2 Benchmarking structure within EN 16321:2012



Source: Sontag et al (2014)

EN 15221-7:2012 Facility Management - Part 7: Guidelines for Performance Benchmarking

This European Standard gives guidelines for performance benchmarking and contains clear terms and definitions as well as methods for benchmarking facility management products and services as well as facility management organisations and operations. This European Standard establishes a common basis for benchmarking facility management costs, floor areas and environmental impacts as well as service quality, satisfaction and productivity. This European Standard is applicable to Facility Management as defined in EN 15221-1 and detailed in EN 15221-4.

Standards setting requirements for audit and certification of EnMSs

ISO 50003:2014 Energy management systems -- Requirements for bodies providing audit and certification of energy management systems

ISO 50003:2014 specifies requirements for competence, consistency and impartiality in the auditing and certification of energy management systems (EnMS) for bodies providing these services. In order to ensure the effectiveness of EnMS auditing, ISO 50003:2014 addresses the auditing process, competence requirements for personnel involved in the certification process for energy management systems, the duration of audits and multi-site sampling.

ISO 50003:2014 is intended to be used in conjunction with ISO/IEC 17021:2011. The requirements of ISO/IEC 17021:2011 also apply to ISO 50003:2014.

Standards for energy efficiency calculations

EN 16212:2012 Energy Efficiency and Savings Calculation, Top-down and Bottom-up Methods

This European Standard provides a general approach for energy efficiency and energy savings calculations with top-down and bottom-up methods. The general approach is applicable for energy savings in buildings, cars, appliances, industrial processes, etc. This European Standard covers energy consumption in all end-use sectors. The standard does not cover energy supply, e.g. in power stations, as it considers only final energy consumption. This European Standard deals with savings on energy supplied to end-users. Some forms of renewable energy "behind-the-meter" (e.g. from solar water heating panels) reduce supplied energy and therefore can be part of the calculated energy savings. Users of the standard should be aware that this renewable energy behind the meter can also be claimed as energy generated. The standard is meant to be used for ex-post evaluations of realised savings as well as ex-ante evaluations of expected savings. This European Standard provides saving calculations for any period chosen. However, short data series may limit the possible periods over which savings can be calculated. The standard is not intended to be used for calculating energy savings of individual households, companies or other end-users.

Standards for energy efficiency services

EN 15900:2010 Energy efficiency services - Definitions and requirements

This European Standard specifies the definitions and minimum requirements for an energy efficiency service which include the energy efficiency improvement guarantee as well as the implementation of an energy management system.

Other related standards under development

In addition to maintaining the ISO standards set out about above ISO/TC 242 on Energy Management is in the process of developing the following standards:

ISO/DIS 50007 Activities relating to energy services -- Guidelines for the assessment and improvement of the service to users

ISO/AWI 50008 Commercial building energy data management for energy performance -- Guidance for a systemic data exchange approach

Standards for Building Automation and Control Systems (BACS)

The process of developing the EU's Energy Performance of Buildings Directive (EPBD) (EC 2002, 2010) has led to the derivation of whole building system energy performance standards. This is supported by a suite of approximately 40 technical standards that are designed to enable the whole building energy performance to be calculated in a harmonised way across Europe. Separate standards are used to derive the energy performance impact of each building system sub-element, e.g.:

- heating, EN 15316-1 and EN 15316-4
- domestic hot water, EN 15316-3
- cooling, EN 15243
- ventilation, EN 15241
- lighting, EN 15193.

The impact of controls is assessed using the standard EN 15232 (CEN 2012), which provides guidance on how to include building automated control and building management within the overall whole building energy impact assessment method. It includes:

- a detailed list of the control, building automation and technical building management functions that have an impact on building energy performance
- a methodology to enable the definition of minimum requirements regarding these functions to be implemented in buildings of different complexities
- detailed methods to assess the impact of these functions on the energy performance of a given building − these methods facilitate accounting for the impact of these functions in the calculation of whole building energy performance ratings
- a simplified method to get a first estimation of the impact of these functions on the energy performance of typical buildings.

Thus this standard is designed to facilitate the specification of control requirements within European building regulations and energy performance rating specifications.

This standard was developed through the European Standards body CEN, specifically CEN/TC247 (tasked with standardisation of building automation and building management in residential and non-residential buildings) and is published by the individual national standards bodies such as DIN in Germany and BSI in the UK.

TC 247 has also developed other relevant European and international standards for building automation, controls and building management, including:

- product standards for electronic control equipment in the field of HVAC applications (e.g. EN 15500)
- EN ISO 16484-3: standardisation of BACS functions (used to assess the impact of BACS on energy efficiency)
- open data communication protocols for BACS (e.g. EN ISO 16484-5: 2012), which is necessary for integrated functions with BACS impact on energy efficiency
- specification requirements for integrated systems (EN ISO 16484-7).

Furthermore, these standards complement broader energy management practice and procedures which are addressed through the standard EN ISO 50001: 2011.

2. Energy management in Europe: an assessment of the current situation

2.1 Levels of energy management

One way of classifying the implementation of energy management is to consider the nature of organisation EM strategies and practices which can be grouped into following cases ranked from least to most proactive strategies:

- no systematic planning; where an organisation only deals with the most essential issues and has no dedicated management process for energy
- short-term profit maximisation approach: where management is focused exclusively on measures that have a relatively short payback period and a high return
- longer-term profit maximisation: where measures with a longer term payback are also implemented
- realisation of all financially attractive energy measures: where all measures are implemented that have a positive return on investment
- climate optimisation strategy: where the organisation is willing to invest in all measures that meet their climate impact mitigation strategy and hence may go beyond purely cost-effective measures.

This approach distinguishes organisations by their level of motivation regarding improving the energy efficiency of their operations and how this is tied to economic evaluation criteria.

Another method of classification is the grouping applied in the survey associated with this study (see Appendix B) which is as follows:

Group a) “unaware” (only little energy efficiency measures/actions taken)

Group b) “awakening” (ad hoc energy efficiency measures/actions – not systematic)

Group c) “engaged” (energy efficiency measures/actions according to a systematic approach)

Group d) “certified” (ISO 50001 or EN 16001 certified).

This approach distinguishes organisations by their level of activeness in energy efficiency measures building up towards a systemic approach and finally EN ISO 50001 certification.

The Sector Forum Energy Management (SFEM 2014) applied a grouping as follows:

no management systems – EE unaware

no management systems – EE aware

with management systems – EE unaware

with management systems – EE aware.

This approach distinguishes organisations by their use of management systems standards (such as the ISO 9000, 14000 and 50000 series) and by their awareness of energy efficiency.

All of these distinctions have their rationale and reveal something about the way that energy efficiency and energy management are approached and implemented with organisations.

2.2 Characterisation of the current situation

With the exception of tracking of the adoption of certification to ISO standards there is no systematic survey of current levels of EM adoption across EU organisations. Appendix B presents the findings of a limited survey across the six largest EU economies that was conducted in support of this study. The Sector Forum Energy Management of CEN/CENELEC has also conducted a limited survey. Otherwise there is a quite rich technical literature regarding the adoption of energy management in the EU including extensive case studies (discussed in section 4.2). Analysis and synthesis of these findings in conjunction with a set of informal interviews with EM experts across the EU has led to the following assessment of the levels of adoption of EM in the EU:

- there is a broad spectrum of behaviours currently seen but on average EM adoption is well below economically rational levels
- (as one would expect), energy intensive and larger organisations are much more likely to have adopted proactive energy management strategies than less energy intensive or smaller organisations
- very few organisations adopt strategies to realise all financially attractive measures and even less to optimise their climate impact
- the case of no systematic planning predominates in SMEs
- short-term profit maximisation is most common in other commercial enterprises such that measures with payback periods of beyond 2 years are seldom considered.
- certification to EN ISO 50001 is growing quite rapidly but from a low base
- motivation to be certified is strongly driven by additional economic incentives (driven by public policy) and this has created a major asymmetry in the level of certification by EU Member State
- the provisions of the EED regarding audits and EN ISO 50001 are most likely increasing adoption rates but the policy is quite recent and its implementation more so such that it is still unclear what scale of impact it has had
- countries with long established EM standards and programmes are significantly more likely to have a high proportion of organisations having adopted EM and a greater depth of EM implementation than those that haven't.

Overall it appears that while awareness of energy management and its significance is increasing most organisations are struggling to implement it effectively. They tend to operate conservative, risk-averse strategies that avoid deflecting time and effort from core business activities for measures that may be seen to be desirable in principle but are perceived to be outside core competences. Given this situation there remains a considerable scope to develop more sophisticated EM strategies that mine the cost effective savings potentials more fully.

Findings of the ECI Survey

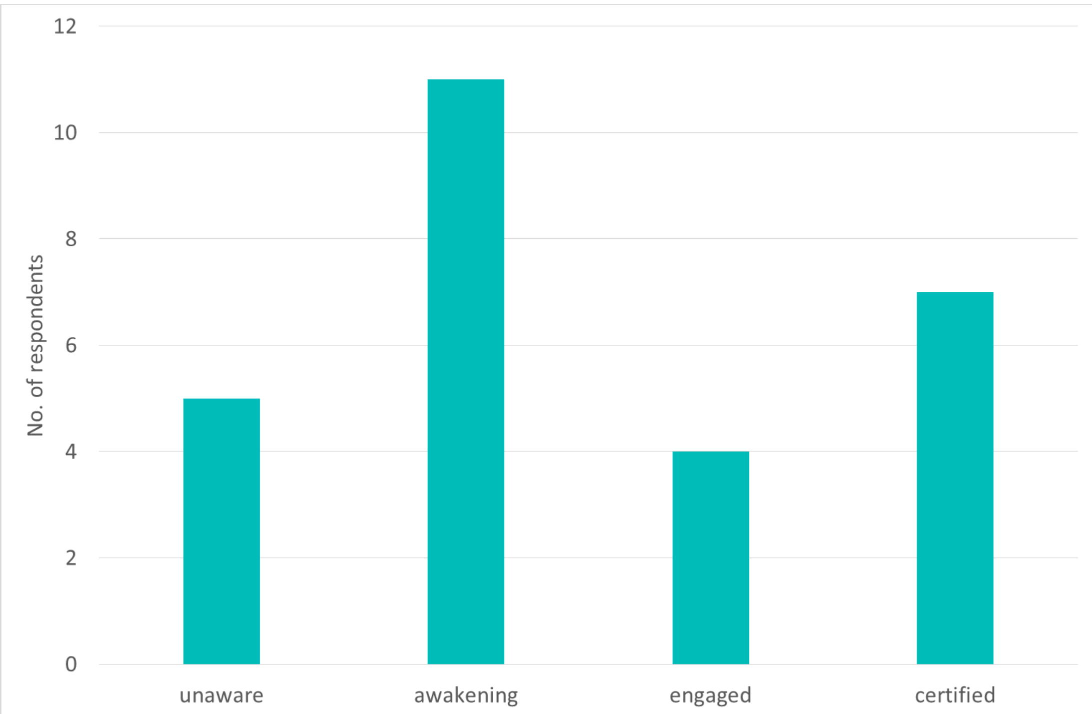
The ECI sponsored survey investigated EM adoption levels in 27 industrial enterprises across the six largest EU countries, see Appendix B. The companies selected were engaged in intensive or relative energy intensive activities mostly in the chemical/ pharmaceutical, automotive, metal refineries & foundries and packaging materials sectors.

The survey found that:

- the group b) "awakening" category seems to be predominant across the countries surveyed, which implies there is interest in EM and some EE measures are implemented but there is a lack of systematic EM
- many potential survey candidates during the recruitment process, stated when the survey topic was described that they are "…*completely unaware regarding the ISO 50001 requirements and energy management systems are not their priority*…" and declined to participate. It is thus very difficult to encourage companies that might fall into the group a) "unaware" category to engage with a survey of this type. This may be because given the rise in the cost of energy, mainly electricity, prices that all energy intensive companies will need to take actions to control and reduce costs; however, it is just as likely that their low motivation in discussing energy management and ISO 50001 topics is correlated to their lack of activity in the area
- there were few companies falling within the group c) "engaged" category except in the automotive sector where they were quite common; otherwise almost all companies implementing an EnMS seemed to go straight towards certification. This insight is significant because the number of companies certified under ISO 50001 is available in the public domain as discussed in further below. If this impression is generally correct it suggests that the number of companies certified as having an EnMS does not substantially underestimate the total number of companies using an EnMS, and thus that such listings are valid indicators of the current level of EnMS adoption
- those that have an EnMS and don't seek certification may be motivated by a desire to keep their processes confidential due to concerns about disclosing competitive advantages to their competitors. This may explain the behaviour of the automotive companies approached.

Figure 2.1 shows the distribution of surveyed companies by EM level of EM engagement from the ECI survey; note, the unaware group is under-represented as those that would not participate but said they were unaware of the EN ISO 50001 standards are not included.

Figure 2.1 Industrial organisations as a function of EM engagement – findings from an ECI survey



Findings of the Sector Forum on Energy Management Survey

The Sector Forum on Energy Management of the European standards bodies CEN and CENELEC conducted a survey among a set of their national standards bodies (NSBs) and national companies and organisations regarding EnMS and EN ISO 50001. Table 2.1 presents a summary of the findings regarding the benefits of EnMS and of certification to EN ISO 50001. The frequency of responses to the questions in the left column is rounded to the nearest 25% and grouped depending on whether the organisation has an energy management system or not and whether it has, or has not, made investments in energy efficiency measures.

This survey does not report the frequency of organisations by EM grouping but the associated text conveys a strong impression of level of engagement found.

In addition the survey discovered that 100% of organisations that had attained EN ISO 50001 certification had previously been certified for other Management Standards (mainly the ISO 14001 series and about the 55% came from a previous EN 16001 certification).

The survey showed that, currently, EnMS and/or EN ISO 50001 implementation is not mandatory in EU countries, while in some cases they are recommended. Incentives are granted especially to energy intensive industries to understand and manage their "energy use and consumption" and measure the energy performance improvement. The link between national regulations defining the incentives scheme and EnMS implementation is strong, while there is seldom an explicit requests to apply EN ISO 50001. Moreover, when the recommendation is embedded in the national energy efficiency policy and integrated in the country context, the achievement seems to be more visible and the energy saving more easily measurable.

The incentives have different forms: in most cases a taxes' rebate (often fossil energy related taxes e.g. excise or CO_2 taxes) is adopted; another form is a "bonus" given to energy certificates when obtained through an EN ISO 50001 certificate or any EnMS.

An interesting comparison has been made between incentives and number of EN ISO 50001 certified sites. This was possible thanks to a survey performed by the Federal Environment Agency (Dessau – Germany) that is still collecting, with a monthly update, information all over the world about certified EN ISO 50001 organizations. Although this is not an official list, it is the most accurate existing report and it allows to trace the development of EN ISO 50001 adoption and implementation. As shown in table 1, Germany is "leading", with about 3440 certified sites (up-date May 2014), confirming that the main driver for the certification is the incentive scheme. In the following places we can find France (973 sites), The Netherlands (408 sites), UK (355), Italy (245), Sweden and Spain (about 230 each).

Table 2.1. Expected benefits from EnMS implementation and EN ISO 50001 certification

Average values calculated on inputs given by NSBs **Feedbacks received from:** United Kingdom, Denmark, Slovakia, Sweden, Italy, France, Norway Legend "100 – red" stands for "Maximum interest" "25 – green" stands for "Minimum interest"	**No management systems - EE unaware**	**No management systems - EE aware**	**Yes Management systems - Energy unaware**	**Yes Management systems - Energy aware**	**EN ISO 50001 implemented but not certified**
Value of EN ISO 50001 implementation					
1. Implementation of EMS brings a significant **improvement of the energy performance** level from an initial energy baseline.	100	75	75	50	25
2. A systematic approach **(plan-do-check and act)** in addition to a case by case implementation leads to a continuously energy efficiency improvement	100	75	75	50	25
3. EnMS supports the development of an **energy policy** and contributes to the structure of an energy plan to achieve targets	100	75	75	50	25
4. EnMS ensures the engagement **(commitment and agreement)** of the management and has a positive contribution towards the energy targets	100	75	75	75	25
5. An energy management system **creates awareness** and a commitment about energy (i.e. consumption, use, efficiency, renewable sources) within the organization.	100	75	100	75	25
6. EMS improves the ability of organizations to manage **energy risks** with regards to possible impacts in an efficient and effective way	75	75	75	75	25
7. EMS strengthens the **competitiveness** of organizations and reduces their vulnerability with respect to energy price fluctuation and availability of energy	75	75	75	50	25
8. An energy management system allows the establishment of a **benchmarking** process.	75	75	75	75	50
9. An EMS allows to gain external **visibility** of energy saving actions on solid grounds.	75	75	75	75	75
10. An EnMS provides a **better understanding** between predictable energy demand and supply.	75	75	75	75	25
11. An EnMS **reduces energy costs** and improves profitability	75	75	75	75	25
Value of En Management System certification					
a) More ***credible company image*** *for a sustainable growth*	75	75	75	75	75
b) Participation to ***tender*** *requests*	100	75	75	75	75
c) Recommendation from ***certifications*** *body*	25	50	50	50	50
d) Stronger and long lasting ***commitment*** *to energy management within the organization*	75	75	100	100	75
e) ***Competitive*** *advantage, possibly in addition to other management systems*	50	75	75	75	75
f) Easier access to ***TPF*** *for energy related investments*	75	75	75	75	75
g) Access to ***incentives****(tax reduction, subsidies, etc)*	75	75	75	75	50
h) Increases ***competitiveness***	75	75	75	75	50
i) ***Compliance*** *with new* ***EU directive***	75	50	75	75	50

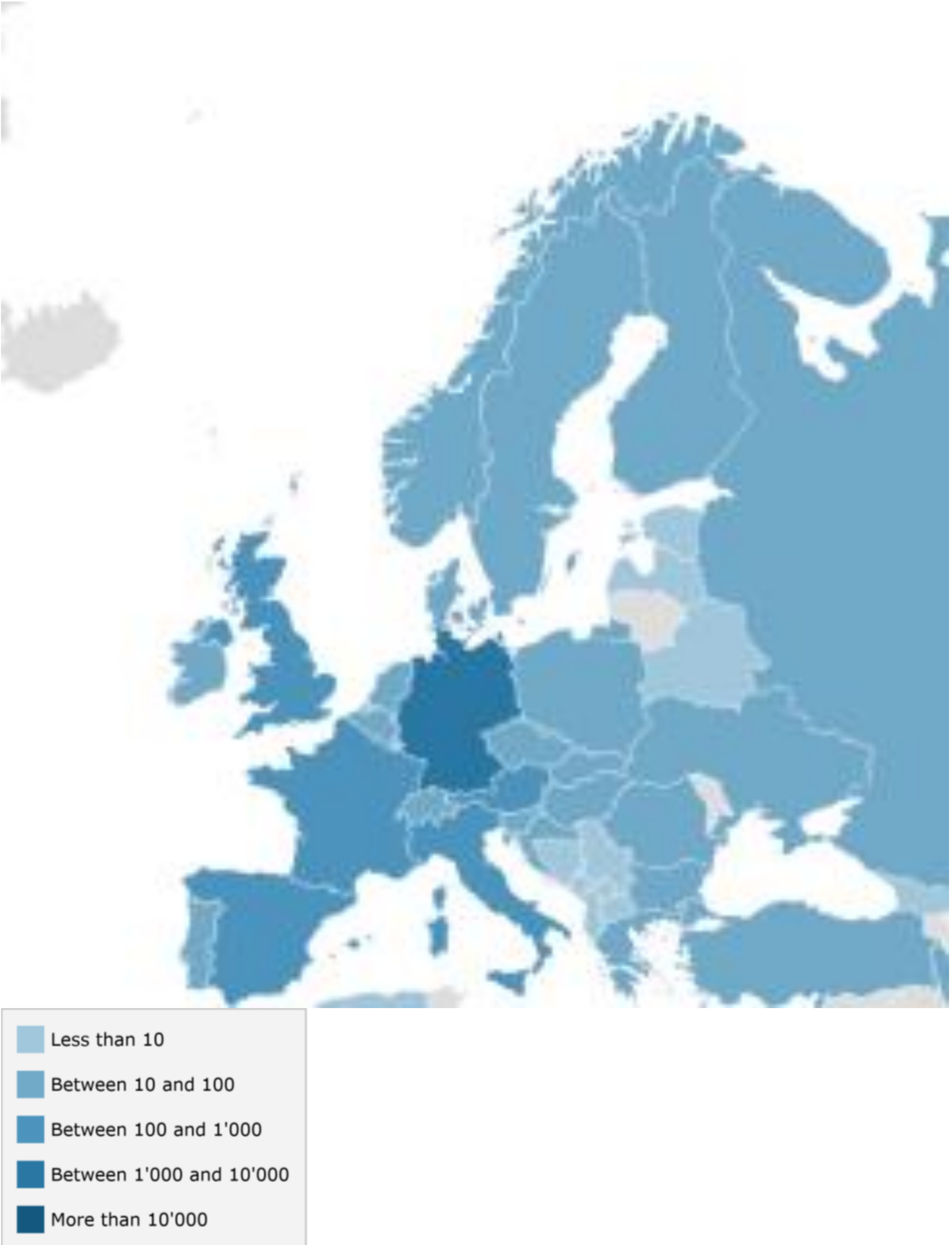
Source: SFEM (2014)

Levels of certification to EN ISO 50001

ISO compiles and annual survey of the number of organisations with EN ISO 50001 certification delivered through certification bodies that have been accredited by members of the International Accreditation Forum (IAF). In practice essentially all EN ISO 150001 certifications are thought to be done via such bodies and hence this should be a comprehensive list. At the time of writing the survey has been conducted from 2011 to 2014; however, it complements longer running surveys of the levels of certification to older ISO management standards including the ISO 9001 series addressing quality management and the ISO 14001 series addressing environmental management.

Figure 2.2 shows the distribution of EN ISO 50001 certifications by European country while Figure 3.3 shows the time series of certifications by EU country.

Figure 2.2. Distribution of EN ISO 50001 certification by European country in 2014

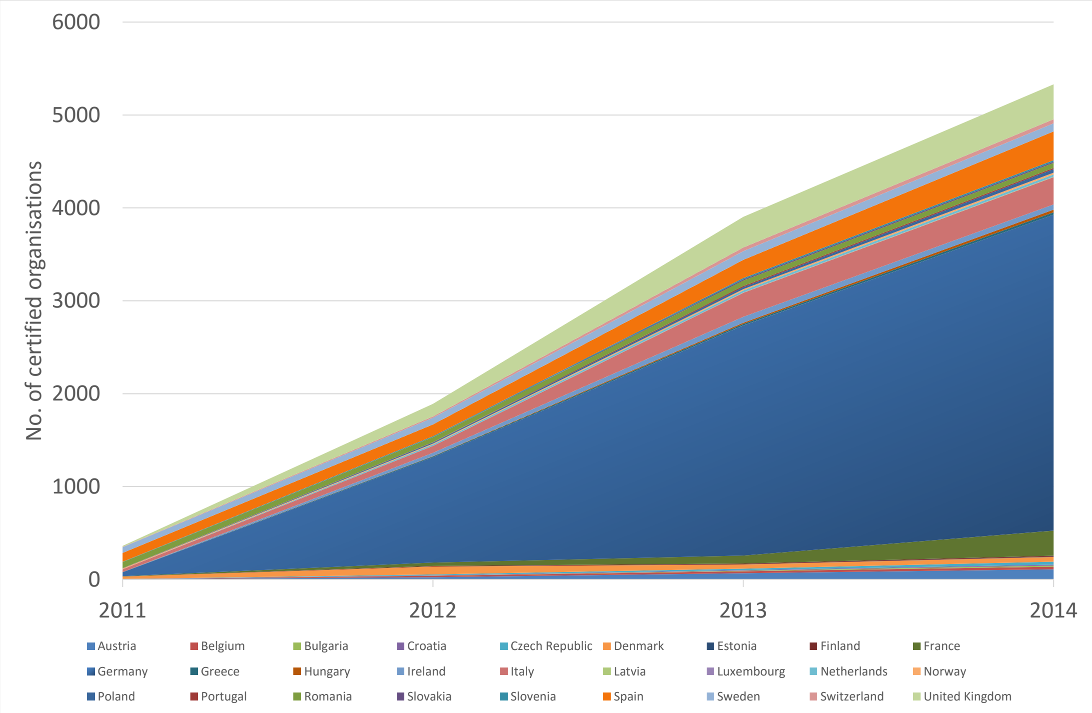


Source: ISO (2015)

These reveal that the number of certified organisations in Europe has been growing roughly linearly with about 1660 new certifications being added each year. Within Europe, Germany dominates the overall number of EN ISO 50001 certifications, accounting for 63.8% of the total number of certified organisations, followed by: the UK (7.1%), Spain (5.8%), Italy (5.5%), France (5.1%), Austria (2.0%), Sweden (1.6%), Ireland and Romania (1.1%), Denmark (1.0%), Switzerland (0.8%), Poland (0.7%), Czech Republic (0.6%) and all other countries 0.5% or less. From this it is clear that Germany is an exception, despite the relatively large size of its economy.

Overall this data indicates that just over 1 in 5000 EU organisations (i.e. companies and public sector organisations) is currently certified under EN ISO 50001. This value of 0.02% of organisations compares to 1.3% of EU organisations having ISO 9001 certification and 0.3% having ISO 14001 certification.

Figure 2.3 Distribution of EN ISO 50001 certification by European country in 2014

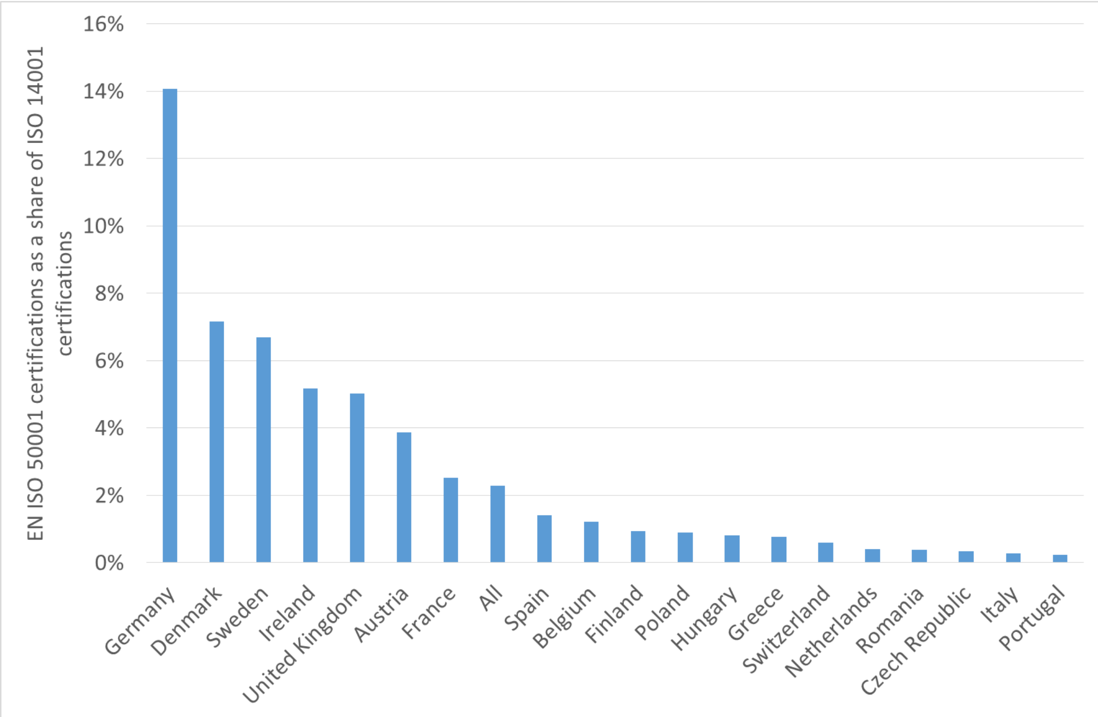


Source: ISO (2015)

Levels certification to EN ISO 50001 compared with other leading management standards

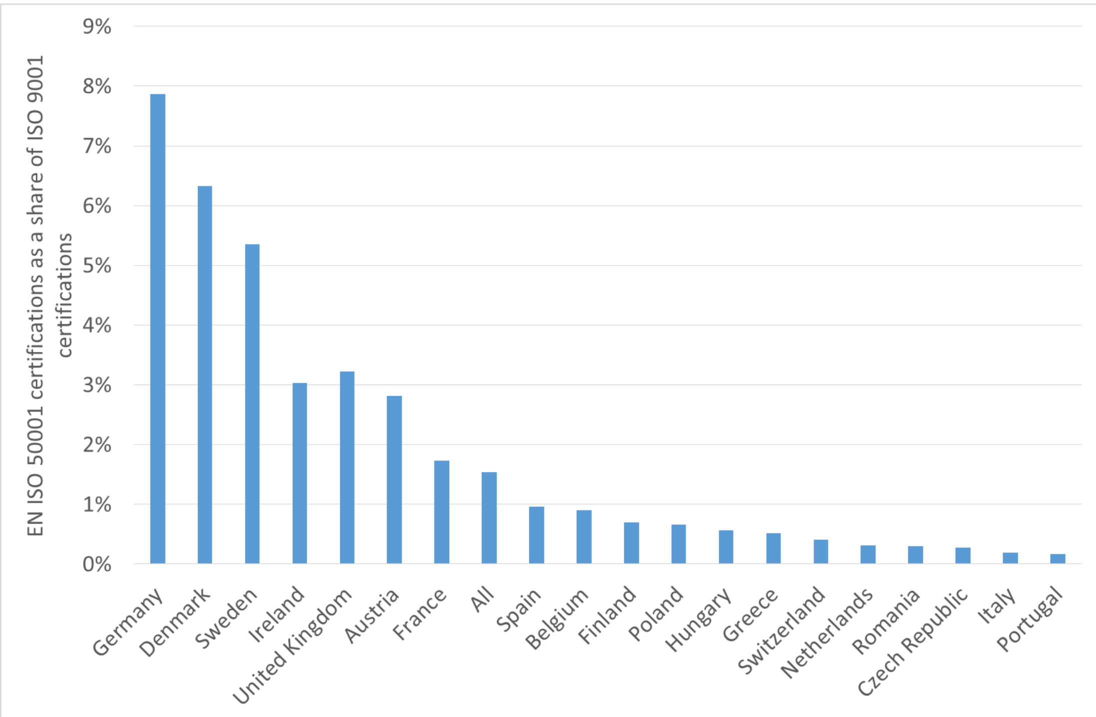
Given the lack of a survey of overall energy management adoption in the EU the next best method to gauge relative adoption levels is to benchmark EN ISO 50001 adoption levels against the other, more established, management standards, ISO 14001 (Environmental Management Systems) and ISO 9001 Quality Management. Figures 2.4 and 2.5 show this for a selection of European economies. Unsurprisingly the levels of adoption of the EN ISO 50001 standard are significantly less than the other older and more established standards. On average EN ISO 50001 certifications are 2.3% of those for ISO 14001 and 1.5% of those for ISO 9001. However, it is just as revealing to see which countries are leading and which lagging against these benchmarks. The top seven countries (DE, DK, SW, IE, UK, AT and FR) all have relatively longstanding EM policy support programmes of varying types. This would seem to suggest that EM adoption (at least as expressed by certification to EN ISO 50001) is quite strongly correlated with these policies. However, it clearly isn't as simple as this because NL, FI, CH and Flanders all also have relatively long standing EM programmes in place and these economies have quite modest levels of uptake of EN ISO 50001. At least in the case of the Netherlands and Switzerland this is explicable because while they have long standing EM policies these are not tied to EN ISO standards and hence there is no specific reason why organisations in these economies should seek to be certified to this standard. In the other economies this is less clear, however, so it may be indicative of less activity to date. The connection with national policy frameworks is further investigated in Chapter 6.

Figure 2.4 EN ISO 50001 certifications as a share of ISO 14001 certifications by European country in 2014



Source: ISO (2015)

Figure 2.5 EN ISO 50001 certifications as a share of ISO 9001 certifications by European country in 2014



Source: ISO (2015)

Commercial and public buildings

There is no publically available survey of the number of commercial and public sector organisations that have EN ISO 50001 certification across the EU as ISO does not yet compile this information;

however, if (as seems plausible) the distribution of certifications by business and organisation type is similar to that for ISO 9001 and 14001 (for which there is data), then commercial enterprises will account for about 16% of all EN ISO 50001 certifications and public sector organisations will account for about 7%. This means that about 1 in a 13000 service sector organisations were certified to EN ISO 50001 across the EU in 2014.

Light industry and SMEs

There is no publically available survey of the number of industrial enterprise that have EN ISO 50001 certification across the EU as ISO does not yet compile this information; however, if (as seems plausible) the distribution of certifications by business and organisation type is similar to that for ISO 9001 and 14001 (for which there is data), then industrial enterprises will account for about 77% of all EN ISO 50001 certifications. This means that about 1 in a 1500 industrial enterprises were certified to EN ISO 50001 across the EU in 2014. Most probably there is a higher proportion of energy intensive industries carrying this that light industry and SMEs, so the ratio is likely to be higher for the latter category.

Energy intensive industry

As set out above about 1 in 1500 EU industrial enterprises were certified for EN ISO 50001 in 2014 and most probably the ratio is less than this for energy intensive industry; however, there is a lack of data.

3. The influence of human factors in energy management

Human motivational, organisational, competency, response and productivity factors underpin the ability to design and deliver an effective EM programme. This section explores how these factors need to be taken into consideration in the development of any EM programme and also considers the human factors which are specific to given sectors.

3.1 Human factors common to all sectors

As discussed in Chapter 5 on the topic of barriers the key to successful energy management is to have the support and engagement of essential actors within an organisation. At the core of this is the need to build support among these actors for the EM policy to be defined and approved and for an implementable strategy to be developed. At a minimum this requires a clear value proposition to be formulated and persuasively articulated to the relevant decision makers. In principle this can happen bottom up when a facilities or operations manager can start to build a business case for why the organisation should pay greater attention to energy management. However, top down approaches, wherein a company board or senior management team decide to establish an energy policy founded on the aim of continuous improvement delivered via energy management, may have as much or more success. Ultimately there is a need for both senior decision makers and the staff directly responsible for operational cost management to work together if progress is to be made.

Why should organisation boards care about EM?

Energy costs and associated carbon emissions costs affect both the bottom line and the image of an organisation. In an increasing number of situations, see Chapter 6, they are also the subject of legal fiscal, environmental and regulatory requirements. Given that energy and carbon costs are variable and carry risk it is increasingly incumbent on organisation boards to adopt risk mitigation strategies through proactive energy management. Boards are much more likely to adopt energy policies and empower energy management if they are aware of both the downside of failing to manage this risk and the upside of the benefits from doing so. Thus clarifying the value proposition is a key need. A priori many boards and senior management teams will be unware of the extent of cost effective savings potentials that are realisable through EM and the extent to which taking an early lead can create a longer term competitive advantage. In fact awareness of these issues usually comes with direct experience of EM and hence there is a slightly chicken and egg situation where engagement and experience is needed to better envisage the benefits. This is why externally delivered awareness raising efforts and case studies from equivalent sectors are important precursors to action. These are also areas where government can work with private sector associations and thought leaders to help inform the sector of the opportunities.

Is board level engagement necessary?

The answer to this question obviously depends on the specifics of the organisation but in general it is, or if not, that at least the senior executive management is engaged and supports the EM effort. If the board establishes an energy policy and demands regular reporting from senior management on progress against that policy then it acts as a clear stimulus for action. The senior management then have a mandate and direct motivation to ensure the organisational structures are in place to implement the policy. This will then help ensure resources are made available in terms of staffing effort, budgets, capacity building and access to external services and goes a long way towards ensuring there is accountability in each of the key implementing departments. Crucially this can also help counteract one of the key energy efficiency split incentive barriers wherein equipment and facilities procurement managers are rewarded for procurement at least cost as opposed to best value for money over the life cycle of the service. If a holistic energy policy is in place it becomes a joint responsibility of the procurement and O&M teams to manage Opex and well as Capex costs and thus there is more likely to be a constructive dialogue between them. A board endorsed energy policy will also help to improve the standoff which can occur between, potentially overly narrow, risk assessment by production management acting against the interest of O&M expenditure. The policy serves as a cue to derive a holistic risk assessment where decision making aims to minimise the net effects of production-downtime risk and operational/reputational risk. Lastly, board engagement sends a signal to the whole enterprise that the topic is serious and worthy of collective effort and that staff will be held accountable for their delivery of the policy. If the policy is more long-term it will also help to improve upon typical investment cultures which make inappropriate trade-offs between downstream cost reduction investments and business development investments. The former should be funded to the extent that they are cost-effective over the period of the investment, while the latter should be judged against each other and thus financed differently. Allowing the formulation of an internal revolving fund topped-up through the value of energy savings accrued against an energy cost baseline is one such route but would typically require high level approval to be established.

Team work

The establishment and implementation of an EnMS usually requires a team to be established and tasked with its design, schedule, implementation, review and renewal. A key first step is to determine which staff within an organisation should be engaged and who they report to. As previously mentioned it is rarely adequate just to pass this responsibility to the O&M team as others such as production, procurement and finance need to be engaged. Senior management also has a key role, as previously mentioned. Establishing clarity about the responsibilities, delivery and accountability of the team leader and members of the EnMS team is thus also critical. This is also an area where abiding by an EM standard can help as it provides a systematic and structured means of considering the actions needed and hence facilitates mapping of personnel against roles.

