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AN INTRODUCTION TO ENERGY MANAGEMENT SYSTEMS: ENERGY SAVINGS AND INCREASED INDUSTRIAL PRODUCTIVITY FOR THE IRON AND STEEL SECTOR

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FOREWORD

OECD Steel Committee delegates discussed a draft of this report at the Steel Committee meeting on 12 December 2014. One substantive comment was received and incorporated, and delegates agreed to declassify the report in January 2015. The report will be made available on the Steel Committee website: www.oecd.org/sti/steel.

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AN INTRODUCTION TO ENERGY MANAGEMENT SYSTEMS: ENERGY SAVINGS AND INCREASED INDUSTRIAL PRODUCTIVITY FOR THE IRON AND STEEL SECTOR

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EXECUTIVE SUMMARY

Energy efficiency – which can be defined as using less energy for the same or even increased output – is increasingly being recognised as one of the most important and cost-effective solutions to reduce greenhouse gas (GHG) emissions. Along with the benefits to the environment, successful energy efficiency projects also typically improve a company's overall efficiency, including by increasing productivity and competiveness.

The iron and steel industry is the largest energy consumer of all the industrial sectors, with energy costs representing around 20-25% of the total input costs for steel producers. Lowering these costs has therefore become one of the most important priorities for steel producers (Horvath, 2012).

Industry experience has shown that companies can save around 10-30% of their annual energy consumption and reduce their costs through better energy management, often just by making operational changes (McKane et al., 2007; SEAI, 2013). By using proven best practices, the iron and steel industry can benefit from many of these energy-saving opportunities, often with short paybacks of one to two years or, in some cases, a matter of months.[1]

Implementation of an energy management system (EnMS)[2] is useful to identify energy-saving opportunities and reap long-term benefits. An EnMS involves a systematic process for continually improving energy performance and maximising energy savings. The key success factor, however, is to encourage all staff to manage energy use on an on-going basis.

An EnMS provides a framework for industrial facilities to manage on-going energy use as well as identify opportunities to adopt energy-saving technologies, including those that do not necessarily require capital investment. In addition, the outcome of a successful EnMS is not just a reduction in energy use and cost, but also a multitude of other non-energy efficiency benefits – such as productivity, quality, resource management, decreased liability and asset values. In fact, a recent IEA study has shown that some non-energy-related impacts of improved energy efficiency delivered as much as 2.5 times the value of the energy demand reduction (IEA, 2014b).

Depending on the current level of operational practices, an EnMS also often has the potential to achieve considerable energy savings through operational change alone, rather than through capital-intensive technology changes. However, in companies without a clear energy strategy in place, opportunities for energy efficiency improvement may be known but not promoted or implemented because of a variety of barriers, including senior management commitments, low energy prices, limited knowledge of the topic, limited finances, among others (Worrel, 2011).

Since there are both private (energy cost savings) and public (reduced greenhouse gases) benefits, this is an area in which the design of policy incentives requires careful consideration. Government energy management programmes are crucial in helping companies overcome the more general barriers (typically lack of awareness) to the implementation of an EnMS, and provide guidance and support for the implementation process. Once a company successfully implements an EnMS, the information it provides will in turn help address a variety of the other common barriers to energy efficiency, such as financial viability and the perceived technical risks of energy efficiency projects. Experience has already shown that the market uptake of energy management systems correlates with government-led programmes that stimulate and encourage companies to implement them (Goldberg et al., 2011). Importantly, such programmes, if effectively implemented, can deliver a very cost-effective result for governments.

Practical resources – such as training, technical assistance, benchmarking tools and case studies – have a key role to play in supporting the implementation of an EnMS. Energy management programmes that include such resources can help overcome many of the barriers facing EnMS implementation. They also enable companies to engage effectively with the programme.

Typical government incentives for EnMS implementation might include an exemption from a related policy, such as a carbon or energy tax, technical assistance, or direct financial incentives, such as subsidies for audits or special initiatives. While the economic merits of some of these options (i.e. a tax exemption) is debatable, it must be borne in mind that the provision of such incentives for the implementation of an EnMS are generally designed to be short-lived, after which companies witness first-hand the benefits the EnMS can have on their operational efficiency. While the increased uptake rate of EnMS by companies has been clearly correlated with the provision of appropriate resources by governments during the implementation stage, it is important to note that as companies gain maturity and see the benefits of EnMS and the considerable cost savings they can achieve, additional financial incentives are often no longer necessary (McKane, 2009; Reinaud and Goldberg, 2012).

Following a company's implementation of an EnMS, the resulting information that quantifies and demonstrates the benefits of energy efficiency projects has the potential to encourage the private sector to invest in the identified opportunities, especially those that are more capital intensive. Documenting and quantifying energy use, energy savings and cost savings in accordance with the standardised methodology provided by an EnMS could also help banks to better assess the risks and returns of these projects.

1. Introduction to energy management

Energy efficiency means using less energy for the same or even increased output. It is increasingly being recognised as one of the most important and cost-effective solutions for reducing greenhouse gas (GHG) emissions produced as part of industrial processes, including in the iron and steel sector. In fact, energy efficiency has the technical potential to reduce industrial energy use by about 20% (IEA, 2013). The importance of this potential is made clear when considering that industry today is responsible for 26% of global CO_2 emissions (IEA, 2014a).

Importantly, energy efficiency not only reduces GHG emissions, but it can also improve a company's competitiveness and productivity more generally. Successful energy efficiency projects can also have spill overs, resulting in company-wide improved efficiencies that bring increased value to the company (see Section 2).

In regard to the iron and steel sector, it has been estimated by the IEA that the technical potential exists to reduce energy consumption by approximately 20% (IEA, 2014a). This figure takes into account the considerable improvements that have already been made in recent years in the sector.

The iron and steel industry is the second-largest consumer of energy among all industrial sectors, with energy costs representing around 20-25% of the total input costs for iron and steel producers. Lowering these costs has therefore become one of the most important priorities for steel producers (Horvath, 2012).

However, at times, industry views energy savings as side benefits of other investments, rather than as a key stand-alone method to generate value. Furthermore, real energy efficiency gains are often perceived as only possible through typically high-cost new technology investments.

Industrial energy efficiency is often achieved as much by changing how an industrial site is operated as by installing best-available technologies (BATs). While stand-alone BAT investments are still important in achieving the full potential of energy efficiency, implementing an energy management system is an important first step in identifying and prioritising the full range of energy efficiency opportunities in advance of other major investment decisions related to physical capital. Experience from industry has shown that companies can save up to 10-30% of their annual energy consumption – and thus also similarly reduce their operating costs – through better energy management, with much of it involving operational changes alone (McKane et al., 2007; SEAI, 2013). By applying proven best practices, many of these energy-saving opportunities can also be achieved with short paybacks of one to two years, or in some cases just months (see Section 2).

By implementing an EnMS to improve energy performance, companies also optimise their industrial systems and improve overall monitoring of system efficiencies. Subsequent productivity benefits for companies using an EnMS can also include enhanced production and capacity utilisation, reduced resource use and pollution, and lower operation and maintenance (O&M) costs, all of which result in increased value generation, and thus competitiveness, for the company.

This paper proposes that an EnMS helps companies to maximise their energy savings and productivity, simply by achieving the full cost-effective potential offered by energy efficiency. The paper also explores barriers to EnMS implementation, and they can be supported and promoted by governments.

1.1 What is an energy management system (EnMS)?

An energy management system (EnMS) is a systematic process for continually improving energy performance and maximising energy savings.[3] The principle of an EnMS is to engage and encourage staff at all levels of an organisation to manage energy use on an on-going basis.

An EnMS achieves this for companies in the iron and steel sector by establishing a framework for industrial facilities to manage their on-going energy use and identify opportunities to adopt energy-saving technologies, including those opportunities that do not necessarily require capital investment. An EnMS helps ensure that energy efficiency improvements do not just happen on a one-time basis, but rather are continuously identified and implemented in a process of constant improvement. Experience has shown that even optimised systems lose their initial efficiency gain over time due to personnel and production changes if energy efficiency is not integrated into management practices (Jelic et al., 2010).

An EnMS can be implemented according to either the available ISO 50001 energy management standard or a custom EnMS approach. A key focus of any EnMS, regardless of the approach taken, is that it involves all levels and functions of the company and requires the continuous commitment of top management. This ensures the on-going motivation of employees, which is a key element in the effective functioning of the EnMS framework. As with other recognised management systems (e.g. the ISO 9001 quality standard), an EnMS is incorporated into the same management structures as a company policy or strategic objectives.

An EnMS can also work very well in the iron and steel sector in conjunction with the recently developed ISO 14404[4] standard, the first sectorial document of its kind that provides a calculation method for CO_2 emission intensity from steel plants with blast furnaces. Merging the CO_2 and energy monitoring systems takes into account the emission savings related to energy use reduction. This gives an EnMS an additional value, as the impact of specific measures can be better understood and assessed.

