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Promotion Systems and Incentives for Adoption of Energy Management Systems in Industry

Some International Lessons Learned Relevant for China

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Promotion Systems and Incentives for Adoption of Energy Management Systems in Industry

Some International Lessons Learned Relevant for China

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June 2011

July 2011 (second edition).

Abstract

Standards for Energy Management Systems (EnMS) have shown to be central in energy savings agreements between the government and enterprises and have usefully contributed to effective energy savings performance. Companies that have obtained certification have often achieved energy savings beyond the expectation of the agreement, typically making savings of 10-20% within the first five years.

This brief discusses the experience of long-standing programmes to promote certified, standardised EnMS adoption in Denmark, Sweden and Ireland. Experience in several other countries is touched on as well. Particular attention is given to the incentives framework that these countries have adopted to promote EnMS as part of their broader energy savings agreement programmes. Readily available information on schemes to certify proper adoption of standardised EnMS is also summarised. In its final section, the brief provides some suggestions for China's efforts to roll out implementation of EnMS, based on the international experience.

Acknowledgements

The authors express special thanks to the following individuals who contributed ideas, case studies and comments on the publication: John O'Sullivan (SEAI, Ireland), Erik Gudbjerg (Lokalenergi, Denmark), Agneta Persson (WSP, Sweden), Han Wei (China Sustainable Energy Program, Energy Foundation, China), Wang Geng (China National Institute for Standardisation) and Marco Matteini (UNIDO). Thanks also go to Xu Xin and Helen He (Institute for Industrial Productivity) for translation services.

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1 Introduction

1.1 Energy management systems

Energy Management Systems (EnMS) enable organisations to establish systems and processes necessary to achieve operational control and continual improvement of energy performance (O'Sullivan, 2011). This paper focuses on EnMS standards, implementation and certification processes and their linkages with wider policy or programme packages.

Implementation of an EnMS assists a company to develop a baseline of energy use, actively manage energy use and costs (in particular as energy prices are becoming increasingly volatile), reduce emissions without a negative effect on operation and continue to improve energy use/product output over time (Scheihing, 2009). EnMS help companies more easily implement and meet the obligations of a range of energy, environmental and climate policies, and facilitate trade in markets that are demanding more traceability, quality and environmental credentials from their suppliers.

The following are examples of companies who have achieved major energy intensity improvement using EnMS:

- Dow Chemical achieved 22% improvement between 1994 and 2005 ($4B savings) and is seeking an additional 25% between 2005-2015.
- United Technologies Corporation reduced global GHG emissions by 46% per dollar of revenue from 2001-2006
- Toyota's North American Energy Management Organisation has reduced energy use per unit by 23% since 2002; company-wide energy savings efforts have saved $9.2M since 1999 (Scheihing, 2009).

In addition, a common experience of companies that use EnMS effectively is that many other significant operational savings are also uncovered, either as a *by-product* of implementing of an energy saving project, or through the *process* of identifying such projects. As well as energy-related cost savings, non-energy benefits can be significant. A 2003 study of commercial and industrial energy efficiency programmes in Wisconsin valued these benefits at approximately 2.5 times the projected energy savings of the installed technologies. Benefits included sales levels, productivity, non-energy operating costs, equipment life, maintenance costs, waste generation, personnel needs, injuries or illnesses, defect or error rates, and employee morale or satisfaction (Hall & Roth, 2003).

1.2 Benefits of EnMS standards and certification

Energy management systems were initially left up to companies to design themselves, or were integrated, at a basic level, into Environmental Management Systems (EMS) or Quality Management Systems (QMS), leading to varying degrees in quality and durability.

Standardised EnMS methods have emerged as an important tool for companies and governments in the context of energy savings agreements.

Experience has shown that the use of standardised methods greatly facilitates the identification of energy saving opportunities and improvements in operational control that would not have been possible with self-designed systems. For example, companies using standardised EnMS in Ireland have reported an increased pace in energy performance improvement despite not being new to energy management – having already achieved significant savings over a previous 10 year period without the use of a standardised management systems approach. The efficacy of the energy management systems is improving with experience and maturity (pers. comm. O'Sullivan, Petersson et al., 2011). In addition, the requirement to appoint a representative from management level, convene staff from a range of different functions within the company and commit necessary resources has proven to be key in the follow-through and implementation of energy savings, and builds internal capacity for ongoing improvements. Standardisation thus enables energy savings opportunities above and beyond what companies might have done without EnMS standards.

EnMS standards and certifying that companies are implementing the standard are important for underpinning energy savings agreements or programmes. Whereas non-standardised energy management systems have many interpretations and vary in practical application, standardised EnMS provide governments and enterprises with a common understanding of EnMS, its content, scope, processes and methodology. Proper operation of EnMS is relied upon to provide baseline energy use data, identify energy savings opportunities through both improved operational management and renovation projects, develop energy conservation implementation plans, schedule implementation of the plan, and evaluate energy savings achieved (Gudbjerg, 2009).

For enterprises, proper EnMS standards adoption can (i) ease the burden of ensuring compliance with the many government regulations through use of one systematic approach, (ii) ensure that energy conservation plans, identified projects and (perhaps) ultimate targets are firmly grounded in the specific realities of their enterprise, and suitably customised to on-site circumstances, as these are generated through the EnMS system under the control of the enterprise, and (iii) provide a scientific mechanism to identify energy savings measures which can generate the greatest profitability to the enterprise while also meeting obligations to the state.

In the countries with the longest and richest experience in implementing EnMS in industrial enterprises, enterprises are required to implement certified, standardised EnMS as a core part of their broader energy conservation agreements with the government. While enterprises participation in the broader energy conservation agreement programmes is voluntary, enterprises are obligated to implement certified, standardised EnMS if they decide to participate in the broader programme, and are given incentives to participate in the overall energy savings agreement programmes, such as financial incentives, technical assistance and training.

As China moves to rollout implementation of standardised EnMS in industrial enterprises in the coming years, some of the issues being pondered by authorities and experts include:

- What will be the most effective ways to promote EnMS adoption by enterprises?
- How can incentives for enterprise adoption of EnMS best be strengthened?
- What should be the scope and process for certification of proper adoption of the EnMS standard by enterprises?
- Which energy performance indicators should be used and how will performance of good energy management be evaluated?

