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Energy Performance Evaluation Methodology Development and Promotion in APEC Economies

Final Report

APEC Energy Working Group

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Abbreviations and Acronyms

ASEAN	Association of Southeast Asian Nations
CEC	China Electricity Council
CIPEC	Canadian Industry Program for Energy Conservation
DOE	U.S. Development of Energy
EPA	U.S. Environmental Protection Agency
EPI	Energy Performance Indicator
EEI	Energy Efficiency Indicator
ESCO	Energy Service Company
EENP	Energy Efficiency National Partnership of Singapore
EnMS	Energy Management System
EUEEP	China End-Use Energy Efficiency Project
GEF	Global Environment Fund
kgce	Kilogram of Standard Coal Equivalent
METI	Ministry of Economy Trade and Industry of Japan
MIIT	Ministry of Industry and Information Technology of China
NDRC	National Development & Reform Commission of China
OEE	Office of Energy Efficiency of Canada
SEP	Superior Energy Performance
tce	Ton of Standard Coal Equivalent
UNDP	United Nations Development Program

1. Introduction

Energy Management System (EnMS) is an important management means by which organizations establish the systems and procedures necessary to achieve operational control and continual improvement of energy performance. It has been applied in many economies and areas, such as Australia, China, USA and India. As International Standard of Energy Management System (ISO50001) was promulgated in 2011, EnMS should be widely promoted in the future.

Among these EnMS components, energy performance evaluation plays a fundamental supporting role in measuring and evaluating the improvement of energy performance. Therefore developing a mature and practical energy performance evaluation methodology becomes a key point to promote and implement EnMS.

Nowadays many economies in APEC region have implemented a series of energy efficiency policies, programs and mechanisms (including EnMS). Some of these have developed energy performance evaluation methodologies, conducted energy performance evaluation pilot projects, and obtained lots of experience and effectiveness. These are the foundation for the development of a comprehensive and commonly-recognized energy performance evaluation methodology.

In the study, a general energy performance evaluation methodology for industrial enterprises will be developed based on summary and analysis on energy performance evaluation methodologies and practices in APEC economies, to facilitate the implementation of EnMS, establish a long-term energy efficiency improvement mechanism as well as provide support for relevant energy efficiency programs.

1.1 What is Energy Performance Evaluation?

Performance evaluation is first employed in investment project management and then widely applied particularly in business and human resources management. It is classified into individual performance and organizational performance, and it is comprised of actions of individuals or organizations and corresponding results.

Energy performance evaluation means applying scientific criteria, methods and procedures to make correct evaluation as much as possible on energy performance achieved by individuals or organizations.

In this study, we focus on the energy performance evaluation on organizations, namely industrial enterprises. In this context, parties involved in energy performance evaluation may include the evaluator, the organization to be evaluated, and a third party (if needed). If the evaluator and the organization to be evaluated reach an agreement or launch a partnership, under which the organization to be evaluated promises to or is required to compulsorily realize certain energy efficiency goals within certain time, the evaluator may organize a third party to evaluate energy performance

of the organization to be evaluated or conduct this on its own, and then gives rewards or punishments to the organization to be evaluated as agreed in advance. The mechanism of the energy performance evaluation is shown in Figure 1. If the energy efficiency measures are initiated and implemented completely by the organization to be evaluated, and the organization has the ability to conduct energy performance evaluation, the energy performance evaluation can be conducted by itself.

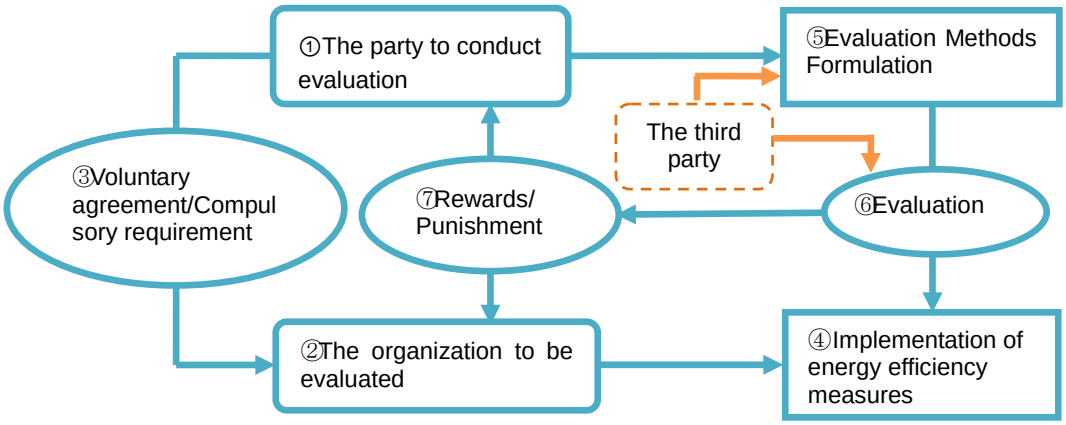

Figure1: Mechanism of Energy Performance Evaluation

Development of energy performance evaluation methodologies is a key component of a successful energy performance evaluation program. A mature energy performance evaluation methodology should include evaluation scope, indicator, criteria, method, procedure, etc. A typical process to establish energy performance evaluation methodology is shown in Figure 2.

