Overcoming Implementation Gaps Through A Business-Oriented Energy Management System Support Package in China

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ABSTRACT

Seeking new ways to achieve further energy efficiency results in the face of rising energy, environmental, and economic challenges, the Chinese government is encouraging the country's largest energy-consuming industrial enterprises to establish Energy Management Systems (EnMS). International and increasing Chinese experience shows that effective EnMS implementation is a key means for enterprises to continuously and systematically identify, achieve, and sustain substantial cost, energy, and emissions savings, and increase competitiveness.

In the past few years, China has developed national and provincial-level EnMS standards and policies, sector guidelines, and local capacity to implement EnMS. These efforts helped create initial awareness, an institutional framework, and a few strong case studies around international-standard EnMS implementation in China. However, further policy design and implementation efforts are necessary to achieve impact in China's changing competitive industrial environment. Additional domestic and international support could greatly help to build capacity, approaches, and tools that can be harnessed by the market to achieve scale.

This paper provides an overview of China's experience in promoting EnMS, and discusses efforts underway to fill gaps in the implementation of quality EnMS in China. It explores the collaborative work of local governments, enterprises, and experts to develop a local platform of EnMS knowledge, experience, examples, and tools through pilot and large-scale capacity building and implementation programs. The paper then provides conclusions on where further support is needed for effectively scaling up China's promising program.

Introduction

China's economy has relied on heavy-industry led growth to power its development since the turn of the century. This has lead to rapid growth in industrial energy consumption and emissions, and now overcapacity in key heavy-industry sectors. After the past ten to fifteen years of significant investment in these sectors, China's industrial growth is starting to slow down, and new efforts must be made to address enterprise competitiveness. The Chinese government has made energy efficiency a priority through the period of growth, but until recently relied mostly on government requirements and subsidies for equipment upgrades. After earlier provincial experimentation, however, the central government included a mandate for the largest industrial enterprises to implement Energy Management Systems (EnMS) in the current 12th Five Year Plan (FYP).[1] As proven by international and domestic Chinese experience, EnMS is a key means for

[1] The Chinese government uses Five Year Plans to set its main economic and social development and reform strategy, and includes key industrial, energy, and environmental targets, policies, and requirements.

continual, long-term energy efficiency improvement in an enterprise through a combination of equipment, system, operations, and management changes.

China has established an institutional structure of local energy conservation centers and third party service providers to monitor and support enterprises in their EnMS implementation. Local and international groups have carried out capacity building programs and developed an initial set of locally appropriate case studies, tools, and technical support and training materials. Because many local governments and service providers are new to EnMS, however, support for additional capacity building, case study development, and scale-up is necessary to ensure all of China's tens of thousands of large industrial enterprises can implement EnMS effectively.

China is currently developing and will begin to implement its 13th FYP from 2016 to 2020. This will include further ramped-up efforts to address the growing economic, energy, and environmental challenges that China is currently facing. According to the leadership announcement as part of the Third Plenum of the 18th Party Congress, China will do this by relying more on the market (18th CC of the CPC 2013a, b). This provides the perfect opportunity for domestic and international stakeholders to support China's vital EnMS work.

Overview of China's Experience Promoting EnMS

China's Industrial Sector and its Energy Consumption

Driven by rapid urbanization and increasing living and consumption standards, China has been in a period of accelerated industrial development since the turn of the century. Industrial value added grew at 11.3% per year from 2001 to 2010 (NBS 2011a). However, beginning in 2013, China's economic and industrial growth entered into what the Chinese leadership calls the "New Normal" after years of beating targets and achieving double-digit growth rates. After years of investment in factories and infrastructure projects, China is facing severe overcapacity in some industries (e.g. iron and steel, cement, and chemicals), as well as extreme environmental pollution. In order to successfully transition its economy to more economically and environmentally sustainable growth, China will need to rely more on domestic consumption as opposed to infrastructure and fixed asset investment. The transition will require production of less energy-intensive and more high value-added products as China also needs to meet rising demands for better environmental protection from its growing middle class (World Bank and Development Research Center of the State Council, P.R. China 2013).

Industry is by far China's largest energy user, responsible for about 70% of the country's energy use and an even greater share of its carbon and other emissions. Given China's shortage of natural gas and other energy resources, China's industry sector has relied largely on coal and coal-based electricity (NBS 2015). Coal use in industry totaled more than 2.5 billion tonnes of raw coal in 2012[2] (NBS 2015). Accordingly, in 2010, China's industrial sector emitted about 5,400 Mt CO_2. This was higher than the total energy-related emissions from the United States or any other entire country besides China (IEA 2012).