Whether following a customised approach or the ISO 50001 standard, the basic EnMS process is based on the Plan-Do-Check-Act continual improvement framework:

Plan: Conduct an energy review and establish the baseline, benchmark against similar sites, set objectives and targets, develop resources and action plans necessary to deliver results in accordance with the organisation's energy policy.

Do: Implement the action plans.

Check: Monitor and measure processes, review the level of target achievement and the effectiveness of the EnMS against the objective of the energy policy.

Act: Recognise achievements, take action to continually improve energy performance and the EnMS, derive new objectives.

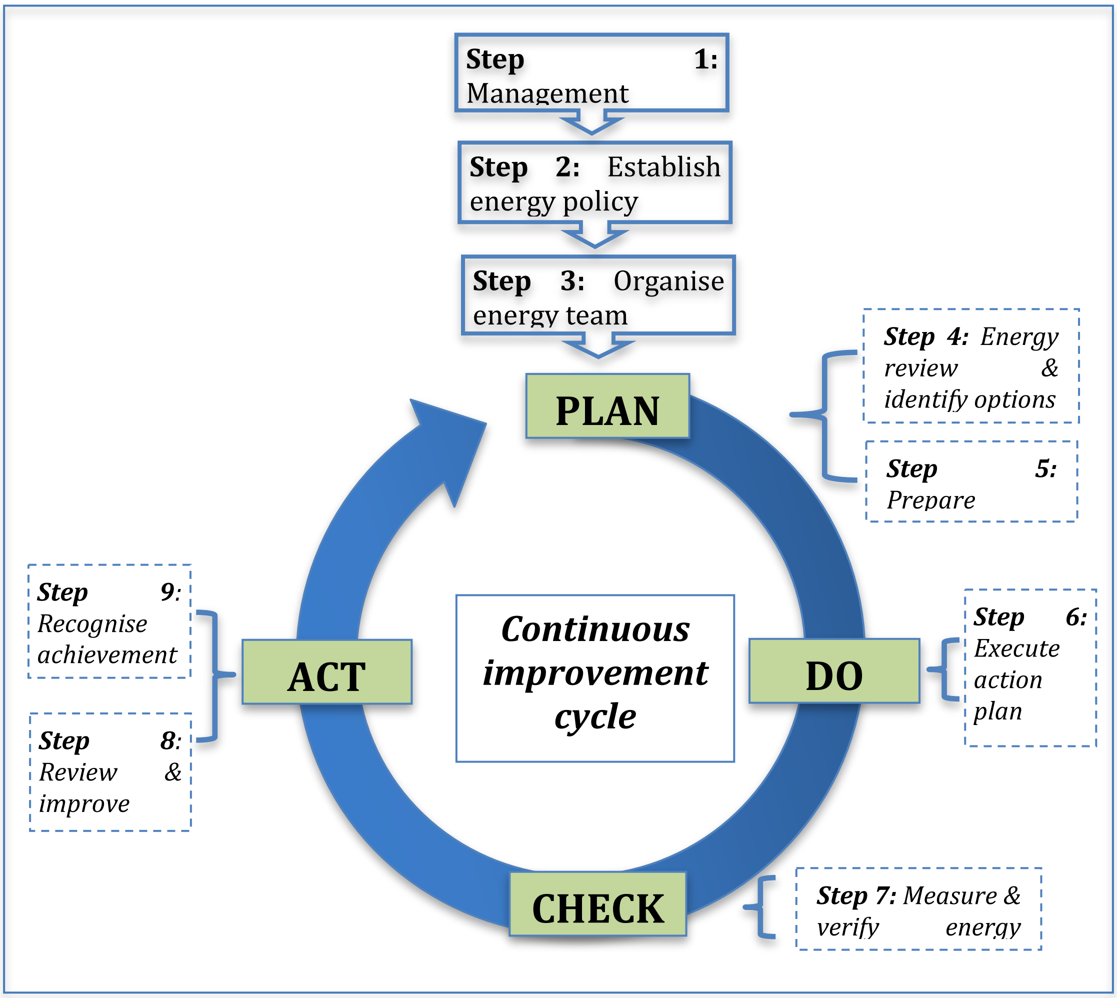
Source: GSEP 2013

This Plan-Do-Check-Act framework provides a procedure for companies to:

- Develop a policy for more efficient use of energy;
- Fix targets and objectives to meet the policy;
- Use data to better understand and make decisions concerning energy use and consumption;
- Measure the results;
- Review the effectiveness of the policy; and
- Continually improve energy management.

Within the Plan-Do-Check-Act framework the successful implementation of an EnMS depends on a sequence of steps to ensure the process of continuous improvement is achieved (see Figure 1 below and Appendix 2). The key steps of the process are senior management commitment (Step 1), and having an accurate baseline of energy use (Step 4). No EnMS will work effectively without the commitment of senior management and energy savings are very difficult to achieve and verify without having an in-depth understanding of the current energy usage on-site.

Figure 1. Illustration of the EnMS Plan-Do-Check-Act framework



There are a variety of detailed EnMS resources (guidelines, software, etc.) publicly available to assist in the implementation of an EnMS in the iron and steel sector – either as a customised process or according to ISO 50001.

1.2 The ISO 50001 – Energy management systems standard

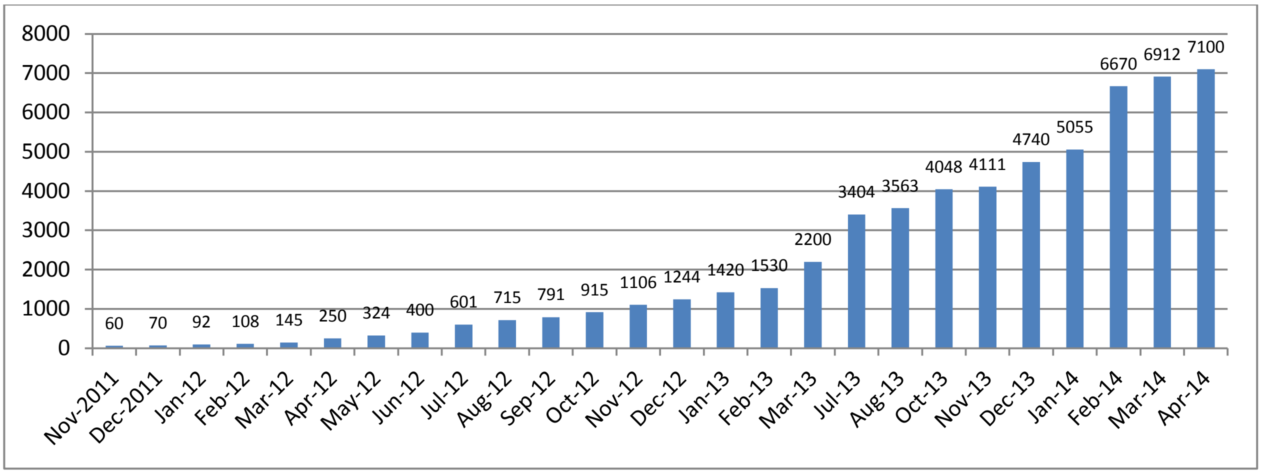
ISO 50001:2011, a voluntary international standard for energy management systems, was developed by the International Organization for Standardization (ISO). The standard was developed to equip organisations with the requirements of an EnMS. It draws on numerous national and regional energy management standards, specifications and regulations, including from China, Denmark, the European Union, Ireland, Japan, Korea, the Netherlands, Sweden, Thailand, and the United States.

The ISO 50001 is a classical management system standard for manufacturing and services, and can be adopted by different organisations of all sizes in both public and private sectors. It was designed in such a way that it can be integrated with other management systems, especially those concerning quality and environmental management, or be implemented individually. As with ISO 9001 (quality management) and ISO 14001 (environmental management), it is based on the Plan-Do-Check-Act framework.

Importantly, the ISO 50001 standard does not fix targets for improving energy performance. Instead this is up to the user organisation or regulatory authorities. This means that any company can implement ISO 50001 in accordance with its own energy policy and establish a continuous energy performance improvement process in line with its capacity and budget resources (ISO, 2011).

Companies that have implemented a standardised EnMS as part of a wider energy management programme have often achieved savings beyond what they would have achieved through self-designed systems. An example of this can be found in Ireland where companies using a standardised EnMS and that are taking part in the government LIEN programme have reported faster energy performance improvement, despite not being new to energy management and having already achieved significant savings over a previous 10-year period without the use of an EnMS standard (IEA/IIP, 2012).

Figure 2. Number of ISO certified sites worldwide



Source: R. Peglau, German Federal Environment Agency.

2. Benefits and costs of an EnMS for the iron and steel sector

The benefits of implementing an EnMS are considerable for the iron and steel sector, whether for the energy or the non-energy-related benefits, since it is an effective means of overcoming the still very prevalent informational, institutional and behavioural barriers to energy efficiency (see Section 3).