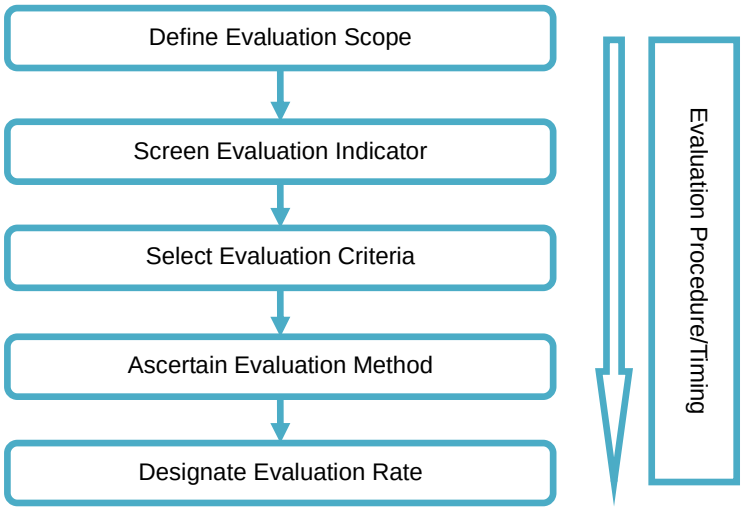

Figure 2: Typical Process to Establish Energy Performance Evaluation Methodology

The core part is the determination of evaluation indicator and evaluation criteria, but sometimes it is very difficult. For example, if we want to adopt an energy performance indicator, it is easy to determine the decline rate of energy consumption per unit of

product as an evaluation indicator, and the national/international energy efficiency standards as its evaluation criteria. However, if we want to develop a technology or management indicator, it will be hard to find a indicator to describe the technology or management level and which technology or management measure is the national/international advanced. See the table below for details.

Table 1 Example for Energy Performance Evaluation Indicators

1. Evaluation object	2. Evaluation Indicator	3. Evaluation Criteria	4. Evaluation Method	5. Evaluation Result
1.1 Energy efficiency	Energy consumption per unit of product	National or international energy efficiency standards	Measurement and comparative analysis, and then quantitative grading	1.Outperformance 2.Accomplished 3.Not accomplished
1.2 Technology	?	?	?	
1.3 Management	?	?	?	

1.2 Why Energy Performance Evaluation is so important?

Energy performance evaluation is closely associated with energy efficiency policies, standards, actions, mechanisms, etc. It is a useful tool to evaluate whether these policies, standards, actions and mechanisms function well and to what extent the goal has been achieved. Specifically speaking, energy performance evaluation will:

- Be able to measure energy performance and serve as basis of rewards & punishments for these energy efficiency policies, programs, mechanism, etc;
- Be possible to link energy performance with personnel management, and make responsibilities clear and arouse enthusiasm of energy efficiency improvement;
- Be able to figure out the priority area to carry out energy efficiency measures for the next step and improve energy efficiency continuously.

Energy performance evaluation also plays an important role in developing energy management system of the organizational level efficiently. It worked as a “Re-Assess” part for energy management system.

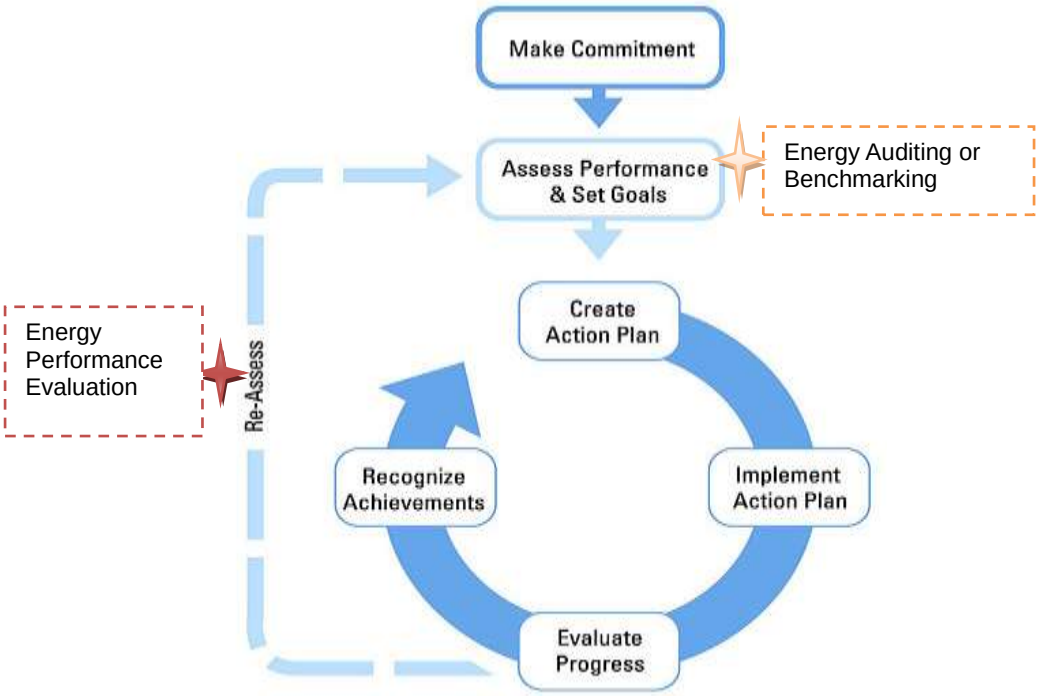

Figure 3: The Role of Energy Performance Evaluation for Energy Management System

For an organization that has set energy efficiency goal (through energy audit or benchmarking), and already implemented energy efficiency measures (such as energy management system), it is necessary to work out a practical energy performance evaluation methodology, to evaluate energy performance, to determine if the organization has reached the energy efficiency goal and met the requirement of energy management system, and also to lay a foundation for the organization to improve energy efficiency continually.

1.3 What should be learned from the Study?

The project will focus on energy performance evaluation and especially analyze energy performance evaluation methodologies and experiences of five economies in APEC. Then it will develop a general energy performance evaluation methodology for industrial enterprises. Based on the methodology proposed, a case study will be provided and relevant implementation and harmonization recommendations will be proposed. On one hand, this will provide experience and practice for the development of energy performance evaluation methodology reference to current energy management system certification programs directly and promote implementation of energy management system in APEC region. On the other hand, this will lay a sound foundation to integrate current energy performance evaluation methodologies and facilitate international coordination & mutual recognition, exchange and cooperation as well.