Because of the scale of the energy consumption and emissions in the country's industrial sector, China's government has promoted perhaps the world's most aggressive industrial energy efficiency program.

[2] Including coal used to produce electricity consumed in industry and coal used for producing coke.

Chinese Industrial Energy Efficiency Policy Framework

Starting in 2006, the Chinese government has led an aggressive national effort to reduce the energy intensity of the country's economy. China achieved a 19.1% reduction in energy intensity during 2006-2010 (NBS 2011b). The industrial sector provided the largest contribution.[3] The country is well on its way to achieving its 2011-2015 energy intensity reduction target of 16% but further reductions are critically needed. In the coming years, however, further improvements in industrial energy efficiency will become more and more difficult to achieve through past approaches and existing tools and capacity.

Top-10,000 Enterprises Energy Efficiency Program. Building on a previous, successful program for the top 1,000 enterprises, the 12th FYP highlights the Top-10,000 Enterprises Energy Efficiency Program (Top-10,000 Program) as a central approach to helping China achieve its energy intensity reduction target. The Top-10,000 Program actually covers more than 16,000 of China's biggest energy using enterprises,[4] including more than 14,000 industrial enterprises. These enterprises account for 85% of China's total industrial energy use and more than 60% of total national energy use. The Program aims to achieve a cumulative savings of 250 Mtce (625 Mt CO2e) by 2015. Energy savings agreements between enterprises and the government set out responsibilities for both parties and include mandatory, quantified energy savings targets for each enterprise. Enterprises are also required to report on energy use patterns in specified formats, assign energy management personnel, and meet minimum energy efficiency performance standards for certain processes and equipment, as well as achieve their savings targets.

Government energy consumption supervision system. Government supervising authorities are required to assess enterprise progress towards targets and compliance with regulations every year. The authorities also need to assist enterprises in taking advantage of the wide range of government support programs available. Specialized government-directed energy conservation centers are now in place in virtually all provinces. At present, provincial energy conservation supervision institutions have been set up in all of China's 31 provinces. There are now a total of about 2000 energy conservation supervision institutions including those at the provincial, prefecture, and county levels. Staff capacity in these supporting centers is varied and significant capacity building is required if they are to effectively support both the central government and enterprises in implementing China's industrial energy efficiency policies and programs.

Market-based mechanisms. The Chinese government has been seeking to bolster market-based mechanisms to complement regulatory incentives. It is strengthening price and tax-based incentives to support the implementation of various programs, and is encouraging innovative market-based project investment solutions. Efforts currently include further implementation of energy price reforms and favorable tax treatment policies, development of carbon emissions cap and trading schemes, further encouragement to commercial banks for scaling up energy

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[3] Total primary energy savings during the 11th FYP, compared to a frozen baseline of energy intensity at 2005 levels, is calculated at 765 mtce (NDRC 2011). Total industrial sector energy savings reported by the Ministry of Industry and Information Technology during the 11th FYP amounted to 630 mtce (MIIT 2011).

[4] The Program includes all enterprises that consume more than 10,000 tons of coal equivalent (tce) per year, for which government supervision of enterprise energy use is mandated under China's Energy Conservation Law (as amended in 2007).

efficiency financing programs, and continuing support for China's rapidly growing energy performance contracting industry operated by energy service companies (ESCOs). Most importantly, as part of the Third Plenum of the 18th Party Congress, China's leadership set the market as the key to maintaining its growth and solving the problems brought from previous growth. This devolvement of power from the government to the market includes the recent decision to end subsidies for some energy efficiency projects, a reduction in project approval power, and limiting market participation to entities that have applied, been accredited, registered, and listed by the government.

Energy Management Systems (EnMS)

Energy Management Systems (EnMS) are systematic processes for ensuring continual improvement of energy efficiency in an enterprise. They aim to achieve cost savings through improved management and operational control of existing facilities, and implementation of prioritized projects. It requires a cross-departmental approach for the entire enterprise.[5]

At this stage in China's energy efficiency efforts, promotion of EnMS is especially important for the following reasons:

- Operation of EnMS can help enterprises cut costs and better compete in the current economically difficult domestic industrial environment. Many industrial sectors are facing tough times given surplus domestic capacity and prospects for continuing slow demand growth. EnMS can provide a systematic way to steadily reduce operating costs, often through low-cost measures, and improve the company bottom line.
- Operation of EnMS can identify new, different types of energy efficiency improvement measures by digging into system optimization issues and crosscutting measures. Most enterprises in China in the past have focused on relatively simple energy efficiency projects involving switch out of equipment, addition of waste heat or gas power generation, or other projects involving discreet equipment-focused retrofits. Some are now at a loss as to where to find new savings. EnMS can help identify savings in process adjustments, cross-workshop energy system optimization, and improved management protocols that provide substantial additional savings.
- EnMS can be continually operated by enterprises themselves, with an internal profitability focus that resonates with the emerging more market-oriented environment, without needs for continuous government involvement.