Building-up the necessary competences

Simply appointing a designated EM team is likely to be insufficient, at least in terms of producing the more cost effective outcomes. Risk and benefit assessment is only as useful as the competences of the staff conducting it. The same is true of the specification and implementation of energy saving measures. In a worst case scenario ill thought through or poorly implemented measures could incur costs through unintended downtime in an industrial process and hence be counterproductive. The need is therefore to ensure that the teams charged with designing and implementing the EM policy are sufficiently competent to conduct the required tasks. In most cases this will require the commitment of resources to provide skills training and to outsource specialist activities. Taking steps to ensure that competences are adequate and objectives are being delivered is also helpful. These may include external auditing and benchmarking in addition to training activities. In some regions standard and certification procedures have been established to ensure the competence of energy experts charged with implementing EN ISO 50001:2011 e.g. in Italy the UNI CEI 11339: 2009 standard has been established for this purpose. Organisations also need to be fully cognisant of their legal responsibilities including any legal requirements with respect to: audits; carbon accounting, emissions and reporting; voluntary agreements that entail legally binding commitments, etc. (see Chapter 6 for examples).

Crawl, walk, run

Establishing an effective EnMS takes time and this needs to be factored into the delivery strategy. There are two countervailing aspects in play. On the one hand organisations that have never implemented EM previously are likely to have some very low hanging fruit i.e. very obvious and highly viable energy savings opportunities. On the other hand newly established EnMS are less mature, have less effective coverage across the ensemble of energy systems within the organisation, and usually have less staff engagement and less competent delivery. Overall the interaction between time and delivery is not necessarily what might be imagined in advance of the process i.e. it is rarely the case that the savings are identified and delivered and then there is not much worthwhile left to do. Rather, effective EM entails a continual process wherein more of the organisations activities are addressed progressively and new and better ways are identified to save energy that are responsive to technological development and also reflect development of the implementation capacity. As a result of this human and organisational capacity growth keeping pace with the rate of technological option depletion many organisations find that energy savings improvement rates can be maintained over time or even increased.

Supporting productivity

EM brings some significant potential co-benefits but may also bring some risk to an organisations productivity and hence needs to be designed to support the maximisation of overall productivity. EM measures that address building energy services in the workplace are likely to improve the work environment through provision of better quality lighting, thermal comfort and air quality. In part this is because proactive EM accelerates the adoption of newer and more advanced technology but importantly it is because it instigates a much more systematic monitoring and control structure with embedded user feedback. The co-benefits of these aspects can entail significant increases in worker productivity, work environment satisfaction levels and staff retention and recruitment levels. The value of these benefits may be comparable with the value of the energy savings although they are inherently less easy to quantify and usually require quite sophisticated research designs to be assessed. Nonetheless, research into this topic has found these benefits do exist and hence they should be considered in the overall assessment of the EM value proposition.

In the case of the productivity of industrial processes EM measures carry up-side and down-side risk. Poorly thought through measures, if implemented, could disrupt production and thereby lose far more value than they provide. Conversely, there are many instances where the extra level of understanding and control provided via EM can actively increase productivity, reduce material consumption and losses, and improve reliability in the production process. Therefore EM measures require professional predictability with a good level of understanding before implementation. Awareness and knowledge of these factors is therefore vital for successful outcomes. It is equally important that management structures the EM delivery roles such that all key parties necessary to its success are properly invested in its delivery within the broader context of enhancing productivity and value to the enterprise. There are to classis split incentives that need to be addressed to ensure this is done. One is the split incentive between Capex and Opex account managers, wherein the procurement budget account manager is rewarded for procuring goods and services at least cost even though this may often conflict with the O&M or Facility Manager’s objective of reducing the operating costs. The second is between the production manager and the O&M manager, where the former is rewarded for keeping production working and thus is unlikely to have much interest in reducing operating costs if it is perceived to carry risk to continuity of production. Good management recognises these dichotomies and puts in place structures that broaden the responsibilities of Capex and production managers to include the need to minimise Opex costs within an overall objective of maximising the enterprise’s economic efficiency. Equally, front line energy managers need to be fully cognisant of the impact their actions could have on production and hence ensure their measures are well designed, scheduled and executed.

External and internal services

One service delivery organisational issue many enterprise will need to address is how much reliance they should place on internal as opposed to external services for the delivery of their EM programme. External services can be helpful to increase the prospects of necessary competences being covered, to provide some degree of third party independence and in some instances to finance and operate the whole programme or parts of the programme.

Third party services are likely to be most helpful where significant proportions of the organisation's energy consumption are in cross cutting energy end-uses, rather than in highly process-specific end-uses, as identifying and accessing these savings is the typical area of competence of third party energy experts, auditors and ESCOs. Third party services are obviously required for certification to a specific energy or environmental management standard. ESCOs can also provide finance for the energy efficiency measures so in instances where it is particularly challenging to find internal finance, perhaps because of competing and more profitable uses of internally or externally sourced capital, it could still be viable to enter into an energy performance contract (EPC) with an ESCO, and wherein the ESCO or a third party would provide the finance, help define an energy consumption baseline, implement the measures and support the impact monitoring and assessment in exchange for a share of the value of the savings in the Opex budget. According to the standard EN 15900: 2010 the implementation of the "Energy Efficiency Services" provided by an ESCO, includes the implementation of the EnMS on the specific site being addressed. Training and benchmarking are other roles that could be provided by external services as well as a more comprehensive and independent overview of the EnMS's implementation.

On the other hand in many instances internal service providers may have a deeper understanding of the specific issues involved in the organisation's energy usage, may have better expertise (especially with respect to a specific production process) and better appreciation of the organisational objectives, and critically carry less IP risk. This latter factor is a key concern of many enterprises who may fear that the introduction of external consultants could compromise their specific IP advantage (note EN 16247 includes a code of conduct provision to prevent such events).

As a result the EM process will need to strike the best balance between the use of internal and external service providers given the circumstances of the organisation in question. In general, though, there is a tendency to under-utilise external services and this can come at the cost of having less cost-effective savings from EM. Organisations should be wary of believing they have all the necessary competences in house unless this has been clearly demonstrated, as there is usually scope for additional specialist knowledge to identify the most viable energy savings opportunities.

Evaluation and review

Establishing a robust evaluation and review process is a critical component for effective EM. Determining the impact of the programme obviously necessitates establishment of a robust baseline, appropriate energy performance indicators (EnPI) and sufficient monitoring of these to enable evaluation to be conducted. In human terms it requires personnel to be tasked with these activities and ideally there should be some degree of independent oversight to confirm that the impacts have been correctly established and reported.

Establishment of broad support

In many cases it will be beneficial to sensitise and engage a broad swathe of the organisations personnel in the EM process. This will be the case if broad-based behavioural change is required and may also help facilitate cooperation. On the other hand the overhead in terms of tying up staff time needs to be appraised and acted on appropriately.

Communication

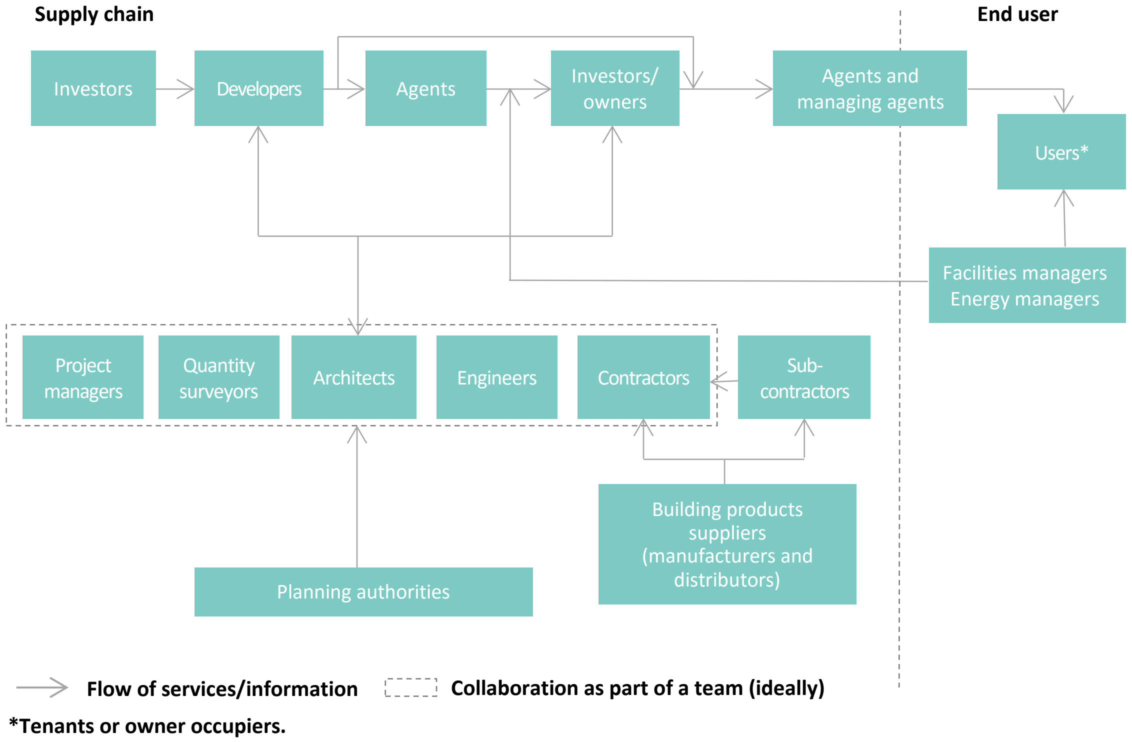
Usually and EM programme will be accompanied by an internal communication effort to alert staff to this activity and its importance. It may also often feed into external reporting and communication efforts such as providing key numbers and narratives behind an organisations corporate social responsibility (CSR) communications

3.2 Specific human factors within commercial and public buildings

Energy management in service sector buildings entails putting in place the systems to implement the energy savings opportunities set out in Chapter 4. The success of the EnMS is sensitive to human factors in terms of having the authority and resources needed to develop and implement the energy policy and in terms of the response of the occupants and key stakeholders to the measures envisaged. Service sector buildings have complex operational structures involving numerous stakeholders.

To understand the complexity of the environment involved in the design, procurement, installation, commissioning and operation of building controls, it is appropriate to consider the range of actors involved in the supply chain for non-domestic buildings (Figure 3.1).

Figure 3.1 Non-domestic buildings sector: supply chain and end users



Source: Carbon Trust (2009)

The key stakeholders in the establishment of the EM policy are the organisation's senior management and/or board with input from the Facility Managers/Energy Managers and the procurement department. However, the level of decision making will vary depending on who controls the building stock and the investments made within it. For example, the owner occupier arrangement is much less common in the service sector building stock than the residential sector, and it is common for sites to be tenanted by multiple organisations that may have only partial or no control over the building energy systems. Establishing lines of responsibility and ensuring the EM value proposition is shared appropriately among the relevant stakeholders is therefore critical. In the case of rental property this can be done through rental agreements, such as green leases, that reflect the value of the energy costs and thus create an incentive for the owners, and via them their designated facility managers, to implement an effective EnMS. However, the essential component for success is to ensure that every actor that is key to the delivery of a viable EM programme has an adequate incentive to want to deliver it.

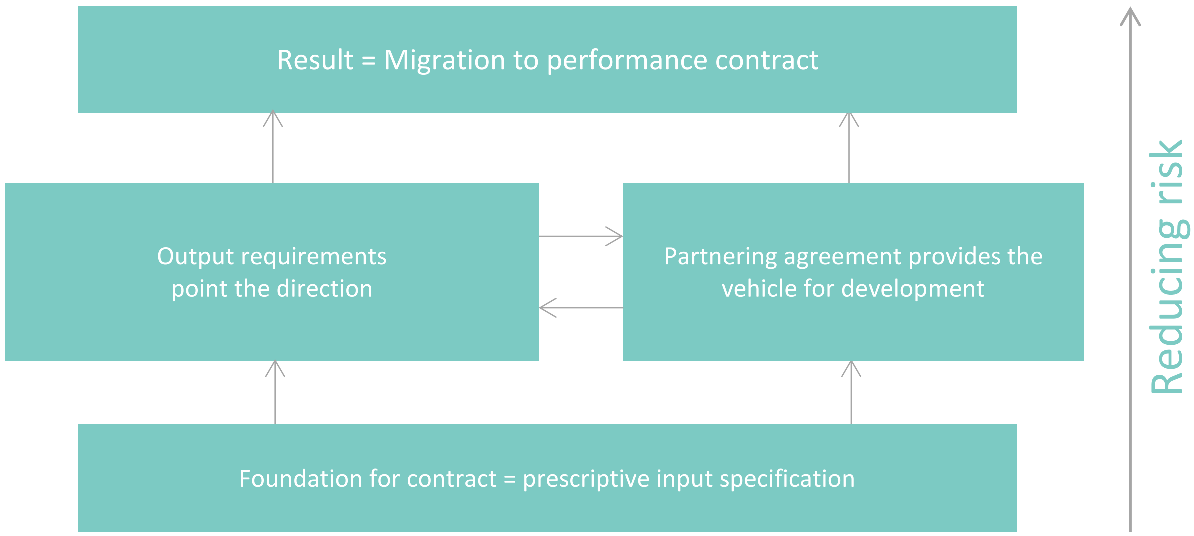
Performance-based service provision

One of the main barriers to strategic operation of buildings is the traditional approach to specifying and procuring O&M services. Traditionally, property owners, occupiers and managers seek proposals for maintenance when what they really need is operation. Maintenance supports operation and only needs to be carried out to the level that ensures the desired operational requirements of the building energy services are met. The emphasis must therefore be on operation and not on maintenance. Building energy services will not be optimised unless they are operated to provide best value for occupier requirements. Maintenance alone is not enough.

The problem is exacerbated by maintenance being procured by contractor proposals rather than in response to a specification. The selection of a contractor will be made following a comparison of contractor proposals and will usually be based on lowest cost. The contractor's proposals will often be based on assumptions of the client's requirements and therefore there will be little or no parity with regard to the proposals received.

Performance-based service provision ensures that operation is given the prominence it deserves and that the success of the service is measured by output rather than input. It can be introduced at any time in the building life cycle or throughout the life of an O&M contract by migration from a prescriptive input specification to an incentivised output performance specification. This process transfers the risk to the party that best understands it and hence reduces failures and costs. This is particularly applicable to EM. Figure 3.2 outlines the migration from a prescriptive input service to an output-performance-based service such as energy performance contracting (EPC).

Figure 3.2. Performance contract strategy.



Real-time energy monitoring

The right energy-monitoring software is able to provide real-time and historic data on the energy consumption of both individual items of plant and equipment and a building as a whole, allowing facilities managers to implement informed changes that will have measurable impact. Ideally a system will be put in place that combines energy-management software with expert insight and include:

- energy – gas, electricity, oil, solar, wind and water, with further analysis to identify dynamic and controllable loads. Ideally permit other emission sources such as transportation, business travel

and waste to be included. It is recommended to install metering on the main utilities, building services and data centres
- monitoring – real-time consumption, carbon and cost (CCC) information via the internet
- optimising – limiting CCC to that needed for the occupier to deliver its business plan
- targeting – setting and realising challenging but achievable targets while meeting the optimum requirements
- alerts – via diagnostics to inform managers about deviations from expected performance levels
- **r**eporting – provision of regular reports on CCC trends with exception reports of deviations from targets and motivational information display dashboards.

Continuous commissioning

Continuous commissioning is an operational strategy that continues commissioning beyond the original working settings of equipment and seeks to understand and optimise performance in use via an expert monitoring feedback and diagnostics process empowered with the authority to intervene to remedy significant failures when identified. Ideally it is part of a process, focused on operation, by which a building and its services are conceived, designed, constructed, commissioned, operated, maintained and decommissioned to provide the optimum of cost and value for the occupier. Research results demonstrate that the application of continuous commissioning to existing buildings delivers substantial operating-cost savings and greater occupant satisfaction. Specifying and operating the building energy services as part of a continuous commissioning process will go a long way to ensuring their full potential is realised. The process provides a strategic approach for incorporating and delivering all the necessary human interface/operation considerations and enables buildings to deliver what is required of them in the most cost-effective and sustainable way without compromising quality. Its main characteristics are that it is:

- ongoing − the continuous commissioning principles are embedded in the client's overall operating strategy, enabling ongoing delivery with minimal external support
- holistic − continuous commissioning involves the whole organisation from top to bottom and addresses all factors affecting the project's success (technical, motivational and managerial).

Continuous commissioning is thus a classic and proven energy management technique.

3.3 Specific human factors within industry and SMEs

There are certain organisational factors commonly found within industry which need to be addressed for effective EM. In particular it is common to have split incentives between the interests of the Capex and Opex budget holders and also between the production and operation managers. If the role is not defined and their appraisal conducted in such a manner that it is clear that their actions need to contribute to Opex cost minimisation as well as to their traditional functions then they are likely to hinder the objectives of the EM programme.

Industry is much more likely to have IP risk issues from providing open access to third parties, such as energy auditors (e.g. via the code of conduct defined in EN 16247 parts 1 and 5 5), than is the case for the service sector and thus organisational firewalls may need to be established to mitigate this as well as the traditional use of non-disclosure agreements.

In the case of SMEs constraints on human resources for allocation to non-core business activities is a clear limiting factor that needs to be addressed for EM uptake to increase. For this reason SME associations and government need to find means to support SME's to benefit from EM in a more direct and less intrusive manner than may be implied by full adoption of and certification to EM standards such as EN ISO 50001.

4. Savings potentials from energy management and best practice

This chapter presents information on the theoretical potentials and typical actual energy, cost and emissions savings achievable via energy management. The savings observed in practice are based on the findings reported in case studies. The theoretical potentials are derived from audits and an analysis of theoretical savings potentials from benchmarking studies. These analyses are then applied in section 4.3 to derive holistic pan-EU savings potentials through the application of scenarios for the main energy end-uses in the EU (service sectors buildings and industry).

4.1 Theoretical savings potentials from the application of energy management

In this section evidence regarding the theoretical scale of savings potentials is presented based on detailed audit and benchmarking evidence. To the extent possible these savings are contextualised in terms of the likely technical potential for savings and the different levels of energy management set out in section 2.1. This helps illustrate what the residual savings potential is likely to be depending on the degree of ambition of EM practice adopted.

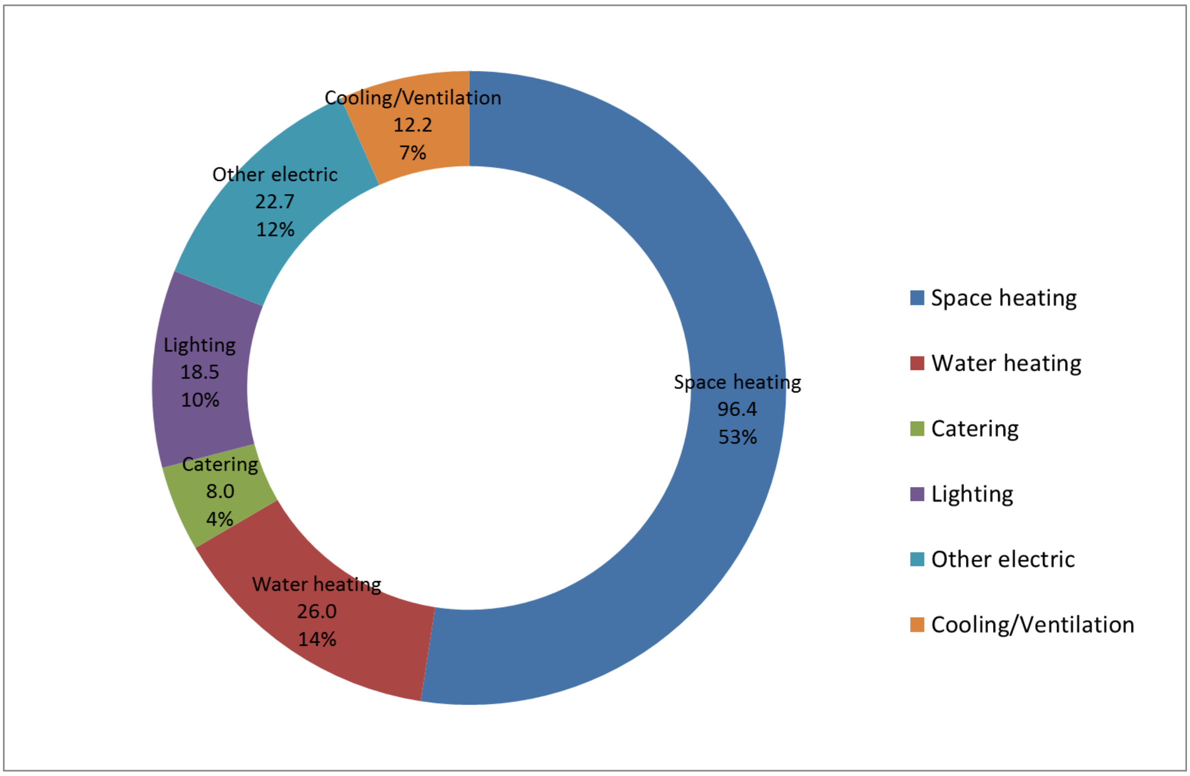
The analysis is presented separately for each of the principal end-use type as follows:

Theoretical savings potentials within commercial and public buildings

There is a rich literature on the energy savings potentials in service sector (i.e. commercial and public sector buildings) in the EU. Applying the boundary conditions of what part of this potential is within scope from implementation of EM (see definition used in this study in Chapter 1) requires separating out the potential due to improved building fabric measures (which are deemed to not fall within EM scope) from those parts related to the operation of the building stock and the energy efficient renewal of its building energy services equipment.

Figure 4.1 shows the estimated breakdown of European service sector building final energy consumption by principal end use in 2013, from which it is clear that space heating is dominant, followed by water heating. The essentially purely electric end uses of lighting, cooling/ventilation and other electric equipment account for 29% of final energy use, but when electric space and water heating is considered electricity accounts for 44% of final energy use and a much greater proportion of primary energy use.

Figure 4.1. Estimated distribution of European service sector building final annual energy consumption by end use in 2013 (Mtoe).



Source: (Waide et al 2013)

Typical savings potentials reported in the literature for European service sector buildings are between 25% and 45% of the primary energy use; however, these potentials are composed of the sum of potentials by different energy end-uses. EM related savings potentials from the optimisation of the electrical end-uses tend to produce relatively (i.e. in terms of the percentage of the consumption of the end use) greater savings than those accessible in the thermal energy end-uses, albeit that large cost-effective potentials have been identified in both. Often the largest relative potentials for improvement are in the areas of lighting, ventilation, air conditioning and space heating (typically in that order). For example, the Task 0/1 report of the ongoing EU Lot 37 Ecodesign preparatory assessment for lighting provisionally finds that there is a maximum savings potential of 70% from the optimisation of lighting systems in European service sector buildings (Table 4.1), which equates to a potential of ~90TWh, although the latter figure includes outdoor lighting too.

Table 4.1 Estimated annual indoor lighting energy consumption per sector and maximum savings identified in the EU

Sector	Energy consumption (TWh)	Savings potential up to %
Education	17.2	70%
Hotels and restaurants	23.5	70%
Hospitals	20.3	70%
Retail	47.3	70%
Offices	29.0	70%
Other		70%
Other (% sports)	18.0	70%
Other (% industry)	18.0	70%
Other (% any other)	4.6	NA
Households	82.0	80%

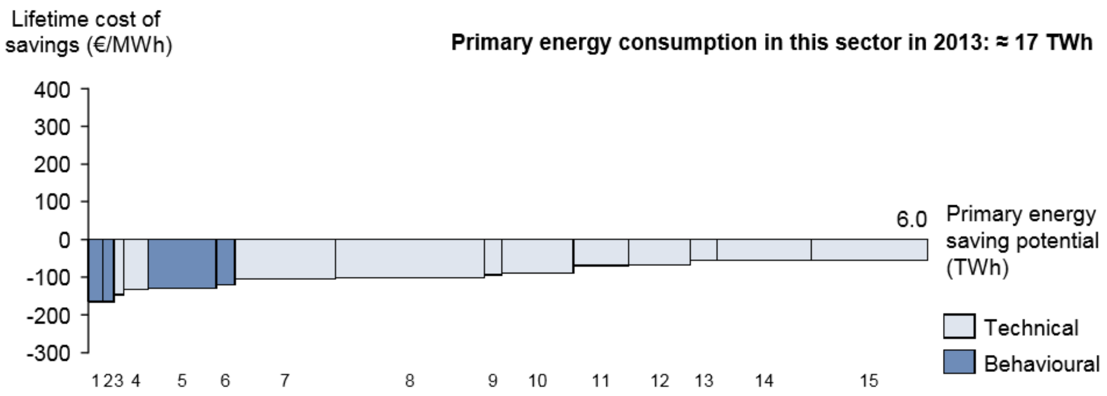
The potential to optimise the lighting system is the sum of measures to optimise each of the following system elements: electrical efficiency, the installation, the luminaire, the lamp or light source, the control system, the control gear, and the design process. Essentially all of these aspects can be addressed through proactive EM although some of them are accessible more rapidly and cost effectively than others.

Implementation of an effective building energy management is the single measure that will access the greatest part of the EM related savings potential in the service sector building stock and will do so very rapidly, without necessitating significant capital investment in the existing building energy services equipment. Waide et al (2013) found that if BACS were properly designed, installed, commissioned and operated, making using of all economically viable control-related energy-savings opportunities, the average savings per commercial/public building would be of the order of 37%, for space heating, water heating and cooling/ventilation, and 25% for lighting. These savings capture the large majority of savings that can be achieved through optimising behaviour.

Experience shows that the energy savings to be expected from the use of BACS is highly dependent on a number of real-world concerns. For example, BEMS, when operated as simple plug-and--play tools by typical building management operatives, will produce quite different levels of savings than when operated by an expert user. The whole nature of the way BACS are installed and commissioned, combined with the quality of the user interface, user training, and support, monitoring and evaluation system including continuous commissioning, has a very large impact on the outcomes to be expected.

The above estimates are quite consistent with studies that have investigate the depth and cost-efficiency of energy savings potentials in EU service sector buildings. For example a recent energy efficiency cost curve for service sector buildings in Ireland (SEAI 2015) suggests that, for the technologies considered, total primary energy savings potential in the sector is 6.0 TWh, corresponding to around 35 % of the primary energy demand in this sector in 2013, which is estimated to be 17 TWh. The largest savings potential among the technical measures in the commercial buildings sector relates to the installation of energy efficient lighting with lighting controls (1.1 TWh) and heat pumps (0.8 TWh), retrofit with roof insulation (0.7 TWh) and energy efficient glazing (0.7 TWh), and installation of more efficient air-conditioning (0.5 TWh). Of the behavioural measures, reducing the room temperature by 1 degree Celsius has the largest potential of 0.5 TWh. Behavioural measures are the most cost-effective in this sector. However, all of the savings potential in the commercial buildings sector is cost-effective – that is, all savings carry a negative lifetime cost. In this case subtracting those savings that are more difficult to access through EM results in an EM only savings potential of about 26% of total commercial sector energy consumption.

Figure 4.2 Energy efficiency cost curve for Irish commercial sector buildings



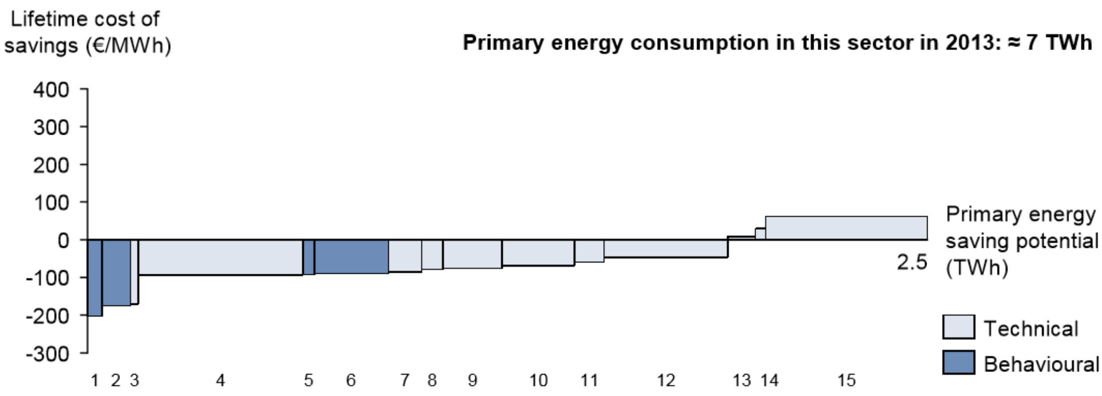
Measure	PE saving (TWh)	Measure	PE saving (TWh)
Total technical measures	**5.15**	14. Energy efficient glazing	0.67
3. Energy efficient appliances - Refrigeration	0.07	15. Heat pump	0.82
4. Draught proofing	0.17		
7. Roof insulation	0.71	**Total behavioural measures**	**0.80**
8. Energy efficient lighting with lighting control	1.11	1. Turn off lights for extra hours	0.10
9. Cavity wall insulation	0.12	2. Enable standby features on all PCs and monitors	0.08
10. More efficient air conditioning	0.51	5. Reducing room temperature	0.49
11. More efficient boiler with heating control	0.39	6. Reducing hot water use	0.13
12. Solid wall insulation	0.44		
13. Energy efficient appliances - Office equipment	0.19	**Total**	**5.95**

Source: SEAI (2015)

Figure 4.3 shows the comparable efficiency cost curve for Irish public sector buildings. The total primary energy savings potential in the sector is 2.5 TWh, which again corresponds to about 35 % of the total energy demand in the public buildings sector in 2013 (ca. 7 TWh). The largest technical savings potential is from the installation of energy efficient lighting with lighting controls (0.5 TWh), retrofit with roof insulation (0.2 TWh) and energy efficient glazing (0.5 TWh) and the installation of more efficient boilers (0.4 TWh) and more efficient office appliances (0.2 TWh). Reducing the room temperature by 1 degree Celsius is, as for commercial buildings, the behavioural measure with the largest savings potential (0.2 TWh).

The majority of the energy saving potential in public buildings is cost-effective. However, it can be seen that savings related to space heating (such as insulation and energy efficient glazing) are rather less cost-effective than in the commercial sector, due to the greater prevalence of oil and gas heating and the differentials in energy tariffs applicable in Ireland.

Figure 4.3 Energy efficiency cost curve for Irish public sector buildings

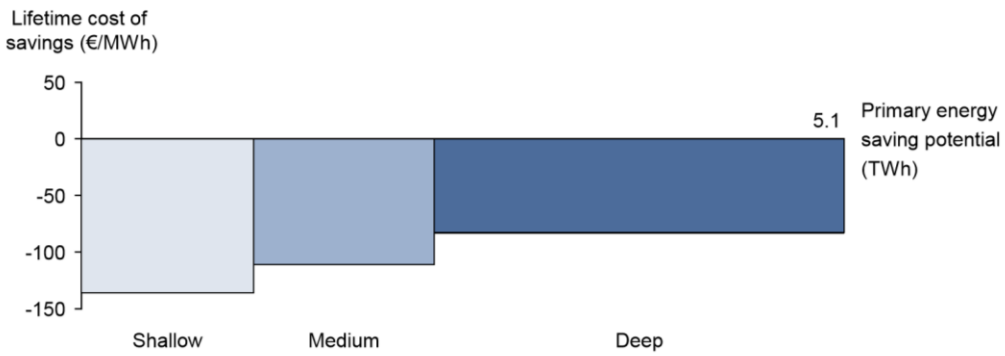


Measure	PE saving (TWh)	Measure	PE saving (TWh)
Total technical measures	**2.09**	14. Heat pump	0.03
3. Energy efficient appliances - Refrigeration	0.03	15. Energy efficient glazing	0.47
4. Energy efficient lighting with lighting control	0.48		
7. Draught proofing	0.10	**Total behavioural measures**	**0.38**
8. Cavity wall insulation	0.06	1. Turn off lights for extra hours	0.04
9. Energy efficient office equipment	0.17	2. Enable standby features on all PCs and monitors	0.08
10. Roof insulation	0.21	5. Reducing hot water use	0.03
11. More efficient air conditioning	0.09	6. Reducing room temperature	0.22
12. More efficient boiler with heating control	0.36		
13. Solid wall insulation	0.08	**Total**	**2.47**

Source: SEAI (2015)

The same analysis assessed the breakdown of savings potentials through the implementation of shallow, medium and deep packages of measures. It finds that about 22% of the total savings potential can be realised through the shallow package of measures, another 22% from medium options and the remaining 56% from the deep package of measures. These packages are roughly analogous to what would be expected from different depths of energy management. Thus savings of about 8% from the implementation of shallow measures, 15% from shallow medium measures and 35% from deep measures.

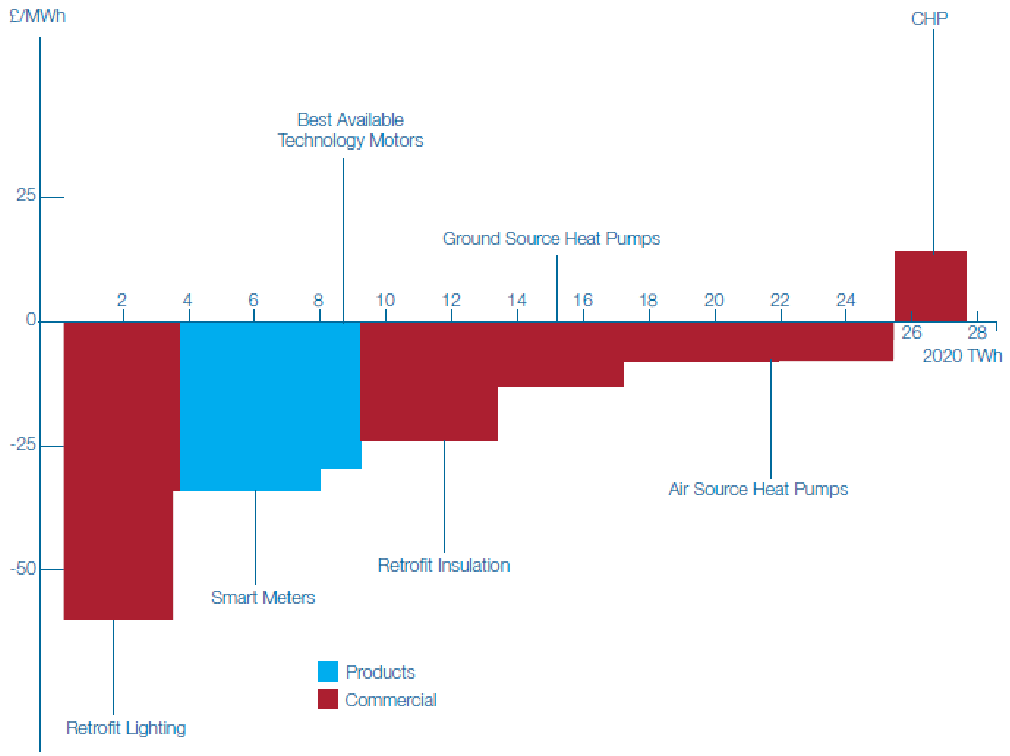
Figure 4.4 Energy efficiency cost curve for Irish commercial buildings packaged by depth of measures



Source: SEAI (2015)

Analysis from the UK shows very similar findings. The Marginal Abatement Cost Curve for cost effective non-domestic carbon abatement measures was analysed within the UK's Energy Efficiency Strategy for 2012 and is shown in Figure 4.5. It is estimated that the implementation of all the measures shown could result in annual energy savings of 27 TWh by 2020. The majority of the potential savings relate to heating energy, whilst the most cost effective measures are replacing light fittings and controls, and provision of smart metering.

Figure 4.5 Marginal abatement cost curve for non-domestic buildings in the UK



Source: DECC (2012)

Within the public sector some of the measures with the greatest energy saving potential include estate rationalisation, optimising existing building systems, and carbon and energy management. For energy intensive health sector buildings, renewable energy technologies can also be cost effective and offer significant savings potential, while for local authority buildings, with larger base heat demands, combined heat and power can be cost effective.

Cost effective measures to reduce energy consumption in UK service sector buildings

Electrical energy efficiency: the most cost effective retrofit energy efficiency measure is lighting. This includes installing presence detection control and replacing lamps and fittings.

The use of smart meters will enable occupiers to better understand their energy consumption and encourage both energy efficient building operation, such as switching off PCs when not being used, and also the purchase of energy efficient equipment, such as printers and fridges. Switching monitors off as part of an energy management programme is one of the top energy saving measures in non-domestic buildings.

The efficiency of motors in fans, pumps and lift mechanisms can be improved by installing variable speed drives, automatic controls to switch them off when not required, and effective management, repair and maintenance.

Heating energy efficiency: Heating energy can be reduced by implementing relatively simple and cost effective measures such as programmable thermostats, reducing room temperatures, installing more energy efficient boilers, optimising system start times, and installing TRVs. Cost effective insulation measures can include installing roof and wall (cavity and internal) insulation, and low emissivity glazing.

Low carbon energy supply: Ground source and air source heat pumps can be used for heating and cooling. Viability for retrofitting ground source heat pumps will be dependent on land availability around the building for installing the underground pipes.