Specific objectives are expected to achieve based on sufficient investigation and analysis:

I. Summarize key indicators, evaluation criteria, evaluation methods, etc. in energy performance evaluation of targeted economies;
II. Analyze similarity and difference, implementation results, etc. of relevant energy performance evaluation methodologies;
III. Get development methods, implementation experience, etc. that could help for the establishment of energy performance evaluation for industrial enterprises;
IV. Propose an energy performance evaluation methodology for industrial enterprises.

1.4 What is the Working Method?

To develop energy performance evaluation methodology for industrial enterprises, it is necessary to carry out desk review of energy performance evaluation methodologies and practices in APEC economies, and then conduct comparative analysis on them to get experience and learn to develop the evaluation methodology. According to the general methodology developed, a customized methodology applied by a specific cement enterprise will be introduced, which results in a case study as a reference for other industrial enterprises. A workshop will be conducted to discuss the general methodology and exchange views, and relevant implementation and harmonization recommendations will be proposed based on the comments of experts. The working method is as follows.

1.5 What are the Targeted Economies?

The determination of targeted economies is very important. Many economies in APEC have carried out energy efficiency programs since 1990s. For example, most economies have adopted the Voluntary Agreement (VA) with key energy-consuming units. Some of them, such as China and Japan, take advantage of mandatory means to carry out energy efficiency programs. Others, such as USA, use certification means to improve the national energy efficiency.

Table 2: Examples of VA in APEC Region

Australia	Energy Smart Business Program, Greenhouse Challenge
Canada	Industry Program for Energy Conservation (CIPEC)
Japan	Keidanren Voluntary Action Plan on the Environment
USA	Aluminum Industrial Partnership; PFC Emissions Reduction Partnership for the Semi-Conductor Industry

With International Standard of Energy Management System (ISO50001) being

promulgated, energy management becomes an important means for the implementation of national energy efficiency programs, such as Superior Energy Performance of USA. These energy management programs of APEC economies also build foundation for this study.

The targeted economies should have the following features:

- Conduct national energy efficiency program with comparatively mature energy performance evaluation methodologies;
- Carry out or plan to implement EnMS certification in their national program; or
- Have comparatively mature energy evaluation methodologies, such as benchmarking;
- Relevant materials are available (related reports, governmental websites, etc.).

According to materials investigation, five economies with their energy performance evaluation programs and a regional program are chosen as objects for the study, and they are:

- Canada
- China
- Japan
- Singapore
- USA
- ASEAN

The targeted economies have been indicated in the figure below.

Figure 4: Five Targeted Economies and one Region for Survey and Analysis

2. Survey on Energy Performance Evaluation Methodologies and Practices in APEC Economies

2.1 Canada

The Office of Energy Efficiency (OEE) is Canada's centre of exchange for energy, efficiency and alternative fuels information. In order to improve energy efficiency of industry, OEE starts the Canadian Industry Program for Energy Conservation (CIPEC) since 1975[1]. As a voluntary program, CIPEC has made a great success through the implementation of energy conservation polices and measures. Performance Evaluation is also an important method to ensure the successful implementation of CIPEC. Energy Performance Benchmarking and Energy Performance Evaluation are the two important types of Energy Performance Evaluation of Canada.

About CIPEC

The Canadian Industry Program for Energy Conservation (CIPEC) is a partnership between private industry and the federal Government with aims to promote and improve Canada's industrial energy efficiency and reduce greenhouse gas emissions from energy use in the industrial sector. Members of CIPEC include more than 1,400 companies and trade associations. CIPEC is responsible for providing energy-related information and professional knowledge as well as analysis reports for industrial departments to assist them in studying technically feasible energy conversation opportunities so as to achieve specific industrial goals. CIPEC encourages energy management best practices through dialogue and collaboration via an Executive Board, Task Force Council and sector task forces , those who lead the way will be recognized and rewarded by CIPEC.

2.1.1 Benchmarking[2]

The Canadian Industry Program for Energy Conservation (CIPEC) and its associated partners have developed two benchmarking programs for Canada's industrial sectors:

- Energy performance benchmarking
- Best practices benchmarking

Similar industrial companies may compare their energy use, greenhouse gas emissions and best practices using criteria indicators for their industrial sectors.

Energy Performance Benchmarking

Energy performance benchmarking focuses on a comparative analysis of energy use per unit of physical production, also known as energy intensity.

Typically, the steps involved in energy performance benchmarking are:

[1] http://oee.nrcan.gc.ca/industrial/cipec/about.cfm?attr=24.
[2] http://oee.nrcan.gc.ca/industrial/technical-info/benchmarking/4377.

I. Determine plant's energy intensity by fuel type;
II. Compare energy intensity with the energy intensity of other plants in the industrial sector referring to appropriate benchmarking guide. The sector energy data is available through the Canadian Industrial Energy Efficiency Data and Analysis Centre (CIEEDAC), at Simon Fraser University and supported by Natural Resources Canada;
III. Access the technical information which will help to improve facility's energy performance;
IV. Select CIPEC sector task force to obtain additional information, and improve energy performance continuously.

Best Practices Benchmarking

Best practices benchmarking involves comparing facility and systems operation status with the best-in-class operations.