This brief provides an overview of international experience in methods for promoting EnMS adoption by enterprises, experience in certification of EnMS adoption, and the structure of incentives for enterprise adoption. A list of references for further reading is also attached at the end. Further information on topics that are briefly summarised here, especially from the country practitioners involved, may be available and could be further researched.

2 Overview of EnMS programmes

A number of standards for Energy Management Systems (EnMS) exist or are applied in the EU (as an EU-wide standard), Denmark, Sweden, Ireland, South Korea, South Africa the US, Spain, China and Thailand. A new international standard, the ISO 50001[1] was released in June 2011 and is or will be adopted in a number of countries. The use of the Danish, Irish and Swedish standards has now been superseded by European standard.

Source: Kahlenborn 2010

Figure 1 Energy Management Standards

While not technically standardised EnMS, similar energy management initiatives exist in Japan, the Netherlands, India, Australia and the US.[2] These other initiatives are not covered in the report. The countries with EnMS standards and their links to broader energy efficiency programmes described in more detail in this report are Denmark, Sweden, and Ireland.

2.1 Recent developments in China

China also has been active in developing EnMS standards and planning for large-scale implementation. China's General Administration of Quality Supervision, Inspection and Quarantine issued China's new national standard for EnMS requirements, with voluntary

[1] Energy management is also integrated to some extent into the current ISO Environmental Management Standard 14001.

[2] The US Association of Energy Engineers (AEE) has independently developed a programme to certify energy managers (CEM) since 1981. It does not appear to link in with the US voluntary agreements (between industrial enterprises and the Department of Energy's Industrial Technologies or the Save Energy Now LEADER programmes), or the ANSI/MSE standard. In Japan, energy-intensive firms are required to appoint a certified energy manager and develop an energy management plan. In India, the Bureau of Energy Efficiency directs Designated Consumers to appoint a certified energy manager, who needs to obtain the relevant qualification (Chakarvarti 2010). Australia, under its Energy Efficiency Opportunities agreement, requires companies to undertake an energy assessment and report on energy efficiency opportunities identified providing guidelines on how to do this; however, this is also not technically an EnMS standard. See http://www.ret.gov.au/energy/efficiency/eeo/industry_guidelines/Pages/default.aspx

implementation beginning November 1, 2009. The national EnMS standard--GB/T 23331-2009-- follows the "Plan Do Check Act" (PDCA) approach (as explained in the next section) and incorporates many aspects from the EnMS standards used by other countries. It can be applied to both industrial and building facility energy users. In addition, China has played an active role in the development of the new ISO 50001 standard and is considering revisions to its GB/T 23331-2009 standard based on the ISO 50001 standard.

The Central Government has been organising pilot applications of the standardised EnMS in various industrial subsectors, and summing up experiences as they evolve. The Central Government is thus developing the generic EnMS standard to include sector-specific information. Work is proceeding on a variety of guidance materials to assist enterprises in adoption. In addition, Central Government units are moving to develop a system for certification of proper EnMS compliance. The Central Government is also exploring how to select and organise certification bodies, and accredited two bodies to undertake certification during the pilots, as is done in China for many other standards.

Shandong Province is at the forefront of developing EnMS at the provincial level. The province prepared its own EnMS standard for application in industrial enterprises and implementation guidance during 2007–08 before the national standard was issued. Eight pilot industrial enterprises undertook efforts to adopt EnMS according to the provincial standard and guidance, beginning in 2008. An evaluation of pilot project progress during May–June 2009 showed success in implementing many basic energy management procedures and achievement of a great deal of practical experience as a result of the standard. Areas for further strengthening of the standard were also highlighted. Guidelines on the use of standard were published in January 2010 and sub-sector level guidance is now also in development to both further improve implementation guidance and to expand the adoption of EnMS by a greater number of industrial enterprises. For 2010 the goal was to achieve adoption of the provincial standard EnMS in 30 new enterprises, and then to add 100 new enterprise applications each year during the 12th Five Year Plan.

2.2 General characteristics of EnMS standards

The EnMS standards in Figure 1 are based on the typical "Plan-Do-Check- Act" (PDCA) cycle, and include requirements for establishing a company energy policy with concrete objectives, putting in place actions to reduce and monitor energy use, tracking energy savings (internally) and planning improvements. The standards can apply to all types of companies, providing a framework within which companies tailor their own energy-management systems. The EnMS are generally all compatible with ISO standards for quality (ISO 9000) and environmental management (ISO 14001). This provides an opportunity to develop integrated standards that will reduce on-going certification costs and reduce compliance overhead for overlapping requirements.

The standards comprise the following common elements:

- Company establish an energy policy.

- The principle of continuous improvement is embodied in the standard.
- Companies are required to develop an energy management plan or programme.
- Management commitment is required and an appointed energy representative is responsible for coordinating employees from a range of different functions.
- Companies need to have an energy management baseline, conduct an energy review, establish performance indicators and energy savings targets, and document energy savings for internal purposes.
- Operational control.
- Checking, monitoring measurement and analysis.
- Legal and other requirements (register of legislation).
- Control of records.
- Internal auditing.
- A management and review process must be undertaken (Desai et al., 2008).

While the content and scope of the standards are very similar, the differences lie in whether terms in the clauses are defined specifically or allow the company to define them themselves. For example, some standards provide definitions for what should be measured and what energy performance indicators should be used (e.g. the US standard) whereas others do not define these terms (EU standard) (Desai et al., 2008).

2.3 Entities involved in EnMS standardisation and certification

To ensure the robust development and use of an EnMS standard, a range of organisations are involved.

The standardisation body is the body responsible for developing the standard in consultation with government entities, industry and other stakeholders. In the case of ISO, a large number of national standards bodies, United Nations Industrial Development Organization (UNIDO), national ministries and energy agencies, technical institutions, academia and consumer groups form working groups.[3] International Standardisation Organization (ISO) standards are usually subject to lengthy negotiations, in order to ensure the international standards are objective and not biased towards an existing national standard, and to balance between overall quality and flexibility at the company level.

[3] See http://www.iso.org/iso/standards_development/processes_and_procedures.htm

In the case of standards developed nationally, the standardisation body is responsible for the overall coordination and development of the standard. The standardisation body is a public organisation with some degree of independence and solicits the involvement of energy ministries and agencies, industries, technical experts and others.