The cost effectiveness of combined heat and power (CHP) systems is highly site specific. A common cost effective retrofit application is the replacement of a boiler with a CHP unit in a central energy centre for a hospital or university campus.

Behavioural measures: Significant potential has been identified from behavioural savings, particularly associated with the roll out of smart meters. There is a much greater range of control options for energy consuming systems which can be retrofitted in non-domestic buildings compared with domestic properties. This includes simple devices such as TRVs as well as full Building Energy Management Systems retrofitted with minimum disruption through the use of wireless meters and sensors. Product innovation is producing much more intuitive user interfaces and visual displays for these systems leading to greater engagement and understanding of energy consumption patterns by occupants.

Source: EUREM (2015)

Theoretical savings potentials within light industry and SMEs

The literature often reports higher savings potentials, in relative rather than absolute energy consumption terms, for light industry and SMEs than for energy intensive industry. This is logical as businesses with less employees and where energy is a relatively low proportion of costs will have less incentive to proactively manage their energy efficiency than is the case for larger and energy intensive businesses. The energy consumed within specific industrial processes is likely to account for a smaller proportion of total energy consumption in less energy intensive industries. Conversely, energy consumption in cross cutting activities such as motive power, compressed air and lighting will often account for a higher proportion of the businesses total energy consumption.

Energy efficiency cost curves for the industrial sector published in the literature are usually not differentiated into light and heavy industry, or into SMEs and large businesses, so there is a dearth of sources on the cost effectiveness of energy savings achievable by specific industry sub-sectors and types. There are a number of case studies, however, and these are analysed in section 4.2.

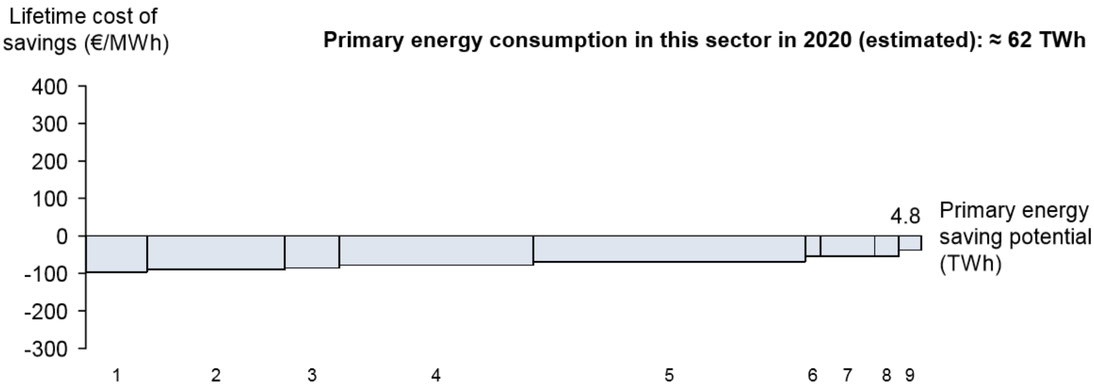
A summary from a sample of the findings reported in the literature on energy efficiency cost curves in the industry sector are presented immediately below.

Theoretical savings potentials within energy intensive industry

An energy efficiency cost curve for Irish industry is shown in Figure 4.6. Total primary energy savings potential in this sector to 2020 is estimated to be around 4.8 TWh, which corresponds to about 8 % of the total projected energy demand in the sector in 2020 under a business as usual scenario (SEAI 2015). The estimated savings potentials in the Irish industry sector is low compared with those found in other sectors. This is explained by the fact that by 2020 nearly 60 % of industry final energy consumption is expected to be related to high or low temperature processes, the majority of this in the food and drink, basic metals and non-metallic minerals sub-sectors. Compared with end-use processes such as lighting, refrigeration and motor systems, the savings potential from heating processes, particularly in the basic metals and non-metallic minerals sub-sectors, is relatively small. However, in lighter industry the share of non-heat process related energy consumption will be higher, and hence the relative savings potentials will be higher. The study also noted that Ireland's energy efficiency programme for large industry, the LIEN[2], covers more than half the total industry primary energy demand, and was reported to have delivered ~580 GWh in primary energy savings in 2012. As a result, the remaining potential for LIEN members is lower than for non-LIEN members. Energy savings opportunities in the industry sector include: more efficient motor, refrigeration, compressed air and steam systems; process integration and heat recovery; more efficient HVAC (heating, ventilating, and air conditioning) and lighting; and CHP (combined heat and power). The largest savings potential is estimated to be from process integration and heat recovery for low temperature processes (1.6 TWh), more efficient motor systems (1.1 TWh) and CHP (0.8 TWh). The remaining measures are estimated to offer further potential savings of 1.3 TWh.

[2] http://www.seai.ie/Your_Business/Large_Energy_Users/LIEN/

Figure 4.6 Energy efficiency cost curve for the Irish industrial sector in 2020



Measure	PE saving (TWh)	Measure	PE saving (TWh)
1. More efficient refrigeration	0.35	6. More energy-efficient lighting	0.09
2. CHP	0.79	7. Process integration & heat recovery - high T processes	0.31
3. More efficient compressed air systems	0.31	8. More energy efficient steam system	0.14
4. Motor efficiency	1.10	9. More efficient HVAC and ventilation	0.13
5. Process integration & heat recovery - low T processes	1.55	**Total**	**4.76**

Source: SEAI (2015)

All measures modelled in the industry sector are found to be cost-effective. This reflects the fact that the utilisation of equipment in industry is typically high, meaning that the premium for high efficiency equipment is paid off over a much shorter period than the lifetime of the equipment.

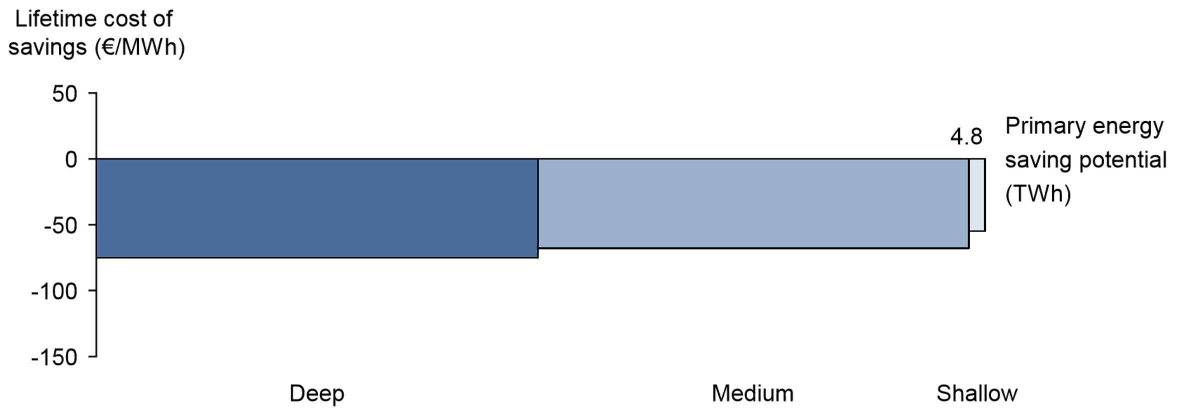
Figure 4.7 shows the energy efficiency cost curve broken down into packages depending on the depth of EM required to implement them. Table 4.2 shows which measures are classified in each of these groupings. All the packages for the industry sector are cost-effective and those within the Deep package are more cost-effective over their lifetime than is the case for the other packages. However, this is explicable because measures are classified in the Deep package due to either a high capital cost, or a low decision frequency, or both, and thus life cycle cost-effectiveness is not the determining factor behind the classification. Nonetheless, it is telling that the measures that are less likely to be implemented within industrial EM programmes are those that concern cross cutting (i.e. are not specific to an industrial process) energy uses, which is likely to be due to a natural tendency to focus first on the principal processes combined with the greater distribution of the cross cutting loads within and across sites and also into the lighter and smaller industrial sectors.

Table 4.2 Grouping of measures and by depth of EM within the Irish industry sector analysis

Sector	Shallow	Medium	Deep
Industry	• Energy efficient lighting	• **All Shallow measures**	• **All Medium measures**
		• More energy efficient compressed air systems	• More efficient HVAC and ventilation
		• Process integration and heat recovery – high and low temp. processes	• CHP • More efficient refrigeration
		• More energy efficient steam system	• Motor efficiency

Source: SEAI (2015)

Figure 4.7 Energy efficiency cost curve for the Irish industrial sector by depth of EM package

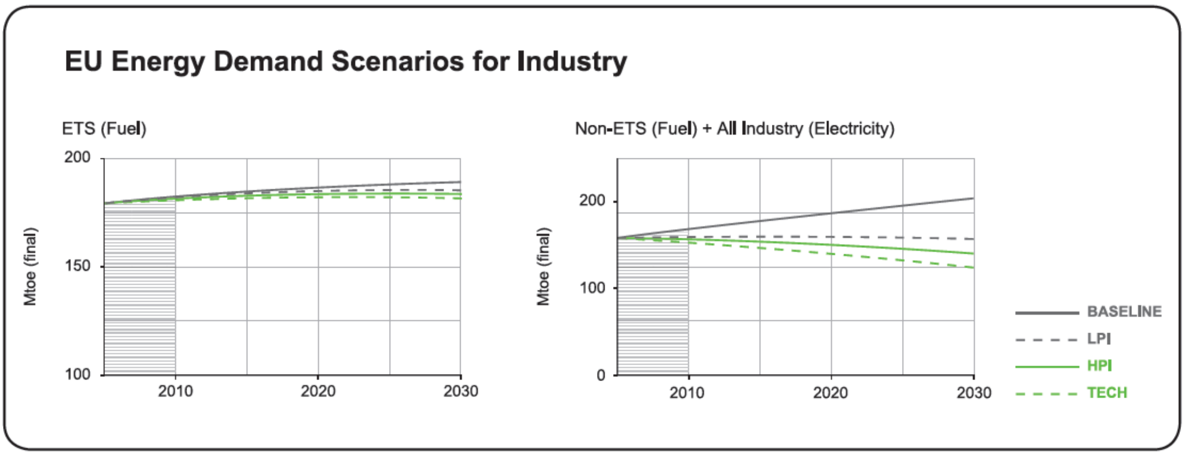


Source: SEAI (2015)

The UK Technology Innovation Needs Assessment (TINA 2012) estimated that deployment of innovative but cost effective abatement technology and energy/carbon management would result in industrial sector emissions being 38-68% lower than the BAU by 2050. Most of this abatement is via energy efficiency gains. These savings potentials address greenhouse gas emissions and hence include options to decarbonise energy supply as well as some non-energy related opportunities but the majority are associated with energy efficiency gains. The reported savings potentials are much greater in the UK analysis than for the Irish analysis. This difference is partly explicable by the considerably longer time period of the UK analysis, which considers the impact of measures implementable over a 37 time period as opposed to just 5 years for the Irish analysis. It is probably indicative of the extra continuous improvement benefits that can be achieved through EM sustained over a long period.

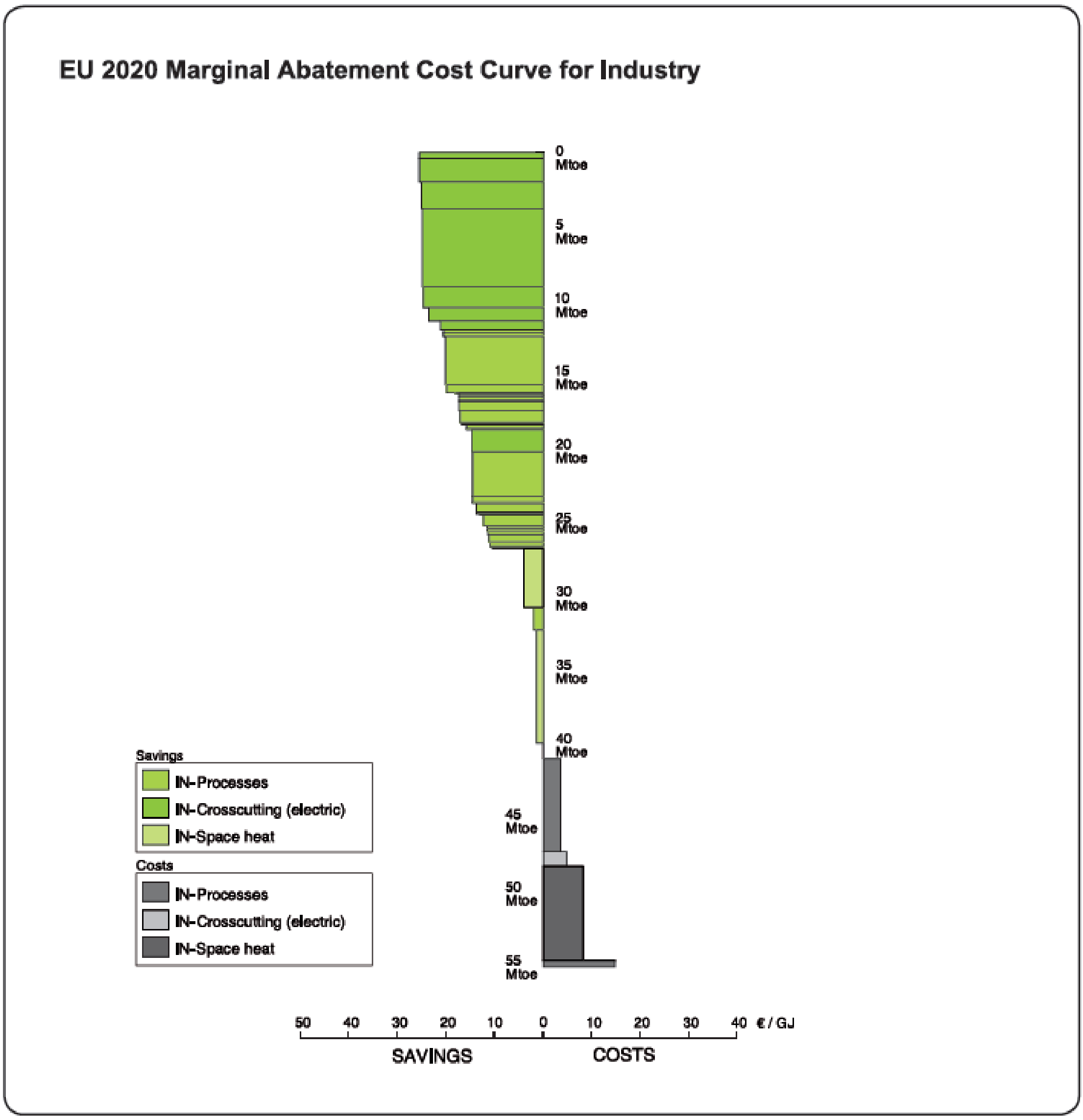
Moving to pan-EU assessments, an analysis by Ecofys (2010) and Fraunhofer into energy efficiency savings potentials in the EU estimated substantial differences in industry energy savings potentials between industry covered by the EUETS and that part which isn't, Figure 4.8. The left-hand figure includes the overall industrial fuel use among industry within the EUETS i.e. excluding electricity energy use. The right-hand graph estimates the energy use in the less energy intensive industry that is not part of the EUETS and also includes the electricity use of ETS industries. This was done because electricity use from ETS sectors is not directly affected by the Scheme, but rather by instruments like the Ecodesign Directive that applies to the non-ETS industry as well. Figure 4.8 shows the estimated MACC for energy savings in the EU industry sector in 2020, from which it is projected that 40 Mtoe of energy savings can be made cost effectively.

Figure 4.8. EU energy demand scenarios for industry



Source: Ecofys (2010)

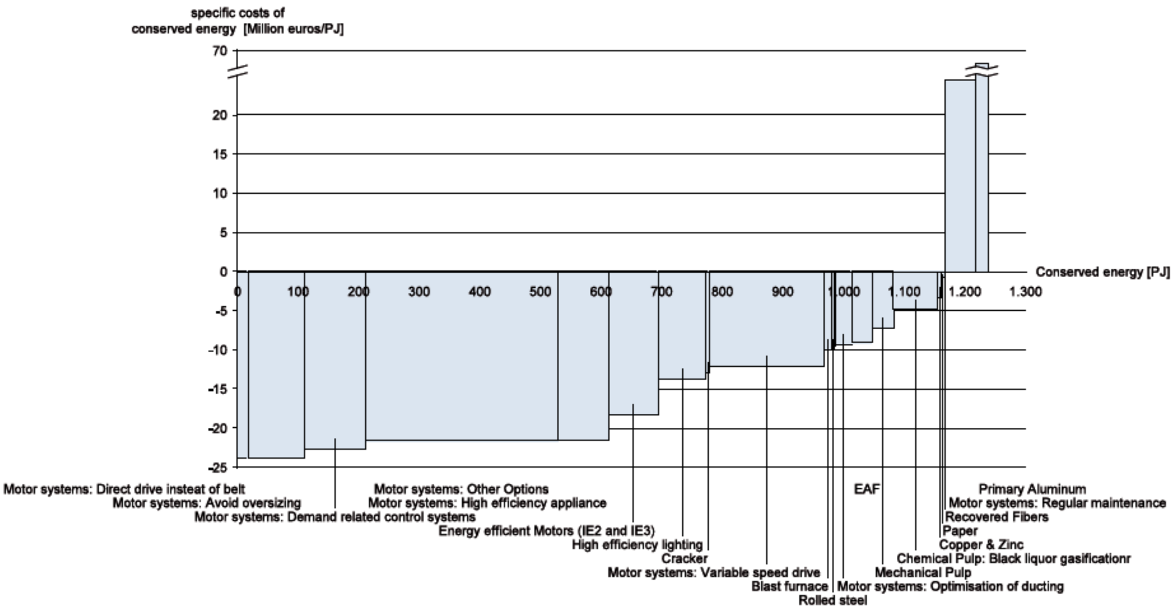
Figure 4.9. EU 2020 Marginal Abatement Cost Curve for industry



Source: Ecofys (2010)

A more recent and detailed "exemplary" conservation supply curve of European industry has been developed by Fleiter et al (2013). This shows total cost effective energy savings of ~1200 PJ in 2030 (29Mtoe), Figure 4.10. As is the case in the Irish analysis the majority of savings are through measures that address cross-cutting end-uses such as motor systems. Overall the analysis indicates that ~€22 billion/year can be saved cost effectively by 2030 through EM in the EU industrial sector.

Figure 4.10. EU 2030 Energy conservation supply curve



Source: Fleiter *et al* (2013)

The same paper also demonstrated, however, that the findings of cost supply curve analysis can be very sensitive to the assumptions made in the analysis and that even when using the same dataset a factor of four difference in the cost effective savings potential could arise as a result. This suggests that while macro assessments can be informative they need to be treated with caution and that it might be more reliable to derive industry sector savings estimates based on a statistical analysis of a set of case studies as set out in section 4.2. This phenomenon is quite likely to explain the variance in savings potentials seen in say the Irish and UK analyses as their policy frameworks and pedigrees are not dissimilar and if anything historic rates of improvement in UK industry appear to have been greater.

4.2 Typical savings potentials from the application of energy management

There are numerous case studies of the implementation of EnMS from which it is possible to gather real world data of the type of impacts that are observed from EM in practice. Appendix C provides a set of such case studies for each of the principal energy end-use sectors (service sectors buildings, light industry and heavy industry).

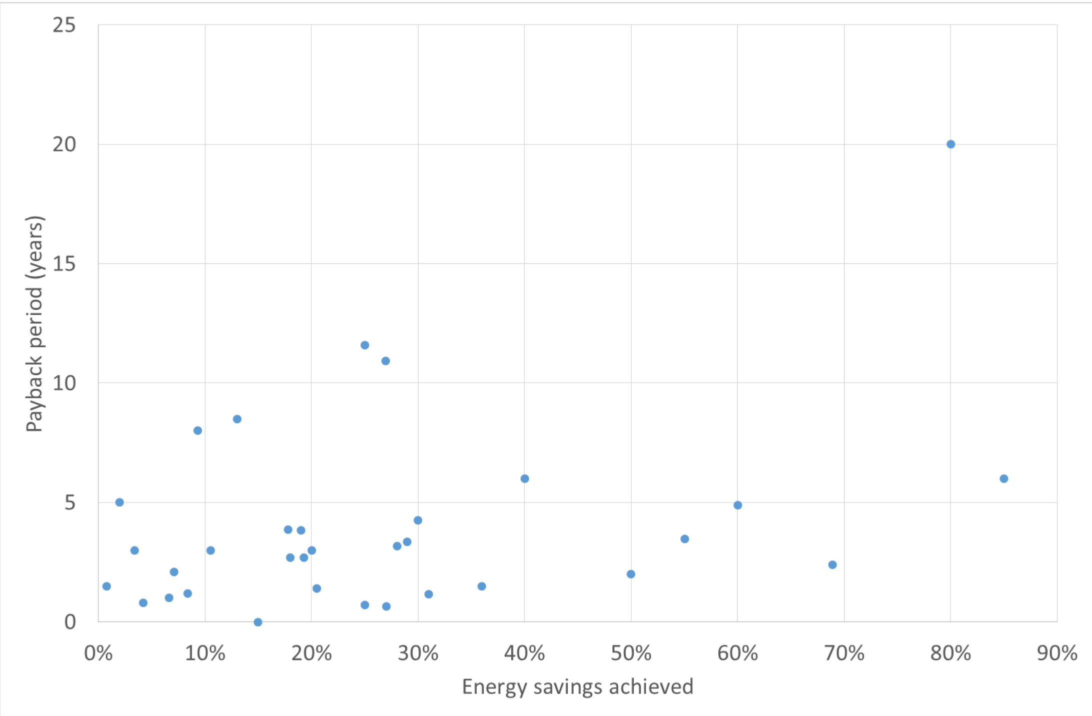
An aggregate analysis of a broad set of European industrial case studies

In order to have more rigour in the analysis of industrial savings potentials a database of 53 European industrial energy management case studies was compiled at random for this study from reported cases in France (Ademe 2011), Germany (Dena 2015) and the UK (CBI 2013, BSI 2015). This included case studies from a broad range of industrial sub-sectors and varied in the depth of EM implementation, from as little as EM focused on specific processes to as much as EM across large companies.

The distribution of the payback period as a function of the energy savings achieved (expressed as a share of total energy use) is shown in Figure 4.11. This shows that:

- the payback periods ranged from 0 to 20 years with an average of 4.4 years
- the savings potentials ranged from less than 1% to 85% with an average of 26%
- there is no correlation between the payback period and the savings potentials

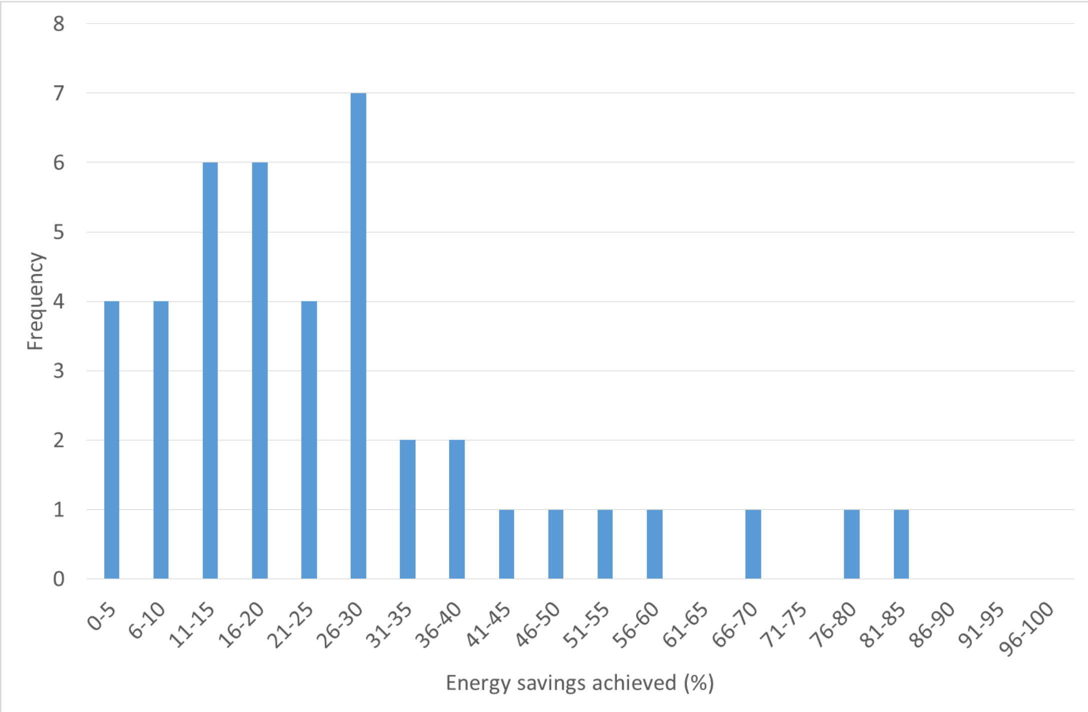
Figure 4.11. Payback period versus energy savings for a set of energy management case studies in France, Germany and the UK



Source: own analysis

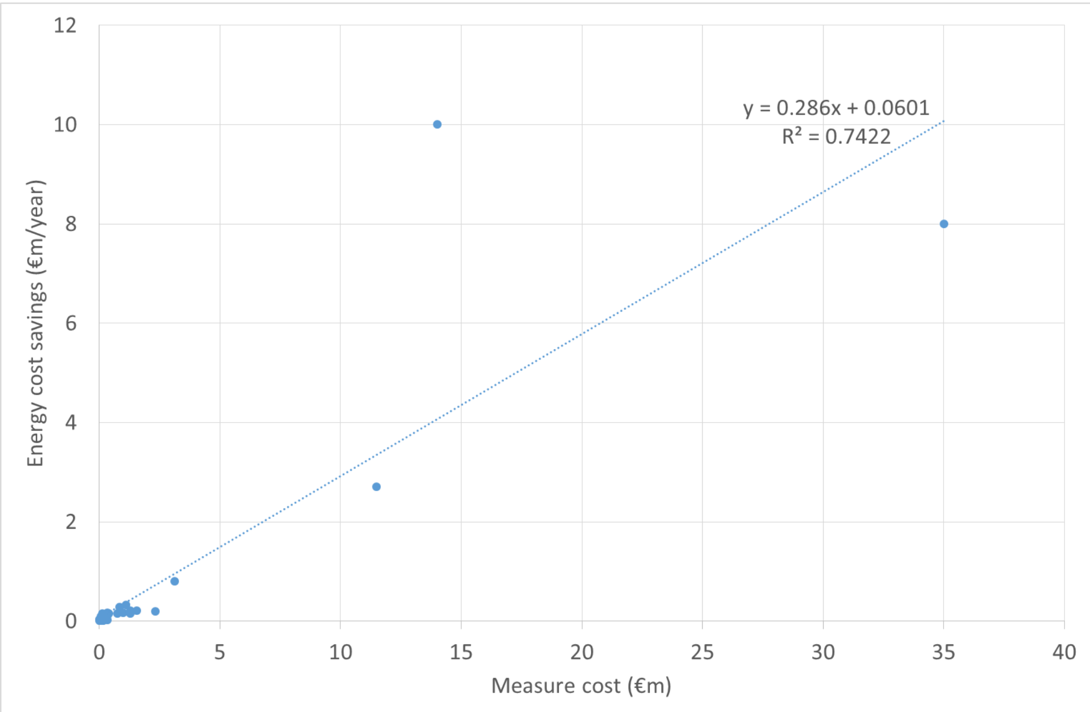
Most commonly the EM projects produced savings between 11 and 30% of total energy consumption but much larger savings potentials were also delivered in some instances, Figure 4.12. The cost of the EM measures ranged between 0 and €35m, with a weak correlation between the value of the annual energy savings and the cost of the EM measures, Figure 4.13.

Figure 4.12. Frequency of percentage energy savings attained for a set of energy management case studies in France, Germany and the UK



Source: own analysis

Figure 4.13. Value of annual energy savings as a function of the cost of the energy savings measure for a set of energy management case studies in France, Germany and the UK



Source: own analysis

Although it is possible that projects which exhibit more favourable outcomes are somewhat more likely to be promoted in these case studies, the average savings potential is less than estimated in the CSC/MACC approaches and is in line with recent historic industrial sector improvement potentials in economies such as Denmark, the NL and UK.

4.3 Macro-scale savings potentials

In order to clarify the value proposition from broader adoption of effective energy management a set of scenarios were developed and modelled using specifically designed energy capital stock models which treat each energy use sector individually. Three energy management scenarios were developed as follows:

- A Reference Scenario that considers the energy use by sector that is anticipated with a continuation of current trends
- A techno-economic Optimum Scenario that considers the energy use by sector that would be expected were all cost-effective energy management options to be adopted as rapidly as is realistically technically feasible
- A Recommended Actions Scenario that explores what savings from energy management would be expected to be achieved were the specific recommendations in the study (See Chapter 7) to be implemented across the EU.

These scenarios are modelled separately for the services and industrial sectors.

These scenarios are informed by findings drawn from a detailed literature review, the numerous case studies considered in section 4.2 and interviews with specialists in the field. They are also based on a thorough evaluation of the likely costs and benefits of broader adoption of specific energy management measures and the expected uptake in response to a more proactive policy portfolio. The results are presented separately in the report for the industrial and tertiary sectors. The modelling method treats each of the sub-sectors within these broad economic sectors distinctly e.g. for the industry sectors presented in Figure 1 and for the following service sector sub-sectors: retail, education, health, office, hotel/restaurant, other.

Scenarios considered

This section derives estimates for the potential for savings from increased use of energy management in service sector buildings and industry across the EU. Three scenarios were developed:

- **Reference Scenario**, that considers the energy use by sector that is anticipated were there to be a continuation of current trends regarding the adoption of EM
- **Optimal Scenario**, which considers the energy use by sector that would be expected were all cost-effective energy management options to be adopted as rapidly as is technically feasible[3]
- **Recommended Action Scenario**, which assumes that the recommended actions outlined in chapter 7 are implemented.

These scenarios were simulated separately for the European industrial sector and service sector buildings using dedicated energy models. The scenarios are projected from 2015 to 2035.

In the case of the service sector a building energy stock model was used to estimate the expected impacts on building energy use and costs of the three scenarios[4]. Projections were generated by

[3] i.e. that EM is implemented in all industrial and service sector enterprises/entities where it is cost effective to do so and that all cost-effective EM measures are implemented in these organisations

principal energy end use, building type and fuel from 2015 to 2035. In broad terms, the Reference Scenario is aligned with the European building component of the International Energy Agency's *World Energy Outlook 2012* Current Policies Scenario (IEA 2012b) in order to ensure consistency and comparability of energy-supply assumptions and prices. The other two scenarios assume higher levels of adoption of EM and hence higher levels of penetration of energy saving technologies and optimised user behaviour practices in line with their underlying premises.

For the industrial sector a new dedicated bottom-up energy model is developed that takes the consumption of each industrial sector and projects it from 2015 to 2035. The model is aligned with Eurostat data to populate the historical time series of energy consumption, intensity and output by type of industrial activity. The Reference Scenario is aligned with the European industry component of the International Energy Agency's *World Energy Outlook 2012* Current Policies Scenario (IEA 2012b) in order to ensure consistency and comparability of energy-supply assumptions and prices. Underlying this the model distinguishes between a) different levels of EM adoption and b) different levels of implementation of cost-effective energy savings measures depending on the comprehensiveness of the EM programme that is adopted. The rate of adoption of EM is driven by the assumptions applied in the three scenarios and the depth of savings per enterprise that adopts EM are then driven by assumptions regarding the varying levels of comprehensiveness of the EM programme adopted as applied to the sector in question. In broad terms it is assumed that there is less potential, when expressed as a percentage of total sector level consumption, for energy to be saved in energy intensive sectors than there is in less energy intensive sectors. This reflects that these sectors already have a relatively high motivation to save energy and hence are more likely to have implemented such measures than low energy intensity sectors (a premise that is supported by evidence in the literature).

For the Optimal Scenario it is assumed that all EM-inducible energy-saving measures which are cost effective over their life cycle are implemented. As a result almost all enterprises and organisations, no matter what their size and energy intensity, will be assumed to be adopting some kind of EM policy and programme. The scenario takes account of the cost of human effort involved, not just capital costs. Specifically it takes into account that less energy intensive companies with smaller staff levels (i.e. SMEs) will not find it economically viable to invest so much time and capital into EM as larger and more energy intensive organisations and hence will generally have less sophisticated EM programmes.

For the Recommended Actions scenario the levels of EM adoption and the depth of the EM programmes adopted are driven by the expected increase in impact compared to the levels projected under the Reference Scenario. Invariably some level of professional judgement is required to estimate this difference based on what is known about the impact of EM policies and programmes to date, as discussed in Chapter 6, and then projecting the consequences of increasing the scale of policy effort in line with the recommendations in Chapter 7.

The boundaries of EM compared with general energy saving measures

For the energy savings potentials analysed in this study EM is assumed to apply to the energy savings which are inducible from:

- behavioural changes
- optimisation of energy using systems through better control
- optimisation of energy using systems/processes through upgrades of some parts of the system/process

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[4] This is an adapted version of the building stock model that was developed for the study *Building Automation: the scope for energy and CO_2 savings in the EU* (Waide *et al* 2013)

- equipment capital stock procurement changes

It does not include energy savings which are inducible from the procurement of wholly new buildings or industrial plant and the early retirement of less efficient buildings or industrial plants. This is a somewhat arbitrary set of distinctions, especially as it is perfectly appropriate for EM procedures to inform decisions about when to renew major capital stock at the whole building or plant level; however, the intention is for the analysis to be bounded by real world decision making where EM concerns will rarely be the determining factor in such investments, although they may inform them.

There is invariably some blurring between these levels of intervention. For example, improving the control of a company's electric motor stock may require both investment in an energy management system to monitor and control the motor stock and investment in variable speed drive systems for use in motors subject to variable part load demands. Thus there is need to invest in diagnostics, a control system and devices that can improve control of the loads in question. There will also be behavioural change needs associated with this systems level upgrade that most probably pertain to the motor system operation and procurement processes. With so many potential levels of intervention it makes more sense analytically to apply a cost-curve approach to simulate the techno-economic savings potentials required for the Optimal Scenario and so this is the approach which is adopted here.

The literature on cost curves is quite rich regarding the sensitivity of outcomes to the assumptions regarding discount rates, see for example Fleiter *et al* (2014), but is much less rich on the impact of the depth of consideration of the technical options available to save energy. In fact these analyses are much more sensitive to this aspect than they are to the discount rate. Several common issues are encountered: i) the degree to which all technically available savings options are considered, ii) the calibre of assumptions regarding the savings potential per savings option considered, iii) the calibre of assumptions regarding the cost of the measures, iv) the calibre of assumptions regarding the applicability of the measures i.e. how widely they can be applied across and within sectors. These are the parameters that really influence the results produced. In general issue i) tends to lead to overly conservative analyses because analysts are never fully informed of all the applicable energy savings options and are unable to consider them all in their analyses. By contrast, issue iv) could tend to lead to overestimates of how broadly applicable energy savings options are across a sector, especially if there is unintended double counting. Given these concerns the method to simulate the broad scale effects of EM which is deemed most appropriate for use in this study combines the findings from cost curve analyses with the findings from the case studies that are based on real world EM experiences. This approach allows the broad theoretical scope of the cost curves to be married with actual in-field experience of EM to give hybrid estimates that are both comprehensive yet grounded in reality.

Projected EM adoption levels and estimated savings per service sector building type

Service sector

EM related energy savings in the service sector mostly result from energy savings in building-related energy consumption. Additional savings are possible in transportation but analysis of service sector transportation is beyond the scope of this investigation and thus the analysis presented below is confined to the built environment.