Generally, the steps involved in energy best practices benchmarking include:

I. Identify areas for improvement that will benefit most from the benchmarking;
II. Research and identify key factors and variables used to measure the improvement;
III. Determine if the data is already available or how it will be obtained;
IV. Analyze the data and identify the best practice/performance by selecting the best-in-class category (e.g., companies that perform each function at the lowest cost with the highest energy efficiency);
V. Determine the conditions under which the best practices can be achieved and specify the action(s) that must be taken to achieve the desired results;
VI. Implementation:
    - ✧ Set specific improvement targets and deadlines;
    - ✧ Develop a continuous procedure to monitor, review and update the data and analyze it over time. This will provide a basis for the monitoring, revision and recalibration of the measurements for further benchmarking studies.

Taking energy conservation technologies and energy management into full account, Canada’s benchmarking tools include both best practice for energy conservation technologies and best practice benchmarking for energy management, and judge the level for energy efficiency of enterprises by defining energy efficiency indicator (EEI).

Specifically, the formula is EEI=100×Total energy consumption of best practice/ Total energy consumption of plants.

Best practice for energy conservation technologies grades enterprises on whether they

apply specific technologies to each technical process; while best practice for energy management assesses and grades enterprises on all links involved in energy use and management, such as:

- Enterprises' commitment to energy conservation
- Development of energy conservation plan
- Organize to implement work for energy conservation
- Energy efficiency financing
- Information exchange and frequency
- Management and employees' awareness of energy conservation and participation

Now Benchmarking applied in almost 20 industrial sectors.

Table 3: The Industrial Sectors Subject to Benchmarking in Canada

Aluminum	Brewery	Cement	Construction
Dairy	Fertilizer	Food and Beverage	Foundry
Lime	Mining	Petroleum Products	Oil Sands
Plastics	Pulp and Paper	Rubber	Steel
Textiles	Wood Products	Transportation Manufacturing	

2.1.2 Energy Efficiency Evaluation Tool

Basic Content

Canada has designed and developed a tool for evaluating energy efficiency. The tool evaluates energy conservation technologies, management practices and energy efficiency of enterprises, through which opportunities for enterprises to improve energy efficiency can be found. Such a mode similar to energy diagnosis or audit can help enterprises to identify energy performance gaps and realize constant improvement in energy performance.

So far as the mode chart for the tool for evaluating energy efficiency is concerned, the energy efficiency evaluation will search and analyze energy conservation potential and provide appropriate improvement plans by evaluating technical best practice, best practice for energy management and energy efficiency.

Energy efficiency evaluation is carried out as follows:

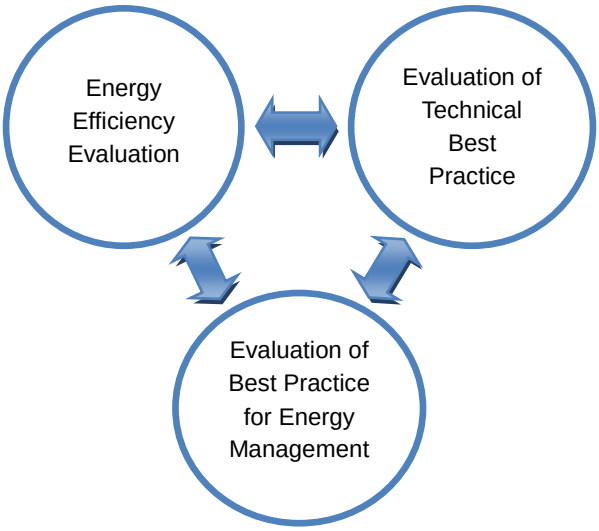

Figure 5: Three Steps for Energy Efficiency Evaluation Tool in Canada

Promotion Status

(I) National energy efficiency projects to apply the energy efficiency evaluation tool

- Petrochemical industry
- Power generation industry
- Upstream industry for petroleum and gas
- Cement industry
- Textile industry

(II) The benefits for plants to apply this energy efficiency evaluation tool

- Establish overall indicators for evaluating energy efficiency and set basic criteria
- Figure out causes for changes in energy efficiency
- Recognize opportunities and determine priority
- Initiate procedure for constant improvement
- Promote competitiveness
- Have a overall understanding of energy conservation opportunities in industries
- Make clear cost and savings

2.2 China

2.2.1 Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises

China regards the energy-consuming intensity as a restrictive indicator of national economy and social development for the first time during the "11th Five-Year Plan" period.

In order to achieve the 20% reduction of energy consumption per unit of GDP during the "11th Five-Year Plan" period compared with that of the late "10th Five-Year Plan" period, Chinese government uses its powerful administrative ability. It segments and allocates the energy efficiency goals into provincial regions, top 1,000 energy-consuming enterprises and five major power generation companies. Energy objective accomplishment status and policy implementation are important during the comprehensive evaluation of leading group and leaders & cadres.

The evaluation system on energy efficiency goals responsibility is comprised of two levels according to the evaluation object: one is energy conservation evaluation conducted by upper level government to the lower level government; the other is the evaluation by governments to enterprises, including "Top-1000 Enterprises Energy Conservation Action Program" organized and implemented by the state[3] and "Provincial Key Energy-Consuming Enterprises Energy Efficiency Program" organized by 30 provinces at home [4]. As the total energy consumption of top 1,000 enterprises in China and key energy-consuming enterprises under provincial administration accounts for about 80% of domestic industry energy consumption [5], evaluation system of responsibility for achieving energy efficiency goals for enterprises is an important way to realize the energy efficiency goal during the "11th Five-Year Plan" period.

The content of evaluation system of energy efficiency goals responsibility, implementation information and results of top 1,000 enterprises are introduced as below.

Basic Content

China promulgated "Implementation Plan of Energy consumption per unit of GDP Assessment System" (Hereinafter referred to as "Implementation Plan") in 2007, and therefore made the mandatory evaluation system for top 1,000 enterprises' energy efficiency goals responsibility system clear at the national level. Provincial energy conservation authorities in charge were responsible to organize and implement evaluation pursuant to the territorial principle, and National Development & Reform Commission (NDRC) made uniform arrangement.