China's initial EnMS efforts. As China's first major efforts at industrial energy efficiency, the 11th FYP and its Top-1,000 Program (2006-2010) were largely focused on building the initial institutional infrastructure and capacity for energy efficiency improvement, and support for equipment-level upgrades. China's large eastern industrial Shandong Province, however, piloted EnMS in a small group of key enterprises during the 11th FYP. The Province was interested in using EnMS for more effective implementation of efficiency regulations and investments, and to promote continuous improvement. Shandong issued its own EnMS standard, implementation guidelines and training programs, and developed a plan for broader roll out.

National standard (GB/T 23331). The Standardization Administration of China (SAC) issued a

[5] ISO 50001 provides one framework for such a system.

national EnMS standard (GB/T23331) in 2009 and revised it in 2012 with increased consideration of the international ISO 50001 standard. At the same time, guidance materials on how to implement the national EnMS standard were released. To provide more detailed technical support for EnMS implementation, the China National Institute of Standardization (CNIS) has been developing sector-based EnMS implementation guidelines for the iron and steel, cement, coal, and other sectors.

EnMS certification program. China's central government developed an institutional structure for EnMS certification where accredited certification agencies are responsible for the validity of EnMS certification and to continuously improve the quality of their services to enterprises at a reasonable cost. The central government gave provinces the flexibility to make EnMS certification voluntary or mandatory. For those provinces that do not adopt mandatory certification, local energy conservation authorities should develop clear and consistent evaluation standards, and ensure that these standards are being followed by relevant agencies or experts conducting evaluation of enterprise EnMS performance.

The Certification and Accreditation Administration of China (CNCA) initiated an EnMS certification pilot program with 31 accredited certification bodies in 2010. The pilot program initially covered 10 sectors (iron and steel, nonferrous metals, coal, power, chemicals, building materials, machinery, light industry, textiles, and paper), and then extended to three additional sectors (information technology, public buildings, and transportation) in 2012. Government-directed training courses for EnMS certification compliance auditors were conducted to improve the capacity of accredited EnMS certification bodies. According to CNCA, by the end of September 2014, there were 647 companies accredited for EnMS certification.

Top-10,000 Program requirement. In November 2012, the Chinese government, through the National Development and Reform Commission (NDRC) and the Ministry of Industry and Information Technology (MIIT), officially mandated provinces to promote EnMS and evaluate the EnMS performance of enterprises that are covered in the Top-10,000 Program. Provincial energy conservation authorities are required to make plans to advance EnMS adoption in Top-10,000 Program enterprises in their respective jurisdictions and encourage Top-10,000 enterprises to improve their energy management level and comply with the national EnMS standard.

Gaps in EnMS Implementation

While a few provinces have begun to show meaningful results, EnMS implementation is just starting in the majority of provinces in China. In Shandong, the leader so far, 657 enterprises have completed initial EnMS establishment and received certification or favorable performance evaluation by the province. Shandong authorities expect about 1,000 enterprises will have completed initial EnMS establishment by the end of 2015 (Shandong Energy Conservation Office, pers. comm., May 2015). In Yunnan Province, which is far more typical, less than 30 of the approximately 400 Top-10,000 enterprises in the province have a certified EnMS (Yunnan Industrial Energy Efficiency Officials, pers. comm., May 7, 2015). According to national EnMS experts, enterprises with certified EnMS numbered in the hundreds, not in the thousands, at the end of 2014 (National EnMS Expert, pers. comm., January 15, 2015).

China's EnMS implementation program will thus certainly need to continue over at least the

next five years. The effort so far has suffered from the following shortcomings which will need to be addressed in the future:

- The current top-down approach for promoting EnMS too often portrays EnMS establishment primarily as a necessary administrative measure to meet regulatory requirements under the Top-10,000 Program. Experience so far shows that this often leaves enterprises poorly motivated and passive—reacting only to demands by the regulators. Resulting actions typically focus only on completing required paperwork. Alternative, more business-oriented approaches, such as those piloted by IIP and others, focus more on the cost-savings benefits to enterprises and the strong business case for EnMS establishment. Results of the business-oriented approach show great promise in pilots so far, but this approach needs to be further scaled up.
- Recent EnMS promotion efforts have at times failed to engage enterprise senior management in a meaningful way, with work focused only within the relevant energy management department. As is well known both in China and internationally, EnMS needs to cut across the whole enterprise to fully realize its advantages and this requires active senior management involvement.
- There is a lack of experienced, high-quality service providers to assist enterprises in establishing EnMS. EnMS implementation requires a combination of both the knowledge of management systems and the practice of energy efficiency opportunity identification and implementation. Traditional service providers like ESCOs and industry research institutes are very capable of helping improve the energy efficiency of certain processes or equipment (as opposed to management and systems-level improvements). At the same time, many new EnMS certification and consulting organizations are entering the field from their experience with quality and environmental management systems which have not been very successful in China to date. Thus there is a big gap between the significant needs of Chinese enterprises and the capacity of domestic EnMS service providers.
- There is a shortage of practical, business-oriented approaches, tools, case studies, and training course materials and curricula. EnMS standards and the key steps to establishing EnMS are well covered in most current EnMS-related training courses. However, the use of practical tools and case studies are still missing in training curricula. Business focus is typically absent. Courses may be dry, without sufficient opportunities for dialogue and on-site learning from practitioners or peers.

Example of Possible Solutions

Because of China's unique challenges and situation, China requires multiple customized solutions to ensure its EnMS implementation efforts succeed. In one effort, EF China and IIP are working with domestic and international practitioners, enterprises, and government institutes and agencies to build the support package that will enable scaled-up implementation of effective EnMS to deliver the necessary cost, energy, and emissions savings in Chinese enterprises.

Case studies and tools. To help convince the senior management of Chinese enterprises of the value of EnMS, and provide practical examples of the motivations, process, and results behind EnMS, IIP developed nine business case studies that demonstrate the cost-saving and other benefits of EnMS implementation in both large and small corporations. The seven Chinese

case studies focus on two key heavy industry sectors: iron and steel, and cement, and geographically in the developed industrial centers of eastern China, especially Hebei and Shandong Provinces. The most detailed case study is that of the successful EnMS of Baosteel, the fourth largest steel producing company in the world. While this case study of such a large, famous company is very useful in bringing attention and inspiration to the potential of EnMS, it is hard for most Chinese enterprises to harness the resources available to Baosteel for their own EnMS work. IIP has also developed case studies for the Beijing Cement Plant, Hansteel (now part of the fifth largest steel producer in the world), Jinan Iron and Steel, two cement plants in Shandong under the China United Cement Company (in Dezhou and Qufu), and Gold Huasheng Paper in the Suzhou Industrial Park. IIP has disseminated these case studies through its website, WeChat social media platform, one-on-one meetings, and training workshops. International case studies are of 3M and Darigold. IIP has also developed EnMS implementation guidance materials for iron and steel and cement companies.

Through pilot enterprise work, IIP also worked with international experts to develop a locally appropriate, practical tool and guideline for the key Energy Review phase of EnMS implementation. Out of this, IIP developed a simplified, practical spreadsheet tool to help enterprises begin their EnMS establishment by collecting energy consumption, production, and other data in one place for reference, analysis, and use. The tool and guideline help enterprises to perform a regression analysis by themselves to develop energy consumption baseline equations that are more accurate than the unit production energy consumption ratio most Chinese enterprises currently use to benchmark energy consumption. IIP has also translated and localized the U.S. Department of Energy's detailed, practical EnMS ISO 50001 eGuide. The next step to maximize impact is to integrate these tools with local training and enterprise support programs, and develop additional practical tools to guide Chinese enterprises and experts in all sectors and regions in each stage of EnMS implementation.

Additional tools and case studies, such as those in other sectors and in less-developed regions and enterprises, are necessary for wider scale learning and replication. Local governments in China's western, less-developed provinces are eager to promote EnMS implementation in local enterprises, mostly in the dirty coal- and petrochemicals industries, but have little experience or capacity, or relevant tools or case studies to share (Gansu, Sichuan, and Yunnan Provincial Energy Conservation officials, pers. comm., April and May 2015).

Business-oriented EnMS pilots and approaches. After initial capacity building and international best practice sharing activities, IIP and EF China provided key support to three pilot enterprises in Shandong, and helped build the capacity of local government agencies. The most successful of the three pilots in Shandong's industrial Dezhou prefecture was an old, dirty, inefficient paper mill more than an hour's drive through rural towns outside of the third- or fourth-tier city. With 1,300 employees, the enterprise produced 83,000 tons of paper, generating revenue of approximately $75 million in 2013. Its 66,000 tce of total energy consumption (79,000 tons of raw coal and 80 million kWh of electricity) accounted for 30% of its total costs. The privately owned company was struggling for survival because it was losing money and under potential attack from the provincial environmental authorities for excessive air and water pollution. Over the course of nine months of support for EnMS establishment and implementation, however, the enterprise has implemented many identified energy saving equipment and management upgrades, leading to significant cost savings and improved environmental performance.