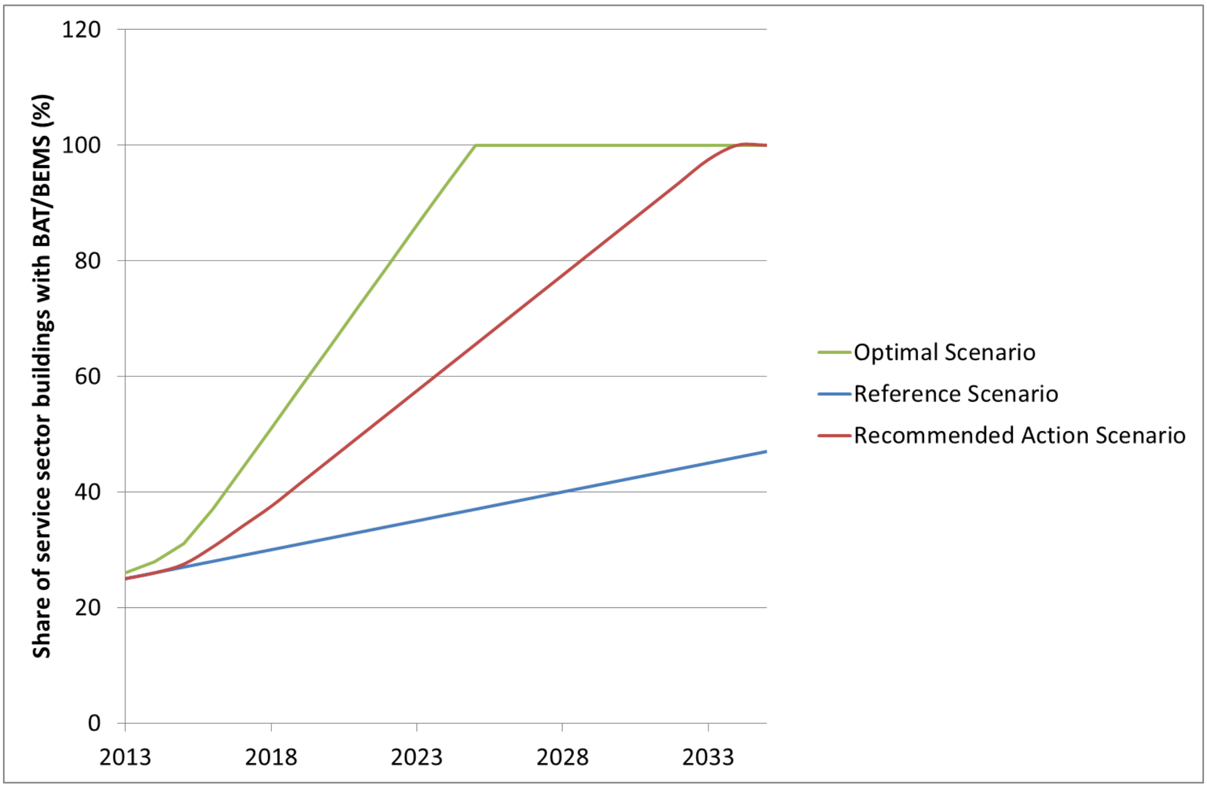
EM adoption rates

While energy consumption is a significant component of bottom line costs for the building stocks of service sector organisations they are low energy intensity businesses and energy is a relatively modest part of overall costs, which tend to be dominated by wages. As a result, service sector businesses usually have less incentive to allocate staff time to energy management than higher intensity industrial businesses and hence are less likely to have adopted an EM strategy, despite these being cost effective. For this reason EnMS adoption rates are much lower in the sector. Nonetheless awareness of energy management is increasing in this sector and so the share of enterprises having EnMS in place is increasing. There is a dearth of data on what proportion of service sector buildings have implemented EnMS in the EU and there is a need to strengthen EU research in this domain to establish a clearer picture. Data on the organisations that are certified to EM standards such as EN ISO 50001 shows that these are dominated by industrial enterprises, although, there are many more service sector organisations that have certification to the ISO 14001 series on environmental management, which will include an energy management component. Despite these observations almost all service sector buildings have some level of "energy management" in place be it as simple as someone being designated to set programmed thermostats and turn off lights, up to having a comprehensive EM policy and programme at the other extreme. Given the dearth of data the analysis presented here assumes the effective EM adoption levels in service sector buildings are the same as those for the level of adoption of proper building energy management, automation and controls systems, as discussed below.

BACS adoption a key component

For most service sector buildings, especially the larger ones, the building energy management system (BEMS) is the principal EM tool and its level of adoption and impact is a good indicator of the level of EM applied in the building in general. The share of building area with operational BEMS installed is increasing and is expected to continue to increase without additional measures; it is assumed to reach 35% of service sector floor area by 2023 and 45% by 2033 without additional measures to stimulate the market (Figure 4.14), (Waide *et al* 2013).

Figure 4.14 Assumed penetration of BACS (building automation and control systems) for energy management as a share of European service sector building floor area (m^2) from 2013 to 2035



Source: Waide *et al* (2013)

Energy savings per adopted EM strategy

Adopting an EnMS strategy will lead to different levels of energy savings depending on the depth of EM strategy adopted, the quality of its implementation and the nature of the opportunities in the service sector organisation considered.

Energy savings from BACS

Currently, BACS are probably saving an average of about 10% of building HVAC energy consumption in service sector buildings where they are installed above the BACS baseline, i.e. about 2.6% of EU building HVAC energy consumption as a whole (= 0.26*10) compared to the baseline.

If BACS were properly designed, installed, commissioned and operated, making using of all economically viable control-related energy-savings opportunities, the average savings per commercial/public building would be of the order of 37%, i.e. 27% higher in absolute terms than is currently achieved with BACS. There are a number of reasons for this, as partially set out below, but inadequate operation is the main reason why existing BEMS do not save more energy than under the Reference Scenario. Thus there is an unexploited HVAC and hot water energy savings potential of about 34% (= 0.26*27 + 0.74*37).

In the case of lighting, the overall savings potential from further deployment of optimised controls alone is probably about 25% of building lighting electricity demand, but a wide range of figures is seen in the literature.

Savings from the optimum application of BACS in other end uses are usually less significant.

Experience has shown that the energy savings to be expected from the use of BACS is highly dependent on a number of real-world concerns. For example, BEMS, when operated as simple plug-and-play tools by typical building management operatives, will produce quite different levels of savings than when operated by an expert user. The whole nature of the way BACS are installed and commissioned, combined with the quality of the user interface, user training, and support, monitoring and evaluation system including continuous commissioning, has a very large impact on the outcomes to be expected.

The savings potentials derived from the use of BACS in the base buildings analysed in the three scenarios were applied across the European building stock as a whole to produce time-dynamic estimates of energy savings potentials.

Under the Reference Scenario, penetration of BACS rises by roughly 1% per year from 26% of the service sector floor area to 48% by 2035, which is in line with current market trends. The net energy savings per installation are assumed to be 10% for space heating, water heating, cooling/ventilation and lighting. Individual buildings will achieve much greater savings than this, but these values reflect the fact that there is currently a spectrum to savings and that in the worst cases building energy use can even increase owing to improper operation of complex control systems. The 10% savings reflect the aggregate benefit expected from current BACS with the spectrum of installation, commissioning and operation behaviour currently seen across the EU building stock.

Under the Optimal Scenario, penetration of BACS ramps up at a much faster pace and reaches 65% by 2020 and 100% by 2025 (see Figure 4.14). This reflects that the analysis of cost-benefits of BACS shows that they are cost-effective for all service sector buildings regardless of national energy prices, usage and climatic factors, provided they are correctly installed, commissioned and operated. This idealised scenario assumes there are no barriers to greater installation than the rapidity with which industry could respond to client demand and equally assumes a fully rational market.

The net energy savings per installation are assumed to be 37% for space heating, water heating and cooling/ventilation, and 25% for lighting. It is instructive to contrast these energy savings estimates with those that would be derived by applying the energy efficiency factors indicated in the EN 15232: 2012 standard. When weighted by building type and energy service (heating/cooling, hot water and other electrical end uses) to represent the average energy use per floor area of the EU service sector building stock the savings potential in moving from a class D to class A BACS is 49%, whereas the savings potential in moving from a class C to class A BACS is 26%. Class C is considered to be the reference case for new installations whereas much of the existing stock will have poorer class D controls and building automation technology configurations, thus the savings per installation assumed in the Optimal Scenario is consistent with the potentials expressed in EN 15232.

Under the Recommended Action Scenario, penetration of BACS rises more gently than under the Optimal Scenario, reaching 50% by 2021, 66% by 2025 and 90% by 2031 (see Figure 4.14). This slower rate of adoption reflects that even with the implementation of a strong policy mix supported by sustained programmatic actions, the rate of ramp-up and adoption of any technology is constrained by a blend of capacity limitations and market barriers. Equally, the average net energy savings per installation are assumed to be lower than under the Optimal Scenario, at 27% for space heating, water heating and cooling/ventilation and 20% for lighting.

Energy savings from other EM actions

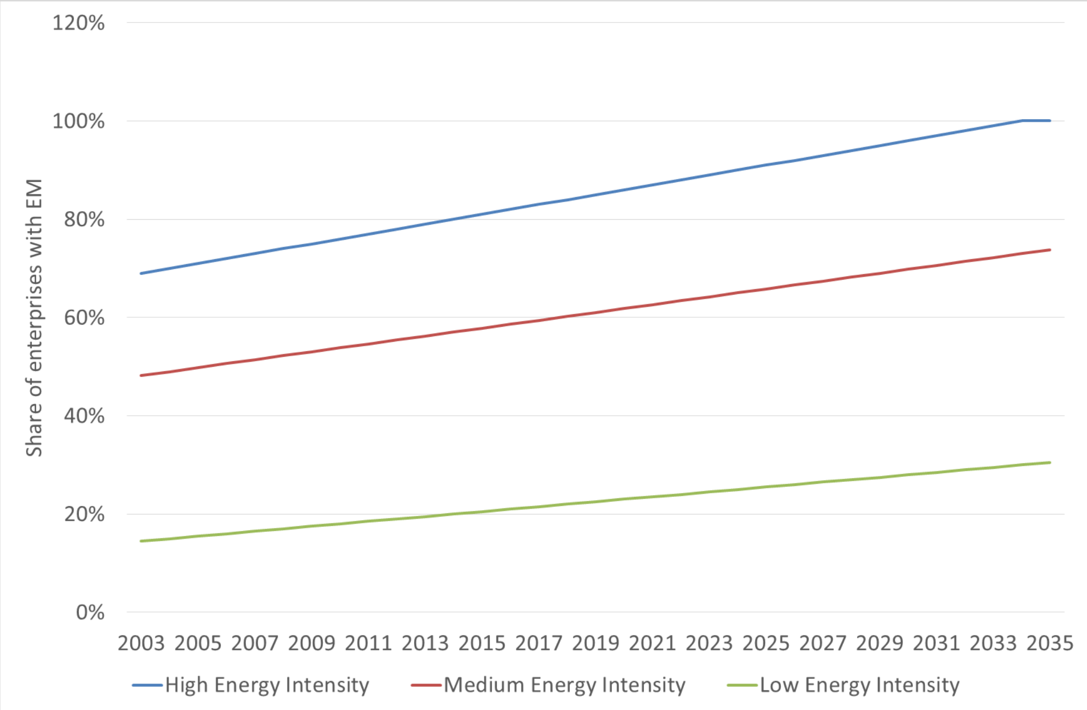
Implementing an effective BACS will help to manage the savings from better operation of the existing building energy services equipment stock but a comprehensive EM strategy in the service sector will deliver more savings than this. First, it will begin to capture savings from low or no cost behavioural measures. Second it will influence the building services equipment procurement process and third it will influence the large capital stock procurement process. The latter is a relatively slow effect but will lead to permanent change over the longer term. The type of savings achievable in the first option are mostly overlapping with the savings that can be achieved from optimised BACS so will not be considered again here to avoid double counting. The second option affects energy consumption quite quickly. The first procurement choices are likely to be low cost high return options such as optimising the lighting systems. The payback from such measures will often justify premature (i.e. before the equipment fails) replacement of the existing equipment system. Collectively, these measures are (rather conservatively) estimated to increase the average savings potentials from EM in service sector buildings by a factor of 1.24 compared to the BACS only savings effect. This is roughly in line with the evidence of the EM case studies but is probably some way below the full potential were all cost effective energy savings identified and adopted.

Industrial sector

EM adoption rates

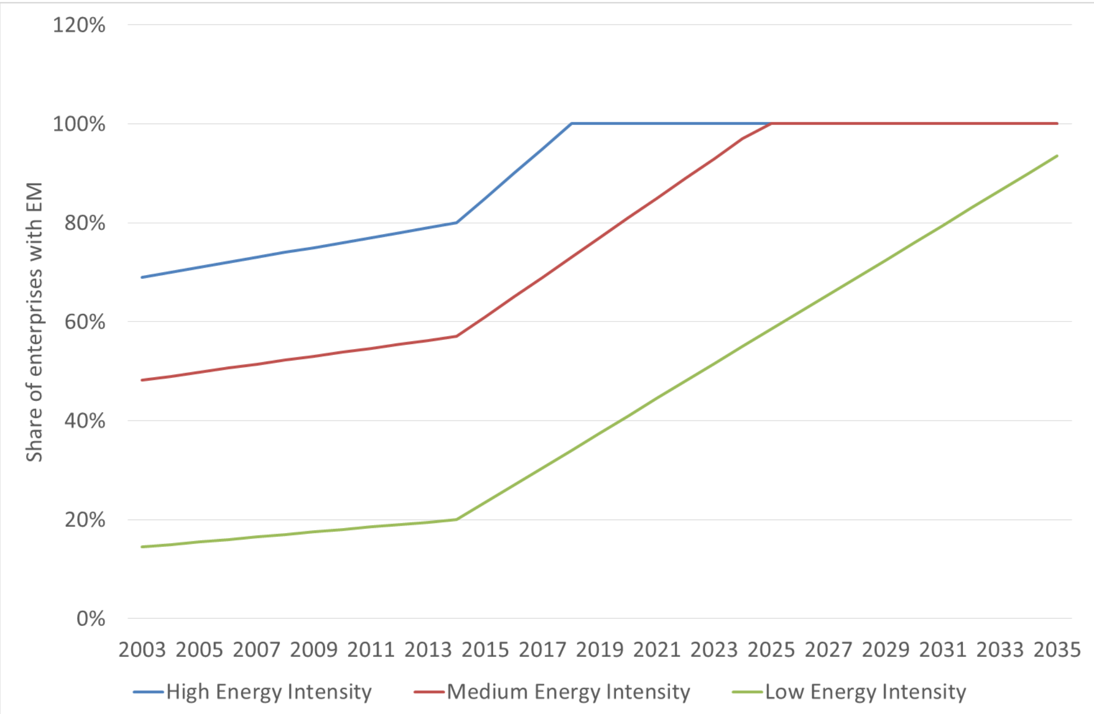
The energy intensity of industry is a major driver of EM adoption where heavy, energy intensive industries such as iron and steel, cement, chemicals, glass and paper, are much more likely to have adopted EM strategies than light industry. Asides from sensitivity to energy intensity the size of the enterprise is also thought to have a strong influence on adoption rates such that SME's are less likely to have adopted EM strategies than larger companies. Thus even in the relatively energy intensive sectors not all companies are thought to have EM policies in place although the majority will. Figure 4.15a to c shows the projected levels of EM adoption in Europe's industrial sector under the Reference Case, Optimum and Recommended Actions scenarios.

Figure 4.15a Share of EU industrial enterprises that have adopted EM under the Reference Scenario as a function of their energy intensity



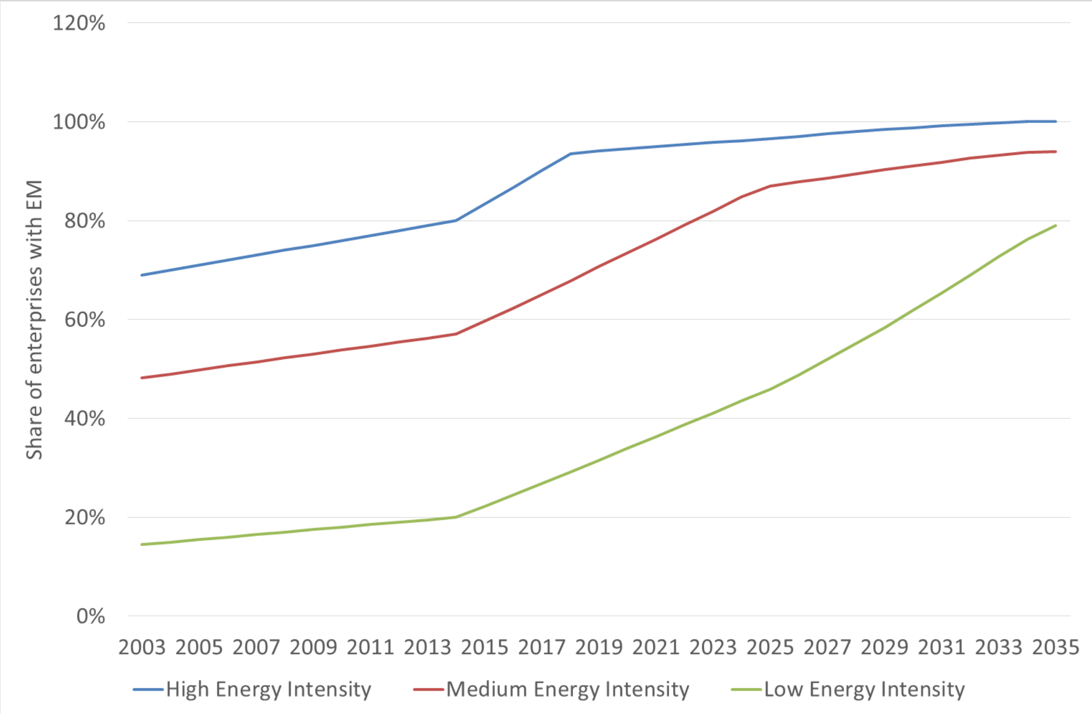
Source: own analysis

Figure 4.15b Share of EU industrial enterprises that have adopted EM under the Optimal Scenario as a function of their energy intensity



Source: own analysis

Figure 4.15c Share of EU industrial enterprises that have adopted EM under the Recommended Actions Scenario as a function of their energy intensity



Source: own analysis

Energy savings per adopted EM strategy

The energy savings per EM strategy adopted can be expressed in terms of the share of energy saved as percentage of the base case energy consumption of an enterprise (i.e. their consumption had they not adopted the EM strategy. A variety of assumptions are simulated in the model but they average out to produce maximum average annual energy savings under the full EM strategy case of 18% for high energy intensity industry and 32% for medium and low energy intensity industry compared to the case where the enterprise has little or no EM strategy in place. This matches the synthesis of the findings of the case studies and potential studies.

Expected energy savings across the service sector

Service sector buildings

The expected total annual service sector buildings energy savings under the Optimal Scenario and the Recommended Action Scenario compared to the Reference Scenario are shown in Figures 4.16 and 4.17, respectively. As the Reference Scenario already includes a default increase in deployment of EM, these scenarios show the additional savings potential that remains to be realised above and beyond what is expected with current trends and practice. In the case of the Recommended Actions Scenario they indicate what could be achieved from a robust set of policy measures that are carefully implemented. The results may be summarised as follows:

- under the Optimal Scenario, annual energy savings peak in 2035 at 61.8 Mtoe, which is 25.2% of all EU service sector building energy consumption
- under the Recommended Actions Scenario, annual energy savings peak in 2035 at 47.5 Mtoe, which is 19.5% of all EU service sector building energy consumption.

Cumulative savings in final energy consumption from 2015 to 2035 under the Optimal Scenario are 921 Mtoe, whereas under the Recommended Actions Scenario they are 624 Mtoe. These are 18.4% and 12.4%, respectively, of the cumulative service building energy consumption under the Reference Scenario from 2013 to 2030.

Figure 4.16 Service sector building additional energy savings under the Optimal Scenario compared with the Reference Scenario from 2013 to 2035. Source: own analysis

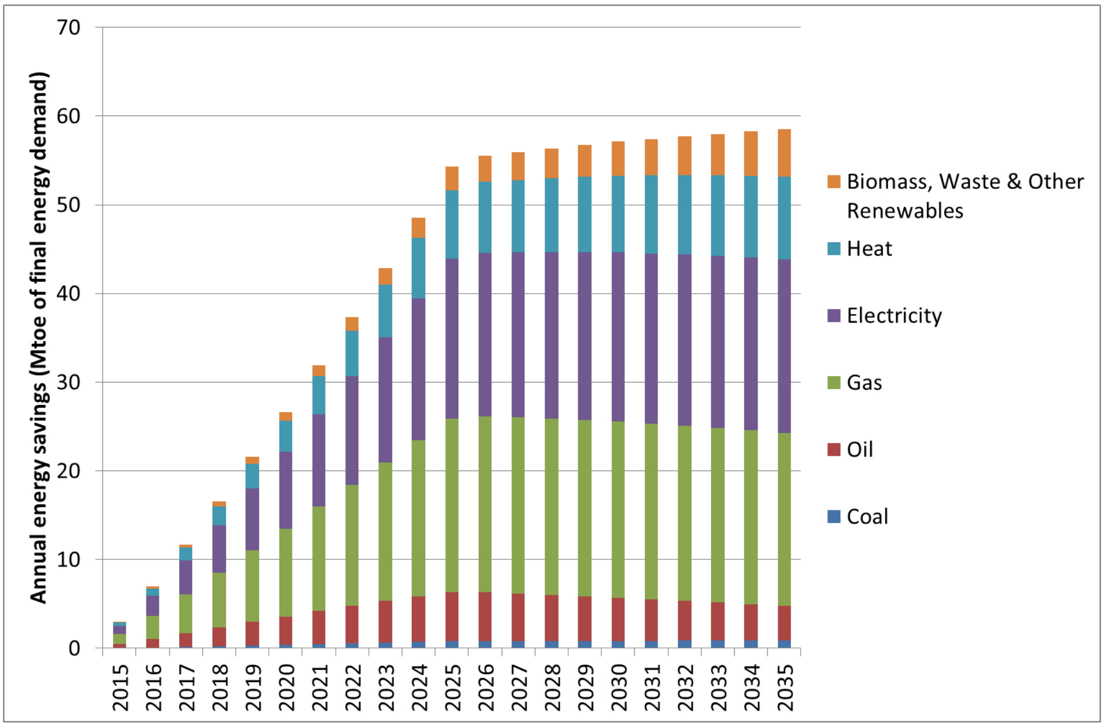
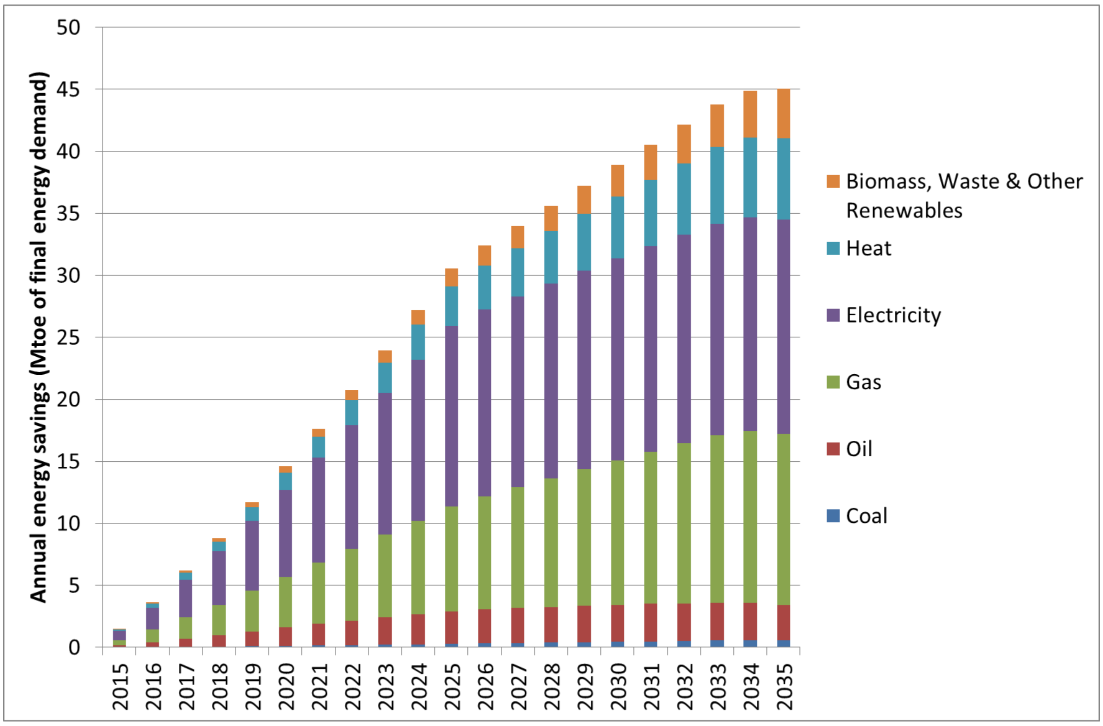


Figure 4.17 Service sector building additional energy savings under the Recommended Action Scenario compared with the Reference Scenario from 2013 to 2035. Source: own analysis



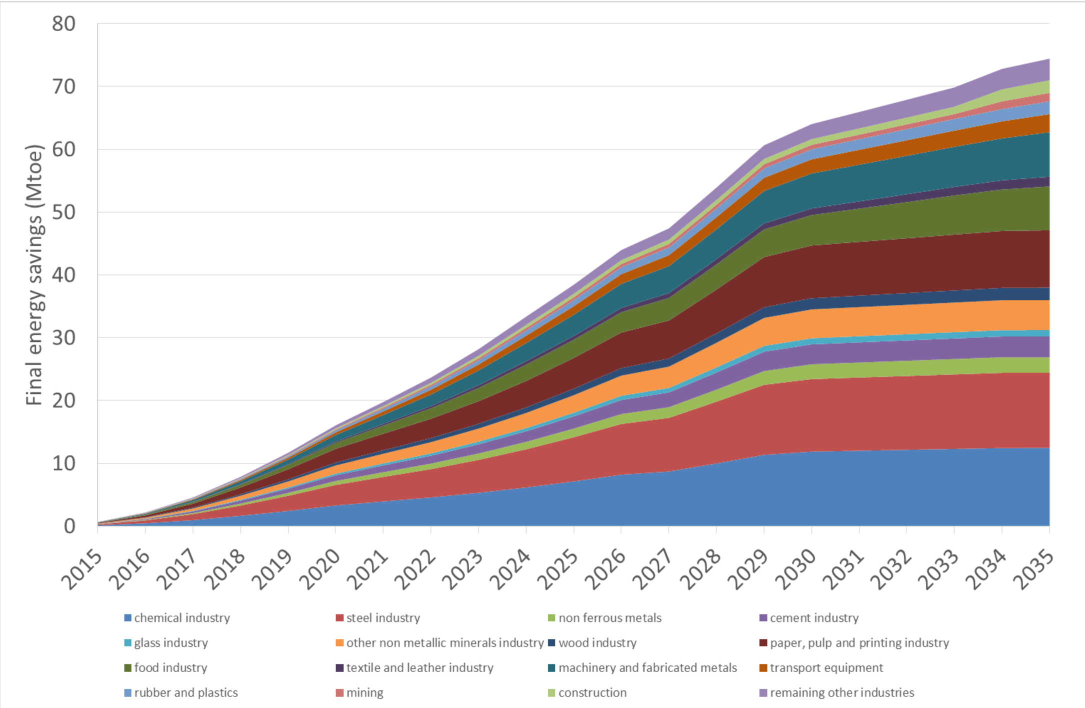
Industry

The expected total annual industrial sector energy savings under the Optimal Scenario and the Recommended Actions Scenario compared to the Reference Scenario are shown in Figures 4.18 and 4.19, respectively. As the Reference Scenario already includes a default increase in adoption of EM, these scenarios show the additional savings potential that remains to be realised above and beyond what is expected with current trends and practice.

- Under the Optimal Scenario, annual energy savings peak in 2029 at 74.4 Mtoe, which is 20.3% of all European industrial energy consumption.
- Under the Recommended Actions Scenario, annual energy savings peak in 2035 at 57.2 Mtoe, which is 15.6% of all European industrial energy consumption.

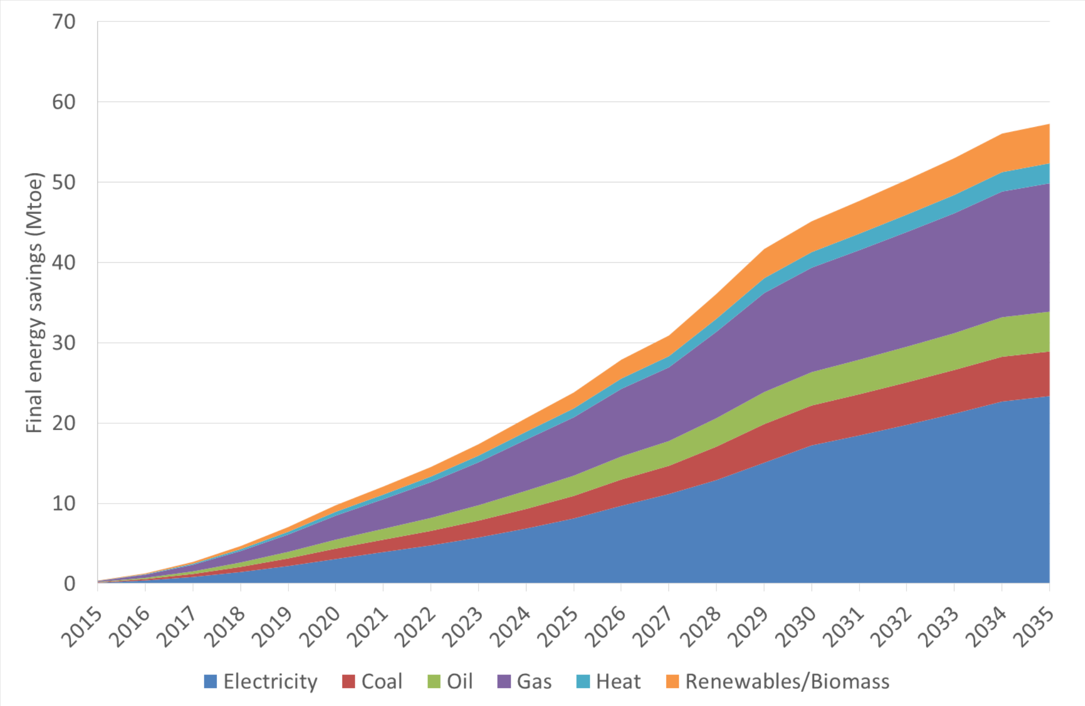
Cumulative savings in final energy consumption from 2013 to 2035 under the Optimal Scenario are 807 Mtoe, whereas under the Recommended Action Scenario they are 560 Mtoe. These are 11.9% and 7.2%, respectively, of cumulative industrial energy consumption under the Reference Scenario from 2015 to 2035.

Figure 4.18. Industrial sector additional energy savings under the Optimal Scenario compared with the Reference Scenario from 2013 to 2035



Source: own analysis

Figure 4.19 Industrial sector additional energy savings under the Recommended Action Scenario compared with the Reference Scenario from 2013 to 2035



Source: own analysis

Estimates of investment needs and bill savings

Service sector buildings

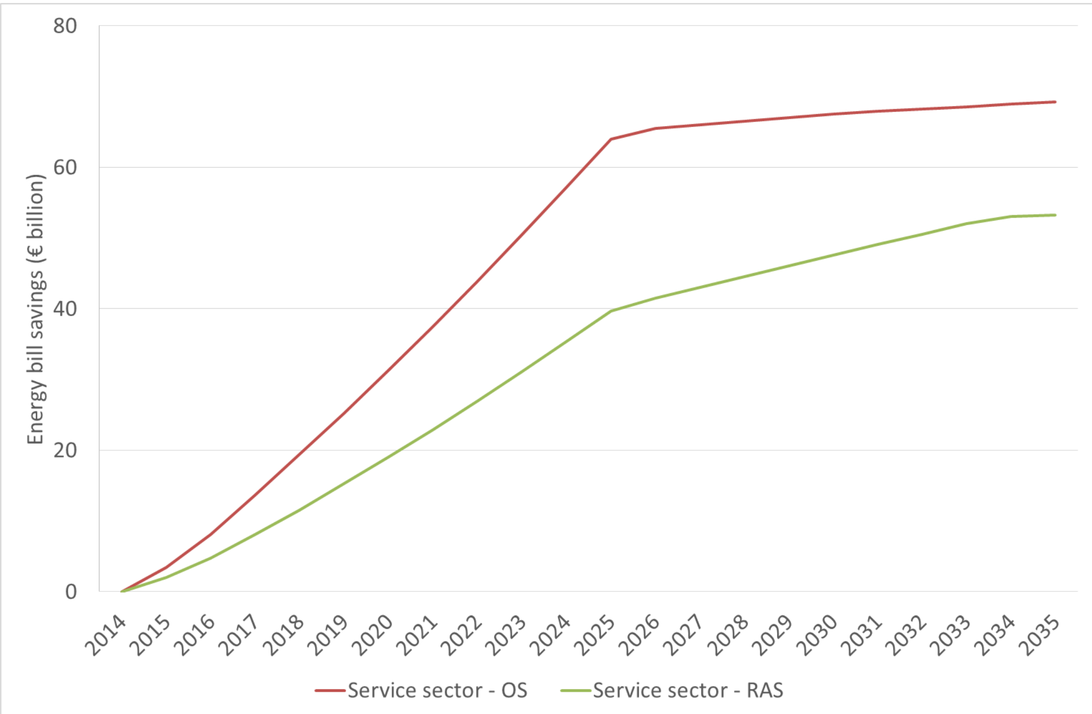
The associated additional investments compared to the Reference Scenario scaled up over the entire EU service sector building stock are shown in Figure 4.20. Cumulative total additional investments from 2013 to 2035 are €53.9 billion under the Optimal Scenario and €45.7 billion under the Recommended Actions Scenario; however, although the totals are similar, the profile of incremental investment is much higher initially for the former than for the latter. Under the Optimal Scenario, incremental investments peak at €5.7 billion, before dropping sharply, whereas in the Recommended Actions Scenario they peak at €2.8 billion, but this order of incremental investment is sustained for much longer. In both cases, incremental investments drop away to zero compared to the Reference Scenario as maximum penetration is reached and the market becomes a replacement market.

The value of avoided energy bills attributable to this investment is shown in Figure 4.21. Under the Optimal Scenario, savings in annual energy bills rise quickly to €64 billion in 2025 and then rise more slowly to €69 billion at the end of the scenario period as the savings from EM under the Reference Scenario begin to catch up.

Figure 4.20. Investments in energy management in European service sector buildings under the Recommended Actions and Optimal Scenarios from 2015 to 2035

Source: own analysis

Figure 4.21 Savings in European service sector energy bills under the Recommended Actions and Optimal Scenarios from 2015 to 2035



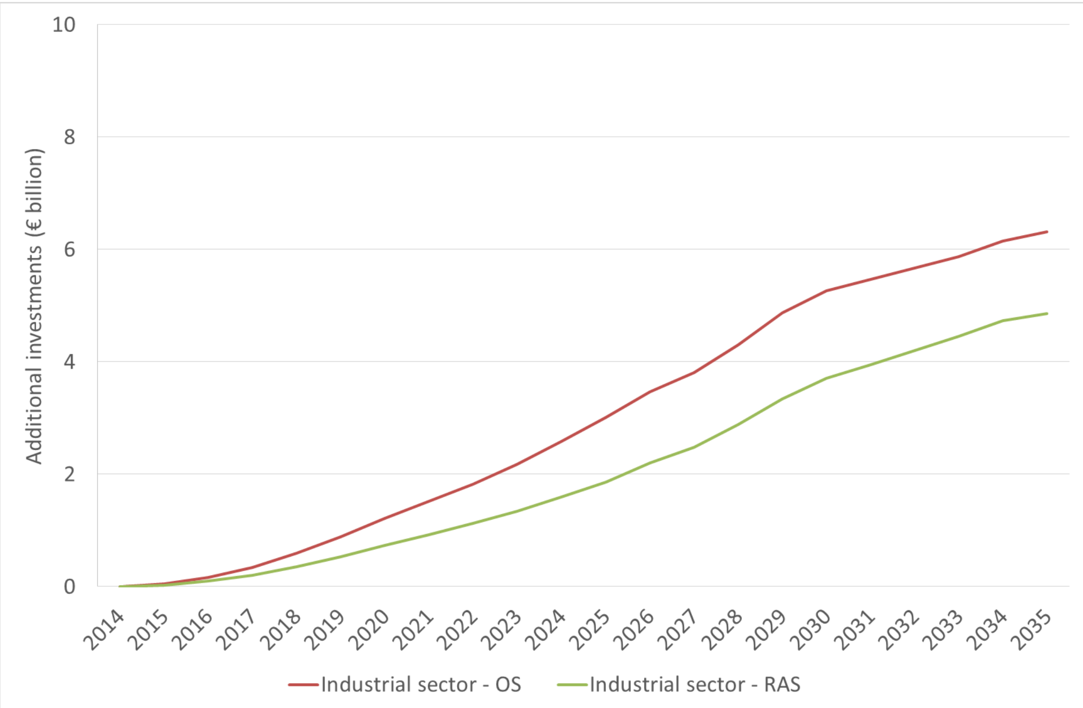
Source: own analysis

In the Recommended Actions Scenario, annual energy bill savings peak at just under €53 billion at the end of the scenario period. Cumulative total additional energy bill savings from 2013 to 2035 are €1029 billion under the Optimal Scenario and €697 billion under the Recommended Actions Scenario. These are 19.1 and 15.3 times, respectively, as great as the magnitude of the additional investment.