According to the "Implementation Plan", evaluation objects referred to enterprises of certain scale that were in nine key energy-consuming industries, namely, iron & steel, nonferrous metal, coal, power, petroleum & petrochemical, chemical, building materials, textile, papermaking, and conducted business accounting independently. Altogether 1,008 enterprises consumed gross energy equivalent to 180,000 tce in China in 2004, so they were generally called as "top 1,000 enterprises".

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[3] http://www.ndrc.gov.cn/zcfb/zcfbtz/tz2006/t20060414_66211.htm

[4] From 5,000 tce to 100,000 tce of annual comprehensive energy consumption of provincial key energy-consuming enterprises.

[5] Xiong Huawen, Energy Research Institute of National Development and Reform Commission, 2010 Industrial Energy Conservation Seminar, August 2010, Xi'an, Shaanxi.

Evaluation content includes six elements about energy efficiency goals accomplishment and energy conservation measure fulfillment. In terms of evaluation criteria, different scores are set based on energy efficiency goals accomplishment status and energy conservation measure fulfillment status. Quantitative grading is adopted for evaluation: the full score is 100 points, 40 points for energy efficiency goals accomplishment status and 60 points for energy conservation measure fulfillment status Energy efficiency goals accomplishment status is a veto indicator, i.e. the one not reaching the energy efficiency goal is evaluated as unaccomplished grade. The evaluation result has four classes: outperformance (higher than 95 points), accomplished (80-94 points), basically accomplished (60-80 points), and failed (below 60 points). The “Implementation Plan” has prepared corresponding rewards & punishment measures for energy conservation performance of enterprises. See the table below for detailed evaluation indicators and rewards & punishment methods.

Table 4: Grading Table about Evaluation indicators system of Energy Efficiency Goals of Top 1,000 Enterprises

Evaluation indicator	Sequence number	Evaluation content	Score (Point Possible)	Grading criteria
Energy efficiency goal (40 points)	1	Energy savings	40	Get 40 points if annual goal is accomplished, 35 points for 90% goal accomplishment, 30 points for 80%, 25 points for 70%, 20 points for 60%, 15 points for 50%, and 0 point for those less than 50%. Get 2 extra points for outperformance by 10% and 6 extra points at most. The indicator is a veto indicator. Failing to reach the goal means getting an unaccomplished grade for enterprises.
Energy efficiency measures (60 points)	2	Organization and leadership of energy conservation work	5	1. Organize the energy conservation work leading group within main responsible person of the enterprises, and deploy energy conservation work regularly, 3 points; 2. Set or designate special energy conservation administration organ and make sure the energy conservation work carried out successfully, 2 points.
	3	Energy efficiency goal segmentation and fulfillment	10	1. Segment energy efficiency goals into workshops, teams or individuals annually, 3 points; 2. Evaluate energy efficiency goal fulfillment status, 3 points; 3. Implement rewards & punishment system, 4 points.
	4	Energy conservation technology progress and energy conservation technology reform and implementation	25	1. Grade 10 points for first leading 20% enterprises in terms of product unit energy consumption or comprehensive energy consumption level in the same industry among 1,000 enterprises, 5 points for those among first 50%, and 0 point for those among last 50%; 2. Set special fund for energy conservation research & development and increase the fund annually, 4 points; 3. Implement and complete annual energy conservation technical reform plan, 4 points; 4. Eliminate backward energy-consuming process, equipment and products pursuant to provisions, 7 points.

	5	Energy conservation laws & provisions performance	10	1. Implement energy conservation law, auxiliary provisions, local provisions and government rules & regulations, 2 points; 2. Execute mandatory energy consumption standards for energy-intensive products, 4 points; 3. Implement mandatory management systems for main energy-intensive equipment, 2 points; 4. New, technical reform and expansion projects should be built according to energy conservation design specifications and energy efficiency standards, 2 points.
	6	Implementation of energy conservation management	10	1. Implement energy auditing or monitoring, and fulfill improvement measures, 2 points; 2. Set energy statistical positions, build energy statistics records, deliver energy statistical statements timely and up to standards, 3 points; 3. Allocate energy measuring devices pursuant to laws and provisions, conduct verification and calibration regularly, 3 points; 4. Disseminate knowledge about energy conservation and conduct training work for energy conservation technologies, 2 points.
Subtotal			100	

Notes: Energy efficiency goals are annual objectives of enterprises set according to energy efficiency goal responsibility documents; unrealized energy efficiency goals of last year should be put into those of following years.

Table 5: Rewards & Punishment of Responsibilities Evaluation for achieving Energy Efficiency Goals of Top 1,000 Enterprises

Accomplishment status	Rewards & punishment methods
Outperformance and accomplished class	They are informed of recognition by NDRC and provincial governments, commended and rewarded in national energy conservation commendation activities.
Unaccomplished class	They are informed of criticism in a circulated notice and unqualified to get annual rewards, honorable titles, national exemption from inspection and other supporting measures, and approval for newly built high energy-consuming investment projects and exam & approval for land of new industries will be suspended; They are required to propose rectification measures and report to the provincial government within one month after evaluation & assessment result which is punished to the public and conduct rectification within limited time; State-owned assets supervisory authorities take evaluation & assessment results of state-owned sole proprietorship and state-owned holding enterprises among top 1,000 enterprises as important basis for performance assessment of enterprises' responsible persons, and exercise "one-vote veto".