The accreditation body is the body that has the authority to give responsibility to certification bodies or conformity assessment bodies for issuing certification. The accreditation body needs to ensure that the certification body is competent to certify enterprises and ensure the standard is being effectively applied by enterprises. The ISO issues an accreditation standard ensuring that accreditation bodies are themselves accrediting organisations competently. [4] Accreditation bodies can sometimes initially form part of a government policy agency, but as the institutional and governance capacity develops, these usually become independent organisations such as a government authority or a company and may be subject to accreditation laws.

Certification bodies are those that conduct certification audits and are able to certify that enterprises are properly applying the standard. They need to apply to accreditation bodies in order to be accredited.

Appendix 1 illustrates the common roles and functions of particular schemes.

2.4 Certification process

In theory, the application of an EnMS standard can be used for the internal purposes of a company and no external reporting, certification or verification is needed. For example, several companies have adopted EnMS standards themselves because they saw commercial benefits of having a guideline for systematically managing their energy use.

Any energy saving objectives identified by the company through the EnMS are specific to the company, and, if not otherwise specified by an external policy or programme, performance against these objectives does not need to be externally verified. Rather, in order for companies to comply with the standard, they need track and document energy performance.

In practice, certification of a company's proper use of that standard by accredited certification bodies is required by national governments when linked to a policy or programme, or desired by companies who wish to gain external recognition. External government policies or programmes usually specify companies' obligations to report and verify energy use savings.[5]

[4] This standard ISO/IEC 17011:2004 specifies general requirements for accreditation bodies assessing and accrediting conformity assessment bodies (CABs).

[5] No public reporting is required in the existing US ANSI/MSE standard as it has no formal links with government programmes. However, the ISO 50001 standard is at the centre of the Superior Energy Performance where certification, reporting and verification infrastructure is being set up. The SEP is being

In these cases, enterprises commit to implement and maintain a certified EnMS according to a standard specified by government programme. This ensures continuous improvement and operational control of energy performance. The certification process provides a structure that indirectly controls compliance with the government programme (compliance with legal and other requirements) and ensures that enterprises are equitably and systematically reporting information at no – or much reduced – direct cost or additional management burden to the government. By linking the requirement of implementing an EnMS as part of a government programme, additional requirements to 'business-as-usual' or requirements under the standard can be imposed and measured within the certification process.

In the ISO and European schemes, the certification process is as follows:

- To obtain certification, certification bodies conduct two on-site company audits; the timing in between each audit depends on the implementation conditions and preference (but is typically within around 12 weeks apart). The first audit is a high level visit to ensure the company is setting up the overarching elements of the management system. This first audit detects 'show-stoppers' or major non-compliance or missing elements of an EnMS. Direction is given to the company on shortfalls or failings to be corrected for the stage 2 audit.

- The second audit is a detailed clause-by-clause assessment determining whether the company is operating in compliance with each clause. Examples of questions an auditor might ask are provided in Table 1. During the audits, non-conformities can be found, based on evidence of a failure to operate in compliance with a requirement. If non-conformance is found, these can be categorised as Major (Category 1) or Minor (Category 2). See Table 2 for definitions and examples. Certification lasts for three years and is subject to two periodic/surveillance audits during that process.

- Figure 2 illustrates the certification process.

Table 1 Typical questions an auditor might ask (Denmark example).

Clause in EnMS	Requirement of clause	Examples of questions asked by certification body auditor
General requirements	The organisation needs to document the scope of the EnMS and ensure that it is implemented and supported throughout the	How does the organisation interact with its energy use? How significant is this interaction? What are the current levels of energy performance? What management systems are currently in place?

linked to the Save Energy Now programme, whose participants will be given preferential links to the SEP. However, more information is required to determine these links.

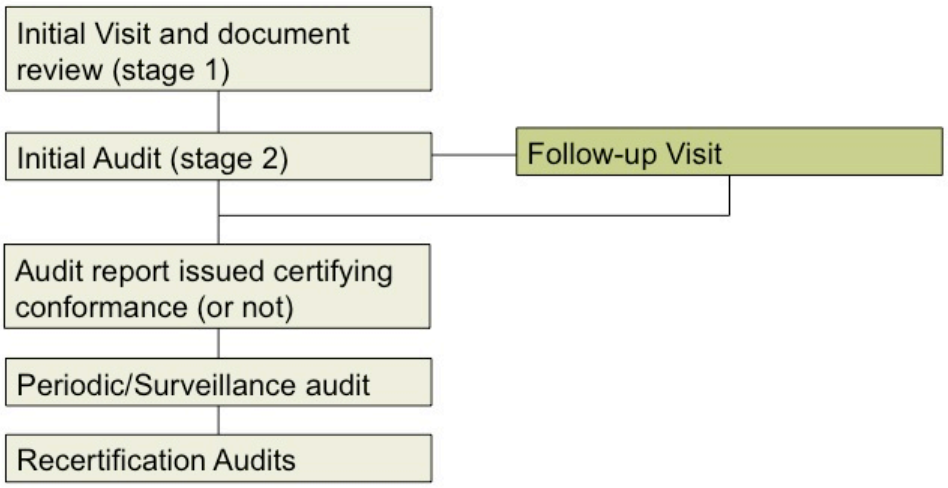
	organisation.	
Energy policy	The company needs to develop an energy policy to establish the framework for what has to be achieved, before moving into the PDCA.	Is the policy relevant to operations? Does it contain a commitment to continual improvement? Does it provide a framework for setting and reviewing objectives and targets?
Objectives, targets, and programmes	When setting objectives and targets the organisation needs to consider several factors.	Are objectives and targets documented and measurable, maintained throughout the organisation? Consistent with the policy and continual improvement?
Management review	The Management review should be a critical assessment of the performance of the EnMS by top management.	Does top management review the EnMS at pre-defined intervals? Does the review address the need to change policy, objectives or procedures in light of: Audit Findings, Changing circumstances, Commitment to continual improvement?

Source: Weldingh (n.d.).