IIP and EF China worked with an international and domestic expert team to develop and introduce a UNIDO-based business-oriented EnMS approach and tools to the enterprise. The interaction focused on EnMS as a cost-saving tool in addition to helping the enterprise meet the increasing energy and environmental requirements from government and society. The attendance of the enterprise's deputy general manager in the introductory session to hear this message was key to getting his support for the work. In addition to energy management experts, IIP also had sector experts help identify specific energy and cost saving opportunities. This was also critical in securing high-level management support in this Chinese enterprise.

Through onsite and remote support, the enterprise conducted a regression analysis of their energy consumption baseline, prioritized and began implementation of identified energy saving projects, held daily energy management team meetings, and received a score of 80 on their expert evaluation in November 2014 (the end of IIP's support to the enterprise). Energy savings from the 11 identified projects were 10% of their total annual energy consumption (66,000 tce), with cost savings of $800,000 per year. As of November 2014, the paper mill had implemented 6 of the 11 improvements, with savings of 3,000 tce and $300,000.

IIP and EF China also worked with U.S. Strategic Energy Management (SEM) experts at EnerNOC to develop a more detailed 8-step process and approach for enterprises to establish a business-oriented EnMS, and strengthened the capacity of local governments and experts to support enterprises in implementing EnMS. With the local energy efficiency authorities, IIP worked with international and local experts under a World Bank project umbrella in Jiangsu and Sichuan Provinces to provide capacity building and technical support to four pilot enterprises. Through this support, at least two of the EnMS pilot enterprises, one chemical and one non-ferrous metal plant, have been successful.

IIP and EF China are applying the results and lessons from previous work in their current work in Yunnan Province. In cooperation with national experts and a local university, IIP and EF China are combining large-scale but practical, high-quality classroom training with smaller hands-on learning-by-doing training through technical support to pilot enterprises. Classroom training will be delivered to three separate audiences: government officials, third-party service providers, and enterprise senior management and energy management staff. The curriculum includes peer learning through invitation of the successful Shandong pilot enterprise to share their experience, as well as interaction and role-playing between the trainers and trainees. Provincial and local government officials, third party service providers, and enterprise staff will all be involved in technical support to the pilot enterprises in Yunnan to build their capacity. This work will increase the critical mass of both persuasive replicable case studies in various sectors and regions as well as high-quality third party consulting company staff to scale up impact once there is awareness and demand of the benefits of EnMS among other companies.

While much good work has been done on the foundation laid by the government, reaching the scale and diversity of all of China's Top-10,000 and additional key enterprises across the country will require significant additional support for capacity building, tool and case study development, peer-to-peer learning and best practice sharing, and implementation. This is especially the case in China's most undeveloped western regions, and largest and dirtiest industries facing competitiveness and overcapacity challenges, such as the iron and steel, cement, and chemicals industries.

Conclusion

Propagation of EnMS in Chinese industrial enterprises has the potential to achieve a step change in China's all-important industrial energy efficiency drive. Operation of quality EnMS can provide the foundation for developing broader, cross-organization and system optimization measures that hold much of the potential for further energy savings now that many of the easier measures may have already been undertaken in a plant. Propagation of EnMS also can help better align enterprise internal cost-savings incentives with the government's public interest drive for greater energy efficiency and emissions reduction. Promising work during the last four years has laid the ground for the future. What is needed now is effective scaling up.

Promotion at the provincial and prefecture levels holds the key for EnMS implementation as these are the levels where public sector energy efficiency units and third-party energy efficiency service companies intersect with industrial enterprises on a daily basis. In China, support is needed for (i) further piloting of quality EnMS implementation efforts among interested enterprises using a business-oriented approach, (ii) organizing and funding larger and larger-scale promotion efforts, and, especially, (iii) massive capacity building efforts for local public sector support units, service company staff specializing in EnMS, and enterprise energy management staff (including promotion of case study dissemination, training, development of locally useful tools, development of performance evaluation methods, etc.).

Carefully targeted international support could help a lot to achieve a big impact. Areas frequently requested by Chinese practitioners include: (i) provision of business-oriented case studies of effective cost savings in foreign companies achieved through operation of EnMS, (ii) assistance in developing EnMS implementation tools for Chinese conditions; (iii) assistance in developing practical training materials and implementation tools that can be used on-site; and (iv) assistance in developing methodologies for evaluating newly established EnMS in selected enterprises.

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