In terms of evaluation procedure, the top 1,000 enterprises should submit self-examination reports of energy objective accomplishment and energy conservation work progress in previous year to the local provincial energy conservation authorities and then send to NDRC before the end of January every year. Provincial energy conservation authorities in charge will organize experts into the evaluation group to evaluate and check energy objective accomplishment status of enterprises, and submit comprehensive evaluation reports to provincial governments and NDRC before the end of March every year. NDRC publishes evaluation results of top 1,000 enterprises' to the public after examining and collecting these results.

Development and Implementation

NDRC organized and carried out evaluation and published the public notice about the top 1,000 enterprises' energy efficiency goal accomplishment for four times during the "11th Five-Year Plan" period.

The top 1,000 enterprises have saved 165 Mtce during the "11th Five-Year Plan" period[6], outperforming the objective in the period. Energy efficiency of Top 1,000 enterprises was greatly improved, of which energy consumption per unit main product reached leading level at of the domestic industry, and some energy efficiency indicators reached internationally advanced level[7].

[6] From public notice of NDRC, *Table of Top 1,000 Enterprises' Energy Efficiency Goals Accomplishment Status during the "11th Five Year Plan" Period*, website: http://www.sdpc.gov.cn/zcfb/zcfbgg/2011gg/t20111227_452721.htm

[7] From NDRC, Top 1,000 Enterprises Outperform Energy Conservation Tasks during the "11th Five Year Plan" Period: *The 4th Review of Energy Conservation & Emission Reduction during the "11th Five Year Planning" Period*, website: http://www.sdpc.gov.cn/xwfb/t20110930_436609.htm

Energy efficiency goal responsibility system played a significant role in implementing the "Top 1,000 Enterprises Energy Efficiency Program" successfully during the "11th Five-Year Plan" period. Firstly, it made clear responsibilities for key energy-intensive enterprises. Therefore these enterprises attached obviously more importance to energy conservation work and most of them established leading groups headed by their main responsible persons. Secondly, it put in a key position to strengthen enterprises' capability building and organization development, urge enterprises to improve energy efficiency continuously, regulate basic work such as energy measurement & statistics, and formulate energy conservation planning and energy utilization status reports, etc. Following the relatively strict evaluation system, enterprises developed energy auditing, implemented energy conservation technology reform, etc. in a succession. A great number of advanced and applicable energy efficiency equipment, process and technologies were promoted and applied, and a lot of key energy efficiency projects are under way, all of which lays a good foundation to update energy conservation management comprehensively.

Based on the experience of "Top 1,000 Enterprises Energy Efficiency Program", China plans to conduct "Top 10,000 Enterprises Low Carbon Program"[8] in the next five years. The new program will extend the amount of main energy-intensive units to 17,000, the total energy consumption of which accounts for 60% of the national energy consumption in 2010, and energy-savings goal is 250Mtce during the "12th Five-Year Plan" period. The evaluation system of responsibility for achieving energy efficiency goals will be applied and developed to evaluate the new program.

2.2.2 Energy Efficiency Benchmarking Activity

Energy efficiency benchmarking activity is that enterprises compare their energy efficiency indicators to counterparts domestically and internationally, fix their energy efficiency leverage indicators, and reach energy efficiency leverage indicators or higher energy efficiency levels through energy conservation management and technical measures.

Energy efficiency benchmarking activity in China is originated from "Top 1,000 Enterprises Energy Efficiency Program". The main industrial enterprises are required to start benchmarking activities to improve energy efficiency to the advanced level, to strengthen structural adjustment, to conduct technical reforms and to enhance energy conservation management. NDRC printed and issued the "Implementation Plan for Launching Energy Efficiency Benchmarking Activities in Key Energy-Consuming Units" in September 2007, which provided policy basis for key energy-consuming enterprises to substantially conduct energy benchmarking work. The Ministry of Industry and Information Technology (MIIT) of China proposed a series of policy documents in 2010 to develop energy efficiency benchmarking activities by starting

[8] http://www.sdpc.gov.cn/zcfb/zcfbtz/2011tz/t20111229_453569.htm.

from four industries, namely, iron & steel, nonferrous metal, chemical industry and building materials.

Nowadays energy efficiency benchmarking activity in China has already had relatively mature implementation guidance, and pilot projects have been extended in some industries including iron & steel, cement, chemical industry, power, etc. It can be predicted that energy efficiency benchmarking, as an important content in Chinese energy conservation management, will be put into practice more intensively during the "12th Five-Year Plan" period.

Basic Content

(1) Energy Efficiency Benchmarking Guidance for Key Energy-Consuming Industries

NDRC, United Nations Development Program (UNDP) and Global Environment Fund (GEF) launched China End-Use Energy Efficiency Project (EUEEP) jointly from September 2007 to December 2009 and developed research on energy efficiency benchmarking of key energy-consuming industries and pilot projects. The project selected 10 enterprises in three pilot industries namely iron & steel, chemical industry and cement, developed pilot projects and training work, published "Energy Efficiency Benchmarking Guidance for Key Energy-Consuming Industries" targeting at iron & steel, chemical industry and cement industries, and facilitated research and practice of energy efficiency benchmarking of nonferrous, coal and other industries.

"Energy Efficiency Benchmarking Guidance for Key Energy-Consuming Industries" summarized the content of energy efficiency benchmark activities as follows: fixing one objective and building two databases and three systems. "Fixing one objective" means choosing benchmarking subject grounded on actual situations of enterprises and determining proper energy efficiency benchmarking improvement objective; "building two databases" means building the energy efficiency benchmarking database and the best practice database grounded and established on energy efficiency benchmarking indicator system; "building three systems" means building the energy efficiency benchmarking indicator system, energy efficiency benchmarking management comprehensive evaluation system and energy efficiency benchmarking work organization & management system[9]. See the figure as below.