Table 2 Categories of non-conformities - example of the Danish standard

	Major or Category 1	**Minor or Category 2**
Definition	*"The absence of, or the failure to implement and maintain, one or more EnMS requirements, or a situation which would, on the basis of objective evidence, raise significant doubt as to the capability of the EnMS to achieve the policy and objectives of the organisation (EA-guideline EA-7/02)"*	*"An isolated failure; or a nonconformity that judgement and experience indicate is not likely to result in the failure of the EnMS or reduce its ability to assure effective control".*
Example	*Requirement:* DS 2403, 4.6: Management review *Failure:* No evidence that the management review has been thorough *Evidence:* No documented review received, no top management involved	*Requirement:* DS 2403; 4.2. Policy *Failure:* Due to the standard the policy should be available to the public *Evidence:* No such evidence was shown to the audit team that the energy policy was published.

Source: Weldingh (n.d.).



Source: Weldingh (n.d).

Figure 2 The certification process (three-year cycle).

These processes can then be merged to the other processes required by the government policies they underpin. In Sweden, the energy savings agreement lasts five years. A company's system must, within the first two years of the programme, be certified by an independent certification body. Within the remaining three years of the programme, the company must continuously improve its energy management system. Documentation from the third party EnMS certification shall be submitted to the Swedish Energy Agency. The Agency also cooperates with the certification bodies and SWEDAC (the Swedish accreditation body) in order to verify that the certifications and re-certifications continue according to plan (Petersson et al. 2011).

2.5 Certification costs

Danish, Swedish and Irish experiences show that, on average, it costs a company €10,000 to 15,000 to implement and certify an EnMS (Gudbjerg, 2009). In Ireland certification costs would range from about €3000 for a small site to €15,000 for much larger site requiring a number of days to undertake an audit. Other sources estimate typical costs for certification in the order of US $12,000 to 20,000 per site.

3 EnMS as part of Energy Savings Policies and Programmes

Experience has shown that the market uptake of EnMS standards is correlated with government-led programmes to stimulate and encourage enterprises to apply the standard. In Denmark, Sweden and Ireland, the standards are underpinned by a voluntary energy agreement between enterprises and the government. Uptake was relatively high (60%, 25% and 50% respectively by industrial energy use as at 2009, see McKane et al., 2009). This is compared to the US standard (ANSI/MSE 2000:2008), available since 2000, where the absence of a supporting programme was likely the cause of the low market uptake (less than 5%), despite the standard being in place the longest (since 2000, compared to 2001 in Denmark, 2003 in Sweden and 2005 in Ireland).

The Agreements-EnMS packages of Ireland, Denmark and Sweden are briefly described below. Other countries are linking or are considering linking EnMS standards to energy savings programmes include Germany[6], Austria, the UK, the US and Canada (NRC, 2010). The US is currently piloting the use of the ISO 50001 standard within the upcoming Super Energy Performance (SEP) programme, due for introduction in the fall of 2011.[7] ISO 50001 is central to the SEP programme and formal links are being established between the SEP programme and the voluntary agreement, the Save Energy Now LEADER programme, although further information is required to determine these links.

An initiative very similar to the energy saving agreements in Denmark, Sweden and Ireland exists in the Netherlands. As part of its negotiated agreements (known as the Long Term Agreements), companies are required to have an energy management system in place and must follow certain specifications such as an energy management checklist (Vermeeren 2008). Under the LTAs, companies are also provided incentives to participate by means of an exemption from complying with environmental permitting procedures. However, the energy management requirements are not a standard per se and companies are not required to obtain certification.

3.1 Denmark

Denmark's Voluntary Agreement on Industrial Energy Efficiency (DAIEE) mandated the use of the Danish Standard on Energy Management DS2403 up until 2009. This has now been replaced by the European standard EN 16001.

Government programme: The DAIEE was launched in 1996 prior to the development of the national standard that was introduced in 2001. In addition to the adoption of the

[6] Since 2009, energy-intensive companies in Germany can profit from financial incentives through the Renewable Energy Law (EEG) when holding certificate of a functional and certified Environmental Management System (ISO 14001 or EMAS) or EnMS according to EN 16001 (Kahlenborg, 2010).

[7] Recent evidence suggests that the current US standard ANSI/MSE2000:2008 will be replaced by ISO 50001. As well as the US, Canada, Ireland, Denmark, UK, USA, China, Sweden, Germany and Spain and at least 30 others intend to adopt ISO 50001 (in whole or in part) (NRC, 2011).

standard, the agreement has four main elements: energy audits, special investigations (that focus on specific areas of their primary processes), energy management, and investments in energy efficiency. Since 2000, independent energy audits are no longer mandatory as the energy management system gained greater emphasis. In 2003, the energy management systems of companies had to be certified by DANAK, the Danish accreditation body. Typically, after adopting an EnMS, and carrying out special investigations that identify energy-saving opportunities, companies are committed to implement all "profitable" energy saving measures with a payback period up to four years (Price et al., 2010).

Financial incentives: In return for participating in and meeting the requirements of the voluntary agreement, companies receive CO_2 tax rebates. For instance, in 2002, a heavy process company with a voluntary agreement with the DEA only paid 3% of the standard tax (i.e., €0.4/t CO2 or $0.6 USD/t CO2), while a heavy process without signing agreement had to pay 25% of the tax rate (i.e., €3.4/t CO2 or $4.8 USD/t CO2). Companies can also apply for a subsidy to cover up to 50% of the costs of independent energy audits. Subsidies for investments on energy efficiency were provided for up to 30-50% of the (Price et al., 2010).

Training: The Danish Energy Agency has established a programme to train energy engineers to help companies implement the EnMS standards. Guidelines and case studies are also available. They have been instrumental in the promotion of EnMS standards (pers. comm. Gudbjerg).

3.2 Ireland

The Sustainable Energy Authority Ireland (SEAI) developed and launched the Energy Agreements Programme (EAP) and has full responsibility for administering the EAP, and supporting and providing services to EAP companies. Until recently, EAP required that participants in the programme adopt the Irish Energy Management System Standard IS393. Now this standard has been replaced by the European standard EN 16001 (O'Sullivan, 2011).

Government programme: As a subset of the Large Industry Energy Network (LIEN), the EAP has an objective of stimulating energy efficiency activity within the largest consumers of energy in Ireland that may not otherwise occur, or not occur within the same timescale or to the same scale of potential without the Programme structure in place. Over a 15-year period, average energy savings of 2% per year have been achieved by LIEN members (representing 14.2% of total).