Industry

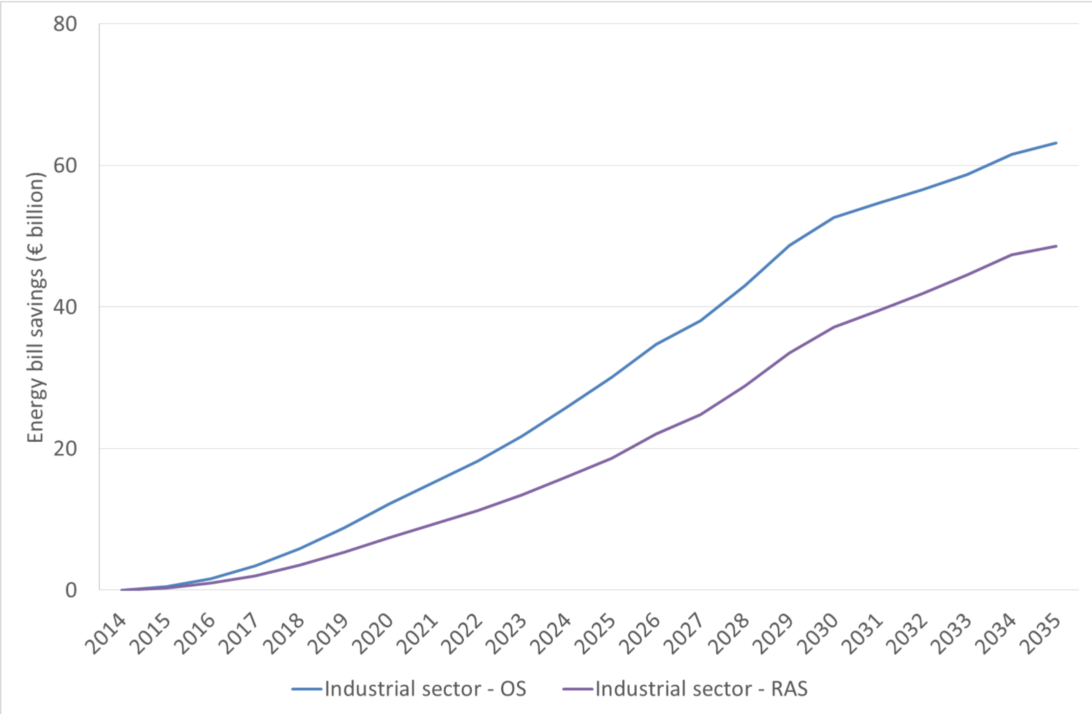
The associated additional investments compared to the Reference Scenario scaled up over the entire European industrial sector are shown in Figure 4.22. Cumulative total additional investments from 2015 to 2035 are €65.5 billion under the Optimal Scenario and €45.6 billion under the Recommended Actions Scenario. Under the Optimal Scenario, incremental annual investments peak at €6.3 billion in 2035 whereas under the Recommended Actions Scenario they peak at €4.9 billion.

Figure 4.22 Investments in European industrial energy management under the Recommended Action and Optimal Scenarios from 2015 to 2035



The value of avoided energy bills attributable to this investment is shown in Figure 4.23. Under the Optimal Scenario, savings in annual energy bills rise to €63 billion in 2035 whereas under the Reference Scenario they reach €49 billion. Cumulative total additional energy bill savings from 2013 to 2035 are €655 billion under the Optimal Scenario and €456 billion under the Recommended Actions Scenario. These are both approximately 10 times, as great as the magnitude of the additional investment over the period.

Figure 4.23 Savings in European industrial sector energy bills under the Recommended Action and Optimal Scenarios from 2015 to 2035



Source: own analysis

5. Barriers to energy management and best practice

There are manifold barriers to the greater adoption of EnMS and to the implementation of more effective EM. For example, a good summary of barriers faced by industrial energy audits (one element within EM) is provided in ECEEE (2014). While in the buildings sector the barriers that limit the better use of more effective automation and control strategies (a major EM opportunity) are documented in Waide *et al*, (2013). These have a substantial overlap with the broad generic barriers to energy efficiency documented in WEO (2012) in that they include: EE is not visible to end users & service procurers and is usually not measured; limited awareness of the value proposition and opportunity; energy expenditure is a low priority; split incentives e.g. competing account holders for capital and operational budgets; scarce investment capital or competing capital needs; unfavourable perception and treatment of risk; limited staff resources and know-how on implementing energy-saving measures; limited government resources to support implementation; fragmented and under-developed supply chains and services markets. All these factors apply and act to hinder adoption of cost-effective energy management and hence supporting measures are required to help overcome these constraints and enable good practice to flourish. Critically though there is a need to raise the prioritisation of energy management, and not just energy audits, as a strategic objective of organisations (Corremans 2010) and this has implications for the most appropriate focus of remedial policy measures.

5.1 Market failures and barriers to energy management

Policymakers need evidence of a market failure before they will consider implementing policies to overcome. This is especially true in the industrial sector as policymakers will often assume that industry is already acting in an economically rational manner with respect to fixed and variable cost management.

In an economically rational world energy costs should be controlled and optimised as part of normal business practice. Companies with large energy bills, such as metallurgy, chemicals and paper, are more likely to operate in this way because energy costs, as a proportion of revenue, can easily be as high as other major cost items such as raw materials and wages. Less energy intensive businesses will be less likely to manage their energy costs, even when there are cost effective means of reducing them. This situation occurs due to a variety of transaction costs that reduce businesses and public sector organisations ability to optimise their energy-related costs. The adoption of cost-effective energy management programmes are thus constrained by the same factors.

Table 5.1 summarises generic barriers to energy efficiency, many of which also apply for EM. The specific factors applicable to EM are discussed in detail for each of the principal energy end-use sectors considered.

While the energy bill of an organisation will be known its energy performance, and hence potential for improvement, will not unless efforts have been made to establish it. Thus the first problem is lack of visibility. When something is not measured or visible it is not valued and will tend to be ignored unless it is so conspicuous that it can't be ignored, as is the case in organisations where energy accounts for more than about 10% of their overheads. Even when energy performance if it is not part of "core business" it may well be given a low priority and hence not be managed. Split incentives such as the landlord-tenant dichotomy for service sector buildings, the divergent interests of Capex and Opex budget holders (from industry and service sector buildings) and the divergent interests of production and operation managers in industry all mitigate against economically rational energy management. If, as is commonly the case, the capital needed to deliver EM is drawn from the same pool as investment capital it will be competing against other business opportunity costs and hence will be underfunded in relation to its true cost-effective savings potential when viewed from a broader business perspective. This practice undervalues the steady drain of Opex on an organisation's finances and results in excessively short payback periods being prescribed. Lack of familiarity and knowledge with EM also tends to unduly increase the risk weighting given to EM investments and results in more funding constraints.

Table 5.1. Barriers to and opportunities for energy efficient transformers (adapted from *World Energy Outlook 2012* © OECD/IEA, 2012; IEA 2012b: Chapter 9, p. 280)

	Barrier	Effect	Remedial policy tools
VISIBILITY	EE is not measured	EE is invisible and ignored	Test procedures/measurement protocols/efficiency metrics
	EE is not visible to end users & service procurers	EE is invisible and ignored	Ratings/labels/disclosure/benchmarking/audits/real-time measurement and reporting
PRIORITY	Low awareness of the value proposition among service procurers	EE is undervalued	Awareness-raising and communication efforts
	Energy expenditure is a low priority	EE is bundled-in with more important capital decision factors	Regulation, mechanisms to decouple EE actions from other concerns
ECONOMY	Split incentives	EE is undervalued	Regulation, mechanisms to create EE financing incentives for those not paying all or any of the energy bill
	Scarce investment capital or competing capital needs	Underinvestment in EE	Stimulation of capital supply for EE investments, incubation and support of new EE business and financing models, incentives
	Energy consumption and supply subsidies	Unfavourable market conditions for EE	Removal of subsidies
	Unfavourable perception and treatment of risk	EE project financing cost is inflated, energy price risk under-estimated	Mechanisms to underwrite EE project risk, raise awareness of energy volatility risk, inform/train financial profession
CAPACITY	Limited know-how on implementing energy-saving measures	EE implementation is constrained	Capacity-building programmes
	Limited government resources to support implementation	Barriers addressed more slowly	Shift government resources toward efficiency goals
FRAGMENTATION	EE is more difficult to implement collectively	Energy consumption is split among many diverse end uses and users	Targeted regulations and other EE enhancement policies and measures
	Separation of energy supply and demand business models	Energy supply favoured over energy service	Favourable regulatory frameworks that reward energy service provision over supply
	Fragmented and under-developed supply chains	Availability of EE is limited and it is more difficult to implement	Market transformation programmes

Abbreviation: EE = energy efficiency.

Lack of knowhow and lack of staff to work on EM further constrain implementation, as does the multi-faceted nature of its delivery where fully invested multi-disciplinary teams are required for effective outcomes. Relatively weak markets for business models that support EM such as EPCs, ESCO services, auditors, certification, training, green leases, etc. is another limiting factor that impedes the broader adoption of EM. Taken in the round these barriers can be summarised as a mix of transaction costs, market failures and imperfections, technical limitations and market immaturity. Much, however, can be done via public policy but also corporate and public sector policy to mitigate these barriers as will be described in section 5.2 and Chapters 6 and 7.

5.2 Defining best practice in energy management

Build awareness among key decision makers

Energy efficiency is just one of many operational factors that companies and organisations need to consider and hence it will always compete with other concerns, especially when it is not deemed a core concern. Nonetheless, once companies appreciate how good an investment it can be the case for taking action becomes clearer and resources are more likely to be allocated to addressing this. Thus measures to raise awareness of the opportunity are the first need in instigating any EM programme.

Adopt an energy policy, produce diagnostics and establish an implementation plan

Once awareness is raised among the necessary decision makers then actions can be undertaken to clarify the nature and scale of the opportunity and used to inform the development of an implementation plan. This plan can then be put into action, its impacts reviewed and the process repeated through a system of continuous improvement.

Establish an effective EM team

The establishment of a competent EM team is central to this deliver this. The Institute of Industrial Productivity have defined the attributes that are necessary for such a team as shown in the text box below.

Address split incentives

Split incentives are one of the key issues that successful EM needs to identify and address. In particular there is a need to unify management objectives for Capex and Opex budgets to ensure that Capex cost cutting is not unduly adding Opex burden and to ensure that Capex account holders are rewarded for the benefit their procurement policy delivers to Opex as much as they are for constraining Capex.

Resource the activity

Effective EM will not occur unless sufficient resources in terms of staff and budgets are not allocated to it. The EM management team need to ensure that needs are identified and adequately met.

Source competence

EM is a skilled activity and its results will be constrained by the skills and competences of its practitioners. EM management teams need to ensure they appoint suitably skilled individuals to perform the tasks and whenever appropriate consider bringing in external (to the sit or organisation) competence to perform key EM tasks and/or to provide training. Competence can also be supported and partially verified via third party certification.

Audits, diagnostics and benchmarking

Proactive efforts need to be under taken to understand the energy flows within the organisation and to conduct diagnostics to determine savings opportunities. Appropriate techniques range from intermittent audits to continuous monitoring and benchmarking. In general the more of the organisations energy flows that are subject to these audits/diagnostics and benchmarking the greater the level of savings that will be identified and achieved. Generally, a strategy should be developed to establish a hierarchy of information gathering approaches by type, location and energy source so that the most promising opportunities can be implemented first. These would be implemented progressively, over time, in order of opportunity and resources.

Monitor, evaluate and report

Progress in rolling out the EM programme needs to be monitored along with measurement of impacts in terms of energy and cost savings. The programme needs periodic evaluation for effectiveness and this requires regular documentation of activities and reporting.

Rinse, repeat and scale

Following evaluation of each programme cycle fresh targets and objectives should be set and the boundaries of the programme widened until a point is reached where all cost effective opportunities are within the programmes practical scope of implementation. Systematic expansion of the EM effort will periodically require fresh assessment and allocation of resource needs.

Attributes of a successful energy management team

A diverse team of personnel supported by senior leadership, managers and plant leaders will ensure that energy saving goals are well understood and prioritized throughout the organisation, every step of the way.

Leadership – Identify a charismatic and passionate leader regardless of their role in the enterprise to ensure decision making autonomy and innovative idea advancement.

Diversity – Include a variety of business unit representation, such as production, engineers, operators, financial representatives, procurement and marketing to ensure company-wide awareness and adoption of energy goals.

Knowledge – Ensure a clear understanding of the role energy plays in creating bottom line advantage. Look for knowledge of energy management systems and people able to coordinate and understand different teams, business processes, various production lines and organisational development.

Commitment – Assess the team members' ability to participate on the Energy Management Team. Competing priorities, bandwidth and other factors can reduce a participant's value. Ensure the participant's commitment is solid and in alignment with expected team outcomes. Team members meet regularly, develop clear, updated action plans and learn to act as opportunity arises.

Communication - Team members effectively convey information through daily energy reports that are readily understood by others and mirrored by their actions.

Flexible – Open to adapting to mid-course changes and unexpected interruptions and other fluctuations common in production processes.

Motivators/Influencers – Team members are leaders within their work unit and must have the ability to overcome inertia and motivate their peers to follow them.

Executive support – The executive team must support a work environment where energy teams advance energy goals through training and education.

Source: IIP, http://www.iipnetwork.org/attributes-successful-energy-management-team

6. Polices to encourage energy management

This chapter sets out experience with energy management policies in the EU. It presents a relatively comprehensive summary of this experience by principal energy end-use sector and economy.

6.1 Existing policy frameworks at the EU level

Synopsis

In recent years there have been a number of technical and policy developments in the EU that are providing some support to higher and more effective EnMS adoption. On the technical level the ISO 50001 series of energy management standards has been issued and revised (ISO 2011) and serves to provide a consistent platform for energy management. While the use of this standard is steadily growing its level of adoption is still quite low and much remains to disseminate its (or equivalent standards) use.

Public policies to promote energy management can broadly be divided into those that target the tertiary buildings sector and those that apply to industrial enterprises and SMEs; however, the measures adopted at the EU level leave some very significant gaps.

In the buildings sector the EPBD (2010) includes some measures and encouragement for EM, however, this is essentially limited to energy performance certificates that can be based on either operational energy consumption or asset energy ratings and hence either give modest or no encouragement to savings through energy management in the operational sense. The majority of the other measures within the EPBD apply to whole building energy performance when assessed as an asset and hence only encourage improvement through new build or major renovation interventions i.e. do not address improvements through improved operation of existing buildings. The exception to this are Articles 14 and 15 which addresses heating and AC system inspections respectively; however, while these could be applied to promote some improvements in energy management it is not well targeted in this respect and so its impact in this regard is expected to be weak.

The EED (2012) currently requires EU Member States to make energy audits mandatory for large enterprises and gives the possibility for such enterprises that have implemented broader energy management schemes such as ISO 50001 to be exempt from the requirement provided the energy management scheme includes audits of a recognised quality. While this is welcome progress compared with previous policy frameworks it leaves several important gaps, some of which are mitigated in the national transposition of laws and policies:

a) it does not oblige affected enterprises to implement an energy management system (just to conduct audits; although this does give mild encouragement to EnMS adoption) nor does it create an incentive for organisations to adopt EM other than through the findings of the audits
b) it does not oblige or encourage affected enterprises to implement cost effective measures identified in the audits
c) it does not create a system to support the adoption and implementation of energy management systems
d) it only applies to large enterprises.

With respect to point b) the EED falls short of the requirements already imposed for example in Japan (Kimura & Noda 2014) and Denmark (Togeby *et al* 2012). In the former the strength of obligations on companies to conduct energy audits and implement the measures is related to the company's energy use; however, a large proportion of tertiary sector enterprise and almost all industrial enterprise are required to undertake energy audits and to implement measures with a sufficiently short payback time. Furthermore, the quality of the audits has to be approved by the relevant line ministry. Danish regulations impose similar requirements on the more significant energy using sectors of industry. Nonetheless, while audits are an important technical input and stimulus to action to address energy savings they are one element within energy management and the main deficiency within the EED measures is that they do not address the organisational and institutional policy issues that are also a part of energy management. Nor do they adequately address other barriers, such as competition for investment finance.

The EED also has several measures that are intended to support energy savings in SMEs. These include requiring Member States to:

- develop programmes to encourage SMEs to undergo energy audits and the subsequent implementation of the recommendations from these audits
- set up support schemes for SMEs, including if they have concluded voluntary agreements, to cover costs of an energy audit and of the implementation of highly cost-effective recommendations from the energy audits, if the proposed measures are implemented
- bring to the attention of SMEs, including through their respective representative intermediary organisations, concrete examples of how energy management systems could help their businesses
- encourage training programmes for the qualification of energy auditors in order to facilitate sufficient availability of experts.

All these measures are laudable but they are mostly quite open-ended with respect to how they are defined, implemented and with respect to their scale of implementation. As the nature and scale of requirements is left unspecified Member States have considerable freedom to do rather little in this domain while still technically meeting the legal obligations i.e. of having done something, no matter how modest. Inspection of the activities mentioned in national energy efficiency action plans reveals that many are exercising this freedom.

Critically none of the provisions in the EED require Member States to develop dedicated finance mechanisms or subsidies to support savings through energy management measures. Rather the Directive simply states:

> Without prejudice to Union State aid law, Member States may implement incentive and support schemes for the implementation of recommendations from energy audits and similar measures

The EU emissions trading scheme (EU ETS) and the integrated pollution prevention and control (IPPC) Directives also provide some indirect encouragement to greater adoption of effective energy management within major industries but these are poorly focused as far as energy management is concerned and hence will only weakly stimulate greater levels of adoption.

Thus in summary, the existing EU policy frameworks are helpful but insufficient to stimulate more than a part of the full economically ration savings potential from energy management.

Energy Efficiency Directive (EED)

Directive 2012/27/EU of the European Parliament and of the Council amending **Directives 2009/125/EC** and **2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC**

Directive 2012/27/EU amends Directive 2009/125/EC on Ecodesign requirements for energy-related products and Directive 2010/30/EU on energy efficiency labelling of energy-related products, and repeals Directive 2004/8/EC on the promotion of cogeneration and Directive 2006/32/EC on energy end-use efficiency and energy services. Member States were required to transpose most of the Directive's provisions into national legislation by 5 June 2014. It is a broad ranging Directive that covers many aspects of energy efficiency including several that concern energy management. Its provisions cover:

- National Energy efficiency Action Plans (NEEAPS)
- energy efficiency obligations imposed on energy suppliers
- building renovations and public sector buildings
- SMEs and energy audits
- public procurement
- metering/billing and information
- heating and cooling (DHC, CHP/cogeneration, microgeneration)
- energy services
- transformation, transmission and distribution
- training, accreditation, certification
- funding and financing.

The Directive establishes a common framework for promoting energy efficiency in the Union to ensure that the 20% energy efficiency target in 2020 (*i.e.* reaching a 2020 energy consumption of no more than 1483 Mtoe of primary energy consumption and no more than 1086 Mtoe of final energy consumption) is met and to paves the way for further energy efficiency afterwards. This includes requiring MS to track and report their progress towards attaining their proportion of these targets. Specifically, the Directive provides for the establishment of indicative national energy efficiency targets for 2020 and required the Commission to assess in 2014 whether the Union could achieve its target of 20% improvement in energy efficiency by 2020 and to submit its assessment to the European Parliament and the Council, accompanied, if necessary, by proposals for further measures.

The Directive states that by 30 April 2014, and every three years thereafter, Member States shall submit National Energy Efficiency Actions Plans (NEEAPs) that cover significant energy efficiency improvement measures and specify expected and/or achieved energy savings. The Energy Efficiency Directive lays down rules designed to remove barriers and overcome some of the market failures that impede efficiency in the supply and use of energy. For end-use sectors, the Directive focuses on measures that lay down requirements on the public sector, both as regards renovating the current building stock and applying high energy efficiency standards to the purchase of buildings, products and services.

The Directive also requires, that Member States should establish long-term strategies to increase the energy efficiency renovation rate of the building stock and that public bodies’ buildings should have an exemplary role. Specifically, the Article 5 requirements, on the Exemplary role of public bodies’ buildings, are:

- MS shall ensure from 1 January 2014, 3 % of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least EPBD minimum code levels
- the 3 % rate shall be calculated on the total floor area of occupied buildings with a total useful floor area over 500 m2 (250 m2 from 2015) and not meeting the EPBD levels
- MS may opt for an alternative approach whereby they take other measures, including deep renovations and measures for behavioural change of occupants, to achieve equivalent savings in central government buildings by 2020
- MS shall encourage public bodies, including at regional and local level, and social housing bodies governed by public law to: adopt energy efficiency plans; implement energy management; use ESCOs/EPCs to finance renovations and implement EE plans.

In addition, Article 6 on purchasing by public bodies stipulates that:

- Member States shall ensure that central governments purchase only products, services and buildings with high energy-efficiency performance, insofar as that is consistent with cost-effectiveness, economical feasibility, wider sustainability, technical suitability, as well as sufficient competition.

Article 7 of the Directive is one of the most important and requires Member States to deliver specified levels of final energy savings through the implementation of national energy efficiency obligation schemes (imposed on energy suppliers and/or distributors) or alternative policy measures. Specifically, the article requires that Member States:

- shall set up an energy efficiency obligation scheme to ensure that energy distributors and/or retail energy sales companies achieve a cumulative end-use energy savings target by 31 December 2020, at least equivalent to achieving new savings each year from 1 January 2014 to 31 December 2020 of 1.5 % of the annual energy sales to final customers of all energy distributors or all retail energy sales companies by volume, averaged over the most recent three-year period prior to 1 January 2013
- may exclude from the calculation all or part of the sales, by volume, of energy used in industrial activities listed in Annex I to Directive 2003/87/EC; and transport fuels
- may allow savings achieved in the energy transformation, distribution and transmission sectors, including efficient DH/C infrastructure, or due to individual actions implemented since 31 December 2008 to count towards the target's attainment
- shall publish the energy savings achieved by each obligated party annually.

Article 8 on Energy audits and energy management systems is the one of most direct relevance to energy management. Under its provisions Member States:

- shall promote the availability to all final customers of high quality energy audits which are cost-effective and either carried out in an independent manner by qualified and/or accredited experts according to qualification criteria; or implemented and supervised by independent authorities under national legislation
- shall establish transparent and non-discriminatory minimum criteria for energy audits (to guarantee their quality)
- shall develop programmes to encourage SMEs to undergo energy audits and the subsequent implementation of the recommendations from these audits
- may set up support schemes for SMEs, including if they have concluded voluntary agreements, to cover costs of an energy audit and of the implementation of highly cost-effective recommendations from the energy audits, if the proposed measures are implemented
- shall bring to the attention of SMEs, including through their respective representative intermediary organisations, concrete examples of how energy management systems could help their businesses. The Commission shall assist Member States by supporting the exchange of best practices in this domain
- shall ensure that enterprises that are not SMEs are subject to an energy audit carried out in an independent and cost-effective manner by qualified and/or accredited experts or implemented and supervised by independent authorities under national legislation by 5 December 2015 and at least every four years from the date of the previous energy audit.

Large enterprises, i.e. that are not SMEs, and that are implementing an energy or environmental management system - certified by an independent body according to the relevant European or International Standards - are exempted from the requirements to have an audit, provided that Member States ensure that the management system concerned includes an energy audit on the basis of the minimum criteria based on Annex VI.

Energy audits may stand alone or be part of a broader environmental audit. Member States may require that an assessment of the technical and economic feasibility of connection to an existing or planned district heating or cooling network shall be part of the energy audit.

Without prejudice to Union State aid law, Member States may implement incentive and support schemes for the implementation of recommendations from energy audits and similar measures.

Article 16, on the Availability of qualification, accreditation and certification schemes is another important article for energy management and specifies:

- where a Member State considers that the national level of technical competence, objectivity and reliability is insufficient, it shall ensure that, by 31 December 2014, certification and/or accreditation schemes and/or equivalent qualification schemes, including, where necessary, suitable training programmes, become or are available for providers of energy services, energy audits, energy managers and installers of energy-related building elements as defined in Article 2(9) of Directive 2010/31/EU
- Member States shall ensure that the schemes provide transparency to consumers, are reliable and contribute to national energy efficiency objectives
- Member States shall make publicly available the certification and/or accreditation schemes or equivalent qualification schemes and shall cooperate among themselves and with the Commission on comparisons between, and recognition of, the schemes
- Member States shall take appropriate measures to make consumers aware of the availability of qualification and/or certification schemes in accordance with Article 18(1).

Article 18 concerns energy services and stipulates that:

1. Member States shall promote the energy services market and access for SMEs to this market by:

(a) disseminating clear and easily accessible information on:

(i) available energy service contracts and clauses that should be included in such contracts to guarantee energy savings and final customers' rights

(ii) financial instruments, incentives, grants and loans to support energy efficiency service projects

(b) encouraging the development of quality labels, inter alia, by trade associations

(c) making publicly available and regularly updating a list of available energy service providers who are qualified and/or certified and their qualifications and/or certifications in accordance with Article 16, or providing an interface where energy service providers can provide information

(d) supporting the public sector in taking up energy service offers, in particular for building refurbishment, by:

(i) providing model contracts for energy performance contracting

(ii) providing information on best practices for energy performance contracting, including, if available, cost- benefit analysis using a life-cycle approach.

In addition to this article the EED lays down a series of requirements regarding metering and billing.

For the energy supply sector, the Directive requires Member States to adopt a national heating and cooling assessment to develop the potential for high-efficiency generation and efficient district heating and cooling, and to ensure that spatial planning regulations are in line with these plans. Member States must adopt authorisation criteria that ensure that a cost-benefit analysis of the possibilities for cogeneration for all new and substantially refurbished electricity generation installations and industrial installations above a certain threshold is carried out and the results are taken into account. Member States should however be able to lay down conditions for exemption from this obligation where certain conditions are met. The Directive sets requirements on priority/guaranteed access to the grid, priority dispatch of electricity from high efficiency cogeneration and the connection of new industrial plants producing waste heat to district or cooling networks, and measures to encourage the use of demand side resources.

Other measures include requirements for national energy regulatory authorities to take due regard of energy efficiency, and an obligation for Member States to remove obstacles to energy efficiency, including split incentives between the owner and tenant of a building or among building owners.

Impacts on energy management

The EED is the most important EU policy instrument addressing energy management although it concerns many other topics too and the parts which do concern energy management are somewhat tangentially focused on it. The audit requirements of Article 8 should go some way towards raising awareness in enterprise regarding energy efficiency savings potentials but they fall short of mandating or really encouraging adoption of energy management and there is a real risk that they treated as just another legal cost of doing business, rather than embraced and acted upon. The provisions for SMEs recognise the need to promote energy efficiency in SMEs and that they are a different case to larger enterprises; however, the requirements are very open ended and could be met by implementation actions on completely different levels of scale thus they lack clarity, focus and accountability. For example, the requirement that MS should establish programmes to encourage SMEs to undergo energy audits and the subsequent implementation of the recommendations from these audits could legally be met by a programme addressing a handful of SMEs up to all SME's in the MS in question. There is thus no requirement to implement these actions at scale. The building sector provisions mostly concern accelerating whole building renovation rates, which while welcome, doesn't address most of the EM opportunity in the building stock. This seems to be a missed opportunity because the EPBD (discussed below) fails to target this too. The requirements to use the public sector building stock in an exemplary role and include energy efficiency provisions within public procurement are helpful, but again fall short of mandating adoption of full EM in the public sector. The training and qualification, accreditation and certification requirements are also helpful, and should bring some credibility to the EM sector if properly respected; however, the requirements are also very open ended and hence MS are free to interpret them in a minimalistic manner should they choose to. There is thus a case to enhance all these requirements in future revisions of the Directive.

Energy performance of buildings Directive

Directive (2002/91/EC) and recast Directive (2010/31/EU)

The Energy Performance of Buildings Directive (EPBD) is the main policy instrument affecting energy use in buildings across the EU. Its original formulation in 2002, required Member States to introduce the following:

- a general methodological framework for calculating the integrated energy performance of whole buildings that addresses all energy flows
- minimum standards on the energy performance of new buildings and large (>1000m²) existing buildings undergoing a 'major renovation'
- energy certification for both new and existing buildings whenever they are constructed, sold or rented out
- implementation of an inspection and assessment regime for air conditioning and boilers or, develop alternative measures to reach the same level of energy savings as were intended by this measure.

The 2010 amendments added several new requirements and strengthened existing ones as follows:

- setting the threshold for minimum energy requirements for major renovations to 50m² in place of 1000m²
- introducing a calculation framework for calculating the cost-optimal levels of minimum energy performance requirements
- minimum energy performance requirements for building elements that form part of the building envelope and have a significant impact on the energy performance of the building envelope once retrofitted or replaced
- setting up EU-wide nearly zero-energy buildings requirements and development of national plans for increasing the number of NZEB buildings
- minimum energy performance requirements of building systems (to be applied in existing buildings and voluntarily be applied new buildings)
- requirement of an inspection and assessment regime for air conditioning and heating systems or develop alternative measures to reach the same level of energy performance
- requirement of an inspection report for heating and air conditioning systems (in case of application)
- independent control systems for EPC and inspection reports
- reinforcement of the energy certification of the buildings
- introduction of penalties.

Certification:

'Member States shall ensure that an energy performance certificate is issued for (a) buildings or building units which are constructed, sold or rented out to a new tenant; and (b) buildings where a total useful floor area over 500 m 2 is occupied by a public authority and frequently visited by the public. On 9 July 2015, this threshold of 500 m² shall be lowered to 250 m². '

Certification refers mainly to following articles of the recast EPBD[5]:

- Article 11 'Energy Performance Certificates'
- Article 12 'Issue of Energy Performance Certificates'
- Article 13 'Display of Energy Performance Certificates'.

The issuing of EPCs has an important role in the transformation of the building sector. By providing information, potential buyers and tenants can compare buildings/building units. Also recommendations are provided for a cost-effective improvement, encouraging home owners to refurbish their building to a better energetic standard.

The EPBD imposes that recommendations for improving energy performance should be part of the EPC. These recommendations (standard or tailor-made) are an important communication tool for the energetic improvement potential of the building. However it should be considered that EPC recommendations cannot substitute detailed building specific energy audits. Standard recommendations for the thermal envelope will mostly depend on the U-value of the construction element. Recommendations should not only focus on an improved U-value, but also require attention to the indoor climate (CA EPBD 2010)[6].

The EPBD has certainly made building energy performance much more visible (through the issuing of EPCs) and has led to the adoption of much more stringent building energy codes. It has also led to the creation of a large number of building auditors to conduct the EPC assessments across the EU. Its influence on energy management is much less clear, however. There are no clauses that expressly

[5] Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports 2012

[6] Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports 2010, '3.1.5 Processes for making recommendations'

concern EM although some of the measure offer some indirect support. EPCs and the whole building energy performance calculation framework will help building portfolio managers to assess the energy efficiency of the building stock and factor this into their leasing/rental or purchase decisions. The requirement for major renovations to meet more stringent building codes will also affect the service sector building stock over time, albeit at a rather slow rate.

In theory the clauses in the article which encourage Member States to consider setting minimum energy performance requirements for technical building systems (i.e. building energy services such as lighting, HVAC, BACS, etc.) would be able to have the greatest impact as such requirements would affect the energy performance of the building energy services equipment each time it is renewed and this happens much more frequently than major renovations to; however, in practice this clause doesn't require Member States to implement such measures and as a result none have. The article requiring regular inspection of the heating and AC systems is also largely circumvented as most MS have adopted the option of pursuing alternative routes to achieve equivalent savings and these are usually much less concrete.

Impacts on energy management

While the EPBD has many laudable elements and should certainly help improve the energy efficiency of the building stock over the longer term, its provisions mostly address new build or major renovations and have very little direct impact on energy management. The principal difficulty with this is that it only creates very slow pressure to improve the energy performance of the existing building stock which the inclusion of an EM focus could have helped to address. The rate of major renovations is too slow to affect a substantial part of the building stock from now to 2030 so measures which target these and new build will inevitably take a long time to have an effect for the whole stock. The requirement to have an energy performance certificate at least gives visibility to building energy efficiency, which is one step necessary for the market to function, however, the EPCs are a static snap shot of building energy performance and are only partially insightful because they do not provide insight into what part of the performance is due to how the building is used, operated and controlled as opposed to its basic asset characteristics. In other words they give no visibility to the savings potential that could be delivered through energy management. The article concerned with minimum requirements for technical systems currently has no teeth, in that MS are free to implement something in this regard if they choose to and most appear to have opted not to. This is a missed opportunity because this article could impose requirements on the performance of critical parts of the building energy services whenever they are renewed such as the control systems, the HVAC and lighting systems; and each of these brings huge potential for energy savings and has a much more rapid renewal cycle than can be accessed through major renovation requirements.

Industrial Emissions Directive (IED)

Formerly known as the integrated pollution prevention and control (IPPC) Directive, this was recast and renamed in 2010 as the Industrial Emissions Directive.

Industrial production processes account for a considerable share of the overall pollution in Europe due to their emissions of air pollutants, discharges of waste water and the generation of waste.

Directive 2010/75/EU of the European Parliament and the Council on industrial emissions (the Industrial Emissions Directive or IED) is the main EU instrument regulating pollutant emissions from industrial installations. The IED was adopted on 24 November 2010. It is based on a Commission proposal recasting 7 previously existing directives (including in particular the IPPC Directive) following an extensive review of the policy (see here). The IED entered into force on 6 January 2011 and had to be transposed by Member States by 7 January 2013.

The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT). Around 50,000 installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit (granted by the authorities in the Member States). This permit should contain conditions set in accordance with the principles and provisions of the IED.

The IED is based on several pillars, in particular (1) an integrated approach, (2) use of best available techniques, (3) flexibility, (4) inspections and (5) public participation.

1. The integrated approach means that the permits must take into account the whole environmental performance of the plant, covering e.g. emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure.

2. The permit conditions including emission limit values must be based on the Best Available Techniques (BAT). In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organises an exchange of information with experts from Member States, industry and environmental organisations. This work is co-ordinated by the European IPPC Bureau of the Institute for Prospective Technology Studies at the EU Joint Research Centre in Seville (Spain). This process results in BAT Reference Documents (BREFs); the BAT conclusions contained are adopted by the Commission as Implementing Decisions. The IED requires that these BAT conclusions are the reference for setting permit conditions. For certain activities, i.e. large combustion plants, waste incineration and co-incineration plants, solvent using activities and titanium dioxide production, the IED also sets EU wide emission limit values for selected pollutants.

3. The IED allows competent authorities some flexibility to set less strict emission limit values. This is possible only in specific cases where an assessment shows that achieving the emission levels associated with BAT described in the BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to the geographical location or the local environmental conditions or the technical characteristics of the installation. The competent authority shall always document its justification for granting such derogations.

Furthermore, Chapter III of the IED on large combustion plants includes certain flexibility instruments (Transitional National Plan, limited lifetime derogation, etc.).

4. The IED contains mandatory requirements on environmental inspections. Member States shall set up a system of environmental inspections and draw up inspection plans accordingly. The IED requires a site visit to take place at least every 1 to 3 years, using risk-based criteria.

5. The IED ensures that the public has a right to participate in the decision-making process, and to be informed of its consequences, by having access to permit applications, permits and the results of the monitoring of releases.

In addition, through the European Pollutant Release and Transfer Register (E-PRTR), emission data reported by Member States are made accessible in a public register, which is intended to provide environmental information on major industrial activities.

Reviews

Articles 30(9) and 73 of the IED require the Commission to review the need to control emissions from certain types of animal rearing and from the combustion of fuels in certain types of combustion plants and to report the results of those reviews to the European Parliament and the Council. This report was adopted by the Commission on 17 May 2013 (COM(2013) 286 final).

Impacts on energy management

There are no formal assessments of the impact of the IED on energy efficiency and energy management within industry and the direct impacts are likely to be modest or negligible. However, to support the process the Commission's Joint Research Centre has produced a set of highly detailed assessments of the Best Available Technology Reference Documents (BREFs) for each industrial process (JRC 2015). These assessments include energy efficiency within them and as the BAT conclusions contained are adopted by the Commission as Implementing Decisions and the IED requires that these BAT conclusions are the reference for setting permit conditions, then they are likely to provide some incentive to improve industrial process energy efficiency.

EU Emissions trading system

Directive 2003/87/EC of the European Parliament and of the Council

The EU Emission Trading System (EU ETS)[7] is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. The first - and still by far the biggest - international system for trading greenhouse gas emission allowances, the EU ETS covers more than 11,000 power stations and industrial plants in 31 countries, as well as airlines[8].

It covers:

- CO_2 emissions from installations such as power stations, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board, petrochemicals, ammonia and aluminium, and the aviation sector
- N_2O emissions from the production of nitric, adipic and glyocalic acid production
- perfluorocarbons from the aluminium sector
- the capture, transport and geological storage of CO_2

By putting a price on carbon and thereby giving a financial value to each ton of emissions saved, the EU ETS has placed climate change on the agenda of company boards and their financial departments across Europe. A sufficiently high carbon price also promotes investment in clean, low-carbon technologies[9]. The 2013 cap for emissions from power stations and other fixed installations in the 27 EU Member States (before Croatia's accession on 1 July 2013) was provisionally set at 2,039,152,882 allowances. For each year after 2013, this cap will decrease by 1.74% of the average total quantity of allowances issued annually in 2008-2012. In absolute terms this means the number of general allowances will be reduced annually by 37,435,387. Thanks to the decreasing cap, in 2020 emissions from fixed installations will be 21% lower than in 2005. The annual reduction in the cap will continue beyond 2020, but may be revised no later than 2025.

Quantifying the impact of the EUETS is notoriously difficult although there have been numerous attempts. A meta study (CCCEP 2013) that surveyed impact studies in the literature found that between the "top down", and sector-based "bottom up" evaluations, the existing literature points to attributable emission savings in the range 40 – 80 $MtCO_2$/year. This is about 2-4% of the total capped emissions (which comprise about 40% of all EU emissions).

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[7] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC; OJ L 275, 25.10.2003, p. 32. Latest amendment: Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009. OJ L140/63, 5.6.2009

[8] http://ec.europa.eu/clima/policies/ets/index_en.htm

[9] http://ec.europa.eu/clima/policies/ets/index_en.htm

These estimates apply to Phase I of the EUETS which was implemented between 2005 and 2007. Studies on the EUETS impacts also show that the economic crisis of 2008 onwards caused a huge weakening of the effect of the programme and led to surplus allowances being accrued – especially in the industrial sector. This induced a collapse in the price of CO_2 and hence removed a large part of the incentive for emissions reductions. There appears to be a dearth of clarity in the analyses of the impacts of the scheme to more recent times and there is also little clarity about what industrial sector companies have done to reduce their emissions. In the cement sector emissions reductions are reported to have occurred mostly through process changes that lead to less CO_2 as a by-product but for other obligated sectors it is likely that most reductions have occurred through a mix of energy efficiency improvements and decarbonised energy supply.