[9] Energy Research Institute of NDRC, *Energy Efficiency Benchmarking Guidance for Key Energy-Consuming Industries*, EUEEP Office, March 2009.

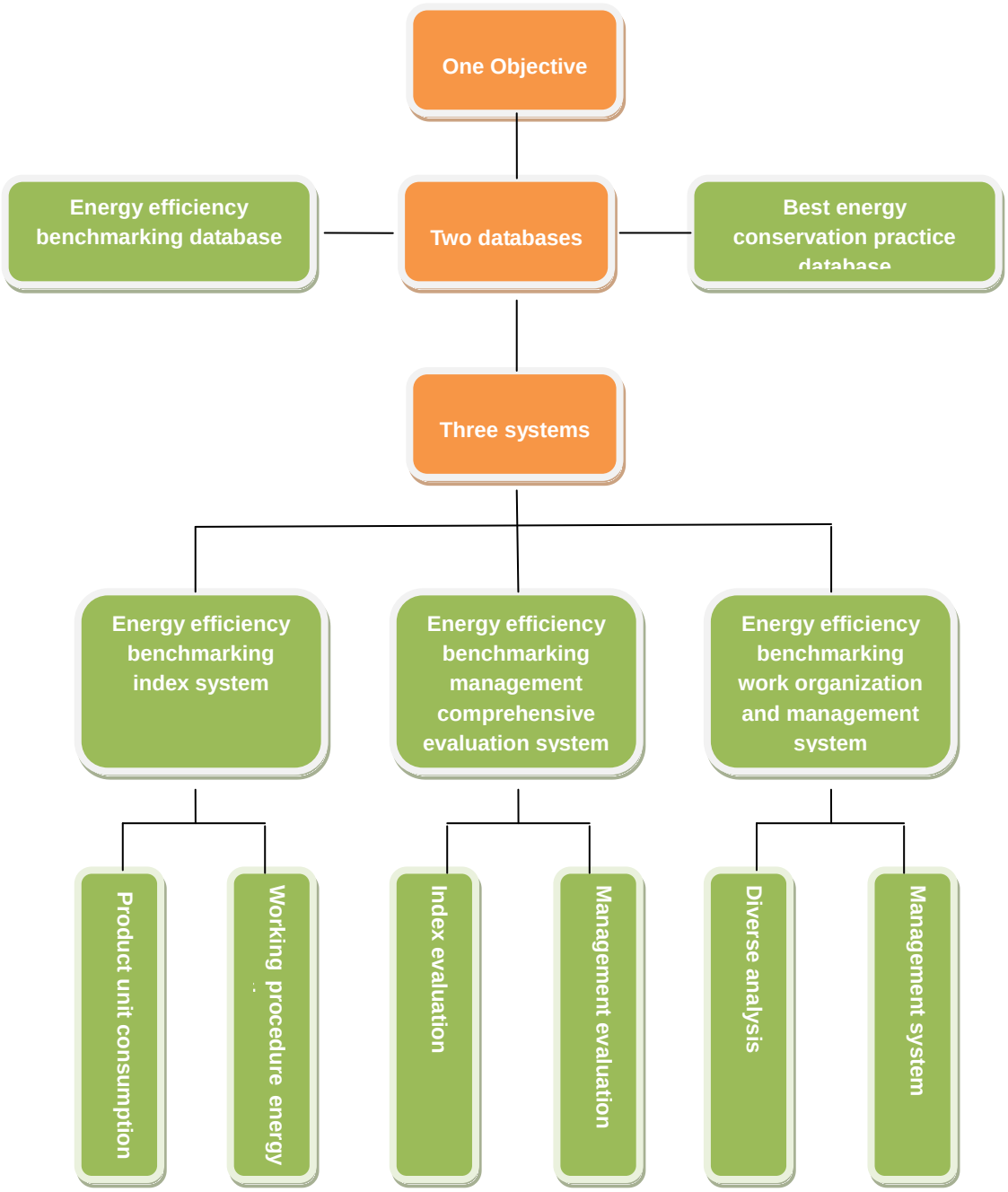


Figure 6: Main Content of Energy Efficiency Benchmarking Activity of China

Energy efficiency benchmarking management comprehensive evaluation is the main content of energy efficiency benchmarking. Comprehensive evaluation could enable enterprises to understand their energy efficiency levels and room for energy management improvement, and then prepare their own proper energy efficiency improvement measures. The combined self-evaluation and the third party evaluation entrusted by governments are adopted for evaluation of key energy-consuming

enterprises. Evaluation indicators include indicators in terms of economy, technology and management, of which economic and technical indicators are quantitative indicators while management indicators are principally qualitative indicators. As for evaluation methods, combined qualitative and quantitative evaluations are adopted. Evaluating criteria is from the best practice and energy efficiency measurement standards, of which the best practice refers to the most efficient energy management and technical measures implemented by leading enterprises of the domestic and the international industries. Energy efficiency measurement standards refer to one set of energy efficiency indicator systems and corresponding benchmark data as leverage to reflect enterprises' energy management performance truthfully and objectively, such as the indicator of energy consumption per unit of product and energy consumption indicators of key industries, etc. The evaluation procedure has five steps as indicated in the table below.