As well as implementing the EnMS standard, participants in the EAP agree to undertake one Special Investigation per year, a feasibility study focussed on a significant energy users and integrated into the EnMS through the Register of Opportunities (O'Sullivan, 2011) with an emphasis on energy efficiency technologies, equipment, control strategies, operation and maintenance and housekeeping.

While the EAP members are undergoing the implementation of the standard, SEAI provides advice and support, financial assistance, Special Working Groups to identify energy-saving opportunities, and Special Initiatives that are designed for specific areas.

Training on EnMS: Training provision for EnMS has evolved since the introduction of EnMS in 2005. SEAI developed a training curriculum and offered training to all EAP members for a number of years. Two training courses were offered, one with emphasis on technical and engineering aspects of an EnMS – the other with emphasis on the EnMS overall. In addition to these training courses, special ad-hoc workshops were held where a specific need was required, e.g. transitioning from IS393 to EN16001, conducting an energy review and to share EnMS experiences.

In 2009, an effort was made to expand the market for EnMS and training with the training offered to any interested party – including energy users, energy consultants, students, etc. Sixteen courses were run that year.

SEAI then reverted back to workshop formats for EAP-only members and allowed the EnMS training to be offered commercially. The requirement for on-going and repeated training for EnMS users is now available commercially, with special topics workshops offered to EAP members. In 2011 SEAI will run two workshops in transitioning to ISO 50001. In addition to this, the LIEN (of which the EAP is a subset) generally offers seminars that are connected with EnMS use. This is a provision to share experiences and disseminate the effectiveness of the EnMS to those not yet implementing but wish to know more (pers. comm. O'Sullivan).

Technical Support: Prior to joining the EAP and committing to implement an EnMS, SEAI offers an Agreement Gap Analysis (AGA) to EAP participants to develop company-specific information on gaps and work effort needed to implement the standard. This input is useful in determining the initial business case of the commitment, the work effort and therefore resources required, identifying the main gaps to a compliant EnMS, and developing a Work Breakdown Structure for project implementation. The AGA also identifies some Special Investigations that the company can consider to implement as they join the EAP.

SEAI provides EAP members with tailored support from an Agreements Support Manager (ASM), according to the needs and requests of each company. The role of ASMs is to help EAP members meet their commitments, facilitate Special Investigations and feasibility studies, implement the EnMS standard and answer any questions. While SEAI does not specially train the ASMs, it does provide direction and development of the role and support offered to members.

Finally, Special Initiatives are conducted by Special Working Groups each year and are focused on specific technologies, initiatives and areas of particular interest to EAP and LIEN members. They benefit EAP participants by:

- Focusing on areas that particularly interest members

- Enabling members to share knowledge and experiences and learn from energy experts
- Identifying energy-saving projects, grouped special investigations, and benchmarking
- Providing shared studies, self-assessments, methodologies and guidelines
- Continuing to add value for members after the initial EnMS implementation phase.

Financial Incentives: No specific financial incentives are given in exchange for EnMS certification. Nonetheless, under the EAP, companies may receive grants to help them undertake Special Investigations and replicate projects identified under the investigations (O'Sullivan, 2011). In addition, the aforementioned training and support offered within agreement packages can often match certification costs (pers. comm. O'Sullivan).

Other: under the LIEN, Irish firms are provided with networking opportunities and are able to share knowledge, access to information, best practices and lessons learned with other companies. SEAI also conducts case studies on companies' efforts as a means of recognising achievements (O'Sullivan, 2011).

3.3 Sweden

The Swedish voluntary agreement scheme, the Programme for Energy Efficiency in Energy Intensive industries (PFE), mandates the European EN 16001 standard, which replaced the Swedish SS 62 77 50 standard in 2009.

Government programme: In 2005, industry began implementing standardised energy management systems (EnMS), with a clear focus on energy efficiency, and received certification according to the SS 62 77 50 standard, and, from 2009, European EN 16001 EnMS standard. This is required by the PFE, a five year voluntary agreement that requires electrical energy efficiency improvements (Petersson et al., 2011). The PFE also includes, in addition to the EnMS: an energy audit, implementing measures with a payback of less than three years, routines for energy-efficient planning and purchasing; and integrating Life Cycle Costs (LCC) of equipment.

Support and training: the Swedish Energy Agency has made available a number of handbooks on energy management, energy audits and analysis, purchasing and planning etc. (McKane et al. 2007). They have also developed case studies, and organised training on LCC and routines for energy-efficient purchasing. Similar to the Danish and Irish schemes, the accompanying support and training has been key in promoting EnMS.

Financial incentives: managed by the Swedish Energy Agency, the PFE offers reduced taxation (approximately €0.5/MWh), introduced in 2005 on industrial process-related electricity (McKane et al. 2007).

Table 3 Overview of EnMS standards within energy saving programmes

	Enterprise-government agreement	EnMS compliance and certification process	Agreement compliance beyond EnMS certification
EU	N/A	Two audits undertaken by certification body, the time in between the first and second audits being dependent on implementation conditions and preference. Certification last three years and is subject two surveillance audits during that time.	N/A
Denmark (EN 16001)	Agreement on Industrial Energy Efficiency (DAIEE)	Same process as above EN 16001	Annual reports on companies' performance as well as reports on the special investigations required to be submitted to the DEA.
Sweden (EN 16001)	Programme for Energy Efficiency in Energy Intensive industries (PFE)	Same process as above EN 16001	A list of measures with a payback of 3 years or less must be submitted to the Swedish Energy Agency. Must demonstrate continued compliance with EnMS by sending EnMS documentation from third party certification to Agency and continuous improvements over 5 years. The Agency also cooperates with the certification bodies and SWEDAC in order to verify that the certifications and re-certifications continue according to plans. Reporting on energy savings as a result of specific procedures for purchasing and planning.
Ireland (EN 16001)	Energy Agreement Programme (EAP)	Same process as above EN 16001	Must report annually on energy performance and energy savings opportunities and conduct 3 Special Investigations over 3 years.

3.4 Incentives

Governmental support for EnMS adoption in the countries reviewed is part of the broader programmes that companies sign up to. Support includes financial incentives (such as tax relief) ease of access to information (best practice, exchange and cooperation schemes, implementation guidelines, etc.) and technical tools (support to carry out energy audits, development of technical energy profiles, benchmarking tools). Table 4 below provides a comparison of these supporting policies.