Experience shows that within a short timeframe of EnMS implementation, the facility level energy savings can be in the region of 10-15%.[5] In addition, energy savings can also be achieved on an on-going basis following the implementation period, and can nearly double the original savings over time (Therkelsen et al., 2013; SEAI, 2012).

Box 1. Example of energy-only savings through EnMS in the iron and steel sector

According to the World Steel Association (Horvath, 2012), most iron and steel companies that used energy management reduced their average annual direct energy intensity by 0.6-4% per tonne of crude steel, with indirect energy savings reaching a higher level of 5-10%. In addition, average payback periods for these energy-only savings investments were just one to three years.

Implementing an EnMS is a key first step to take when addressing the potential of energy efficiency within a company. However, the outcome of a successfully implemented EnMS is not just a reduction in energy use and cost, but also a multitude of other non-energy efficiency benefits, such as product quality, and reduced maintenance and resource management, leading to greater productivity For example, maintenance costs may decline because better matching of equipment to demand needs results in less cycling of equipment operation, thus reducing wear. Optimisation of resource use can be achieved in such cases as steam system efficiency improvements where excess steam capacity is used for other applications (e.g. cogeneration).

Such additional direct non-energy benefits – otherwise known as multiple benefits – have recently been the focus of an extensive study by the International Energy Agency (IEA). The study has shown that the scale of the multiple benefits can be substantial – the value of the productivity and operational benefits derived from strategic energy efficiency measures can be up to 2.5 times the value of energy savings, depending on the value and context of the investment.

Box 2. How a multiple benefits approach in a cost-benefit analysis can apply to the iron and steel industry

Electric arc furnaces are used to melt scrap to produce steel in many countries. To improve energy efficiency for this process, furnace off-gases can be re-used to preheat scrap. After many years of development, various successful scrap-preheating systems are now used around the world, making almost 100% scrap preheating possible and leading to potential energy savings of 100-120 kWh/t compared to typical power usage of 450-550 kWh/t steel. Nonetheless, despite the high energy savings, low power prices can limit the uptake of this energy efficiency measure.

However, this measure has other benefits too: it can reduce electrode consumption, improve product yield improvement by 0.25-2%, increase productivity by up to 20% and reduce flue gas dust emissions by 25% (reducing hazardous waste handling costs). The production costs savings alone, excluding saved electricity costs, amount to USD 5/tonne. Incorporating these additional productivity benefits in the cost-benefit analysis makes scrap preheating an interesting energy efficiency measure with relatively small payback periods, even when electricity prices are relatively low.

These benefits have to be weighed against the costs of implementing energy efficiency measures. As discussed later in this paper, implementing an energy management system incurs both setup and on-going costs, and these costs can vary considerably across countries depending on the current energy efficiency requirements already in place for industry. The costs of implementing an energy management system are usually associated with company staff time, data collection, external experts, monitoring equipment, training, and third-party 50001 certification. In cases where product quality are affected, this must also be taken into account.

Source: Worrel (2011), Barriers to energy efficiency: International case studies on successful barrier removal. www.unido.org/en/resources/publications/energy-and-environment/industrial-energy-efficiency.html.

An added dimension of an EnMS is that it considers all energy use for a facility, even the energy used for non-core activities such as lighting, building envelope performance and general heating. Very often, the considerable potential energy and cost savings to be achieved in these areas are not taken into consideration, as they are not related to the core processes of a facility.

The benefits that an EnMS can bring to companies in the iron and steel sector can also often be increased by employing energy performance or best practice benchmarking mechanisms. Such mechanisms enable companies to compare processes and operations, and their respective energy intensity, internally, externally with similar sites or even just with what is theoretically or technically feasible, in terms of sectorial best-in-class practices or technologies. Such benchmarking tools can thereby assist companies in identifying viable and proven energy efficiency opportunities, setting energy targets and establishing performance monitoring within their EnMS.

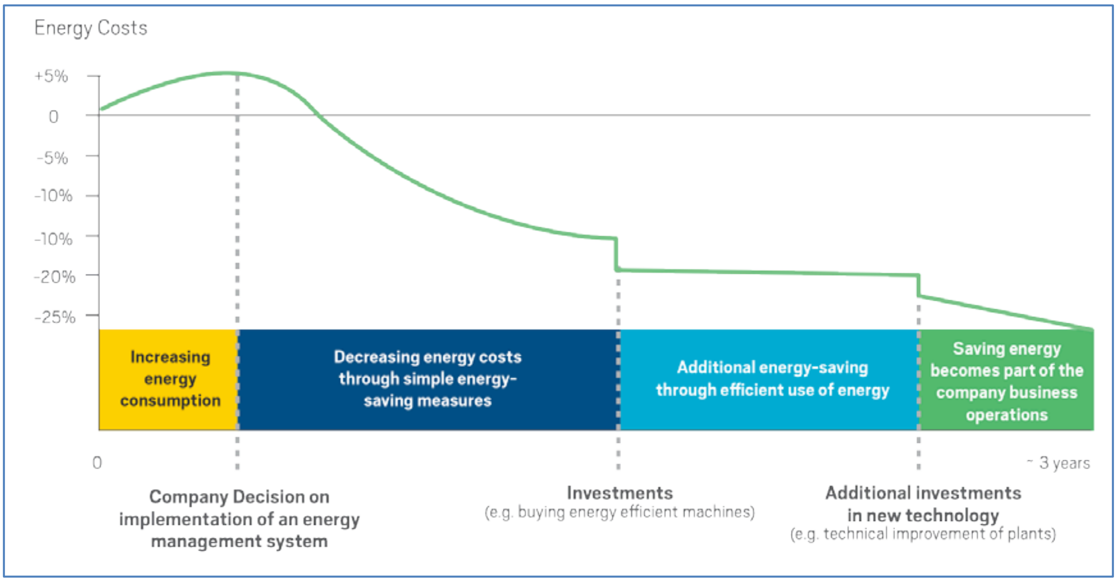
On-going experience from the iron and steel sector and other similarly energy-intensive sectors has consistently proven the high financial and productivity advantages of implementing an EnMS (McKane et al., 2007; IEA, 2014b). To demonstrate these advantages further, the following sections include information on how an EnMS provides energy-saving opportunities within low-cost operational changes. A number of EnMS case studies describing successful short payback projects relevant to the iron and steel sector are also provided.

2.1 EnMS and the benefits of operational changes

An EnMS allows companies to systematically track, analyse, and plan their energy use, thereby enabling greater control of energy performance as well as operational performance. Depending on the operating practices of an iron and steel producing facility, there is often considerable potential for energy savings from making operational changes alone, rather than the typically capital-intensive technology changes. Where operating and maintenance practices are close to best practice, an EnMS is still a strategic tool that can better inform investment decisions in BATs.

Considering Figure 3 below, one can understand how the initial implementation of an EnMS can lead to considerable energy savings – first through low-cost measures that focus mainly on improving current processes and then through typically higher-cost technology changes.

Figure 3. Illustration of continuous cost reduction with EnMS



Source: Clean Energy Ministerial (2013), adapted from Kahlenborn et al. (2012).

Some examples of key operational benefits that can reduce the energy intensity, and therefore the cost per tonne of product for companies within the iron and steel sector following the implementation of an EnMS, are as follows (Hovarth, 2012):

- Optimisation of the purchase and consumption of all fuel types and energy inputs;
- Helping plant operators in the iron and steel industry to monitor and optimise their energy flows;
- Enabling detection of avoidable energy losses (gases, electricity, steam, carbon, among others);
- Effective use of waste heat and gas recycling;
- Early detection of leaks (e.g., air and heat);
- Generating consumption forecasts and minimising peak loads; and
- Improving monitoring of surplus heat, electricity and gas streams to help generate value through export to grids and local users.

An example of the benefits of improved monitoring is the real-time monitoring of off-gas in an electric arc furnace (EAF), allowing a 50% increase on the recovery rate of chemical energy due to post-combustion control (Januard et al., 2006).

2.2 The cost of implementing an EnMS

The cost of implementing an EnMS should be considered differently from those costs related to investing in an energy efficiency capital project. Implementing an EnMS as a new internal process in a company incurs both setup and on-going costs, which are then typically paid back through the operational energy savings identified through the EnMS. The cost of investment in an energy efficiency capital project is paid back through the energy savings achieved as a direct result of its implementation. However, the two measures are closely related and complementary. For example an EnMS may identify an investment project with positive returns.

Experience has shown that energy efficiency projects requiring capital investment can often have payback periods of less than two years, with longer payback periods of up to three or four years only typically being relevant for some specific long-term equipment investments (McKane et al., 2007; Therkelsen et al., 2013; US DOE IACs). Further details of these typical payback periods for specified capital project investment costs are given in Section 2.3.

The cost of implementing EnMS can vary considerably from country to country depending on the current energy efficiency requirements already in place for industry and also whether or not 3rd party certification is involved. Typically EnMS implementation costs are internal company costs, consisting mainly of staff time and data collection costs. Additional costs can consist of external experts, monitoring equipment, training and 3rd party ISO 50001 certification.