Impacts on energy management

It is curious that there appear to be no official EU evaluations of the impact of the scheme in terms of CO_2 savings and how they were achieved. The 2015 evaluation (EVA 2015), in common with previous assessments, is focused on how well the market functions and other process related assessments and does not assess CO_2 savings or what was physically done to achieve them. The attribution of its effects on the industrial sector seem to be even sparser than those across the programme as a whole. An investigation of the literature on this issue in 2012 (Martin *et al* 2012) concluded that "Overall, existing evaluations of the effectiveness of the EU ETS remain at a very aggregate level: there is no robust or precise estimate of the policy's specific effect on the industrial sector". For such a flagship policy this seems to be a serious omission and is suggestive of a lack of confidence in the findings. As a result it is even harder to get any impression of how important improvements in energy efficiency have been to attaining the abatement achieved and what role energy management played within this.

6.2 Existing policy frameworks at the Member State level

Drivers for EnMS adoption

Long term agreements and taxation

The most interesting EM policies are implemented at EU Member State level, although for the majority of EU economies the bulk of activity seems to be driven primarily by the requirements of the EED and hence is also rather new. Several MS have EM programmes of a much older pedigree – especially in the industrial sector. Most notably the long term voluntary agreement schemes operated by Denmark, Finland, Ireland, Netherlands, Sweden and UK, wherein participating enterprises agree to reduce their energy intensity or CO_2 emissions by pre-agreed amounts over a certain period. In each case the authorities have created an incentive to participate in these schemes through access to more favourable tax regimes; often via lower energy or carbon taxes. Thus effective implementation of these policies requires the tax to be in place prior to the LTA offering a means to mitigate its impact. Flanders has also implemented an industrial Long Term Agreement scheme but in this case the inducement to participate is quasi-mandatory as participation is a requirement for industrial sites to be given environmental permits necessary for their operation. Denmark and the Netherlands also include a compulsory component to their schemes as while the decision to engage (and thereby access the tax reduction) is voluntary once engaged it becomes mandatory to implement energy savings measures identified through audits that have cost-effective payback periods of less than a designated number of years. The quality of the audits is independently verified. The Flanders scheme also has this requirement. The example of the Dutch Long Term agreements is presented in the text boxes below, but the schemes have many similarities.

A summary of the characteristics of LTAs is presented in Table 6.1 while Table 6.2 presents a summary of mandatory energy efficiency investment programmes.

The Dutch Long Term Agreements

The Dutch government first introduced Long Term Agreements (LTA) on energy efficiency for Dutch Industry in the early 1990s as an alternative to legislation to implement a stricter energy policy. The idea was that the LTAs would give industry the opportunity to make their own prioritisations regarding the choice of energy efficiencies measures. Although participation within the LTA was on a voluntary base some obligations were imposed, as follows:

- preparation of an energy efficiency plan indicating which measures would be taken in the next 4 years period
- participation in the yearly monitoring to identify the progress on company as well as sector level
- introduction of an energy management system in the company.

A basic rule in the LTA was to continually look for options to improve energy efficiency and thus they embedded the basic premise within energy management. In the 1st generation LTA1 approximately 1200 companies drawn from 31 sectors participated. This covered 75 % of total industrial energy consumption in the Netherlands. The target within the 1st LTA was for an average energy efficiency improvement of 20% for all sectors up to the year 2000. Despite differences in the results per sector the average energy efficiency improvement achieved was nearly 23 %, see Figure 6.1, which represented a total energy saving of 157 PJ. Compared to a baseline autonomous energy saving of 0.8 % per annum the contribution of the 1st LTA was nearly 1.5% per annum.

LTA1 also contributed in many ways to raising awareness about energy efficiency. The instruments applied such as energy audits, consultancy, dissemination of experiences as well as financial support were all well appreciated. The evaluation concluded that participation stimulated companies to do more to improve energy efficiency than companies in the same sector outside the LTA. As energy efficiency was still high on the agenda and the 1st LTA produced positive results there was a positive attitude from both Government and Industry to continue with the LTA concept. Nevertheless some changes were applied for the 2nd generation LTA which was implemented from 2000. These included:

- the establishment of a specific and distinct Benchmark covenant for the energy intensive industry. The aim of this covenant was to ensure that energy intensive industry would belong to the top tier in the world with respect to energy efficiency by 2012 through improvements in the energy efficiency of in the production process. The World top tier was defined as 10 % below the most energy efficient process previously existing

The Dutch Long Term Agreements

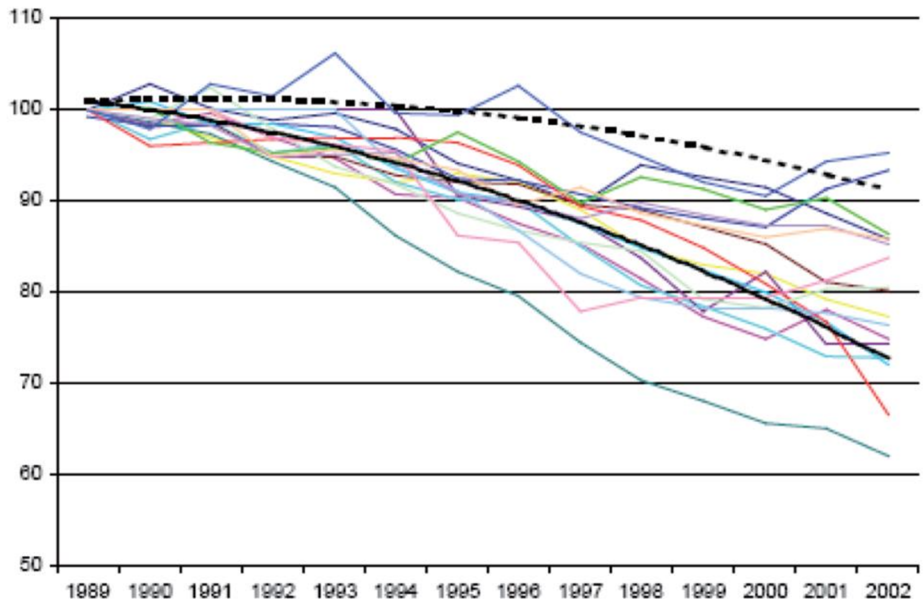
- other companies would be included in the LTA2 scheme. Although no specific energy efficiency targets were set for LTA2 participating companies were expected to implement all measures that were profitable, continue with energy management and implement supply chain measures if possible
- the scope of eligible energy efficiency improvements was widened to include measures that improve energy efficiency in the whole supply chain and/or sustainable energy applications.

The participants in LTA2 represented a total energy consumption level of 150 PJ (2008) whereas the Benchmark covenant represented a level of 700 PJ (2008). The 2nd LTA produced an average energy efficiency improvement to 2008 of 1.5 %/ year, whereas this was 0.5 % for the Benchmark covenant. The differences between LTA-2 and LTA1 are partly explicable by the fact that in LTA-1 a lot of (low cost) opportunities were already applied, which made it necessary to invest more in the LTA-2 period. The difference between LTA-2 and the Benchmark covenant could be attributed to the fact that the support in LTA2 was much more intense. The LTA2 also showed that over time the contribution by non-process related measures to the overall energy efficiency improvement grew, as can be seen in Figure 6.2.

Although the 2nd LTA agreement was meant to last till 2012 the LTA-2 ended in 2008 as the government increased the ambition of their climate policy. Against a context where EU Member States had concluded that industries should make a joint commitment to reduce their greenhouse gas emissions by 30 percent in 2020 compared to 1990. The 3rd generation LTA targeted a 30 % energy efficiency improvement from the period 2005 to 2020, of which it was expected that 2/3rds would be achieved through improvement in processes and 1/3rd via improvements in the supply chain. Under the LTA 3 the participants from the benchmark Covenant and LTA 2 were regrouped and then split according to their participation (or not) within the European Emission Trading System (EUETS). The target of 30 % energy efficiency improvement is only applied to the non-EUETS companies. The EUETS companies have no specific target but they claim that they expect to implement all profitable measures, meaning those with a pay-back period of less than 5 years, and to investigate deeper energy efficiency measures for the longer term. For the EUETS companies it is anticipated that they are actively working on investment to reduce CO_2 emissions which in some cases is delivered via increased energy efficiency. The obligations for the non-EUETS participating companies were similar to the previous generation of LTAs i.e.: setting-up of an energy efficiency plan, yearly monitoring and implementation of systematic energy management. However, there is an additional obligation for the participating branch associations to develop a sector roadmap.

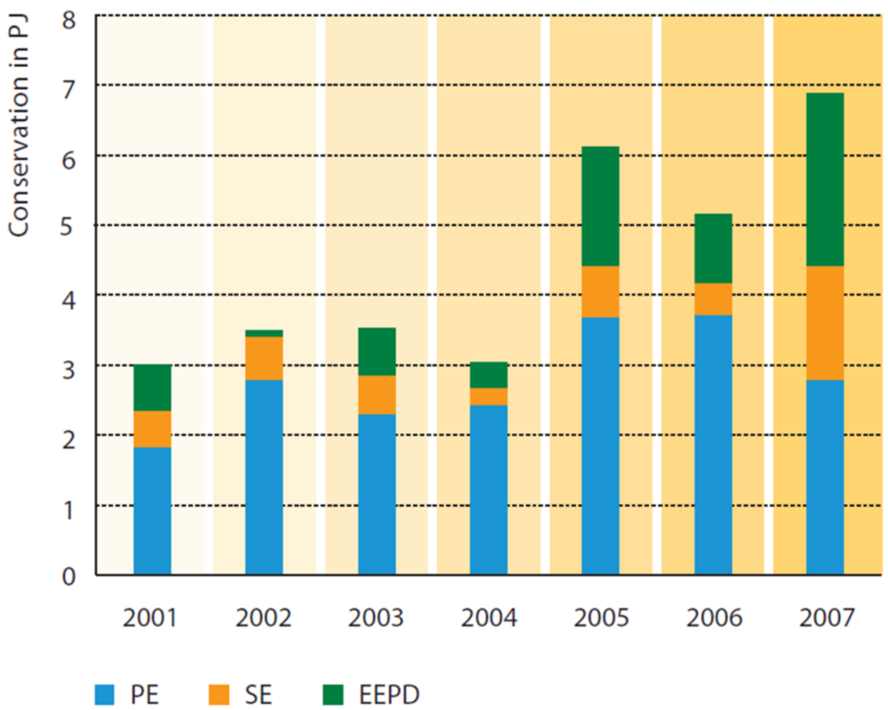
The Dutch Long Term Agreements

Figure 6.1. Energy efficiency improvement for various sectors under LTA1



Source: Wijshoff (2012)

Figure 6.2. Annual energy savings under the LTA2 by type (PE= process efficiency, SE = systems efficiency, EEPD = supply chain efficiency)



Source: Wijshoff (2012)

Other taxation driven EM schemes

LTAs are not the only means to use the impact of energy or carbon taxation to help leverage adoption of energy management. Germany presents the most conspicuous alternative route, wherein the linkage of tax breaks to the adoption of energy management has led to a far greater level of uptake of EN ISO 50001 certification than seen in other countries. A tax on electricity payable by firms was introduced in Germany in 2007 and set at €205/MWh. Up until 2012 companies that paid more than €1000/year for this tax were eligible to apply for a 90% reduction; however, in 2013 the exemption eligibility rules were amended such that companies have been obliged to prove that they have an energy management system certified to DIN EN 16001 or DIN EN ISO 50001 in place to be eligible to receive the tax discounts. As of 2014 about 25000 firms were eligible to receive tax reductions that totalled 2.3 billion Euros in value, and about 3000 EN ISO 50001 certifications were undertaken in early 2014 (Fleiter 2014).

The UK has implemented its Carbon Reduction Commitment Energy Efficiency Scheme for service sector organisations and enterprises not covered by the EU ETS or the UK's Climate Change Agreement schemes. It is designed to incentivise energy efficiency and cut emissions in large energy users in the public and private sectors across the UK, together responsible for around 10% of the UK's greenhouse gas emissions. Participants include supermarkets, water companies, banks, local authorities and all central government departments. The scheme features a range of drivers to encourage organisations to develop energy management strategies that promote a better understanding of energy usage and to take up cost-effective energy efficiency opportunities. Organisations that meet the qualification criteria are required to participate, and must buy allowances for every tonne of carbon they emit. The scheme is expected to reduce non-traded carbon emissions by 16million tonnes by 2027, supporting the UK national objective of achieving an 80% reduction in UK carbon emissions by 2050.

Incentives via Energy efficiency obligations

Denmark, France, Ireland, Italy, Luxemburg, Poland, Slovenia and Spain have permitted energy savings delivered through their energy supplier/distributor energy efficiency obligation (EEO) schemes to be realised through delivery of energy savings in the industrial sector. This has created a market for industrial energy savings, especially when to tradable white certificates, as is the case for France and Italy, wherein energy savings delivered in industrial enterprises can be sold to obligated parties as a contribution towards meeting their energy savings obligations. This therefore creates a stream of incentives for industrial energy savings and is supported by regulated methodologies for verifying savings. In fact the same mechanism is also permitted to generate savings in service sector building energy use in all these EEO schemes, although in practice more savings are delivered through measures applied in the industrial sector. The UK actually operates the oldest and in some ways most successful EEO; however, its savings measures are confined to the residential sector. Austria, Belgium, Bulgaria, Estonia, Latvia, Lithuania and Slovakia are also implementing EEOs but the details of their schemes were not available at the time of writing this report.

The schemes implemented in Italy, France, Denmark and the UK predate the EED Article 7 requirements concerning energy efficiency obligation schemes but the other schemes were introduced in response to this article and hence are too new to have reported any impacts. Summaries of these schemes are shown in Table 6.3. In principle, these obligations are one of the main means by which MS are meeting their energy savings targets under the EED and hence they are of a substantial scale. Therefore, they are capable of providing a major impetus to deliver energy savings in the industrial and service sectors and create a substantial funding stream supported by an independent monitoring and verification system. In principle energy management schemes can take advantage of this funding source to buy down capital costs associated with energy efficiency investments and thus could be beneficiaries of the broader policy. This would have the indirect effect of making EM more attractive as it would help identify more systematically the savings opportunities that would be the target for the incentive.

Not all countries have chosen to implement EEOs as MS are allowed to take an alternative compliance route with the provisions of the article wherein they agree to implement alternative energy savings measures that should deliver the same magnitude of energy savings. Countries that have fully opted for this alternative route include: Czech Republic, Croatia, Cyprus, Finland, Germany, Greece, Netherlands, Portugal, Romania & Sweden.

Table 6.3 presents a summary of EEOs in EU MS.

Direct state incentives for audits or EM

France, Finland, Germany, Norway, Sweden and the UK amongst others have provided direct financial and technical assistance to conduct energy audits and implement energy savings measures in the industrial sector and also sometimes the service sector.

Benchmarking schemes

Benchmarking is one of the most important energy management tools. Depending on its scope it allows comparison of the energy performance of whole enterprises, businesses, facilities, processes, buildings and systems on a common metric. At its best it allows like for like comparison where the results display unequivocal differences in energy efficiency. When this is recognised by all parties it can be a powerful motivation for improvement and means of monitoring improvement. The text box below shows the case of the Danish Elsparefonden building electricity consumptions benchmarking scheme, which is a powerful example of how such schemes can be readily constructed to motivate and support building energy management at low cost.

Examples of how external benchmarking (i.e. across organisations) is applied can be found in the EU funded BESS project (Benchmarking and Energy management Schemes in SMEs) (Wajer et al. 2007a; Wajer et al. 2007b), for example, a benchmarking and energy management scheme was developed for industrial SMEs with a focus on the food and drink industry. This approach was subsequently expanded to new member states and additional sectors in the Ex BESS (2009) project. Similarly, a study by EWI (2010) focuses on energy-related indicators for small and medium companies in Austria. Another focus on SMEs in found in IREGIA (2009) where energy-benchmarking is used as a core element for developing a harmonized approach to improve energy-related competences in SMEs. The more powerful of these benchmarking initiatives demonstrate very significant differences in efficiency between comparable operations and as these are external to the enterprises being benchmarked they can be a strong motivator for improvement as they demonstrate actual rather than theoretical savings potentials and competitive differences. This type of benchmarking can also be locked into public policy initiatives such as is the case for the Flanders benchmarking LTA and the Dutch benchmarking covenant for energy intensive industry.

Benchmarking is not just a government initiated activity. Many companies develop their own internal benchmarks across similar facilities, processes or systems and these are one of the most recognised means of driving EM based improvements. An example from Sontag et al (2014) is given below:

> Opel is one of the largest car manufacturers in Europe with about 37,000 employees at eleven sites and sales of more than one million cars and light-duty vehicles in Europe in 2012. Opel is among others certified according to ISO 14001 with an ongoing certification process for energy management according to ISO 50001. Opel is aiming at a reduction of energy demand due to rising energy costs and environmental concerns for quite some time. Monitoring became especially important during the economic crisis of 2008 when the specific energy costs per car drastically increased due to a drop in production. After labour

costs, energy costs are the second largest block of costs that can be influenced by Opel. Opel's holding company GM has issued an overall target for 2020 to reduce worldwide specific energy demand per car by 20 % until 2020 as compared to 2010

The energy management system of Opel has several levels. On a top level of energy management, an "energy and utility service group" develops strategies, it defines annual and monthly energy targets and breaks them down into energy targets for individual sites. Other responsibilities of this group include the collection, analysis and reporting of energy demand to technical management once per month, the coordination of benchmarking activities and best-practice sharing as well as European energy purchase. On the level of a site, a "site utility manager" coordinates the energy-related activities occurring there. This includes a breakdown of site targets to the production areas, the coordination of energy saving activities and the provision of locally produced energy like heat and compressed air. On the level of each production area, there is a staff member for energy-related issues, usually belonging to maintenance. His tasks include suggesting measures for improvements and to sensitise shop floor workers to energy related issues. These and other users in the company use information from energy benchmarks. Main energy carriers covered there are electricity, gas oil and heat. Corresponding central EPI for Opel are based on the energy consumption per car or unit. The above mentioned overall target value is translated to targets for individual sites and areas. Reporting at the level of sites generally takes place on a monthly basis. Experience of Opel has shown that older production sites can compete with newer sites in energy benchmarks if they have a sufficient discipline to shutdown consumers when not needed. However, due to differences in vertical integration, in supply infrastructure and due to differences in the structure and age of production equipment and buildings, a direct comparison of energy performance is not considered as a suitable option for benchmarking.

While benchmarking is generally a very positive EM measure it does carry some complexities. A summary of these issues reported from a benchmarking user survey in Sontag et al (2014) noted that:

- the costs and benefits of energy benchmarks seem to be largely unexplored. On the one hand, there is practically no limit for adding details to benchmarking systems. With the level of detail, the effort for data acquisition and analysis increases. Yet additional details only provide marginal additional benefits. It remains unclear how to find the most suitable level of detail for energy benchmarking systems
- it remains open how to best link energy performance indicators (EPI) to other performance indicators or other benchmarks that are already established in companies
- and finally, along with the aggregation of complex real world data into single EPI, there is a risk to loose essential information to fully understand the meaning of an EPI. While it is possible to improve the quality of EPI by eliminating factors of influence or by supplementing information to the benchmarks, it is difficult to determine the suitability of certain EPI for specific objects. Therefore, there is a need to determine and assure robustness of EPI.

The Danish building electricity benchmarking scheme

Since about 2005 the Danish Electricity Savings Trust “Elsparefonden” has exploited a legal ruling that required electricity distributors to make available real time metering data (that is gathered by utilities from larger users to inform their electricity supply balancing) to building owners on request. The government made this data available to the Elsparefonden by requiring public sector entities to request it from the utilities and share it in real time. The Elsparefonden then organised the data into a like for like building electricity demand benchmarking tool, wherein data from all building of a similar type is gathered and can be compared in a user friendly manner. For example, the data is displayed in coloured pie charts that show what part is consumed during working hours, night-time and weekends, it then benchmarks the consumption per unit floor area and per employee. The daily consumption profiles can also be shown for any day requested and if sub-metering data is available can be used to show the same type of data for each sub-metered system e.g. lighting, AC, IT, etc. This kind of data allows facility managers to easily see how their buildings compare to their peers and create an easy business case for improvement whenever poor relative performance is identified. It also facilitates demonstration of the true value of EM measures so that consumption profiles before and after adoption of the measure can be directly compared to observe the effect. This makes benefits much easier to quantify, value and believe in than when such data is not being gathered. Private sector entities are also encouraged to share their data but are under no obligation to do so. Clearly, such benchmarking is much more informative and powerful than is possible via static assessments in building energy performance certificates and also had very low overheads to implement as it mostly takes advantage of existing infrastructure.

Figure 6.3. Real-time metering & benchmarking of public libraries in Denmark

Arbejdssteder - individuelle oplysninger

Antal	Arbejdssted	Myndighed/firma	Arbejdssteds-type	Rapport	Areal m²	Årsforbrug kWh	Årsforbrug kWh/person	Årsforbrug kWh/m²	Graf
1	Biblioteksadministrationen	Høje Taastrup Kommune	Bibliotek		14.360	137.867		10	
1	Bornholms Centralbibliotek	Bornholms Regionskommune	Bibliotek		2.236	176.972		79	
1	Brønderslev Bibliotek	Brønderslev Kommune	Bibliotek		2.708	95.497	168	35	
1	Danmarks Blindebibliotek	Kulturministeriet	Bibliotek		6.670	291.864		44	
1	Danmarks Kunstbibliotek	Kulturministeriet	Bibliotek		4.647	57.747		12	
1	Danmarks Natur- og Lægevidenskabelige Bibliotek	Kulturministeriet	Bibliotek		10.826	510.868		47	
1	Det Kongelige Bibliotek Lergravsvej	Kulturministeriet	Bibliotek		6.732	139.928		21	
1	Det Kongelige Bibliotek Njalsgade	Kulturministeriet	Bibliotek		6.840	519.150		76	
1	Frederikshavn Bibliotek	Frederikshavn Kommune	Bibliotek		6.703	240.171	4.803	36	
1	Herlev Bibliotek	Herlev kommune	Bibliotek		2.325	222.390		96	

1 2

I alt for 17 Arbejdssteder: 95.167 5.353.312

Gennemsnit for 17 Arbejdssteder: 5.598 314.901 593 56

Source: Elsparefonden (2015)

Mandatory audits

There is no doubt that the EED Article 8 requirements that require mandatory energy audits for large enterprises across the EU (defined as those of more than 250 personnel and revenues of >€50m) are set to become the key driver for energy audits across the EU. It is premature to speculate on how much impact they have had, however, as requirements for most countries were only due to come into force by December 5th 2015 so it is far too soon to assess any impacts of this policy. Nonetheless, past experience on audits does suggest some caution should be expected as there have been many cases where governments have promoted energy audits with relatively mixed results in terms of subsequent implementation rates. A common problem has been that company personnel charged with energy oversight, who typically operate within the O&M team, may have been willing to pursue the actions identified in the audit but those managing capital expenditure budgets have not engaged and thus viable measures have been left unacted upon. This experience highlights the need to go beyond a policy framework setting requirements for audits to a policy framework that encourages the adoption of EM as a company policy supported by senior management.

Contracting and services

Energy Performance Contracting and ESCOs

The European ESCO market has continued to develop but remains relatively modest in size despite many reported successes. ESCOs will typically enter into energy performance contracts (EPCs) with their clients and these usually entail the ESCO making limited investments in the client’s energy infrastructure and managing their energy use in return for sharing the value of the benefits accrued from reduced energy bills. It necessitates a base line for energy use to be established so that the improvement due to the ESCO’s actions (and associated shared benefits) can be accounted for and compared to that. Many ESCOs favour the adoption of energy management systems as a low cost means of delivering the savings and hence policy measures which successfully drive the ESCO market will also tend to drive development of the EM market. However, this engagement in EM does not necessarily remain in house and the risks coming to an end if the EPC comes to term and is not renewed. Current EU and MS policies to help develop the ESCO market are rather fragmented and haphazard at present. There are several countries that operate limited energy efficiency funds that may be used to help finance ESCO activities. Some states and regions/municipalities are supporting ESCO activities and some financing schemes have been established to help aggregate energy efficiency investment projects and underwrite lending risk. However, at present EPC remains a relatively uncommon practice and much more remains to be done to develop this business model and the ESCO market in general. In Italy ESCOs can be voluntarily certified by an accredited third party, according to national standard UNI CEI 11352: 2014. For the certified ESCOs the implementation of an EnMS is a mandatory requirement of the EPC contract.

Continuous commissioning and re-commissioning services

Continuous commissioning and or re-commissioning (see section 3.2 for a description) is essentially an EM technique that is well suited to buildings and other facilities. In terms of a service it can be considered to lie across the ESCO market and the facilities management markets as it is perfectly possible for FM services to incorporate continuous commissioning within their activities. While continuous commissioning has been shown to produce large energy savings in many instances it remains relatively undeveloped in terms of market penetration. Despite its potential there seems to be very little evidence of any MS policy frameworks dedicated to supporting continuous commissioning; and rather, the support that does exist comes in the form of more cross-cutting instruments such as EE funds, building energy certificates and display certificates and other more generic measures.

Qualified practitioners

As mentioned in section 6.1 the EED (specifically in Articles 8 and 16) contains measures intended to encourage MS to identify limitations in the cadre of EM professionals and develop accreditation and certification efforts to address these. As is the case with the provisions on energy audits, it is too soon for data to have been compiled on the implementation and impact of these measures; however, the requirements leave it to MS themselves to determine whether or not they consider "that the national level of technical competence, objectivity and reliability is insufficient" before they decide whether or not to establish such schemes. Furthermore, there is no guidance or requirements about the number of qualified practitioners that are appropriate or needed to deliver the auditing effort foreseen in the provisions of Article 8. Considering that in most MS there is likely to be a significant shortfall in qualified energy managers and practitioners compared with the scale of the opportunity there is a need to reinforce MS efforts to develop a cadre of competent EM professionals. This is needed in order to ensure that complementary measures to drive up demand for EM do not over stretch the supply chain and result in poor outcomes undermining the savings objectives and the credibility of EM in general. Note, in June 2015 the standard EN 16247-5 Competence of Energy Auditor was issued and in Italy the standard UNI CEI 11339: 2009 to qualify "Energy Experts" has been established.

Other institutional support

Standards

There is now a reasonably comprehensive set of standards to support energy management in the EU as documented in Chapter 1. However, many of these standards are quite recent and will doubtlessly need refinement once put to the test through widespread implementation. Furthermore, the current suite of standards are essentially best suited to implementation by larger organisations with enough staff resources to dedicate teams to relatively holistic EM approaches. SMEs and less energy intensive organisations are likely to find the present set of standards are too involved and remote (i.e. somewhat less tangible) from their principal concerns and operations. There is therefore a need to complement the current standards with simplified and targeted standards aimed at each specific economic activity. These could even take the form of guides regarding which elements of the main EM standards should be the focus of EM within each specific context. To the best of the author's knowledge there is no current initiative looking at this need.

Accreditation and certification

Accreditation and certification efforts are being established in EU MS to support implementation of the EN ISO 50001 and related standards. Accreditation is being managed through each national accreditation agency and each of these will be members of the European-Accreditation (EA) agency. To the best of the author's knowledge there are no activities that aim to compare implementation of EM accreditation and certification practices across the EU and thus it is likely that there will be significant variation in practical implementation and possibly the quality of the resulting schemes. Ideally proactive cross-checking would occur to ensure that the EED Article 16 requirements for the availability of qualification, accreditation and certification schemes are actually satisfying a minimum quality level in all EU MS.

Training

While the EED Article 8 provisions on energy audits does envisage that these will be carried out by qualified professionals it does not define what these are nor does it, or the rest of the EED, set targets for the number of such professionals required. Most EU MS have some infrastructure in place to train EM professionals but the nature, rigour and scale of these efforts varies substantially and so the current situation is ad hoc and is far from ensuring a common minimum level of qualifications is being met. Furthermore, EM practices and the associated techniques, are far from being in stasis and hence there is constant need to update and maintain skills that could be facilitated via retraining programmes. In general this is an area where much could be done to help raise activity levels and improve standards.

In principle, EU coordinated training schemes could help address deficiencies and raise standards in both national accreditation and certification schemes and MS training schemes for EM professionals.

Energy Efficiency Networks

A number of countries have created formal or informal energy efficiency networks to help discuss and disseminate best practices among peer groups in the industrial and service sectors. Germany, for example, operates an extensive Learning Energy Efficiency Network (LEEN) programme wherein 10 to 15 regionally based companies from different sectors share their energy efficiency experiences in moderated meetings (Köwener et al 2014). Following an energy review and the identification of profitable efficiency potentials in each company, all participants decide upon a joint target. Information regarding new energy efficiency solutions is presented by experts during these meetings, together with insights on experience concerning the measures which are implemented. The performance of each company is continuously monitored and is controlled on an annual basis. The network operating period is typically from three to four years. The LEEN management system consists of a variety of documents and calculation tools as well as regulations regarding how to run a LEEN network. Thus it offers the participants a transparent evaluation of their saving potentials and ensures a quality standard. The energy review and the monitoring of implemented measures comply with the EN ISO 50001 standard. Among the 360 participating companies of the publicly funded "30 Pilot- Netzwerke" (30 Pilot Networks) project[10], approximately 3600 cost-effective energy saving measures were identified, corresponding to an energy saving potential of more than 1200 GWh per year, and a CO_2 emission reduction of nearly half a million tons per year. The average internal rate of return was more than 30%, which demonstrates a high degree of profitability. The concept behind the LEEN networks is that engaging in moderated discussions among peers with expert technical support will lower knowledge acquisition transaction costs regarding energy savings in industry, will increase motivation to identify and implement energy savings opportunities and will support company decision making. The benefits can be fully realised by industry itself, and the processes involved can also be self-financed by the companies concerned, while simultaneously using social mechanisms to motivate company management to focus on energy efficiency. The LEEN concept originated in Switzerland in 1987 and was first implemented in Germany in 2002. As of 2014 about 50 networks involving approximately 600 companies were active in Germany. In Switzerland, companies that reduce energy-related CO_2 emissions within the framework of a negotiated and mandatory target, and undergo an annual evaluation, are exempted from a steering tax on fossil fuels. In January 2014 this tax was set at CHF 60 per ton of CO_2 and hence is a significant inducement to participate in the LEENs. Some 70 networks were reported to exist in Switzerland in 2014.

Within Germany the LEEN network process entails the following steps:

- a complete assessment of the saving potentials in crosscutting technologies and several process-technologies
- an economic evaluation of the saving potentials (IRR, Payback Period and Net Present Value)
- exchange of experience (via an information network as a know-how-pool)
- commitment of the management
- higher acceptance of the energy manager
- supply of up to date information on new technologies (presented by engineering experts)
- meeting topics of determined by the participants

[10] http://www.30pilot-netzwerke.de/archiv/nw-de/index.html

- evaluation of the measures implemented through monitoring over a year
- energy manager training delivered over a four year period.

Other EU countries who have created similar networks, albeit not necessarily structured in the same way, include Denmark, Ireland, Netherlands, Sweden and the UK and are related to their Long Term Agreement mechanisms. Table 6.4 presents a summary of the status of EE networks in the EU.

Enterprise management activities

Corporate Social Responsibility schemes

Corporate Social Responsibility (CSR) schemes are a form of corporate self-regulation integrated into a business model. Many corporations, especially large ones, have established CSR initiatives and many of these include components to manage carbon emissions and energy consumption. A typical CSR process with regard to reduction of CO_2 emissions would entail the following steps being taken by senior management or the board:

- commitment – i.e. adopting the policy and committing to its implementation
- integrate in management
- long-term targets and strategy
- reporting and follow-up.

These steps have direct parallels in EM and for most companies a form of EM is the most viable route to reduce their emissions. The more proactive companies set emissions targets and by proxy set energy reduction targets and then implement plans to reduce their energy consumption and or decarbonise their energy supply. For larger companies and franchises this can sometimes entail establishing energy performance monitoring and benchmarks across similar operations and the transfer of knowhow between them about how to reduce consumption/emissions. While it is certainly the case that demand for EM is positively influenced by CSR activities the connection is far from universal. For example, the largest CSR network in the EU is CSR Europe network[11] which brings together 41 national CSR networks and 10000 enterprises. The organisation maintains a well-staffed secretariat and website with many hundreds of tools and reports on different aspects of CSR; however, there is just one product on their website that addresses energy efficiency and this is a catalogue of good practices. It catalogues good practice techniques for Climate Change, Green Public Procurement, Dialogue with Stakeholders, Eco-design and Technological Innovation, Infrastructure, and Measurement and Control, but it does not present a guide for structured EM. This is indicative that there remains much to be done to promote and integrate systematic EM within CSR approaches; albeit this should clearly be a common objective for the EM and CSR communities.

Summary

The Energy Efficiency Directive has clearly had a large impact on the industrial and service sector energy efficiency policy portfolios of EU Member States and for some countries the requirements set out in this Directive form the bedrock of their policies in these sectors. Others, most notably those with a long standing interest in promoting energy efficiency policy, have additional policy measures that often complement the EED requirements. It is too soon for the impact of the EED measure on audits and certification and accreditation to be clear, but it is apparent that these measures are limited and there is much more that could and should be done to help realise the savings potentials through EM. Some MS have adopted relatively holistic policy packages to promote energy savings via EM in industry and services but even the most proactive has found that ample opportunities remain to be exploited and there is plenty of scope to develop EM policies further at both the EU and MS level.

[11] http://www.csreurope.org/

Table 6.1 Summary of long term industrial agreements for those countries which have them

	DK	IE	NL	Sweden	Flanders	Finland	UK
Programme name	LTA	Large Industry Energy Network (LIEN) and SEAI Energy Agreements Programme	Long-Term Agreements	Programme for improving energy efficiency, PFE	Energy policy agreements with energy-intensive companies	Energy efficiency agreements	Climate Change Agreement
Period of operation	1996-2013		1992 to now	2004-12 (repealed due to contravention of EU rules on state aid)	2012-2015	2008-now	2001-now
Incentives to participate	Rebate in Energy Savings Tax	Subsidised audits and support	Participants pay a lower Energy Tax	Five-year exemption from energy tax on electricity (SEK 0.005/kWh)	Required to attain the environmental license to operate	20% subsidy of EE related capital costs (€22.5m of subsidies in 2011)	Reduction of up to 90% on the Climate Change Levy
Other features	Implementation of identified cost-effective EE measures is binding for a 3 year period	Agree to work towards ISO50001 implementation	Businesses must draw up an EE plan every four years and implement cost-effective measures Sectors also do strategic studies (roadmaps) based on a 50% reduction in CO_2 in 2030.	Must implement EM, do audits and invest in measures with payback <3 years	Participants cover 82% of industrial energy use in benchmarking agreement and 6% in the audit agreement		
Sectors covered	Industry	Industry - sites cover >50% of industrial energy use	Industry, services and agriculture. Covers 80% of Ind. energy	Industry	Industry	Industry, Services, Energy	Energy intensive industries: (aluminium, cement, ceramics, chemicals, food and drink, foundries, glass, non-ferrous metals, paper, and steel) and over thirty smaller sectors
Reported impacts		3.26 TWh in2012 from all industrial EE measures (not just LTA)	Average efficiency saving of 22.3% from 1992-2000 = 2%/year From 2009-12 average savings of 1.6%/year.	13.7 TWh from 2007-11 (electricity savings of 1.45 TWh/year)		All industrial EE measures. (Agreements + audits) produced savings of 7.5% in 2010	9,600 facilities have signed up to CCAs accounting for 268 TWh in 2010. Savings target to 2020 of 11%

Table 6.2 Summary of mandatory energy efficiency investment programmes for those countries which have them

	DK	NL	Flanders
Mandatory EE investments linked to EM	Yes if entity has entered into the LTA	Yes	Yes
Programme name	LTA	Environmental Management Act	VLAREM
Description	Must implement all EE measures with a payback of < 3 years	Must implement all EE measures with a payback of < 5 years	Must implement all EE measures with a payback of < 3 years
Sectors covered	Industry	Companies and buildings	Industry
Other features		Entity size limits apply. Local authorities can oblige audits to be done.	Mandatory approved energy plan

Table 6.3 Summary of energy efficiency obligations for those countries which have them

	DK	FR	Estonia	IE	IT	Latvia	Lithuania	LU	Malta	Spain	Slovenia	Poland	UK
EEOS type	Yes	Yes - White certificate scheme	Yes	Yes	Yes - White certificate scheme	Yes	Yes	Yes	Yes	Yes	Yes	Yes - White certificate scheme	Energy Company Obligation (ECO)
Year introduced	2006	2006	2015	2014	2005	2014	2014	2015	2015	2014	2014	2013	2003/2015
Sectors where savings measures can be made	Domestic, Industry, Commerce	Domestic, Industry, Commerce		Domestic, Industry, Commerce	Domestic, Industry, Commerce			All		Industry, buildings, transport	All	All	Domestic
Scale of savings	3% of all non transport energy use	2.5 Mtoe per year in 2013	Target of 6.5 TWh cumulative by 2020	0.55 TWh per year	1.2 Mtoe in 2012	0.979 TWh in 2020	Target of 11.7 TWh cumulative by 2020	Target of 6 TWh in 2020	Target of 0.22 TWh in 2020	Target of 0.571 Mtoe/year	0.75% of energy supplied by 2018	0.55 Mtoe/year	
Allocations of savings by end-use sector	39% Industry, 8% services, 53% domestic	6% industry		Unspecified	53% Industry, 4% services, 43% domestic			Unspecified		54.6% Industry, 15.3% buildings/equipment, 25.3% transport, 4.8% public/agriculture	Not specified	Unspecified	

Table 6.4 Summary of energy efficiency networks applicable to the industrial/service sector for those countries which have them

	DE	FR	IE	IT	NL	Spain	Sweden	Flanders	Finland	UK
Energy efficiency networks	Yes		Yes				Yes			
Sector	Industry		Industry				Industry			

7. Recommendations and action plan

This chapter comprises a set of recommendations on what could be done to improve energy management in Europe. These are informed by the detailed gap and barrier analysis of the energy management industry, in terms of regulation, standards, training, capacity, organisation, awareness and other factors that influence the ability to make economically viable investments in energy management, that were presented in Chapters 5 and 6.