Note that where referring to training, this is provided by the government. Training specific to the EnMS is also common practice by private bodies that provide certification, such as BSI, NQA and others.

Table 4 Incentives and support linked to energy savings programmes.

	Denmark	Sweden	Ireland
CO_2 or energy tax	Yes	Yes	Yes
Exemption from tax	Yes. Rebate from CO_2 tax.	Yes. Rebate from tax on industrial process-related electricity.	No
Sanction if breach on an agreement	Yes	Yes	No
Training &/or training materials for EnMS adoption	Yes. Guidelines and practical and operative tools help companies to implement and operate EnMS	Yes. Government published handbooks on energy management, energy audits and analysis etc.	Yes. SEAI provides a Technical Guideline for the use of the standard and various supporting guides and resources.
Technical assistance to enhance energy performance	Yes. The Danish Energy Agency trains energy engineers to assist companies in implementing EnMS.	Yes. Training on LCC calculations and routines for energy-efficient procurement.	Tailored support – including advice, mentoring and assessment through Agreements Support Managers

	Denmark	Sweden	Ireland
Other support	Special investigations supplement the energy audit and EnMS. The purpose of these investigations is to identify energy saving project. Subsidies of up to 50% of the audit costs can be granted from the DEA as well as subsidies for energy efficient investments.	Yes. Seminars for programme participants and best practice dissemination.	Special initiatives* are conducted every year. Special Working Groups are convened by the SEAI to research specific technologies, initiatives and areas of particular interest to members. Financial support for Special Investigations*: SMEs can also receive some potential financial support from Enterprise Ireland. ** Networking opportunities.
External recognition	No, except for case studies.	No, except for case studies.	No. No formalised recognition, however recognition provided by case studies, profiles in LIEN Annual report, seminar speaker invitations. SEAI has an Annual Energy Awards programme in which LIEN and EAP members have historical track record of successes.
Case studies	Yes	Yes	Yes

*Special Initiatives are government-led initiatives focused on specific technologies and areas of particular interested to EAP and LIEN members. Special Investigations, on the other hand, are requirements on companies to undertake a feasibility study on an aspect of their energy use (technologies, equipment, control strategies, maintenance, housekeeping) and integrated into the EnMS through the Register of Opportunities

**Enterprise-Ireland, a developmental agency for indigenous enterprises in Ireland (part of the Department for Enterprise, Trade and Innovation) does offer some assistance to SMEs. They can cover up to 50% of the costs as part of an environmental package to support SMEs environmental challenges – referred to as Greentech Environmental Supports. See http://www.envirocentre.ie/Content.aspx?ID=5099d296-2c06-4262-a498-82608cbcfe99&PID=fa27b05b-3661-42ec-a0bc-942d579781a7 & http://www.envirocentre.ie/

Not surprisingly, the greatest impact on industrial energy consumption, relative to the size of industry, has been in Denmark, which has had financial incentives since 1992, in the form of a carbon tax rebate, coupled with voluntary agreements and, as of 2001, energy management standards (McKane et al., 2007).

A different approach has been taken in the US, which has not explicitly promoted the use of its energy management standard nor offered either financial incentives or penalties for meeting energy reduction targets. As a result, relatively few plants are using the ANSI/MSE energy management standard in place since 2000 (McKane et al., 2007). This might change with the upcoming Superior Energy Performance programme, which will be launched to promote the adoption of the ISO 50001. SEP will be integrated with the voluntary Save Energy Now programme (although further information is required to determine the links) and a system of rewards "platinum, gold and silver" is available to companies to demonstrate performance improvements.[8]

Experience has shown that in these cases, incentives either in the form of a tax rebate or extensive technical assistance or training are instrumental in bringing in countries into energy savings programmes where certification of EnMS is required. Provision of incentives by government is critical if companies are to adopt the standards. For example, in Ireland, the Agreements Support Managers (ASMs) from SEAI accompany certification assessment personnel during their visit to the company and can provide recommendations on the company's EnMS implementation and further identify specific energy savings technologies, measures and practices that the certification personnel does not necessarily provide (pers. comm. Matteini).

3.5 Lessons learned

3.5.1 General trends in EnMS adoption

European countries that have chosen to standardise EnMS have all taken a similar approach in that they have:

- ensured the systems is compatible with other related standards such as EMS ISO 14001 and the quality standard ISO 9000 to allow the development of integrated systems;
- have learned off each other when developing their national standards (the Swedish and Irish standards are very much based on the Danish standard).

The EU standard picked up on the existing standards to ensure it would be compatible with these standards. The final draft of the ISO5001 standard (FDIS 50001), released for final ballot March 2011, is comparable and consistent with the existing EN 16001 Standard.

It is also important to note that energy savings agreements in Europe have, to date, played a very important role in the countries' energy saving and greenhouse gas mitigation objectives. However, Phase 3 of the EU Emissions Trading System (EU ETS) is expected to increasingly drive company efforts and may, over time, supersede the

[8] See http://www.superiorenergyperformance.net/qualify.html

motivational or compliance considerations of the energy saving agreements. This is because the agreements focus specifically on energy use and savings whereas the EU ETS will drive both GHG emissions reductions and energy savings, and offers companies greater flexibility in the achievement of their GHG targets from all energy sources and process emissions. The interaction between compliance with GHG, rather than energy savings, obligations and EnMS certification requirements is to be further explored.

3.5.2 Effectiveness of EnMS adoption and linked Agreements

International experience shows that when linked to an energy savings agreement between industry and government, standardised EnMS can be very effective in driving energy savings. Industries that implement and maintain an EnMS and obtain certification typically save 10-20% of energy within the first five years (NRC, 2011). Enabling programmes and measures greatly accelerate uptake of an EnMS. Several examples include:

Denmark: Typical savings of at least 10-15% were observed during the first years of implementation of the EnMS. It is estimated that about 60% of the emissions reductions from the DAIEE agreements were due to the implementation and maintenance of an EnMS (Price et al. 2010).