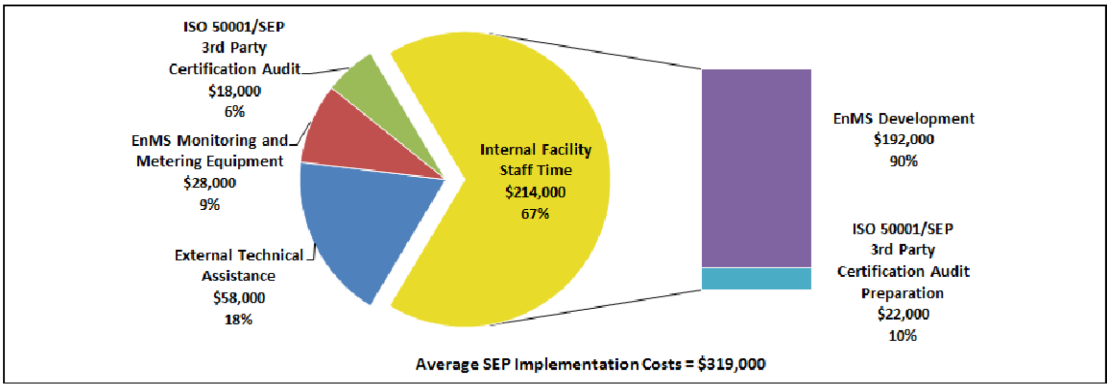
The cost-benefit analysis for U.S. Superior Energy Performance (SEP) certification programme (Therkelsen et al., 2013) provides a good example of the costs for a comprehensive EnMS implementation. The SEP certification provides recognition (Silver, Gold or Platinum levels) to industrial facilities for implementing an EnMS based on the ISO 50001 standard and achievement of established energy performance improvement targets.

The cost-benefit analysis was carried out on nine U.S. facilities that operate in different industrial sectors and was based on the specific costs related to the implementation of an EnMS and the benefits related to operational energy savings only.

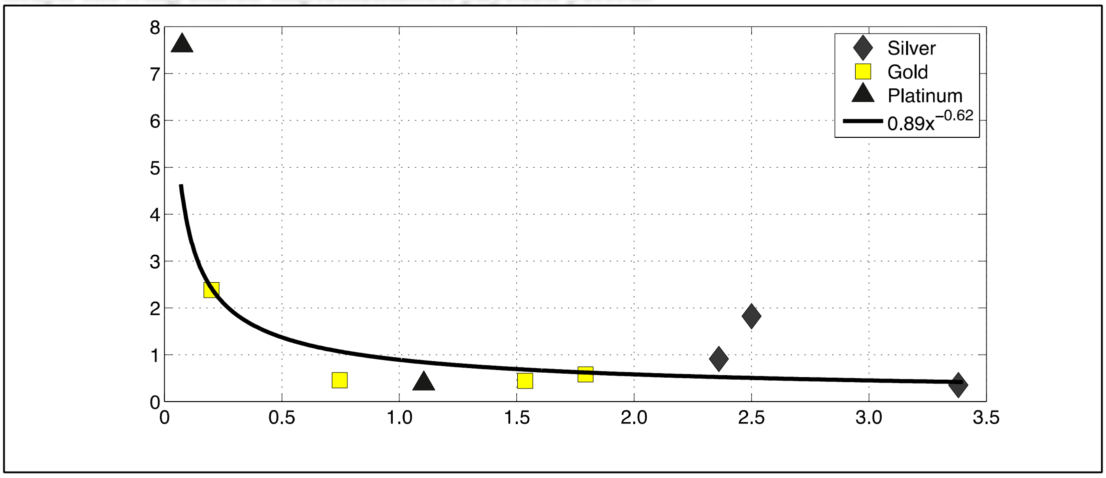
The costs for the nine facilities to develop, implement, and certify an EnMS to ISO 50001 and the SEP programme was an average of USD 319 000, with facilities having smaller baseline energy consumptions tending to have lower implementation costs. Payback rates for implementing the EnMS were found to be less than two years for facilities with a baseline energy consumption greater than 0.27 TBtu[6] (See Figure 4 below).

Figure 4. SEP programme EnMS implementation costs and payback periods

Graph showing breakdown of EnMS implementation costs



Graph showing EnMS implementation payback periods



Source: Therkelsen et al., 2013.

2.3 EnMS case studies from the iron and steel sector

Across industry sectors, the evidence repeatedly points to the commercial viability of implementing an EnMS. The following case studies are a representative sample of the savings an EnMS can bring to companies of all sizes in the iron and steel sector. Further EnMS case studies, including those from other industrial sectors, are available through the GSEP Practitioners Toolbox project (see Section 4.1.2).

CASE STUDY 1: ArcelorMittal Saldanha Works

In 2010, as part of its internal World Class Manufacturing Programme, ArcelorMittal engaged with the UNIDO Industrial Energy Efficiency Project. This UNIDO project supported the introduction of an EnMS and energy system optimisation measures (as per the ISO 50001 standard) at its Saldanha Works in South Africa, which produces hot rolled coil.

By adopting an EnMS, ArcelorMittal saved around **USD 13.5 million in 2011** *with a capital* **investment of just USD 70 500**. *This equated to a 5.3% reduction in average energy demand (compared with 2010 baseline values). The company was able to* **offset its investment in less than four production days**. *In addition, even if no further investment to improve energy efficiency was undertaken and assuming that all assumptions were kept constant within the plant, the savings realised in 2011 will account for about USD 51 million by 2016 (five years after the first investment).*

The 12 measures undertaken to achieve these savings included simple operational changes, such as switching off post-combustion cooling radial fans when not in use, increasing the temperature of the cooling water system in the melt shop and switching off burners at ladle stations when not required, amongst other similar measures.

Note: Monetary values based on ZAR to USD exchange rate of 0.1409 (August 2011).
Source: UNIDO Industrial Energy Efficiency Project.
www.iee.csir.co.za/wp-content/uploads/2013/08/AM-Suldanah-Works-case-study-July-2013.pdf.

CASE STUDY 2: United States Department of Energy's Industrial Assessment Centers (IAC)

The US Department of Energy's Industrial Assessment Centers (IAC) programme has carried out over 16 000 assessments at U.S. SME facilities that have an annual energy spend of between USD 100 000 to 500 000. An example of the types of savings identified for the iron and steel sector on the basis of simple and often very low-cost measures is given below.

Example energy efficiency measures identified by IAC for iron and steel facilities

Description	*Savings (USD)*	*Cost (USD)*	*Payback (yrs)*
Recycling casting sand	*437,377*	*71,170*	*0.2*
Turning off equipment when not in use	*108,914*	*25,000*	*0.2*
Using adjustable frequency drive to replace motor-generator set	*103,515*	*150,000*	*1.4*
Reducing the pressure of compressed air to the minimum required	*173,190*	*46,250*	*0.3*
Using waste heat from hot flue gases to preheat combustion air	*225,013*	*57,159*	*0.2*

Source: U.S. DOE Industrial Assessment Centers (IACs) Database.
http://iac.rutgers.edu/database/

CASE STUDY 3: US Steel's Minntac Plant

As part of the US DOE Save Energy Now programme, the Minntac taconite pellet manufacturing facility upgraded the burners in a kiln serving an important process line. As a result, it achieved annual cost and energy savings of USD 760 000 and 95 000 MMBtu respectively. Further, the assessment team established that, with the new burners, nitric oxide emissions from that kiln were 6% lower. Unscheduled production shutdowns due to the burner system were also greatly reduced and the amount of time needed to clean the slag inside the kiln was reduced by two-thirds, saving approximately USD 30 000 in annual maintenance labour costs. With project costs of approximately USD 1.2 million, the plant achieved a simple payback of 1.5 years.

Additional, longer-term energy-saving opportunities were identified that, if implemented, would result in an estimated total annual energy cost savings of USD 10 million, including:

- **Insulate process components:** *By fully insulating all lines, wall losses could be reduced by about 50%, yielding annual natural gas savings of USD 1.6 million/yr.*
- **Reduce infiltration***: By eliminating air that leaks into the kilns, the plant could achieve natural gas cost savings of about USD 950 000/yr.*
- **Use fans with higher horsepower***: Installing more powerful draft fans would increase the kilns' convective heat transfer coefficient, yielding natural gas savings of USD 709 000/yr.*
- **Eliminate leaks on process lines***: By fixing leaks, it was estimated that the plant could achieve natural gas savings of USD 350 000 per year.*
- **Recover waste heat from pellet coolers:** *By installing absorption chillers, the plant could recover this waste heat and use it for space heating and cooling. If only 10% of this waste heat was recovered for the winter months, the plant would save about USD 1.1 million/yr.*
- **Recover waste heat from water used to cool bearings:** *Recovering waste heat from the cooling water was estimated to save USD 893 000/yr.*
- **Recover waste heat from drying and pre-heating processes:** *If the plant recovered the waste heat from this source, it would save more than USD 24 000/yr.*
- **Install recuperator:** *By installing a recuperator to preheat combustion air, the plant would achieve annual energy savings of approximately USD 1.8 million/yr.*

Source: US Department of Energy, Industrial Technologies Program.
www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/42858.pdf

3. Barriers to implementing energy efficiency, and in turn EnMS

This paper has discussed many important benefits associated with the implementation of energy management systems, and reviewed cases in which the financial benefits outweighed associated costs. An important question is then why government incentives are required to encourage their implementation – why do firms not systematically identify such benefits in the absence of government incentives.