These recommendations are used to inform an action plan that sets out steps for what recommended activities should be considered to help advance best practice in energy management.

7.1 Recommendations

Given the pressing need for the EU to improve its energy security (especially with respect to natural gas imports) and make deep cuts in the carbon intensity of its economy it is appropriate to countenance more proactive stimuli for systemic energy savings than have hitherto been adopted. This is especially the case for savings that require systemic and organisational level changes and as such are only accessible through full energy management.

The measures to support energy efficiency improvements set out in the EED are welcome but also fall someway short of what is likely to be needed to access the cost-effective savings potentials. The EED provisions require energy audits in larger organisations but they don't take the next step towards full energy management, with the exception of the relatively weak inducement of waiving the necessity to conduct an audit if certified to EN ISO 50001 (note, attainment of such certification requires the conduct of such audits and much more). Yet experience has shown that occasional static audits are usually insufficient to induce significant action to access savings potentials, especially if conducted without broad support across the organisation. Energy management, implemented at a level of sophistication that is appropriate to the activity the organisation engages in, is the only means to address the energy culture of an organisation and to thereby realise the cost-effective systemic savings potentials within its activities.

In broad terms two actions are needed to make progress in realising the savings potentials:

- increase adoption of energy management
- increase the quality of energy management.

So what are the actions necessary to drive greater adoption of energy management and to improve its quality? The text below sets these out and delivers a set of recommendations that it is hoped will inform future policy development in this area.

Raising awareness and clarifying the value proposition

Raising awareness of the value proposition of energy management is an essential component for success. Organisations are much more likely to embrace energy savings behaviour if they see what the benefit is likely to be to them and are persuaded by the value proposition.

Clarification of the value proposition has many aspects to it, but the critical elements are to make it tangible, relevant and personal i.e. beyond simply communicating the broad abstract value proposition of EM it is much more persuasive if it is clearly contextualised for the specific type of activity the target audience is engaged in. For example, the management of a bakery will have limited interest in a generic message concerning energy management but if the message is clearly addressing their business and the processes it engages in relative to the competition it will be much more powerful.

Sector networks

For this to be credible it is important that the message is developed and carried by peers respected in the sector. At the public policy level this necessitates that governments identify and engage with these groups to first raise their awareness and then solicit their support in circulating the message among the broader set of stakeholders. This is one reason why programmes to establish sectoral agreements and industry/sector networks are highly beneficial because they engage directly at this level.

Benchmarking schemes

Equally important and in some ways even more powerful are the development of benchmarking tools and programmes. When organisations can see how their sites compare on a credible energy performance benchmark against their peers it is very powerful instrument for motivating change. It provides tangible, immediate and informative comparison, helps set a target to aim for and measure progress against and provides a strong motivational stimulus – in part, of a competitive nature – wherein organisations can rally round an objective of moving up the scale relative to their peers. The experience of benchmarking programmes such as the EU ExBESS (2009) project for SMEs or the Danish Elsparefonden (2015) initiative to benchmark the electricity consumption of service sector buildings are very positive and clearly demonstrate the viability and value of establishing such benchmarks. However, such benchmarks are currently the exception rather than the rule and this undermines the ability to effectively implement EM in the EU.

Two processes should be countenanced to address this, operating at the EU and the MS level. At the EU level there is a need to develop and maintain EU wide benchmarking initiatives that are targeted at each industrial and service sector segment. These should not just be in the form of one off projects, such as ExBESS, but as on-going and maintained commitments. This implies allocating some significant resources to the establishment and implementation of such efforts. Benchmarking programmes should be implemented at the MS level which mirror and complement this. They, will have the flexibility to be adapted to local circumstances and potential differences from the EU as a whole, but could also feed into the EU benchmarking process. Participation in the benchmarking schemes could be encouraged through appropriate incentives (see below) and, as is usually the case for such schemes, designed to maintain anonymity wherein an organisation accessing the benchmarking database could see how their sites or processes compare on the benchmark without being able to see the names of other entities who have contributed data. To be of value such benchmarks will need to be established at sufficient levels of resolution to be meaningful. The Elsparefonden approach shows how easily and practically the electricity consumption of service sector buildings can be compared and thus would be of relevance for office or depot sites of other organisations within the industrial sector. It likely to be possible to create similar benchmarks for other energy use within buildings. Otherwise for industrial processes it is necessary to establish benchmarks tailored to the specific sector in question.

Providing incentives

Experience shows that engagement in EM is much greater when accompanied by some financial or fiscal incentive. The comparatively high levels of EN ISO 50001 certification of German companies is clearly driven by the reduction in energy taxes that are offered to certified companies. The various long term agreement schemes successfully operated by DK, FI, IE, NL, SW, UK all include fiscal inducements to participate. The incentives offered through these schemes provide clearer inducement to adopt EM than do the EE measures based incentives that can be delivered directly by state agencies (e.g. ADEME in France) or through energy efficiency obligation schemes (see below), although both instruments have a role to play

Linkage to taxation

As mentioned directly above some of the most effective national EM promotional programmes have operated through the use of fiscal incentives to encourage participation in collective energy savings targets via EM. It is also possible to create fiscal incentives that are not linked to the attainment of any specific energy savings targets but that directly encourage the adoption of EM, as has been done in Germany. This explains why Germany has the highest rate of certification to EN ISO 50001 of any national economy. Both routes have been proven to be effective to promote EM, however, it is not yet clear which is the most effective at producing actual energy savings. Nonetheless there is clearly benefit from using fiscal measures to promote EM and/or targeted energy savings through EM and thus adoption of either mechanism is recommended and should be more widely adopted across the EU. Fiscal incentives have the advantage that they can be set to be fiscally neutral for the state finances and hence should not present a drain on state funds. If set appropriately, they will generate greater cost-effective energy savings in the targeted sectors than they cost those sectors to comply with and thus will somewhat improve the competitiveness of the affected sectors. However, this is more likely to be the case if they are complemented by supporting policy measures such as those mentioned in the other parts of this section, as these will help overcome barriers to energy savings from EM that pure fiscal incentives will likely not address.

Linkage to EEOs

Several MS have established energy supplier energy efficiency obligation schemes (EEOs) in alignment with the requirements of Article 7 of the EED. These schemes set minimum energy savings targets on energy suppliers in proportion to the level of energy sales they make and thus have created a funding source for energy efficiency measures which are directly linked to the energy markets and hence are independent of government finances. The scale of the funding for EE measures derived from such schemes has the considerable advantage that it is directly driven by the scale of the target and is recovered through an increment to the energy tariffs. As a result the potential for EEOs to create financial incentive for EM is very considerable. However, the realisation of this potential requires EM measures to be eligible within the boundaries of such schemes (this is currently true of most of them but not all – e.g. the UK EEO only applies to the domestic sector) and for suitable energy savings methodologies to be identified. EM is rather complex by its nature in that is a process that could lead to the adoption of a variety of actual energy savings measures. Thus methodologies need to be established that allow the energy savings from EM in all its forms to be properly accounted for and hence to become fungible within EEO schemes. National EEO regulators therefore need to work with the standardisation, certification and the monitoring, verification and enforcement (MV&E) communities to derive such methods and trial them in the market place. So doing will not only help create a stream of EM related savings but will also wider the scope for savings and help lower their delivery costs, thus obligated energy suppliers should also have a direct commercial interest in developing these savings routes. In the long term expanding the range of energy savings methods deployed will deepen the reservoir of savings potential accessible by EEOs and thus will allow for deeper savings to be achieved than would otherwise be the case.

Appropriate obligations

The EED imposes an obligation on large enterprises, defined as those employing more than 250 workers, whose net annual sales exceed EUR 50 million and/or their balance sheet total is more than EUR 43 million, to conduct an energy audits of their facilities energy four years. However, this imposes no obligation to implement EM beyond an audit and no obligation to implement cost effective energy savings or RE measures that are identified. Among EU economies Denmark, the Netherlands and Flanders have introduced varying degrees of compulsion to implement cost-effective energy savings measures and they have some of the most successful programmes in terms of outcomes within the EU. Beyond the EU Japan imposes compulsory requirements on business to conduct audits and implement cost-effective savings measures identified and along with the leading EU economies they enjoy some of the lowest energy intensity businesses in the world. Furthermore, the sharp carbon reductions produced mostly through energy savings that UK businesses has experienced following the introduction of the Carbon Reductions Commitment Energy Efficiency scheme, which creates a fixed-price carbon market for businesses not subject to the EUETS again suggests that obligations can create a most effective driver for energy performance improvement. Clearly, any obligations need to be carefully structured so they are not so weak as to be irrelevant and not so stringent as to be damaging. They also need to be implemented in such a manner as so they cannot be easily circumvented. Attaining the right balance in this regard requires a public administration that has the knowledge and capacity necessary to devise and implement such a scheme and this takes time to develop. Thus, having built up such capacity should be a precursor to the specification of any mandatory requirements that involve significant technical and commercial competences e.g. the appraisal of audits to determine their completeness and validity in terms of the cost effectiveness of energy savings measures identified.

The imposition of such measures could thus be considered as a potentially viable option in more mature programmes. The Commission could foster this by weighting the energy savings permitted in national contributions to the energy savings target under the EED by their concreteness and degree of certainty. Mandatory requirements would likely produce greater confidence in the outcome than softer and vaguer requirements and hence their estimated savings could be given a higher weighting.

Obligations to introduce EM

Aside from prospective obligations to implement cost effective savings the main obligation that would be beneficial in the near term is to upgrade the EED requirements on audits to become an obligation to introduce an energy management scheme. Such obligations could be tailored and staged to the target sectors under consideration, to ensure they are appropriate and that sufficient qualified capacity is in place to implement the measures. One means of doing this could be to distinguish between organisations as a function of their energy intensity and scale. Organisations with relatively high energy intensities and large scales would be the earliest to be subject to obligations, while those with lower intensities and smaller scales could be obligated at a later stage and/or subject to less comprehensive EM obligations. For example, the high intensity/large scale organisation obligations might entail an obligation to be certified to a leading European or national energy management standard, such as EN ISO 50001. This could and should be imposed on the EUETS subject organisations as much as those relevant organisations that are not subject to the EUETS. Although some may argue that this is double regulation, entities subject to the EUETS should either already have met this requirement as one of the most effective means of meeting their emissions target or, if not, are clearly missing an opportunity to meet their emissions target more cost effectively, and so depending on which circumstance the organisation is in such a requirement would either cause no further burden or would provide them a clear benefit. Similarly, it would help ensure that there is some motivation towards emissions reduction in these sectors regardless of the vagaries of the carbon price and hence would create more stability in the carbon markets.

For the sectors not falling within the EUETS a requirement to adopt EM, providing it was sensibly targeted at sectors differentiated to have clear net benefits, would also lead to more significant energy performance improvements than the current energy audit requirements, for all the reasons set out in the body of this report. As mentioned earlier the nature of the EM obligation could be differentiated by the type of organisation considered distinguished by energy intensity and scale (i.e. revenue and number of employees). Full EM in line with EN ISO 50001 would be appropriate for the large scale and intensive organisations while simplified and reduced EM requirements would be appropriate for smaller and less intensive entities. It is beyond the scope of this report to analyse the precise structure that would make sense but the principle is clear.

When considering the merits of this proposal policymakers should also be mindful of the chain of command and influence with the target entities whose energy behaviour they wish to influence. Compliance with a mandatory energy audit, while imposed on an entity as a whole and hence a matter of fiduciary responsibility for the board, is rapidly designated to lower levels in the organisation and hence forgotten about. There is no obligation to report the findings to the board or senior management and to adopt a collective position on how to respond to them; thus the instruction may go out from the top of the organisation to carry out the audit but it is quite likely there will be little follow-up beyond ensuring it was done. The same is not true of certification to an EM standard. In that case there have to be clear lines of responsibility and review, including a regularly maintained company energy policy, and thus the level of engagement of senior management and the board is necessarily greater and more proactive. This is why upgrading the mandatory audit obligations within the EED to mandatory EM obligations should be countenanced.

Adapting EM methods to be appropriate to more economic sectors

The impact from EM is the product of the level of EM adoption and the quality of the EM process followed. One means of ensuring EM quality is to certify performance to a recognised EM standard such and EN ISO 50001 and this is appropriate for companies with large energy bills and/or high energy intensity. For smaller and less energy intensive organisations the requirements for EN ISO 50001 may be too onerous and the benefits may not justify the cost in terms of staff resources, thus there is a need to develop simplified EM practices that are adapted to the needs of SMEs and less energy intensive sectors. Some EU and MS projects have explored this issue and have created tools that are adapted to specific SME or less energy intensive sectors; however, these are not comprehensive (in that they only address some sectors), tend not to have been maintained following the end of the projects and are not yet mature enough to provide the basis for a suite of well-adapted simplified EM standards and tools (e.g. benchmarking) that are targeted to the specific needs of these less energy intensive activities. There is thus a pressing need to develop such methods and to extend the range of EM standards and tools by economic sub-sector, if EM is to become more widely adopted and implemented. It is recommended that the EU and MS develop an ambitious programme of actions to address this need with the aim of developing EM standards and tools that are targeted to the needs of each economic sub-sector among SMEs and less energy intensive businesses.

Improving the quality of EM

As mentioned above, the quality of EM is a key factor driving the level of savings achieved. The provisions of the EED recognise this in that the specified energy audit requirements are required to be carried out by qualified and/or accredited experts or implemented and supervised by independent authorities under national legislation.

In addition, the Article 16 provisions require MS to establish certification and/or accreditation schemes and/or equivalent qualification schemes, including, where necessary, suitable training programmes, for providers of energy services, energy audits, energy managers and installers of energy-related building elements by the end of 2014 whenever the MS considers that the national level of technical competence, objectivity and reliability is insufficient. The limitations of this requirement is that it is left to the MS to decide whether the national level of competence is adequate or not and there seems to be no oversight by the Commission or efforts to verify and benchmark competence across EU MS. It would therefore be helpful were more systematic efforts to be made to ensure that the necessary competences are available at the scale required to implement effective EM across each MS. This could entail the derivation of national targets for qualified EM operatives linked to the scale of the economy and its energy intensity, and backed-up by EU-wide programmes to benchmark the quality of the EM professionals and to strengthen professional practitioner networks. Such an effort would be likely to require the commitment of relatively substantial resources as well as the creation of a dedicated coordination and oversight administrative structure, but would greatly facilitate transfer of knowledge and best practice as well as giving real impetus to EM adoption. This latter effect arises because the more enterprises that undertake good quality EM the more the savings and the more self-evident the value proposition becomes, such that a virtuous circle of quality driving adoption and deepening can ensue.

Whether such an EU coordinated effort is established or not, MS would be well advised to undertake efforts to strengthen the quality of the EM professionals within their economies and to build networks with practitioners from other economies to increase the likelihood that all best practices are being adopted. The establishment of effective and adequately resourced EM certification and accreditation programmes is evidently one part of this.

7.2 An Energy Management Action plan

The principal recommended actions are set out below.

Following review of the EED the Commission and MS should consider amending the provisions which currently exclusively concern energy audits to:

- introduce MS level targets for the share of enterprises that have adopted EM and where the targets are set based on the proportion of enterprises of a given size and energy intensity within each MS
- consider amending the EED energy audit obligations to become an obligation to adopt full energy management for enterprises using more than a minimum prescribed energy consumption or energy intensity level and above a minimum size
- set MS targets for the number of certified energy managers, wherein the targets are proportional to the economy's size and energy intensity and increase with time
- support the development of EM standards and tools which are targeted to each sub-sector and which are designed to be less burdensome and more relevant for SMEs and less energy intensive enterprises
- complete the development of and promote benchmarks of energy performance in the industrial and tertiary sectors that are tailored for relevance to each specified industrial or tertiary sector activity (including SMEs) and require companies and organisations to benchmark their energy use and share the results in an anonymous format with public authorities
- develop and provide free energy management support services to SMEs targeted at those with poor benchmarked efficiency levels (note this would include but not be limited to energy audits) - consider obligating the poorer performers to implement highly-cost effective measures
- provide incentives on energy efficiency capital expenditures for those organisations that adopt relatively advanced EM, wherein the total scale of the incentives provided by each Member State is commensurate to a proportion (say a quarter) of the value of expected energy savings to be achieved over the lifetime of the investment. Financing of these incentives could be integrated within national energy efficiency obligation schemes imposed on energy utilities under the provisions of Article 7 of the EED
- develop extensive capacity building programmes to train organisations in the development and implementation of EM policies and to build and support the energy services sector.

Independently of progress with the EED MS should also consider:

- providing fiscal incentives for EM either in the form of direct tax incentives for companies are certified for EM or in the form of tax incentives to participate in a Long Term Agreement to improve energy intensity via EM

- providing incentives on energy efficiency capital expenditures for those organisations that adopt relatively advanced EM, wherein the total scale of the incentives provided by each Member State is commensurate to a proportion (say a quarter) of the value of expected energy savings to be achieved over the lifetime of the investment. Financing of these incentives could be integrated within national energy efficiency obligation schemes imposed on energy utilities under the provisions of Article 7 of the EED. Develop common EU methodologies to account for and evaluate energy savings produced via EM to facilitate funding through EEOs and similar market mechanisms
- supporting awareness raising and knowledge transfer regarding EM through then establishment of sector level EM learning networks, or Long Term Agreements or similar mechanisms
- establishing and promoting benchmarks of energy performance in the industrial and tertiary sectors that are tailored for relevance to each specified industrial or tertiary sector activity (including SMEs) and require or encourage companies and organisations to benchmark their energy use and share the results in an anonymous format with public authorities
- developing and providing free energy management support services to SMEs targeted at those with poor benchmarked efficiency levels (note this would include but not be limited to energy audits) - consider obligating the poorer performers to implement highly-cost effective measures
- developing extensive capacity building programmes to train organisations in the development and implementation of EM policies and to build and support the energy services sector.

MS targets for EM adoption

To encourage MS to put in place the measures that will bring about higher levels of adoption of EM in their economies the Commission and MS should consider revising the EED to include targets for EM adoption levels in EU MS. These targets would be phased in progressively and increase over time. They would also be set by economic sector and as a function of enterprise size and energy intensity such that the proportion of companies required to have adopted EM to meet the target would be higher for larger and more energy intensive enterprises and lower for smaller and less energy intensive enterprises. The target could include a voluntary aspirational element (set at a higher level) and a binding minimum element (set at a lower level). Compliance with the target would be demonstrated by providing evidence of the share of EM certified enterprises.

Incentives for EM adoption

In order to satisfy these targets MS should consider adopting a portfolio of EM adoption support measures. These could include:

Fiscal incentives for EM in enterprises – either via a sector level agreement to reduce energy intensity via Long Term Agreements linked to fiscal incentives or via direct fiscal incentives linked to being certified for implementing an EM scheme. MS should also consider adoption of other fiscal incentive instruments such as: the UK’s CRC Energy Efficiency scheme which imposes an energy efficiency related carbon cap and trade scheme on large companies and the public sector that are not part of the EUETS; and reduced corporation taxes on energy efficient capital equipment.

Other incentives for EM in enterprises. While fiscal measures may be the best means of enticing enterprises to adopt EM financial incentives funded through energy efficiency obligation schemes or equivalent means could be the best means of supporting specific EM measures and investments and thereby of increasing energy savings. It is recommended that MS should consider adapting EEOs to support this at scale and the Commission should consider providing substantial coordinated technical support to develop and trial common viable methodologies to account for EM related energy savings, so these can be transparently included within EEOs or related schemes.

EM obligations for enterprises

The Commission and MS should consider amending the EED such that the obligations on large enterprises to conduct energy audits every four years evolve into an obligation to adopt a certified EM scheme. This obligation could be introduced in a staged manner as a function of an enterprises energy intensity/energy use. It could also be imposed on EUETS obligated as well as un-obligated parties in order to ensure the latter are following good practice for EM and hence for emissions abatement. MS should also consider imposing obligations or introducing encouragements for enterprises to demonstrate that they have acted on all cost effective energy savings measures, as identified and verified on a commonly established basis.

Promote the value proposition of EM

MS should be proactive in promoting the value proposition of EM to enterprises and should implement measures to raise awareness of the opportunity for enterprises to reduce their costs and meet CSR objectives via EM. These awareness raising activities will gain more attention and traction if supported by a blend of incentives and obligations. Some of the most effective mechanisms are the creation and support of peer networks and of long term agreements, managed by the state. MS should proactively help build these mechanisms in order to help create engagement and diffuse best practice.

Develop energy performance benchmarking

MS, with support from the Commission, should aim to establish EM benchmarking schemes for the service and industrial sectors. This will help demonstrate the value proposition to the target sectors and will facilitate monitoring of progress and diffusion of best practice. To be meaningful these schemes should be sufficiently disaggregated to permit meaningful comparison among peer economic activities. For buildings benchmarking of electricity consumption should be established rapidly and cheaply as has been done in Denmark (see section 6.x), and should be broadened to all energy use as the schemes mature. For SME's benchmarks should be developed for specific activities or processes. For manufacturing and heavy industry efforts should be made to establish benchmarks based on energy use per unit output. Where possible and sensible EU-wide benchmarking should be established. Note, benchmarks need to be anonymous to encourage participation.

Develop differentiated standards and tools

The Commission and EU MS should consider developing a comprehensive suite of EM standards and tools dedicated to the EM needs of each economic sub-sector. These would be designed to be less burdensome and more relevant (targeted) to these specific sectors than the current suite of generic EM standards and would encompass specific methods and approaches for SMEs by type of SME and the same for other less energy intensive enterprises. This would enable energy managers in each area of economic activity to find EM standards and tools directly adapted to their needs.

Support quality of EM delivery

In order to ensure there are sufficient numbers of suitably qualified EM professionals to deliver EM policy objectives MS and the Commission should consider amending the EED to include targets for the minimum number of accredited EM professionals by MS. These targets could be set based on the size and energy intensity of the economy and staged to be phased in over time so they are practicable to attain. The Commission and MS should also consider developing a harmonised EU EM accreditation process so that EM practitioners can be certified to a common professional standard. Rather than simply delegating this process to each national accreditation agency the Commission should consider facilitating cross-accreditation mechanisms wherein parties from other countries could witness the certification process in other MS and thereby identify differences and learn/diffuse best practices.

More generally, MS should aim to develop extensive capacity building programmes to train organisations in the development and implementation of EM policies and to build and support the energy services sector.

Table 7.1 includes a summary of these recommendations.

Table 7.1 Summary of recommended actions at EU and MS levels

Measure	Mechanism	Form
MS obligations	Dynamic EM adoption targets	Set by economic sector, enterprise size and enterprise energy intensity - increasing target with time
Incentives for EM	Fiscal incentives	Either: LTAs with fiscal incentive
		Or: Direct fiscal incentives for EM
		Also consider: Carbon trading EM schemes for non EUETS sectors - ala UK CRCEE
	Other incentive mechanisms	EEOs
		Direct state incentives (least preferred choice)
EM obligations for enterprises	Expand from audits to certified EnMS for enterprises >€50m turnover and with high energy intensity	impose on EUETS obligated as well as un-obligated parties
		introduce in a staged manner as a function of an enterprises energy intensity/energy use
	Consider obligations/incentives to implement cost effective savings	tailored and staged to the target sectors under consideration, to ensure they are appropriate and that sufficient qualified capacity is in place to implement the measures
Clarify value proposition	Targeted awareness campaigns	Sector networks and peer groups
		Awareness through LTAs
		Greater promotion of CSR
Benchmarking	Promotion and incentives	electricity consumption benchmarking for buildings
		energy consumption benchmarking for buildings
		process benchmarks by industry sector
		output benchmarks by industry sector
EM quality	MS dynamic targets for certified energy managers	Targets proportional to economy size and energy intensity, increasing with time
Standardisation and tools	EM standards and tools targeted to each sub-sector	Less burdensome and more relevant EM standards and methods for SMEs and less energy intensive enterprises
	Developed at EU and MS levels	

Conclusions

Strengthening the practice of energy management is a key need if public and private sector organisations are to access the large reserve of energy savings that are not directly addressed through other instruments. In the tertiary sector while measures addressing the energy performance of buildings are partially captured through the provisions of the Energy Performance in Buildings Directive and to a lesser extent the Energy Efficiency Directive these measures leave a substantial proportion of the systems- and operational-level savings potential untouched. This is the domain where energy management can make a significant difference. Similarly, in the industrial sector existing European policy instruments such as the EU ETS and the IPPC directive only provide weak stimuli to encourage the savings that are only accessible through energy management. Not least because the value of carbon credits has plummeted while the energy efficiency specifications within the IPPC are rather loose and have considerable freedom in their interpretation leading to diluted implementation. This leaves a policy vacuum that measures which promote stronger energy management could help to fill.

In this context the development of effective energy management across EU organisations should be viewed as a strategic opportunity and priority. About 11% of all EU energy consumption can be economised cost-effectively through the adoption of more effective energy management and most likely this potential will be “renewable” as more sophisticated technologies and techniques are developed in the future.

A variety of policy and programmatic recommendations have been proposed which can help to realise a large part of this savings potential. These build principally on strengthening the design of the Energy Efficiency Directive and its implementation at the Member State level. Critically realisation of these savings will require efforts at a major scale supported by very substantial financial resources and incentives; however, as the value of the benefits outweigh the costs by an average of twelve to one over the lifetime of the measures this constitutes a highly cost-effective investment and one that merits greater policy attention than it has received thus far.

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Appendix A. Steps an organisation should undertake to comply with EN ISO 50001:2011

General Requirements

To comply with the provisions of the EN ISO 50001:2011 standard organisations need to have established, documented and implemented an EnMS that meets all the requirements set out in the standard. This includes defining the scope of the EnMS with regards to physical site limits and organizational boundaries and also considered the extent of business activities, facilities and decisions to be covered within it. These boundaries can be different for different business aspects e.g. equipment procurement may occur at a different site to where the rest of the EnMS occurs but would ordinarily still be included within the scope.

Energy Review requirements

The energy review requirements are as follows:

- develop & document a robust methodology for producing an energy review that can be repeated or updated
- produce an energy review to include an analysis of energy use and consumption based on direct measurement and other data
- identify all current energy sources
- consider past and present energy use
- identify areas of significant energy use and consumption
- identify facilities and other equipment, systems and processes & people working for or on behalf of the organisation who can affect energy use and consumption
- identify all other variables affecting significant energy use
- determine the current energy performance of facilities, equipment, systems and processes related to significant energy use where these account for both substantial sources of energy use and those offering considerable potential for improvement
- include estimates of future energy use and consumption
- identify, prioritise and record opportunities for improving energy performance

Energy Baseline

The energy baseline requirements are:

- based on the energy review produce an energy baseline against which changes in energy performance can be measured
- record and maintain the baseline

Energy Performance Indicators (EnPI's)

The energy performance indicator requirements are to:

- identify EnPI's for measuring energy performance e.g. kWh/unit area for buildings or kWh/item produced for manufacturing
- record and regularly review the methodology for determining & updating the EnPI's.

Energy Policy

Adoption and documentation of an energy policy by top management is required that includes:

- a commitment to continual improvement in energy performance
- a commitment to ensure the availability of information and of necessary resources to achieve the energy objective and targets
- a commitment to comply with all legal and other requirements that the organisation subscribes to related to energy use, consumption and efficiency
- a framework for reviewing and setting objectives
- supports the purchase of energy efficient products and services and design for energy performance improvement
- is documented and communicated throughout the organisation
- is regularly reviewed and updated.

Management

Top management should appoint a management representative who:

- has responsibility for maintaining and establishing the EnMS
- will report on top management on the performance of the system
- will ensure that the planning of energy management is designed to meet the policy
- will promote awareness of the policy
- will define and communicate responsibilities in order to facilitate effective energy management.

Top management should:

- demonstrate its commitment to support the EnMS
- provide resources needed to implement and maintain the EnMS
- communicate the importance of energy management to those in the organisation
- ensure the EnPI's are appropriate to the organisation
- consider energy performance in long term planning
- ensure that results are measured and reported at determined levels
- conduct management reviews.

For legal and other requirements a legal register should be established relevant to energy use, consumption and efficiency and reviewed at defined intervals in accordance with an agreed procedure.

Energy Objectives, Targets and Action Plans

The following steps should be implemented with respect to energy objectives, targets and action plans:

- objectives and targets should be documented and quantified in a manner that is consistent with the energy policy
- the targets should be consistent with the objectives
- the objectives should consider the legal obligations and significant energy uses and opportunities to improve energy performance
- action plans should include named responsibilities, deadlines and set out what is actually going to happen to meet the objectives
- a statement of the method by which an improvement in energy performance is to be verified should be drawn up
- a statement of the method of verifying the actual results should be developed.

Implementation & Operation

During implementation and operation it is necessary to ensure that the energy review, policy, EnPI's, baseline and objectives are being used in the actual implementation of the system.

Competence, Training & Awareness

The following steps should be implemented with respect to competence, training and awareness:

- identify who needs what training in order to implement the policy and objectives
- ensure those working on in areas related to significant energy use, are competent on the basis of education, training, skills or experience
- maintain records of these competences.

In addition ensure all staff:

- realize the importance of working to the policy
- are clear about their roles in achieving the requirements of the EnMS
- understand the benefits of improved energy performance
- understand how their behaviours can affect energy consumption and how deviation from procedures in the EnMS can effect achievement of the objectives and targets.

Communication

The following steps should be implemented with respect to communication:

- implement a process by which any person working on your behalf can suggest improvements or make comments on the EnMS

- communicate internally regarding the requirements of the EnMS
- make a decision about communicating externally on your energy policy and document how you will do this.

Documentation

With regard to documentation it is necessary to document the scope, boundaries, policy, objectives, targets, action plans and all other documents required by the standard.

For document control it is necessary to:

- approve documents for adequacy prior to use
- regularly review and update them
- indicate changes and revision status
- ensure the relevant versions are available at points of use
- ensure the documents are legible and identifiable.

Operational Control

Ensure all operations and maintenance activities related to significant energy use carried out under specified conditions by:

- setting criteria for operation and maintenance of significant energy uses where there absence could lead to a deviation of policy or objectives
- operating and maintaining facilities, processes and systems in accordance to operational criteria
- communicating the operational controls to those working for and on behalf of the organisation.

Design

During the design process of facilities it is necessary to:

- ensure the energy performance has been considered in the design of new, modified and renovated facilities, equipment, systems and processes that can have a significant impact on energy performance
- ensure that the results of the energy performance evaluation are considered in the specification, design and procurement of the above projects
- ensure the results of the design activity have been recorded.

Procurement

During procurement it is necessary to do the following:

- whilst procuring energy services, products and equipment that can have an impact on significant energy use, inform suppliers that procurement is partly evaluated on the basis of energy performance
- establish procedures & criteria for assessing energy use, consumption and efficiency over the expected lifetime when procuring energy using products, equipment and services, which are expected to have a significant impact on the organisations energy performance
- define and document procurement procedures and specifications.

Monitoring, Measurement & Analysis

Ensure the key characteristics of the organisation’s operations are monitored, measured and analysed wherein the key characteristics should include:

- determination of significant energy use and other outputs of the review
- determination of the relevant variable(s) relating to energy use
- determination of EnPI’s
- determination of the effectiveness of action plans in achieving objectives and targets
- evaluation of expected Vs actual energy consumption
- recording of all the monitored results
- definition and implementation of an energy measurement plan
- regular review of measurement needs and maintenance of all equipment and calibration records and other means to establish accuracy and repeatability
- investigation of and response to significant deviations in energy performance.

Evaluation of Compliance with Legal and Other Requirements

The following steps should be implemented with respect to the evaluation of compliance with legal and other requirements:

- ensure legal compliance evaluations are conducted in accordance to planned intervals and the results are recorded.
- for Internal Audits:

- schedule an audit plan taking into account the importance of processes and areas to be audited
- complete audits
- ensure internal auditors are independent of the process they are auditing
- ensure audit results are recorded and reported to top management.

With regard to nonconformities, correction, corrective action & preventive action:

- ensure actual and potential nonconformities are addressed by making corrections and by taking corrective action and preventive action
- ensure nonconformities and potential nonconformities are reviewed

- ensure nonconformities are reviewed and action needed to prevent them happening again is taken
- ensure appropriate action is determined
- ensure records kept of corrective and preventive actions
- review the effectiveness of corrective and preventive action
- ensure the EnMS is changed as a result of corrective action and preventive action review.

With regard to records:

- ensure all records maintained to demonstrate implementation of the EnMS and energy performance results achieved
- ensure procedures are in place to determine where and how records are kept and by whom.

Management Review

Management should undertake the following steps to review the EnMS:

- ensure top management review the EnMS at planned intervals
- ensure records/minutes are kept
- ensure inputs to the review include; actions from previous meetings, review of policy, review of energy performance and EnPI's, results of legal compliance evaluation, the extent to which objectives and targets have been met, internal audit results, the status of corrective and preventive actions, projected energy performance for the following period, and recommendations for improvement
- ensure outputs from the review include: changes in the energy performance of the organisation, changes in the energy policy, changes to the EnPI's, changes to objectives, targets and other elements of the system consistent with continual improvement, changes to the allocation of resources.

Appendix B. Energy management in Europe: findings from a survey of the current situation

In order to understand more about the state of implementation of energy management in Europe ECI commissioned an investigation into energy management adoption across the EU. This entailed conducting interviews in the six largest EU economies (Germany, UK, France, Italy, Spain and Poland) among 27 companies engaged in intensive or relative energy intensive activities: (mostly: chemical/ pharmaceutical, automotive, metal refineries & foundries and packaging materials but also including companies engaged in malt milling, brewing, LPG gas distribution, and clean air filter systems) The sample distribution is summarised in Table B1 below.

Table B1. Survey sample overview by country and group: n= 27 interviews in total

Country Group	DE	UK	FR	ES	IT	PL	Total
a) unaware	1	2	1		1		5
b) awakening	1	4	2	1	1	2	11
c) engaged		2	1	1			4
d) certified	4	1	1	1			7
Total	6	9	5	3	2	2	27

The respondents were screened and classified into one of four a-priori defined groups as follows:

Group a) "unaware" (only little energy efficiency measures/actions taken)

Group b) "awakening" (ad hoc energy efficiency measures/actions – not systematic)

Group c) "engaged" (energy efficiency measures/actions according to a systematic approach)

Group d) "certified" (ISO 50001 or EN 16001 certified).

The intention was to learn some specific insights per respondent type as indicated in Table B2.

Table B2. Information sought by type of respondent

Group	Information sought
a) unaware	Is the lack awareness regarding EE due to immature management practices or because the (perceived) cost-benefit balance is negative?
b) awakening	What are the motives and the barriers to take energy efficiency one step further into a more systematic approach?
c) engaged	Do they perceive EnMS implementation to have delivered on its promises and what motivation/barrier is there towards certification?
d) certified	Do they perceive EnMS implementation to have delivered on its promises? What advice do they have for new adepts

The recruitment process of companies willing to provide interviews provided some useful insights into the state of energy management adoption across the EU industrial sector.

During the recruitment process, many potential candidates stated when the survey topic was described that they are "*…completely unaware regarding the ISO 50001 requirements and energy* *management systems are not in their priority*…" and declined to participate. It is thus very difficult to encourage companies that might fall into the group a) "unaware" category to engage with a survey of this type. This may be because given the rise in the cost of energy, mainly electricity, prices that all energy intensive companies will need to take actions to control and reduce costs; however, it is just as likely that their low motivation in discussing energy management and ISO 50001 topics is correlated to their lack of activity in the area.

The group b) "awakening" category seems to be predominant in Europe.

Companies falling within the group c) "engaged" category were very difficult to identify except in the automotive sector where they were quite common; otherwise almost all companies implementing an EnMS seem to go straight towards certification. This insight is significant because the number of companies certified under ISO 50001 is available in the public domain as discussed in section X. Automotive companies had a reluctance to discuss their EnMS systems in market surveys; however, a hypothesis regarding why automotive companies are likely to be in the "engaged" group is that they are very keen on going towards integrated management system, all have QM and Env MS in place, and have often developed internal monitoring to control and reduce energy consumption…probably in many cases prior to discussion and development of ISO 50001. However, some potential candidates stated that they have a well-defined energy management system in place which is customized according to their processes, covers benchmarking within their different plants, etc. but is not strictly following the ISO 50001 approach. They do not see a need at present to become certified and spend time and money to adapt and change their EnMS. They also are reluctant to discuss their existing EnMS in detail due to confidentiality concerns in a competitive cost-conscious industry.