Sweden: According to Stenqvist et al. (2011), the PFE Agreements underpinned by the Swedish EnMS achieved 5% savings over five years. Recent analysis (Petersson et al. 2011) reports that in a recent review of the agreements, about three times more electricity than expected had been saved. A major success factor has been the systematic work outlined by the EnMS. The first five-year period of the Swedish PFE programme resulted in an electricity saving of 1.7 TWh/year (of a total 30 TWh/year for the industrial sector eligible for programme participation). In addition, savings of other energy sources have been achieved, but these are not monitored since the programme focuses only on electricity. The participants have:

- invested 708 MSEK (approximately €70 million) in more than 1200 electricity efficiency measures
- carried out more than 350 other measures in order to increase their energy performance, e.g. converted energy use from fossils to renewables, increased production of electricity (approximately 1 TWh) and increased delivery of surplus heat to external parties,
- implemented and certified standardised energy management systems (Petersson et al., 2011).

Petersson et al. (2011), also note the benefits EnMS standards reported by companies:

> *Overall, the implementation of EnMS at the companies turned out to be more valuable than most companies had expected. The fact that most of the companies already had certified Environmental Management Systems simplified the implementation considerably, but had also made many companies believe,*

> *when the programme started, that no extensive profit could come out of the expanded management system. This however proved to be wrong, according to the companies. Reported positive effects of the introduction of EnMS are e.g. the engagement of new personnel and expertise to a great extent: electrical engineers, energy specialists (incl. consultants), process engineers, buyers of production equipment etc. This resulted in a lot of new ideas in the energy efficiency area. The EnMS also lead to more elaborated measurement, calibration and monitoring of energy use in most companies. The certification bodies also conclude that all certified companies have found new efficiency opportunities that they have not found when energy was only a part of the environmental management system* (Petersson et al., 2011, pp.3-4).

Ireland**:** participants in the EAP reported that that 67% of the projects implemented to save energy were derived or driven by the EnMS process. Since the introduction of EnMS in Ireland in 2005 (I.S. 393), the pace of energy savings has increased.

3.5.3 Sectoral considerations

To date, countries have chosen to apply generic standards applicable to all sectors, in an effort to encourage widespread adoption. For example, the EN 16001 standard is deliberately generic so as not to discourage SMEs.

For large enterprises from energy-intensive industries, guidance for implementation tailored to specific sectors can usefully feed into standards adoption by enterprises in those sectors. Another question is whether sector-specific EnMS standards could be developed.

Sector-specific EnMS components could facilitate consistent use of performance indicators and operational control details. Yet an incremental approach may be the most pragmatic way to bring companies in initially, where EnMS is generic to begin with. Once companies gain confidence with adoption of an EnMS and implementation of first solutions, they may be more inclined to adopt more complicated technical solutions. At that point, sector-specific guidance may be useful (pers. comm. Matteini). This approach may be effective only for large companies, since SMEs may not have the capacity to overcome the complexity involved in sectoral EnMS standards.

3.5.4 Other lessons learned

The important factors for successful adoption of energy management standards are the existence of:

Strong compulsion: usually in the form of negotiated agreements, where adoption and certification of EnMS standards is a requirement of participating in the agreement.

Widely available support: technical, financial and education and training. The implementation of EnMS requires significant training and skill. There is a need to build not only internal capacity within the organisation, but also external capacity from knowledgeable experts to help establish an effective implementation structure.

Technical assistance from energy auditors / energy assessors can help to further identify EE opportunities under the EnMS framework and provide recommendations to the company (where certification auditors are not able to provide such advice). When technical assistance is provided on a cost-share basis (rather than fully provided by the government), this can garner greater ownership and commitment by enterprises. In Ireland, the additional cost of the accreditation process by having the requirement to have a SEAI technical assessor was financially supported by the government to 1) encourage the uptake in certification body accreditation to the new standard and 2) support the requirement of having EnMS's that are operating and adhering to SEAI's Technical guideline.

Comprehensive monitoring: company reporting and government verifying progress toward meeting energy efficiency targets and carrying out items in the strategic energy plans.

Continuous learning and improvements in the use and operation of EnMS: implementing an EnMS is the start of the journey. The EnMS can be continually improved offering higher level of performance and effectiveness. The government can have a role in facilitating the development in thinking, methods and the continuous improvement process. Good energy management typically is a good reflection of good operations and business management.

4 Some Suggestions for EnMS Promotion in China

EnMS standards can be effective as stand-alone initiatives, but are more important for their enhancement of higher-level (or effort defining) policies such as energy savings agreements between industrial enterprises and government. In the European countries reviewed above, EnMS are a core, mandatory part of the broader energy conservation agreement packages between governments and industrial enterprises. Enterprises participate in the broader energy conservation agreements in order to receive the tax benefits, technical support and/or reputational benefits that these agreements bring. Providing training on the EnMS as well as case studies is also a key to drive successful implementation of EnMS. Promoted this way, the results in terms of enterprise uptake of EnMS are exceptionally good, with enterprises typically making savings of 10-20% within the first five years.

In its efforts to foster EnMS implementation in enterprises, China also may wish to strongly imbed EnMS implementation within the overall framework of the broader energy conservation agreement and support programmes of the government with key enterprises. If properly implemented, standardised and certified EnMS can be the platform used by enterprises both to meet all of the state's energy efficiency requirements, and also to enhance profits by saving energy costs.

Many of the programmes of the Chinese Government to foster energy conservation in key industrial enterprises[9] are similar in concept to those adopted in other countries, even if governments outside of China typically put more emphasis on voluntary programmes with incentives, rather than mandatory obligations. The "mainstream programme" for key industrial enterprises in China developed during the 11th Five Year Plan, which is expected to be further strengthened during the 12th Five Year Plan, includes:

- Mandatory energy savings agreements between government supervising agencies and key industrial enterprises. The Central Government's Top-1000 enterprise programme set the model. Provinces and prefectures added many agreements with thousands more enterprises under their supervision.
- Requirements for key enterprises to report energy use statistics to the government at least annually. This is required under the Energy Conservation Law, and various regulations define the scope of reports required.
- Assignment of enterprise Energy Managers in key enterprises, as the persons responsible for implementation of enterprises energy conservation work and for

[9] China's energy conservation law and many subsequent regulations employ the term "key enterprises' which include all industrial enterprises with annual energy consumption of over 10,000 tons of coal equivalent (tce), and, if also so designated by provincial/local governments, enterprises with annual energy consumption of over 5000 tce. All Top-1000 enterprises and all Top 10,000 enterprises are key enterprises.

making sure that all relevant state requirements are met. Implementation programmes are underway.