This discussion relates to the long-standing debates about the Porter Hypothesis, and the notion that environmental policies lead to innovations that more than offset compliance costs and result in net benefits for firms. Oates et al. (1995) note that, in a perfectly competitive economy, companies should identify opportunities to reduce costs and inefficiencies by themselves without the need for government intervention. Significant literature has emerged to examine this question empirically (see Ambec et. al 2013 for a review). For example, Lanoie et al. (2011) employed a database developed by the OECD and containing observations from several thousand facilities in seven countries and found that, although environmental regulations do stimulate certain kinds of environmental innovations, such innovations only partially offset the costs of complying with environmental policies.

However, as noted above it is important to distinguish between measures whose benefits are largely public goods, and those which have a strong private benefit component. Energy efficiency clearly falls into the latter category, and so understanding why such measures are not implemented requires careful analysis. The first thing to note is that there is significant variation in management quality across firms, even within relatively narrowly-defined sectors within individual countries (see Bloom and Van Reenen 2010 for a discussion.) This has important implications for the capacity of different firms to identify and exploit opportunities which increase productivity and profitability. This is as likely to be the case in the iron and steel sector as elsewhere.

Focussing on the case of energy-saving strategies, there may be problems of information management. Quite simply, the data collection processes necessary to identify such opportunities may not be in place. In other cases, they may be in place but those employees having access to relevant information on potential opportunities are not able to communicate such information to those with management responsibility for taking the necessary decisions.

In other cases, opportunities for energy efficiency improvement may be known but not promoted or implemented because of a variety of barriers, even when energy is a significant cost. For example, there may be cases in which split responsibilities and capital allocation mechanisms within the firm discourage such investments. If the benefits associated with a given measure are located in one cost centre, while the costs are borne in another one, then sub-optimal decisions will be taken.

Other barriers typically include behavioural, technical and organisational obstacles, all of which prevent companies from undertaking energy efficiency investments and actions. An interesting point to note is that an EnMS is a process that helps overcome many of these barriers to energy efficiency. On the other hand, these very same barriers also affect the uptake of EnMS.

Overcoming such barriers as organisational obstacles and a lack of general awareness of energy efficiency and its benefits is often important for government energy management programmes (see Section 4). However, other barriers such as the financial viability of energy efficiency and perceived technical risks are also often addressed through the subsequent implementation of an EnMS itself. An EnMS helps companies to better understand their energy use and, in turn, assess the risks and financial viability of relevant energy efficiency measures as it enables the documentation and quantification of energy use and associated potential energy savings.

Examples of the various barriers to adopting energy management measures are detailed as follows (see IEA/IIP, 2012; Worrel, 2011):

- **Organisational barriers** – and, in particular, a general lack of support from senior management – play a key role in slowing the adoption of energy efficiency measures. Often energy efficiency is only seen as an operating expense for which budgets are limited and companies instead focus on their core activity, such as production expansion or improvement.
- **A limited knowledge of energy efficiency,** as companies often have no readily available access to information about new and existing energy-saving methodologies technologies.
- **Perceived technical and operational risks** associated with the implementation of energy efficient practices, due to unfamiliarity with energy-reducing technologies and practices relative to core business projects.
- **Low or subsidised energy prices** in some regions, meaning companies may not pay the full cost of their energy use and have less incentive to reduce consumption.

- **Poor understanding of how to create support** for an energy efficiency project, due to the perceived professional and functional boundaries within the organisation. For example, staff responsible for handling a company's energy bills are different from staff procuring energy-using equipment, and those maintaining the equipment.
- **Limited finances,** due to the lack of familiarity with energy efficiency measures, may make companies hesitant about investing in projects that do not have a primary focus on increasing production capacity and revenue. Typically, companies would associate capital investment with company growth and not link this with energy efficiency projects.
- **The perceived complexity of EnMS implementation**, especially where it may also require the installation of hardware (e.g., instrumentation to measure energy and emission streams). This can particularly be the case for SMEs.

A number of driving forces typically direct decision-makers within large industrial companies. The common drivers that senior management takes into account when making new investments or pursuing new business opportunities (whether for energy and/or productivity efficiency reasons) include the following (Reinaud and Goldberg, 2011):

- The **financial** imperatives of a company;
- The **policy obligations** placed on the company to achieve environmental compliance;
- The **knowledge** of energy-savings opportunities within the company;
- The **commitment** of the company to the environment and to energy efficiency; and
- The **demands of the public and market** to improve the company's environmental or energy performance.

An effective approach for stimulating the involvement and commitment of senior management towards implementing an EnMS includes the development of a package of policies or an overarching energy management programme that addresses the above range of drivers, applicable to the sector and country.

4. Government programmes to support EnMS

Government policies, in the form of specifically designed energy management programmes, are an important means of encouraging the use of an EnMS. The main benefit of such government energy management programmes is that they help companies overcome barriers to the implementation of an EnMS, and provide guidance and support for the implementation process. Once a company successfully implements an EnMS it will in turn help address a variety of the other common barriers to energy efficiency, such as financial viability and the perceived technical risk of energy efficiency projects, as described in the previous section.

Taking a very simplified perspective, government programmes can be seen as the necessary initiator to overcome the often sceptical attitude towards energy efficiency, while, once implemented, EnMS can then be seen as the facilitator of information that can help overcome the financial and technical barriers to energy efficiency projects.

For example, government programmes that employ simple initiatives to help companies measure their baseline energy use and emissions, and provide subsequent guidance for identifying opportunities can considerably help reduce important barriers related to lack of information and technical expertise. In addition, providing benchmarking tools that enable companies to compare energy performance and best practices internally within their organisation or externally with other similar sites can help the company set their own energy saving targets. Providing companies with such information and guidance is a key first step to achieving implementation of an EnMS.

Experience has already shown that the market uptake of EnMS is correlated with government-led programmes that stimulate and encourage companies to apply the EnMS (Goldberg et al., 2011). Such energy management programmes typically include a package of policies and initiatives, including voluntary schemes or negotiated agreements that encourage reduction of energy use and/or greenhouse gas emissions. Additional government support is also often included within such programmes and can cover such areas as financial incentives, reward programmes, access to guidance information, and technical tools (Mey, 2011). Inclusion of this type of additional support, especially in the case of financial incentives, depends very much on the particular needs of industry and the barriers applicable to them. Unnecessary support, such as when financial incentives might be made available to companies requiring instead only technical assistance, can lead to abuse of a government programme instead of achieving its real target of creating self-motivated interest in EnMS.

Importantly, such programmes, if effectively implemented, can deliver a very cost-effective result for governments. For example, for each euro of taxpayer money spent in the Large Industry Energy Network programme in Ireland, an average energy savings benefit of EUR 12 was attained in the productive business sector (SEAI, 2011).

Table 1. Examples of government programmes that promote EnMS

Economy	Programme name	EnMS type	Voluntary/Mandatory	Certification	Drivers
China	*Top 10,000 Enterprise Program*	*GB 23331*	*M*	*Voluntary*	*Mandatory*
Denmark	*Agreement on Industrial Energy Efficiency (DAIEE)*	*ISO 50001*	*V*	*Yes*	*Tax rebate*
Ireland	*Energy Agreements Program*	*ISO 50001*	*V*	*Yes*	*Extensive technical support*
Korea	*GHG and Energy Target Management Scheme*	*ISO 50001*	*M*	*Yes*	*Mandatory*
Sweden	*Energy Efficiency in Energy Intensive Industries (PFE)*	*ISO 50001*	*V*	*Yes*	*Tax rebate*
United States	*Superior Energy Performance*	*ISO 50001*	*V*	*Voluntary*	*Awards, possible tax rebate*

Source: Clean Energy Ministerial (2013).

Evidence has shown that, when taking into account regulatory and cultural history in a specific country, a comprehensive effort by government to drive and support EnMS implementation can considerably enhance the rate of energy efficiency improvement (Jelic et al. 2010, Reinaud & Goldberg, 2012). More information about some of the programmes listed in Table 1 is provided below to illustrate this.

European Energy Efficiency Directive[7]

The 2012 Energy Efficiency Directive (EED) for the European Union member states establishes a set of binding measures covering all sectors to help the EU reach its 20% energy efficiency target by 2020 and pave the way for further energy efficiency improvements beyond 2020. Specifically for the industry sector, the Directive requires that all large enterprises (having more than 250 employees and an annual turnover exceeding EUR 50 million or a balance sheet exceeding EUR 43 million) must carry out an energy audit every four years. However, enterprises implementing an energy or environmental management system certified according to European or international standards, such as ISO 50001, are exempted from this requirement if equivalence is demonstrated.