There was also some confusion during the screening process because some respondents considered an "energy management system" to be a simple software tool to meter or monitor energy consumption and there was a need to explain that a full EnMS refers to more than this (e.g. documentation, training, management commitment, audits/reviews, etc.). This type of response was quite common for the "awakening" and "engaged" groups.

Group d) "certified" are easy to identify through international directories and listings.

The responses to the survey are now discussed by topic.

Nature of the Energy Management Team

About 60% (n=16) of the companies in our sample had someone formally appointed to fulfil the function of "Energy Manager" or similar, but none within the "unaware" group a), Table B3. Where an energy manager is designated they reports in most cases directly to the General Management or board level. It is mostly only EnMS certified companies that have a dedicated energy manger.

Table B3. Who is responsible for energy management?

Group	Responsible party
a) unaware	mainly the Quality Manager, also Technical/ Production Manager
b) awakening	mainly the Production/Technical/Operations Manager, also HS&E/ Environment Manager, Utilities Manager; some have an Energy Manager
c) engaged	Facility Manager, Maintenance Manager, Process Control, Energy Manager
d) certified	mainly Energy Manager, also Quality Manager

Maintenance and environmental depts. are often involved in energy management issues. The order of frequency of which departments are involved in Energy Management (ranked in order of the frequency they were mentioned) are:

- maintenance dept.
- HS&E/ Environmental manager
- production/ process (planning)
- Technical Manager/ Operation dept. manager
- procurement
- facility manager
- quality management (QM)
- accounting (for cost control)
- logistic dept.

Use of outsourcing

There is only a marginal degree of outsourcing of energy management among the companies in the survey. The majority of companies stated that they do 100% of energy efficiency activities and EnMS work internally and for those that did outsource it was mostly to have audits performed by external auditors. Among those that did outsource the main services used were: external benchmark checks, consultant advice, contractual work/ trials/ special project installation together with external service providers, energy data collection. However, expenditure on outsourcing services was thought to be <5% of total EnMS expenditure for most companies and <10% for the highest.

Overall the impression is that the energy services industry is underutilised and that companies are either do not see the value of bringing in external expertise or are mistrustful of outsourcing energy management activities.

Budget and Expenditure on Energy Management

– no dedicated budget for “energy efficiency”, but allocated into projects

When asked what is the total budget spent on energy efficiency? All companies stated that there is NO dedicated annual budget for “energy efficiency” measures, but rather this is mostly rolled into the maintenance budget or allocated to individual business units/operational areas (e.g. investments in new equipment and/or replacement). Many companies also explained that the business case for “energy efficiency” investment must be approved individually, show payback and compete against other requests. As a result a huge variation in annual expenditure is common.

In general it was not an easy task for respondents to estimate their energy efficiency budget. A wide span was reported of from < € 10.000 € to more than € 1 Million with two common clusters of:

- some in the range of € 10.000 – 30.000
- some in the range of € 100.000 – 200.000.

Purchasing and maintenance behaviour regarding energy efficiency measures for the “unaware” group

Typical responses to questions regarding procurement and maintenance procedures for companies in the “unaware” group are shown in Table B4 by group.

Table B4. Procurement and maintenance procedures

Question	Responses
Is energy efficiency a criterion in the procurement policy of new devices and equipment?	NO – not really explicitly: "we take this as a side effect, when purchasing new machinery, there are all somehow more efficient than the last gen" YES – just meet the regulations: "no, we are looking for equipment lifetime plus consumption, according to current standards"…" costs are key, meeting the latest regulation is good enough, as always improving in efficiency" YES – looking to even exceed the requirements: "if benefits regarding CO^2 and electricity savings justify the higher costs…best option for best payback"
Does your company perform Life Cycle Costing or Net Present Value analysis for major investments?	NO: "no, too much long term oriented…our management is thinking in 1-2 years payback, hence normal investment costs and amortization are key parameters" "would require a complex controlling system" YES: "we take all running costs into account, part of the capex investigation" "easier for post-calculation"
How would you describe the maintenance management of your company? Is it rather CORRECTIVE, PREVENTIVE or PREDICTIVE?	Said to be often a mix, from past focus on CORRECTIVE, to now more PREVENTIVE, towards sometimes PREDICTIVE "was fire fighter in the past, now we are more preventive…regular line tests and maintenance action plans" "corrective and preventive…we have regular inspection cycles and maintenance works and shot downs in place to prevent early worn out" "predictive approach is part of our philosophy and CIP processes" (continuous improvement processes)

Types of Management Systems adopted

Unsurprisingly for a relatively new management standard the evidence suggests that it is less common to be certified to ISO 50001 than older management system standards

When asked what other management systems certifications are in place the responses were:

- ISO 9001 = 93% of interviewed companies certified (n=25)
- ISO 14001 = 81% of interviewed companies certified (n=22)
- ISO 18001 = 41% of interviewed companies certified (n=11)
- others that were mentioned (only sporadically): BRC, TS 16949, IOP, EMAS, ISO22001.

When asked "Which Energy Management Systems are known or considered?":

- all companies in the group d) "certified" answered ISO 50001
- all companies in the group b) "awakening" (except one) said they would consider to go for ISO 50001 in the medium-term
- companies in the c) "engaged" group use internally developed EnMS, probably implemented prior to ISO 50001 discussions. This is prevalent in the automotive sector and is mainly driven by an approach towards an integrated management system, however, these companies do not see a need to go for certification according to ISO 50001 in the near term.

When asked if they were aware of other EnMS standards – only one respondent cited EMAS and none were aware of Superior Energy Performance

Where:

- BRC = British Retail Consortium
- IOP concerns food packaging
- TS 16949 concerns automotive quality
- EMAS = EMAS (Eco-Management and Audit Scheme) and is an environmental management scheme based on EU-Regulation 1221/2009
- ISO 22001concerns food safety.

Barriers to implementation of an EnMS

Responses to the question regarding what the barriers were to the implementation of an EnMS are indicated in Table B5.

Table B5. What barriers are there to the implementation of an EnMS?

Group and Question	Responses
Groups: a) "unaware" and b) "awakening"? Q. What are the main reasons not having implemented a systematic approach and/or EnMS yet?	• #1 (by a large degree) is costs - capex considerations, concerns regarding high investment and long payback period • #2: lack of resources - time and manpower. • #3: other priorities – need to focus on implementing ISO14001 first, focus on energy supply, focus on production process optimisation Other reasons mentioned: • Unawareness of benefits • Lack of top management commitment • No legal requirement • Lack of demand/ pressure from customer base • More bureaucracy, too many audits and standards to fulfil
Groups: c) "engaged" and d) "certified" Q. What was/is the main resistance towards the decision to implement an EnMS?	• #1 are costs and time resources - concerns regarding high investment and long payback period, lack of manpower, extra work for overloaded staff • #2: resistance to change – disrupt running processes, need to change well established internal structures Other reasons mentioned: • Mentality issues with operators ("need to convince them about relevance of EE") • More bureaucracy, documentation, too many audits • Unawareness of benefits • Concerns with compatibility with other MS (safety, environmental) • Lack of top management commitment Main bottleneck universally stated to be the middle management (e.g. head of single production unit) "easier for post-calculation". Energy managers relative new functions/confronting production managers with "25 years in the company"

Drivers for implementation of an EnMS

Responses to the question regarding what the mains drivers were for the implementation of an EnMS are shown in Table B6.

Table B6. What are the main drivers for the implementation of an EnMS?

Question	Responses
What are the main reasons to implement an EnMS?	Main responses: the clear #1 response is cost savings. Directly related are also reasons: reduction of energy consumption, national incentives/or tax penalties (e.g. the EEG in Germany and the CRC in the UK) #2: clever energy planning and monitoring – ability to track and identify energy consumption in all single processes over time #3: green image – lower CO_2 footprint, environmental aspects, prove sustainability Other reasons mentioned: • Marketing and benchmark – differentiation factor and customer demand • Corporate/ HQ strategy • Better calculation of energy capacity and secure energy supply

Energy Management Systems – positive experiences

When companies in groups c) "engaged" and d) "certified" were asked to summarise the company's initial reasons for implementing an EnMS and whether it delivered on its promises, the positive responses were:

- energy planning and monitoring – effective metering, transparency of energy needs in processes and quantification of consumption, allows visualisation of energy flow and consumption
- energy reduction – helps to compare timeline of consumption and to set annual targets for further reduction
- cost savings – shows payback to management and corporate HQ
- raises awareness – commitment about energy and the need to save energy on all levels of the company, helps to motivate staff to support energy efficiency measures.

Energy Management Systems – weaknesses and ongoing challenges

When companies in groups c) "engaged" and d) "certified" were asked to summarise which elements of the EnMS failed or has not yet met initial expectations they answered:

- the payback period is too long (often > 3 years) – difficult to show amortisation, difficult to justify additional costs and investments necessary and get authorisation from top management
- real time monitoring of energy – still not "online" for energy consumption, ideally would have tracking and analysis via internet/ intranet
- identify optimal energy demand – ideally calculate the minimum reasonable energy consumption for each process
- raise awareness – still need efforts to educate (mainly) operators and subcontractors to be more conscious about energy efficiency
- resistance to change existing processes – still struggling to change running production processes towards optimal energy efficiency goals.

Barriers to ISO 50001 certification

When asked what were the main barriers against ISO 50001 certification, the responses were mainly from the group c) "engaged". Their answers as to why they have not pursued further certification despite having an EnMS implemented are summarised as:

- time constraints – other priorities and general overload
- cost of resources vs. unclear benefits – cost for audits and internal preparation don't have authorisation by top management
- efforts for documentation and audits – again time and costs involved
- no positive marketing effect expected – no pull from customer or general public seen at present.

Drivers for ISO 50001 certification

The main reasons for ISO 50001 certification expressed were:

- the clear #1: sustainability image reasons – show responsible and caring business, gives more credibility internally and externally
- corporate/ Group HQ decision – again, part of global image strategy
- incentives/ avoid tax penalties – mainly in Germany and the UK
- trend towards IMS (integrated management system) – easier to concentrate activities, develop documentation, do audits, etc.
- positive Marketing effect – company gets a differentiation factor and competitive advantage, maybe (not yet, but expected) also advantages in supplier ratings and tenders
- compliance with EU Directive – only mentioned by one respondent.

None mentioned easier access to financing, or third-party-funding, etc. as being a reason.

German certified companies mentioned that they must be must be certified after 2015 to get reduced electricity levy (tax refund) for the German EEG (erneuerbare Energien Gesetz) – renewable energy act.

ISO 50001 certification – timing, milestones and hurdles

Group d) "certified" companies were asked the following questions.

How long did the certification process take? Responses:

- certified companies (group d) mostly stated it took between 6 and 12 months. Depending on which elements have been used from previous MS like EN16001 or ISO14001.

What were the major milestones? Responses:

- regular internal or external audits (every 3-6 months) to check on progress, target-actual comparisons.

What hurdles had to be overcome during the certification process? Reponses:

- learning how to integrate EnMS into the company structure and hierarchy
- revision and integration of existing MS
- organisation of the supply chain management
- a sound status-quo analysis of the company situation (i.e. establishing the baseline)
- learning what the external auditors need to issue certification
- learning how to integrate and formulate a new mission into corporate policy (safety, environmental and energy).

Impact of ISO 50001 on the company's supply chain

Group d) "certified" companies were asked "Does the company also require EnMS certification from their partners and suppliers?" Responses:

- not yet required, but might become a decision criteria in some years
- at present, all certified companies stated to look for energy efficient suppliers – however in some cases, mainly for small and medium sized suppliers the proper ISO certification will be difficult to achieve
- energy efficiency behaviour has positive impact on their supplier rating and purchase selection.

"Our suppliers are not yet required to be certified, but in tenders, suppliers that show awareness and efficient energy planning are preferred"

"not necessarily certified but…we want to have only energy efficient subcontractors on our site"

Support, Training and Information material available on Energy Efficiency and EnMS

Companies with an EnMS in place were asked what type of information was most valuable during EnMS adoption. Responses:

- information on legal requirements, changes regarding standards, directives, procedures
- the text of the ISO standard itself and general explanations
- information on energy planning and monitoring
- how to do internal reviews and audits
- seminars of certifier bodies, showing case studies
- how to train internal personal.

Respondents were also asked what type of information is missing, or whether there are any unmet needs. Responses:

- more case studies and real life examples
- references to latest technology in energy efficiency, devices, equipment and references of suppliers
- details on renewables in the context of energy efficiency of industrial sites (wind turbines, biogas, pellets, etc.)
- information on EnMS and ISO 50001 said to be often "too theoretical and academic"…should be more translated into practical action plans
- more guidance on implementing EnMS according to specific industry segments (e.g. chemical processes, automotive, etc.)
- more information on costs – benefits of EnMS…what are costs to run an EnMS, what are real benefits…what is payback period
- information on national/ EU funding and financing programs
- information on the specific role and responsibilities of the energy manager
- information on how to collect and prepare the really necessary data for certification.

Responses to the question: What are the preferred channels for information?

- generally a mix of different channels is already considered and preferred according to level of detail and target person
- general information, specifically via internet, should remain free of charge as part of public domain, however high willingness to pay for premium information IF focused and valuable for specific company situation
- guides/ handbooks/ brochures – general overview on topics, good for first insights and updates on legal issues, standard text requirements, etc.

- internet/ E-learning – fast and easy to access, complete and large variety of sources, good acceptance among office staff, easy to forward and divulgate
- seminars/ workshops internally – more focused on individual company situation, allows to analyse own processes, high credibility
- seminars/ workshops externally – get out of daily routine and focus really 1-2 days on the topics, exchange face-to-face with peers, see case studies and get examples on best practices.

Summary of key findings

Regarding what may motivate companies in the EU to implement an EnMS the following can be noted, by company group type.

For group a) “unaware” companies:

- they have experienced with MS, but their priority is QM/ Environmental – not EnMS
- the cost-benefits are unclear, they would need more guidance on how to assess the implementation and show savings to their management
- there is a lack of resources, time and manpower
- there are a lack of trained personnel to assess the potential of EnMS
- there’s a lack of awareness regarding information and training material.

For group b) “awakening” companies:

- barriers perceived: cost constraints and lack of time
- benefits perceived: positive effect regarding energy planning and monitoring
- potential energy reduction and cost savings, but unclear payback period
- see positive image effect to show commitment regarding sustainability and green image.

For group c) “engaged” companies:

- want effective energy planning and monitoring
- able to benchmark different sites within the group, part of corporate benchmark strategy
- perceive positive cost savings through energy consumption reduction
- however: no need to get certified due to
  - cost and time constraints
  - efforts for documentations and audits
  - no positive marketing effects seen.

For group d) “certified” companies:

- ISO 50001 certification is mainly driven by image reasons, to show commitment on environmental respect and sustainability
- many certified companies are driven by corporate strategies, e.g. HQ in Scandinavia which is even keener on green image, etc.
- specifically in Germany, IS 50001 certification is pushed by national levy on renewables (EEG) and tax rebates
- easy to combine into existing management systems and/or to adapt towards an IMS (integrated management system) to concentrate internal efforts.

Appendix C. Case studies of typical savings potentials from the application of energy management

This appendix presents EM case studies for each of the principal energy end-use sectors (service sectors buildings, light industry and heavy industry) in order to give real word illustrations of the type of impacts that are observed from EM in practice. The cases studies are presented for each of the principal end-uses sectors as set out in the sub-sections below.

EM case studies within commercial and public buildings

CS1 – EM in UK government departments

British Gas has been working with the Home Office to help them meet the UK emissions reduction targets for public buildings. The Home Office is meeting this through an Energy Performance Partnership (EPP), which is an innovative, energy efficiency solution offered by British Gas in partnership with Amey. The EPP consists of three phases:

Phase 1 – Investment Grade Audit

Used to baseline energy consumption and quantify potential savings to develop the commercial model and the metering strategy to support Phase 3 of the project.

Phase 2 – Construction

The installation of equipment, refitting of new technologies, upgrades of existing aged assets and optimisation. This phase can also include employee engagement and staff training programmes.

Phase 3 – Monitoring and savings verification

The measurement and verification of savings using international standards and well as the maintenance of the plant to ensure the savings are maintained.

As a result of the project, the Home Office partnership has already achieved an annual cash saving of £387,000 which has contributed to an overall saving of £1 million across the entire department. The project delivered a 17% reduction in emissions which exceeds the government's average reduction of 14%. Most of the savings come through energy management related measures.

Source: CBI 2013

In a similar initiative the Department of Energy and Climate Change began implementing carbon reduction measures in April 2009 and measuring progress on a monthly basis. The department's Carbon Management Plan, which covers the period 1 April 2010 – 31 March 2015 sets out the department's plans for energy efficiency and emissions reduction over that period. The main focus of this work has been DECC's London headquarters, 3 Whitehall Place, which has been certified to EN ISO 50001.

The focus on this building has resulted in a significant and sustained improvement in energy performance and reduction in greenhouse gas emissions. As a result of the EM programme the building's gas consumption reduced by 87% and its electricity consumption reduced by 39% by April 2012, for a total energy saving of 60%. This is despite a 42% increase in the number of staff in the building rising from 782 FTEs2 in March 2009 to 1108 FTEs in March 2012. This means that annual office energy use per FTE fell from 4520kWh/person in 2008/09 to 1287kWh/person in 2011/12.

Source: DECC https://www.gov.uk/guidance/making-the-department-of-energy-climate-change-sustainable

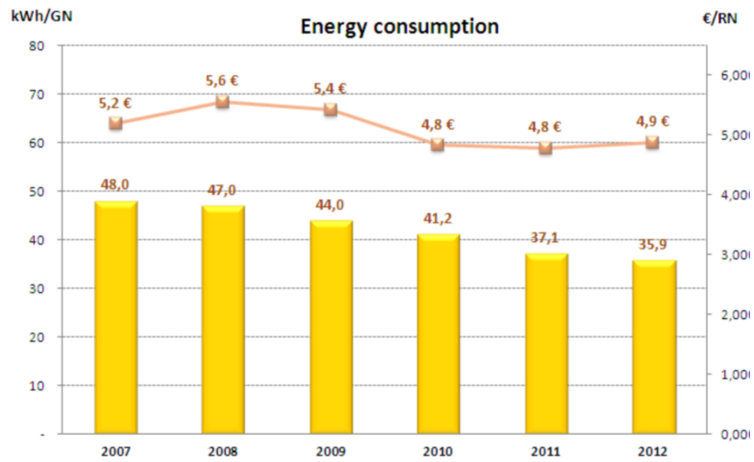
CS2 – NH Hotel's environmental management programme, pan EU

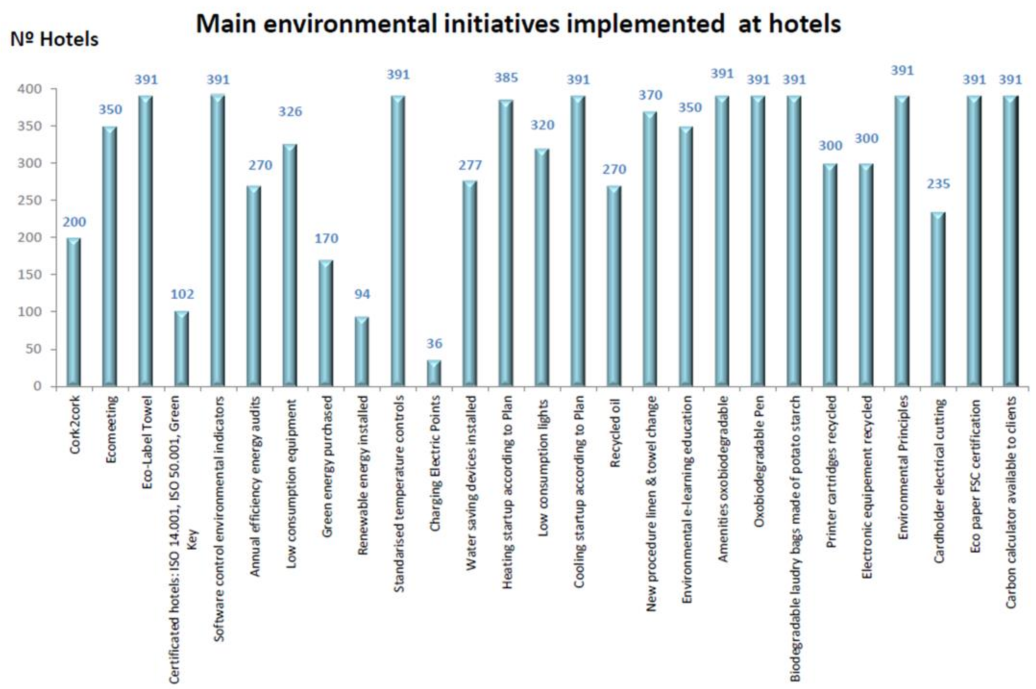
The NH hotels chain implemented an environmental management system in all their hotels across Europe from 2008 to 2012.

The environmental initiatives they implemented focused on:

- sustainability & innovation
- energy efficiency
- operative procedures
- prizes, recognitions & collaborations.

The main energy saving measures implemented included: improved heating and cooling control, better temperature control, energy audits, and EN ISO 50001 certification. Energy consumption across the 400 hotels in the chain declined by 25.2% in the five years to 2012.





Source: JRC - http://iet.jrc.ec.europa.eu/energyefficiency/workshop/energy-audits-and-energy-management-

CS3 – Energy management in Sonae Sierra shopping centres – Pan EU

Sonae Sierra owns 47 shopping centres and manages/leases more than 85 other shopping centres around the world, but mostly in the EU. They began conducting environmental audits in 1997 and environmental management systems in 1999. Energy was identified as having a significant impact on shopping centres and as a result Sonae Sierra conducts energy audits at each of its sites every 5 or 6 years; develops and implements energy consumption minimisation plans in response to the audit recommendations; conducts ongoing monthly energy consumption monitoring and analyses the monitoring results, to evaluate performance against the objectives and targets, and takes appropriate action in response to deviations from expected results whenever necessary. This has led to implementation of the following measures:

- Lighting –Installation of lighting controls in order to properly use daylight; installation of solar reflecting film in glazed areas; lighting refurbishment in parking areas
- HVAC - adjustments in chiller operation; adjustments to free-cooling set-points; adjustments to HVAC condensation pumps operating hours
- For new shopping centres they have adopted standards for lighting and HVAC equipment, glazed areas, energy simulation, automated skylights, electric motor efficiency requirements, HVAC cooling/heat generation efficiency, cooling towers and dry coolers, optimised pumps, pipes and ducts, ventilation fan efficiency, Air Handling Units (AHU's) efficiency, efficient lighting

The outcome is a 35% reduction in energy consumption, expressed in terms of kWh/m^2 of floor area, for their shopping centres from 2002 to 2012.

Source: JRC - http://iet.jrc.ec.europa.eu/energyefficiency/workshop/energy-audits-and-energy-management-systems-under-energy-efficiency-directive-article-8

CS4 –UK supermarket chain shows the benefits of monitoring

Sainsbury's operates over 1,100 supermarkets and convenience stores, each of which requires an intense amount of energy. They use nearly 1% of the UK's energy in total. Sainsbury's aim to be the UK's greenest grocer and have committed, through their 20x20 Sustainability Plan, to reduce absolute operational carbon emissions by 30% by 2020, compared to 2005. To date, they have achieved a 9.1% absolute reduction in electricity since 2007/08, whilst growing space by 25%. This has been achieved by increasing energy efficiency, whilst sourcing more energy from renewable sources. Through the 'reset' project, Sainsbury's improve the efficiency of existing stores through 30 initiatives, including changes to lighting, optimising compressors on refrigeration and installing variable speed drives on fans. These measures alone helped to achieve an average 17% improvement in energy efficiency. Key to this success is closely monitoring performance after the changes to ensure the effectiveness of the work. This also allows Sainsbury's to calculate savings and build a stronger case for future investment.

Source: CBI 2013

EM case studies within light industry and SMEs

CS1 – EN ISO 50001 Certification of Tata Beverages UK

The Tata Group spans seven different sectors, and each subsidiary company operates independently, with its own board of directors and shareholders. The second largest tea company in the world, Tata Global Beverages has a US$1.4bn turnover and 3,000 employees worldwide. With its headquarters in the UK, it has a factory Eaglescliffe on Teesside, as well as plants in India, Russia and the Czech Republic, and joint ventures in the US and Poland. Some 250 million servings of its brands – which include Tetley – are consumed every day around the globe.

Why certification? Tata Global Beverages holds multiple standards, including ISO 9001 (Quality Management), ISO 14001 (Environmental Management), ISO 50001 (Energy Management) and BS OHSAS 18001 (Occupational Health and Safety). With the exception of ISO 9001, which was achieved 20 years ago, Denise Graham, the company's Technical Manager, has overseen accreditation to all of them, and is clear about their purpose: "We don't trumpet our standards – they're not there as a marketing tool; our brand speaks for itself."

She continues, "For us, they're a business tool, there to drive performance; a framework on which to drive and formalize business practices. With the environment, for example – we felt we were doing the right things, but ISO 14001 gave us a clear directional path, a structure." It's also about maintaining best practice, she adds. "The audit processes ensure we're on track and that our policies and procedures are robust." This robust approach has a positive impact on business relationships: "Certification is sometimes required by customers in our industry sector, and they show we are serious about following best practice, not just paying lip service to it. Certification also stands us in good stead with food industry regulators, as we can prove easily that we're meeting – exceeding even – the standards required." Tata's belief in certification as a route to greater business efficiency helps explain why, in addition to ISO 14001, the company sought ISO 50001, which focuses exclusively on energy and requires an ongoing, sustained improvement in energy efficiency and reduction in greenhouse gas emissions. "Whereas ISO 14001 is a generic standard for the environment, ISO 50001 focuses on the cost benefits of using utilities more efficiently. The business case for it is clear."

The strategy has paid off, not least by reducing the company's £750,000 annual energy bill. Denise Graham explains, "ISO 14001 provides a framework for our continued attention to environmental issues – we've just reduced water consumption by 20%, for instance. But ISO 50001 provides a far greater understanding of energy consumption in particular. The assessment required as part of the certification process showed that 96% of the energy used at the factory was electricity. The detailed analysis of that usage enabled us to identify potential cost savings across both the base and variable load."

A series of projects, including fitting intelligence software to compressors to help them work more efficiently, saw the company make overall savings of £56,000 in the first year alone, and an additional £28,000 in the second year. "We may well have made some of those savings without certification, but it focused our minds and helped us to achieve the savings more speedily," says Denise Graham. She adds that the continual drive for improvement is one of the biggest benefits. "ISO 50001 requires new energy initiatives every year. You can't wriggle out of it because of competing business priorities."

Source: BSI 2015

CS2 – Caterpillar UK – savings through an EM system

With worldwide annual sales of almost £38 billion, Caterpillar is the world's leading manufacturer of construction equipment, mining tools, diesel and natural gas engines, industrial gas turbines and diesel-electric locomotives. Serving customers in more than 180 countries their energy requirements are substantial and represent one of their biggest single controllable costs.

When the Caterpillar site in Wolverhampton approached Vickers their annual gas consumption was over 3 million kWh and their energy bills were rising. They needed an energy management system that could run their two buildings more cost effectively, while controlling a combination of direct-fired warm air heaters, radiant tube heaters, indirect-fired warm air heaters, and central heating boilers.

Following a full review of Caterpillar's Wolverhampton operations, Vickers installed a 13-zone Vickers Energy Management System which integrated with Caterpillar's existing equipment. Vickers guaranteed to reduce energy consumption and costs by 20%. Over the first year of operation they more than doubled their estimated savings, delivering a 44% reduction in energy consumption, a cost saving of £35k. This was despite a very prolonged cold period during the winter when Caterpillar expected gas consumption to rise. In addition, carbon emissions were reduced by over 280 tonnes during the year making the facility more 'green' and environmentally friendly.

Wolverhampton is now one of five Caterpillar sites in the UK that use this energy management system.

Source: Vickers 2015 http://www.vickers-energy.co.uk/Caterpillar-Case-Study

CS3 – Energy management at SCA Hygiene Product AG, Germany

In order to continuously exploit energy efficiency potentials, the company SCA Hygiene Products operates a corporate energy saving program called "Key 19 esave". Since its launch in 2003, the company conducted more than 622 energy efficiency measures at its German plants for which no or little investment were needed.

Measures

In addition to pure investment in efficient technologies SCA Hygiene Products has made the increase of energy efficiency an integral part of all daily production operation. The focus of energy efficiency measures was on continuous process improvements through active involvement of all employees - not just a small group of technicians and engineers. Many measures related to cross-cutting technologies such as compressed air and pump systems and heat generation and recovery. A main objective of the "Key 19 esave" program is also to increase awareness and adapt behaviour of all employees and to make it clear to them that every employee is involved in the improvement of energy efficiency.

The company informed its employees on a regular basis by means of cost catalogues on energy costs and their proportion of the total company costs. The aim is to make the employees aware of the cost implications of, for example, a 1.5 mm leak in a compressed air line or of the additional electricity consumption of a paper machine when switching on a special drying module.

A set of staff awareness raising campaigns are used to explain the importance of energy efficiency. For example, on designated "Leak-Seek-Days" the machine will be shut down and all the workers - including the management - search for leaks in order to fix them. The company also offer staff awards for work which contributes the most to energy efficiency optimisation which includes an annual weekend trip to the awards ceremony.

A “Treasure Mapping” procedure is used wherein all energy losses are systematically identified and the savings potentials analysed. The different types of losses, such as electricity, water or time are entered into a map of the facility. As a result, the staff, how high the respective losses are and at what cost they can be resolved.

The technology and process optimisation measures deployed include: optimisation of pump systems, improved insulation of steam lines, use of waste heat from air compressors for the buildings, targeted reduction of energy consumption during machine stops, increasing efficiency in heat generation by flame optimisation and carbon monoxide emission control, process optimisation through, for example, minimisation of the pre-treatment stage, optimisation of setting values, and elimination of a plant (refiner).

Results

The SCA Hygiene Products reduced the energy consumption of its four German plants in Mannheim, Kostheim, Neuss and Witzenhausen from 2003 to 2010 whilst maintain stable production volume to a total of around 220 gigawatt hours per year. Two thirds of the savings were achieved through measures for which little or no investment was required. A total of €35 million was invested in energy efficiency measures which lowered energy costs by €8 million per year for a return on investment of 23 per cent.

Source: Dena http://www.webspecial-energiemanagement.de/index.php?id=133

EM case studies within energy intensive industry

CS1 – Steetley Dolomite UK – overcoming process finance challenges

Steetley Dolomite, with an annual turnover of £35m, is one of the leading producers in the world of dolomitic products which are used in a number of markets including steel, glass, agriculture and asphalt filler. With exports making up 50% of their business and energy accounting for around 40% of total costs, they are focused on how to improve efficiency and remain competitive internationally, especially with government policy adding additional costs. To improve energy efficiency and reduce costs, Steetley Dolomite is investing in a preheater for the rotary kiln. Although this will bring major benefits, they had difficulty raising the £8.5m needed to finance the project. Their previous bank would not provide them with the funds and they then had to delay the investment to shop around for some time before moving to another bank which was willing to put up the loan needed. They also received no support from the Regional Growth Fund which rejected their application with no explanation and had difficulties getting planning permission from Derbyshire Council which was reluctant to help. Now that they have secured funding, the project will become operational this year. It should payback within three years as it will reduce energy use by 30%, saving as much as £2m in energy costs each year. On top of that, the more efficient process will increase output and should add as much as £5m onto annual turnover. Given the substantial benefits, this will allow Steetley Dolomite to compete more favourably internationally.

Source: CBI (2013)

CS2 – Energy management at Wacker Chemie AG, Germany

The WACKER Power Plus project aimed to reduce the specific energy consumption at its Burghausen and Nünchritz sites, which account for over 75% of the groups energy consumption, by ten percent over three years. By the end of 2008 more than thirty energy-intensive production facilities at these sites were examined for their energy efficiency improvement potential and the findings incorporated within the factory energy "Compendium". The Compendium includes: a detailed inventory of energy-consuming processes, checklists and possible measures for saving energy in the processes, and a tool to monitor the effectiveness of the measures based on a set of key EnPI. The project included, among other things, implementation of the following four measures:

Methanolysis - during "methanolysis" methylene chloride (MeCl) is synthesised and then purified. During this process heat is released, which previously could not be recovered because multicomponent mixtures in the boiling state are difficult to control and the reaction mixture is highly corrosive. The introduction of new heat exchangers made from a special material and using a sophisticated operating and safety concept allowed heat to be recovered. In the subsequent MeCl purification step the energy consumption was significantly reduced through the optimisation of process parameters and adaptation of the system configuration.

The Wärmeverbund - A distillation process requires a lot of energy to heat the lower end and provide cooling of the upper end of the column. A new column composite allows the removal of hot product at the top of the first distillation column and uses it to heat the second column. This saves considerable amounts of heating steam and requires less air coolers to be operated.

Use of waste hydrogen - When producing high-purity silicon for solar cells or semiconductors large amounts of high-purity hydrogen is needed. This is fed into the circulating gas system and reused. In order to meet the purity requirements, some of the used hydrogen has to be discharged through the exhaust gas scrubber and replaced by fresh, pure hydrogen. The hydrogen is burned in a boiler to generate steam, thereby reducing the steam production from natural gas.

Expansion of waste incineration - In the waste incineration plant in Burghausen, the last two incinerators of five are now equipped with heat recovery steam generators to reduce the need for steam generation in the natural gas power plant.

Results

A quarter of the developed energy efficiency measures had been implemented by the end of 2008 at a cost of approximately €14 million. This resulted in energy savings worth approximately €10 million per year with a return on capital of approximately 70 percent.

Source: Dena http://www.webspecial-energiemanagement.de/index.php?id=133

CS3 – EM in Du Pont Europe – pan EU

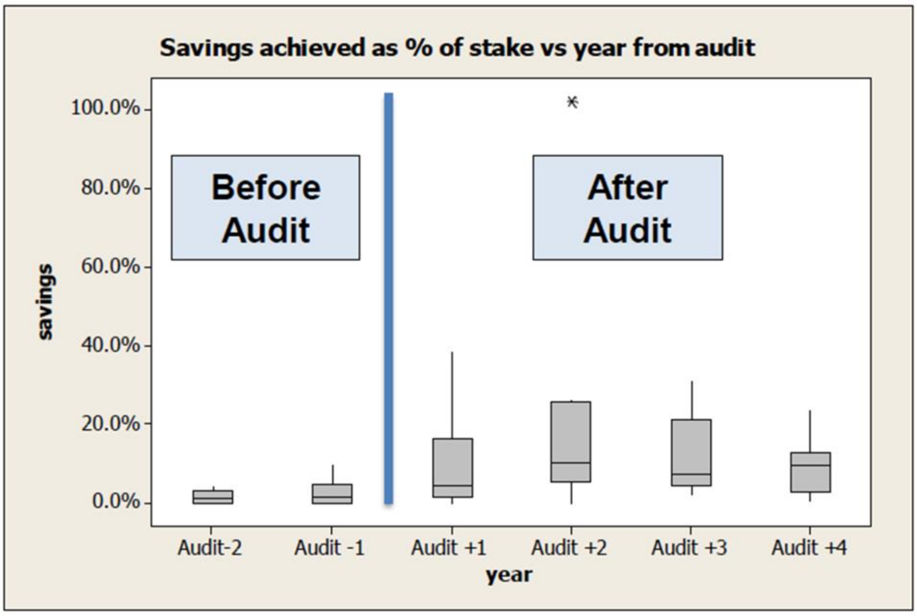
Du Pont's operations in the EU cover 125 sites in 22 countries of which 45 are manufacturing sites and 15 R&D centres. Their annual energy spend is US$230 million. Du Pont's "Bold Energy Plan" involves:

- coordination, coordination at the global, regional and business level
- senior leadership sponsorship
- the commitment to energy savings targets in 26 large sites in the EU
- performance tracking
- establishment of site energy champions and teams.

This is supported by a central Energy Centre of Competency which provides: best practices, tools; training, virtual workshops; energy assessments – technical and management; value accelerators; surveys: steam traps, leaks, insulation; design energy reviews; specialist studies – e.g. pinch, CHP economics; consultancy to help sites scope and implement opportunities; networking.

ISO 9001 and 14001 management systems have been introduced in all sites and EN ISO 50001 at 4 EU sites. Energy Audits are conducted every 4 years at large sites in line with EED minimum requirements, they apply transparent calculations and life cycle costing. As a result some 341 improvement opportunities have been completed in 6 years within the EU.

Du Pont have found that good quality audits add value and that energy saving implementation rates is 3 times greater in the 4 years after the audit compared to the 2 years before. However, poor quality, superficial audits without follow-up support achieve little, damage credibility, and create perception that energy efficiency savings are impractical and insignificant.



Through the implementation of a sustained EM effort they have reduced their energy intensity by 35% from 1990 to 2012.

Source: JRC - http://iet.jrc.ec.europa.eu/energyefficiency/workshop/energy-audits-and-energy-management-systems-under-energy-efficiency-directive-article-8