- Requirements that enterprises meet a series of energy efficiency standards established by national and provincial governments. These include unit energy consumption ceiling standards for quite a few lines of manufacturing as well as efficiency standards for many types of key equipment.

- Provision of various incentives to assist enterprises to meet their energy savings obligations. During the 11th Five Year Plan, this included provision of sizable energy conservation awards per unit of energy savings capacity generated through qualifying large energy conservation investment projects.

Based on international experience, implementation of standardised EnMS may achieve its highest value if implemented as a core, interrelated part of the above government-enterprise energy savings agreements and related activities. If implemented properly, EnMS can provide a systematic, efficient, and continual mechanism imbedded within enterprise internal management practices to ensure compliance with the key requirements of the Chinese Government, such as (i) systematic energy consumption data reporting, (ii) evaluation of the extent to which all equipment and processes comply with applicable energy use standards, (iii) preparation and submission of energy conservation plans, (iv) identification of key energy conservation projects, and (v) reporting on energy savings results achieved as well as reports on progress towards achieving their target.

If certification systems are able to ensure proper adoption, as in Ireland, Sweden, and Denmark, government supervision efforts for enterprise energy savings agreements may be able to focus more on the adequacy and quality of EnMS adoption within enterprises. This can then allow less intense separate supervision of the various individual regulatory requirements of the government (standardised data collection and reporting, checking on enterprise compliance with equipment and unit energy consumption standards of the government, preparation and filing of energy conservation plans with the government, etc.). In the future, steady operation of certified EnMS might perhaps also provide a practical, objective platform to discuss and agree on the energy savings targets to be included in future government-enterprise energy savings agreements.

For enterprises, proper adoption of EnMS may make it easier to comply with the many government regulations, by using one systematic, continually operating approach. In addition, although proper implementation according to applicable standards should be rigorously certified, operation of the EnMS system is under the control of enterprises. Enterprise managers and experts can ensure that the energy conservation plans prepared and identified project opportunities are firmly grounded in the specific realities of their enterprises. The EnMS also can systematically identify the energy savings measures, which generate the greatest profitability to the enterprise, as well as also meet the obligations of the state.

In the interests of both the government and enterprises, proper adoption of standardised EnMS methods have been shown to greatly facilitate the identification of energy saving opportunities, especially through changes in operating practices, which go far beyond what the enterprises had been able to achieve through self-designed systems. This is particularly true for the standardised energy assessment component and the building of capacity within the company whereby top management and staff from all of the different functions of the enterprise partake in the EnMS administration and implementation.

If Chinese authorities and companies wish to implement certified, standardised EnMS as a core part of broader government-enterprise energy savings agreements and support packages, several points might best be kept in mind:

- Rollout of implementation of standardised EnMS might best closely involve government energy conservation supervision and monitoring units, especially at provincial levels (e.g., provincial energy conservation supervision centres). The detailed guidance provided on the standardised EnMS should ensure that proper adoption of the EnMS can meet all relevant local government requirements. The adoption of standardised EnMS can then help systematise and greatly ease the burden and complexity of enterprise energy conservation supervision work, benefiting both the supervision and monitoring units and the enterprises.

- It is possible to minimise the burden on the government, from compliance checks, to checks of certification status only with major non-conformances to the EnMS being escalated. The certification bodies are tasked to audit all clauses outlined in the standard and any additional components of the EnMS requested by the government – including data reporting. All Certification Bodies must be accredited by the government's accreditation body. The cost is embedded within the certification process itself – but can be incentivised for a period of time.

- As the international experience shows, incentives should best be offered to enterprises who adopt certified standardised EnMS, but that these incentives can be grounded within overall energy savings agreement packages. In the Chinese context, the basic point is that enterprises that adopt certified standardised EnMS should be demonstratively in a better position in their broader energy savings agreement relationship with the government than enterprises that do not adopt the EnMS. Perhaps the burden of government supervision should be shown to be clearly easier to accommodate. Perhaps government-supervising units can offer specific programmes of technical support only to enterprises that adopt certified EnMS. Perhaps enterprises that adopt certified EnMS can receive priority consideration for financial support, such as energy conservation project awards.

The Institute for Industrial Productivity and the Energy Foundation's China Sustainable Energy Program are able to further explore with Chinese counterparts thoughts on international experience in implementing EnMS, any of the ideas presented in this brief, and any potential needs for more specific advisory involvement of practitioners from government-sponsored EnMS promotion programmes in other countries.

In addition, it is worthwhile to note that the Institute for Industrial Productivity has developed a tool that uses a benchmarking approach to assess the current energy efficiency levels of ammonia factories. By using the Assessment to Action (A2A) tool, companies can compare their current EnMS practices to a draft of the ISO 50001 standard as well as the companies' technologies compared to best practice technologies.

Participating companies receive:

- A "snapshot" (Report card) of their energy savings performance.
- An identification of opportunities, both in terms of technical best practices and management best practices opportunities. These opportunities are then prioritised.
- An energy management Action Plan checklist and template. This provides companies with suggestions on how they can allocate energy management responsibilities, tasks and scheduling.

Training on the tool is currently being provided free of charge to companies interested.

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6 Appendix 1 Roles and functions of EnMS

	Standardisation body	Accreditation body	Certification bodies (examples)
EU	European Committee for Standardisation (CEN)	European Accreditation member accreditation bodies[10]	BSI, NQA, Veritas among others.
Denmark	Now CEN. Previously Danish Energy Agency (for DS 2403:2001).	DANAK (company managed by a Board consisting of representatives from industry, organisations and authorities).	Veritas, among others
Sweden	Now CEN. Previously the National Energy Agency and the Swedish Standards Institute	SWEDAC (government authority)	Veritas and six others
Ireland	National Standards Authority of Ireland	Irish National Accreditation Body	NSAI, Certification Europe.
US: planned application of ISO 50001.	ISO (PC242 working group, UNIDO). Involvement of the American National Standards Institute (ANSI)	ANSI/ASQ National Accreditation Board (US).	DEKRA Certification Inc. (previously KEMA Registered Quality, Inc.).

[10] List of EA accreditation bodies at http://www.european-accreditation.org/n1/doc/EA-1-05.pdf