Since 5 June 2014, the EED also requires that steelmakers planning new industrial installations or refurbishing their existing industrial installations (a total thermal input >20MW) that generate waste heat at a useful temperature level carry out a cost-benefit analysis to assess the option of introducing co-generation in heating and connecting to a district heating or cooling network.

China's Top 10,000 Enterprise Programme[8]

The Top 10 000 Programme is targeted at improving energy management in key-energy consuming companies (those that consume more than 10 000 tons of coal equivalent (tce)/yr), according to China's Energy Conservation Law. The programme follows on from the Top 1 000 Energy-Consuming Enterprises Programme, which targeted the largest 1 000 enterprises in China and which successfully achieved and surpassed its energy-saving target of 100 Mtce with reported savings of over 150 Mtce in five years.

Some key elements of the Top 10 000 Programme are:

- Conducting energy audits and developing energy conservation plans, based on the Technical Principle of Energy Audits in Enterprises (GB/T 17166).
- Conducting energy efficiency benchmarking.
- Establishment of energy management systems, following China's energy management standard (GB/T 23331).

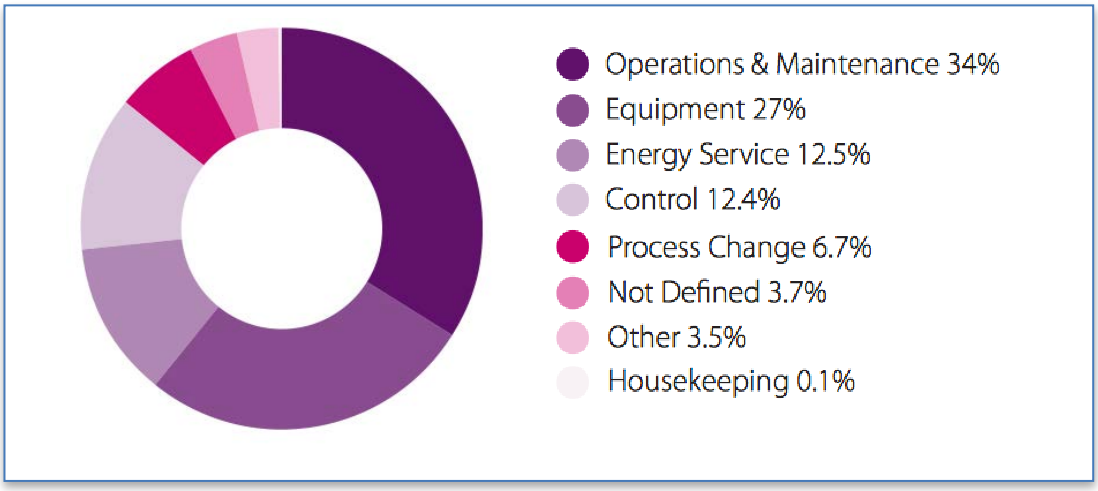
The target of the Top 10 000 Programme is an absolute energy-saving target of 250 Mtce by 2015, equivalent to 37% of the total energy-saving target (670 Mtce, assuming GDP growth of 8.5% per year).

Ireland's Large Industry Energy Network (LIEN)

In Ireland, the government's LIEN programme focuses on driving EnMS implementation within large energy-intensive industries. Between 1995 and 2012, the programme's membership grew to 162 companies that collectively represented over 17% of the country's total primary energy requirement. On average over the last five years, LIEN has achieved approximately 2% year-on-year energy performance improvements for its members. Further, since its inception, the LIEN and the founding member companies have achieved, on average, energy savings of around 28%.

A key outcome of the LIEN has been the demonstration that the majority of a company's energy savings can come from operational changes alone rather than from capital-intensive equipment-related projects.

Figure 5. Categorisation of LIEN energy-saving projects



Note: In addition, the LIEN programme identified that EnMS was a consistent driver for companies to invest in energy efficiency measures. By 2012, EnMS was found to be the driver of over 72% of the energy efficiency projects undertaken by LIEN companies.

Source: Sustainable Energy Authority of Ireland (2013), LIEN Annual Report 2012.

The U.S. experience with operational benefits – Superior Energy Performance (SEP)

Since 2007, the United States Superior Energy Performance (SEP) programme has been certifying industrial facilities that implement an energy management system according to the ISO 50001 global energy management system standard and achieve improved energy performance (Therkelsen et al., 2013). A facility qualifies for recognition at a Silver, Gold, or Platinum level, based on its performance. To date, the programme's participants have demonstrated an average 10% reduction in energy costs within 18 months of SEP implementation, and annual savings of USD 87 000-984 000 using no-cost or low-cost operational measures. In general, the payback period is 1-2 years for energy efficiency projects identified through the EnMS.

The majority of energy and energy cost savings (74%) identified as a result of the programme can be attributed to operational energy performance improvement actions alone. In fact, three facilities have, notably, achieved average energy savings of 9.2% by only implementing operational changes.

In addition, the split between energy savings due to capital and operational energy performance actions changed following facility participation in the SEP programme. Prior to SEP participation, the average split between capital/operational projects was 36/64, which shifted to 26/74 after EnMS implementation (Therkelsen et al., 2013).

4.1 Designing an effective energy management programme

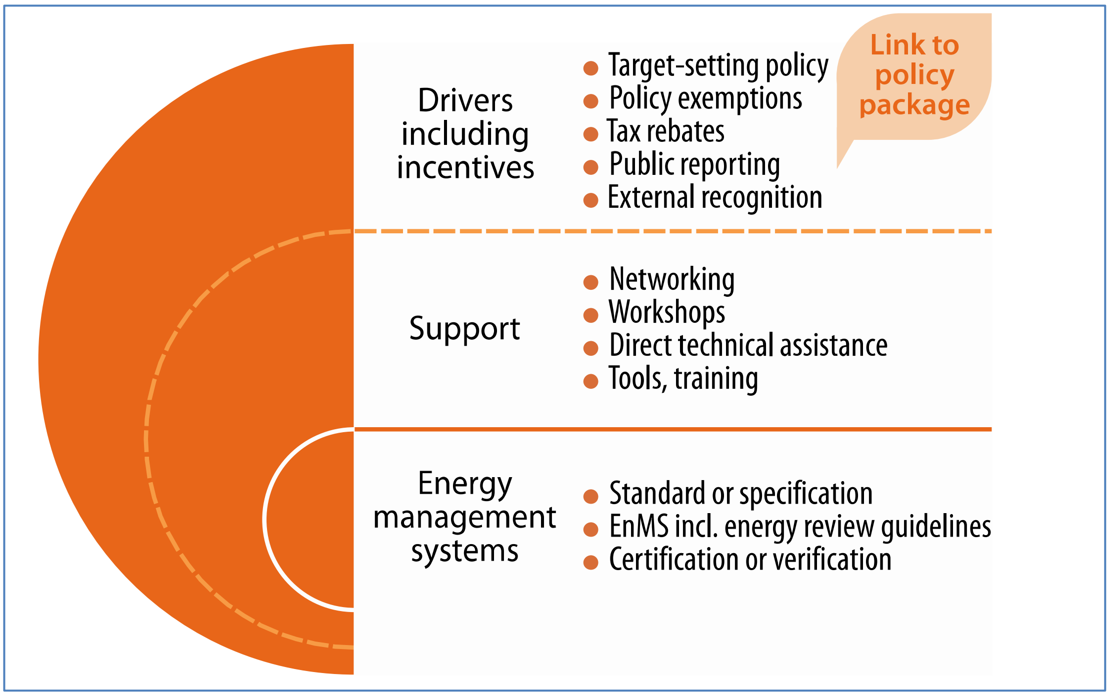
The main objectives of energy management programmes are to decrease industrial energy use and reduce greenhouse-gas emissions through the implementation of an EnMS. However, if properly designed, these programmes can also help attain other objectives, such as boosting competitiveness and redirecting savings to more productive uses.

Although an EnMS is the core activity of an energy management programme, the success of such a programme is heavily dependent on other key components, appropriate drivers, support mechanisms and linkages with other policies. In addition, to be effective, it is important that the development of an energy management programme is coordinated with national and/or regional low-carbon strategies. This enables the programme to be viewed as a tool that contributes to the realisation of the particular strategy.

Drivers – which include regulation, mandatory requirements[9] and incentives (see Section 4.1.1) – play an important role in providing the stimulus for industry to engage in energy management. Supporting mechanisms – including technical assistance, capacity building and training, benchmarking tools and guidance (see Section 4.1.2) – are especially important during the initial implementation of an EnMS to ensure its successful integration into the organisation (IEA/IIP, 2012).

Figure 6 below demonstrates how the sum of all these elements makes up a successful and well-designed energy management programme.

Figure 6. Elements of energy management programmes



Source: IEA/IIP (2012), Energy Management Programmes for Industry, The IEA policy pathway series.

Aside from providing sufficient support and incentives to industry, a government will also typically need to select an approach as appropriate, based on specific governmental and business-related factors such as (GSEP, 2014):

- The level of energy consumption in the industry sector, the energy intensity of companies, and the ratio of small and medium enterprises (SMEs) to large companies;
- Whether companies are competitive and/or present on the global market;
- The culture for management systems in the country (previous uptake of other ISO management systems, such as ISO 9001 and ISO 14001);
- The possibility and culture for government measures in this area;
- The status of energy service companies and equipment suppliers;
- The availability of financial and human resources in companies;
- Customer-supplier relations; and
- The demands for environmental performance such as a reduced carbon footprint and increased energy efficiency.

Taking into account this variety of important elements and country-related factors enables energy management programmes to be flexible instruments that can be adapted to changing policy needs and evolving industries, thereby ensuring continued effectiveness and relevance.

A variety of international organisations such as the Global Superior Energy Performance (GSEP), the International Energy Agency (IEA), the Institute for Industrial Productivity (IIP) and UNIDO provide detailed guidance on EnMS programme development.[10] Organisations like these strongly recommend the development of government EnMS programmes that require large, energy-intensive industry – and encourage other industrial energy users – to conform to ISO 50001 or an equivalent energy management protocol (IEA, 2011).

Table 2. List of some international organisations promoting EnMS adoption

Global Superior Energy Performance (GSEP)	*Promotes government cooperation to advance EnMS in industry and commercial buildings through the Clean Energy Ministerial.*
Energy Management Working Group (EMAK)	*Builds a network of policy makers and industry practitioners to promote energy management in industry.*
Institute for Industrial Productivity (IIP)	*Supports EnMS adoption on the ground in India, China and the United States and compiles and develops global best practice information.*
United Nations Industrial Development Programme (UNIDO)	*Provides capacity building and policy advisory assistance to promote resource-efficient and low carbon industrial production, including on EnMS.*

4.1.1 Incentives to drive EnMS uptake

Given the private financial benefits associated with energy efficiency improvements, it is important that government financial support mechanisms are designed correctly and adapted to market conditions in such a manner to avoid potential unintended consequences that can be associated with the provision of such incentives or subsidies. Many of the financial mechanisms used by governments to support broad energy efficiency policies have a strong focus on leveraging additional private sector financing in order to ensure sufficient financing for relevant energy efficiency projects in their countries.[11]

In contrast, implementing an EnMS is, by its nature, not capital intensive. Even if the outcome of an EnMS is capital investment in a new energy efficiency project, an EnMS generally requires only personnel time and minimal equipment investment (Therkelsen et al., 2013). As a result, the level of financial support required to help drive EnMS uptake is typically considerably lower than would be required in the case of support for capital projects.

This means that energy management programmes, when designed according to industry's real needs, can often be very cost-effective instruments for governments to use in incentivising industrial energy efficiency. For example, energy audits for industry are often partially subsidised by governments or even offered at no cost, as they can leverage a much larger investment in subsequent energy efficiency solutions.

Generally, incentives for EnMS are designed only to induce participation, after which companies witness first-hand the benefits the EnMS can have on their operational efficiency. Such short-lived incentives can include an exemption from a related policy or direct financial incentives, such as subsidies for audits or special initiatives. While the success of energy management programmes to date has been clearly correlated with the provision of appropriate resources during the implementation stage, it is important to note that as companies gain maturity and see the benefits of EnMS and the considerable cost savings they can achieve, additional financial incentives are often no longer necessary (McKane, 2009; Reinaud and Goldberg, 2012).

In addition, following a company's implementation of an EnMS, the resulting information that quantifies and demonstrates the benefits of energy efficiency projects has the potential to then encourage the private sector to invest in the identified opportunities, especially those that are more capital intensive. Documenting and quantifying energy use, energy savings and cost savings in accordance with the standardised methodology provided by an EnMS could help banks to better assess the risks and returns of these projects.

However, incentives for EnMS are only effective when they are adapted to the real needs of industry and designed to motivate private sector participation and not replace it. The range of possible incentives to promote the uptake of EnMS is large and this is simply because of the large variation in market and regulatory forces in different countries. For example, while EnMS incentives can dramatically improve the involvement of industry in implementing energy efficiency they can also in some cases inadvertently lead to restricting private sector investment support that would have occurred naturally in the absence of the particular incentive. This is one amongst other possible hazards that can occur when incentives are used unnecessarily or are not well adapted to the real needs of industry (e.g. using financial incentives instead of direct technical assistance in the scenario that the main barrier to EnMS uptake is lack of knowledge rather than financial constraints).

Box 3. Types of typical incentives for industry implementing EnMS

- *Exemptions from policies in exchange for energy management programme participation, such as from an energy or carbon tax*
- *Rebates or other tax incentives for energy-saving equipment (may not be tied to the energy management programme)*
- *Subsidies for energy audits; reward programme and other forms of recognition; mandatory implementation of EnMS*
- *Public reporting of company performance to encourage best-in-class behaviour*
- *Direct programme and/or technical assistance.*

Source: IEA/II, (2012), Energy Management Programmes for Industry – gaining through saving, IEA Policy Pathways.

Table 3. Examples of EnMS-related incentives from around the world

Country	Incentive type	Incentive description
Canada	*Certification-based subsidy*	*Cost-shared assistance to industrial companies to perform EnMS implementation pilots according to ISO 50001 as well as energy-related assessments. A financial incentive of up to 50% of study costs (to a maximum of CAD 25 000) for ISO 50001 implementation pilots is provided.*
China	*Differential electricity pricing*	*To encourage energy efficient performance in Chinese companies, the government has established a policy permitting differential electricity pricing for high energy-consuming companies. Electricity prices are set based on the energy intensity level of each enterprise – the less energy efficient a company is, the higher its electricity price.*
Denmark	*Certification-based tax rebate*	*Companies that obtain an energy management certification (EN16001 standard), make a number of special investigations that include an evaluation of the profitability of energy efficiency projects, and implement all projects with a simple payback horizon of less than four years can claim an energy tax rebate.*
Finland	*Energy audit subsidy*	*Since 1992, a 40-50% subsidy is available to companies wanting to carry out an audit. By the end of 2011 virtually all energy use by industry had been audited at least once.*
Germany	*Certification-based tax rebate*	*Companies that comply with the energy-saving targets set out in the voluntary agreements and that are EnMS certified (according to the German or ISO 50001 standard) can apply for rebates on energy taxes.*
Ireland	*Direct technical assistance*	*Participants in Ireland's voluntary Energy Agreements Programme (EAP) are allocated an Agreements Support Manager who provides one-on-one advice on the agreement generally. Special Initiatives are also convened by the Irish energy agency each year and are focused on specific technologies, initiatives and areas of particular interest to help implement customised EnMS for EAP members.*
United States	*Energy audit subsidy*	*Small and medium-sized enterprises (SME) with annual energy costs of between USD 100 000 and USD 2.5 million are offered free system energy assessments by energy experts from the Department of Energy.*

Source: OECD (2013).

4.1.2. Supporting mechanisms for EnMS implementation

Practical resources – such as training, technical assistance, best practice sharing, benchmarking tools and case studies – have a key role to play in supporting the implementation of an EnMS. Energy management programmes that include a range of such resources help overcome many of the barriers of EnMS implementation and enable companies to engage most effectively with the programme.

Energy performance or best practice benchmarking enables companies to compare processes, operations and systems to sectorial best-in-class operations in other similar sites. Sharing examples of companies within the iron and steel sector that are achieving savings as a result of EnMS can be an important incentive to others considering the merits of energy efficiency. Proven tools (e.g. energy reviews and cost-benefit analyses) that consider the multiple benefits of energy efficiency measures can provide important guidance to both companies new to EnMS and those wishing to improve their existing energy management processes.

Over the many years that energy management has been practiced by industry and supported by governments, a great deal of valuable information on the topic has become available. There are countless success stories from companies that demonstrate the value of an EnMS and there are a diverse number of best practice implementation materials currently in use. As such, governments have a large array of publically available information that they can integrate into new or on-going energy management programmes.

Box 4. Energy Management Practitioner's Toolbox

While there is currently no central place that hosts a robust platform for internationally available EnMS tools, information resources and training materials, the Global Superior Energy Performance Partnership (GSEP) and the Institute for Industrial Productivity (IIP) have partnered to develop the initial phase of an Energy Management Practitioners Toolbox that will be available to both governments and the private sector. To date, the Toolbox project has succeeded in collecting a library of over 400 practical tools and information resources, comprising case studies, software tools, energy-saving calculators and methodologies, technology guidelines, training materials and other resources. The Toolbox is expected to be publicly accessible in 2015 as an interactive website that will organise the tools and resources by industry sector, mechanical system, steps in the EnMS process and supply chain energy management. For a list of the tools and resources specifically identified for the iron and steel sector, see Appendix 1.

5. Conclusion

With energy costs representing around 20-25% of the total input of iron and steel producers, there is a strong incentive for the sector to engage in energy efficiency measures that will result in less energy consumed for the same or even increased output. Energy efficiency has been shown to achieve both energy savings as well as improved productivity for the iron and steel sector.

Energy efficiency opportunities that bring the best added value to a company are most effectively identified through the implementation of an EnMS. The systematic continuous improvement process behind an EnMS can most accurately quantify the current baseline energy use and, in turn, identify the most beneficial energy efficiency measures to improve energy performance on an on-going basis.

Even though implementation of an EnMS can deliver both energy savings as well as a range of other non-energy benefits (up to 2.5 times the value of the energy demand reduction), there still exist a number of barriers that continue to impede its uptake by the iron and steel industry. A primary barrier is a simple lack of awareness of the true value-added benefits of energy efficiency and how an EnMS can realise those benefits in a cost-effective manner.

Well-designed government programmes that are adapted for the country specific requirements of the industry sector are a key factor in overcoming these barriers and are necessary to achieve sufficient uptake of EnMS implementation.

Importantly, such programmes to promote EnMS uptake can be based on incentives that do not require extensive financial support (such as providing energy audits rather than large capital-intensive technology investment projects). In addition, as companies gain maturity and see the benefits of an EnMS and the considerable cost savings it can bring, additional incentives are often no longer necessary.

NOTES

1 U.S. Department of Energy (DOE) Industrial Assessment Centers (IACs) Database, http://iac.rutgers.edu/database/.

2 Energy management can be applied to a variety of sectors, including buildings, transport and industry, amongst others. This paper focuses only on energy management as applicable to the industry sector and in particular for the iron and steel sector.

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4 ISO 14404-1:2013, Calculation method of carbon dioxide emission intensity from iron and steel production – Part 1: Steel plant with blast furnace.

5 Achievable energy savings will depend on a variety of factors such as plant configuration, location, operation and maintenance practices, sub-sector, and other factors.

6 1 Btu = 1055.05 Joules.

7 *Source:* http://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

8 *Source:* IIP policy database at http://iepd.iipnetwork.org/policy/top-10000-energy-consuming-enterprises-program.

9 Further information on regulation and mandatory requirement type drivers is included in the OECD 2013 energy efficiency paper, “Improving Energy Efficiency in the Iron and Steel Sector: Opportunities and Financing Challenges (DSTI/SU/SC(2013)18)”, and the new OECD energy efficiency policy database portal for the iron and steel sector.

10 GSEP: www.cleanenergyministerial.org/Portals/2/pdfs/GSEP-EMWG_Models_for_Driving_EE-EnMS_June2014.pdf

IEA:www.iea.org/publications/freepublications/publication/policy-pathways-energy-management-programmes-for-industry.html
IIP: www.iipnetwork.org/databases/programs
UNIDO:www.unido.org/en/what-we-do/environment/energy-access-for-productive-uses/industrial-energy-efficiency.html

11 A comprehensive review of financial mechanisms to support industrial energy efficiency is provided in the OECD 2013 energy efficiency document, “Improving Energy Efficiency in the Iron and Steel Sector: Opportunities and Financing Challenges” [DSTI/SU/SC(2013)18].

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APPENDIX 1

GSEP Energy Management Practitioners Toolbox – Resources for EnMS implementation within the iron and steel sector

CASE STUDIES

Source	Name
Australian Department of Industry	*Embedding Energy Efficiency into Core Business Processes at OneSteel*
Energy Conservation Center, Japan	*Continuous Cast Hot Billet Direct Rolling and Furnace Upgrades*
Energy Conservation Center, Japan	*Direct Transportation of Thermal Mass Billets and Introduction of a High-performance Industrial Furnace at Kyoei Steel*
Energy Conservation Center, Japan	*Specific Electric Power Consumption Reduction through Draft Fan Optimisation*
United Nations Environment Program	*Energy Efficiency Projects at Shijiazhuang Iron and Steel Company*
United Nations Environment Program	*Energy Efficiency Projects at Visakhapatnam Steel Plant*
US Department of Energy	*Compressed Air Case Studies*
US Department of Energy	*Compressed Air System Upgrades at a Steel Mill*
US Department of Energy	*Energy Program Participation at Harrison Steel*
US Department of Energy	*Process Heating Efficiency Improvement at US Steel's Taconite Pellet Manufacturing Facility*

GUIDANCE

Source	Name
Asia Pacific Partnership for Clean Development and Climate	*State-of-the-art Clean Technology Handbook for the Steel Industry*
Energy Star	*Energy Efficiency Improvement and Cost Saving Opportunities for the US Iron and Steel Industry*
European Commission	*Best Available Techniques for Iron and Steel Production*
European Commission	*Best Available Techniques in the Ferrous Metals Processing Industry*
European Commission	*Best Available Techniques in the Smitheries and Foundries Industry*
Institute for Industrial Productivity	*Iron and Steel Industrial Efficiency Technology Database*
Lawrence Berkeley National Lab	*Emerging Energy Efficiency and Carbon Dioxide Emissions-reduction Technologies for the Iron and Steel Industry*
Natural Resources Canada	*Benchmarking Energy Intensity in the Canadian Steel Industry*
Natural Resources Canada	*Guide to Energy Efficiency Opportunities in Canadian Foundries*
US Environmental Protection Agency	*Available and Emerging Technologies for Reducing Greenhouse Gas Emissions in the Iron and Steel Industry*
World Steel Association	*Steel Industry and Energy Management Systems*

SOFTWARE

Source	Name
Lawrence Berkeley National Lab	*Energy Efficiency Assessment and Greenhouse Gas Emission Reduction Tool for the Iron and Steel Industry*

TRAINING AND PROGRAMMES

Source	Name
Institute for Industrial Productivity	*SKF Supplier CO_2 and Energy Reduction Initiative*

APPENDIX 2[12]

The sequence of actions required to establish the operational procedures and management practices of an EnMS are detailed below in the form of nine key steps.

Step 1: Build the business case and secure management commitment
A successful programme in energy management begins with a strong organisational commitment to continuously improving energy efficiency. In order to successfully build and communicate the business case for an EnMS, it is necessary to identify its value to the company.

Step 2: Define scope, establish policy and secure resources
Top management is required to create a cross-functional energy team, and appoint and authorise projects for the EnMS leader. Top management is also required to develop an energy policy, allocate necessary resources, ensure fair evaluation, assume performance ownership and carry out the management review.

Step 3: Organise an energy team
The purpose of creating an energy team is to develop the resources and tools needed to maximise implementation of energy efficiency and manage energy on a continuous basis. An energy team is a cross-functional group of individuals that works towards achieving the energy management goals and integrating EnMS into all areas of the company.

Step 4: Profile energy situation and identify options (energy review)
Developing a thorough understanding of the energy use dynamics with sufficient detail forms the backbone of an effective management system. An energy review collects data on energy use, prices, energy-using applications and other factors that can affect energy performance. Benchmarking with other similar sites can also provide beneficial data towards determining viable energy improvement options. From this assessment, a company is able to develop a baseline of energy use, prioritise energy-saving opportunities and set goals for improvement.

Step 5: Prepare for action
After collecting and analysing the energy data, a company is ready to develop energy objectives or goals and targets as well as an energy management action plan. Objectives identify specific outcomes, drive action and provide guidance on what a company must do to improve energy performance.

Step 6: Execute action plan and implement projects
Once the energy management action plan(s) has been finalised, several steps are necessary to ensure that the activities of the EnMS are carried out effectively. These activities include everything from holding energy team meetings and communicating EnMS activities and goals to actually implementing energy efficiency measures.

Step 7: Measure and verify energy use and savings
A successful EnMS must possess a systematic approach to measuring the results of energy efficiency improvements. This approach enables the evaluation of progress toward energy performance goals and improves understanding of how the EnMS yields value for the company.

Step 8: Check, review and improve
Assessing the performance of the EnMS is an important step to ensure the system's on-going adequacy, suitability and effectiveness as well as the continual improvement of both energy performance and the EnMS. The primary criteria of EnMS performance is whether it enables the company to achieve the energy performance goals that were established in the energy management action plan(s)

Step 9: Certify (optional) and recognise achievements

- A third party certification assessment performed by a qualified expert will ensure the legitimacy of the EnMS and its results.
- Providing and seeking recognition for employee energy efficiency achievements motivates employees and helps sustain momentum and support for the EnMS.
- Recognition from external sources validates the EnMS and provides positive exposure for the company as a whole.

[12] The source of the information provided in this Appendix is the following: Global Superior Energy Performance Partnership, EnMS Practitioners Toolbox. *http://www.cleanenergyministerial.org/Portals/2/pdfs/GSEP_EMWG_EnMS_toolbox_factsheet.pdf*