Table 6: Comprehensive Evaluation of Key Energy-Consuming Enterprises' Energy Efficiency Benchmarking Management in China

Evaluating object	Key energy-consuming enterprise
Evaluator	Enterprise self-evaluation and third party evaluation entrusted by governments
Evaluation indicators	Economic indicator: principally quantitative indicators including output indicator, energy consumption indicator, energy efficiency indicator, etc. Technical indicator: principally quantitative indicators including energy efficiency levels of main process and equipment Management indicator: principally qualitative indicators including energy conservation management progress and backward measures
Evaluating method	Combined qualitative evaluation and quantitative evaluation
Evaluation criteria	Best practice Energy efficiency standards
Evaluation procedure	Fix evaluation objectives—build the indicator system—collect materials—analyze materials—make judgments and analysis

(2) Notice on Launching Energy Efficiency Benchmarking and Targeting Hitting Activities in Key Energy-Consuming Industries to reach standard of MIIT

In 2010, MIIT released the "Notice on Launching Energy Efficiency Benchmarking and Target Hitting Activities in Key Energy-Consuming Industries to Reach Standards". Energy efficiency benchmarking activity was launched among 13 products (processes), namely, crude steel (including coking, sintering, pelletizing, pudding, convertor steelmaking, electric furnace steelmaking), electrolytic aluminum, synthesis ammonia, caustic soda, calcium carbide, cement and sheet glass in four key energy-consuming industries namely iron & steel, nonferrous, chemical and building materials, in which advanced energy efficiency indicators of domestic similar enterprises were published.

Table 7: Energy Efficiency Benchmarking and Target Hitting Activity to Reach Standard of China's MIIT

Evaluating object	Four key energy-consuming industries, namely, iron & steel, nonferrous, chemical and building materials
Evaluator	MIIT in charge and relevant associations

Evaluation indicators	Energy efficiency benchmark indicators of 13 products (processes) namely crude steel (including coking, sintering, pelletizing, pudding, convertor steelmaking, electric furnace steelmaking), electrolytic aluminum, synthesis ammonia, caustic soda, calcium carbide, cement and sheet glass
Evaluation criteria	Advanced energy efficiency levels of domestic similar enterprises
Evaluation method	Benchmarking

MIIT proposed the basic operating mode in which enterprises are subjects, relevant industrial associations provide guidance to enterprises, and MIIT is responsible for organization, supervision and guidance. Before the end of January each year, the local administrative departments of industry and information technology summarize the local energy efficiency benchmarking and target hitting activities. Then, they submit their conclusion reports and relevant indicator & data analysis reports to Department of Resources Conservation and Comprehensive Utilization of MIIT. MIIT, together with relevant industrial associations, adjusts and updates energy efficiency standards, and completes indicator systems according to information about benchmarking results successively. Meanwhile, MIIT will organize relevant industrial associations to commend outstanding enterprises which are recommended by local industry & information technology departments.

Development and Implementation Effects

In industries such as iron & steel, cement, chemical, power, 3-5 enterprises of each industry are involved in pilot projects of energy efficiency benchmarking activities now, of which thermal- power industry takes the leading role among these industries in energy efficiency benchmarking work. CEC (China Electricity Council) has published the first 600,000 kW thermal-power units' benchmarking results of China, and energy efficiency benchmarking results of nationwide 300,000 kW thermal-power units. Now CEC is carrying out energy efficiency benchmarking activities of 200,000 kW and 1,000MW units as shown in table below.

Table 8: Pilot Projects in Enterprises' Energy Efficiency Benchmarking Activities of China

Sector	Guide or activity plan	Pilot enterprise	Supporting association
Iron & steel industry	*Energy Efficiency Benchmarking Guide for Iron & Steel Industry*	Angang Steel, Taiyuan Iron & Steel, Tangshan Iron & Steel, etc.	China Iron and Steel Industry Association
Chemical industry	*Energy Efficiency Benchmarking Guide for Chemical (Caustic Soda)Enterprises*	Shandong Hengong, Hebei Shenghua, Henan Yuhang Haohua etc.	China Chemical Energy Conservation Technology Association/China Chlor-alkali Industry Association
Cement industry	*Energy Efficiency Benchmarking Guide for Cement Industry*	Ningxia Saima, Shandong China United Cement Lunan, Anhui Shunyue, Henan Tongli, Huainan Shunyue, etc.	China Cement Association
Nonferrous	*Energy Efficiency*	Yunnan Aluminum and	China Nonferrous

metal industry	*Benchmarking Program of Key Energy-Consuming Enterprises in Nonferrous Metal Industry*	others	Metals Industry Association
Power industry	*Energy Efficiency Benchmarking Program for Thermal-Power Enterprises*, *Technical Plan for Energy Efficiency Benchmarking of Nationwide 600,000 kW Thermal-Power Units (Trial)*, *Energy Efficiency Benchmarking Results of Nationwide 600,000 kW Thermal-Power Units* (*2008*)	Huaneng Dalian Power Plant, etc.	CEC
Coal industry	——	10 representative coal enterprises	China National Coal Association

However, enterprises give a slow push in energy efficiency benchmarking activities and they are not enthusiastic in taking these activities, mainly because energy efficiency benchmarking, a voluntary activity, is of no mandatory requirements for participant enterprises. Although MIIT proposed the basic operating mode in which industrial energy conservation departments provide guidance, relevant industrial associations provide technical support and enterprises implement the activities, enterprises' self-evaluation is in the dominating position in practical work without adequate evaluation and supervision; besides, there are still lots of work to do for determination of indicators, development of restrictive and incentive mechanism, etc.

2.2.3 Energy Efficiency Star of Suzhou

Suzhou City of China initiated the Energy Efficiency Star program among industrial enterprises in 2009. As an energy conservation innovative work referring to American "Energy Star" and Japanese "Top Runner" program, the Energy Efficiency Star initiated by Suzhou aims to bring in international and domestic advanced energy conservation technology and management experience, guide and help enterprises to build a complete EnMS, fulfill energy conservation technology projects, cut down industrial carbon emission, better utilize renewable resources, and enable enterprises' energy consumption per unit of product indicator to reach leading levels in the industry and improve competiveness. Meanwhile, the Energy Efficiency Star of Suzhou supports and cultivates energy conservation service industry to develop, pushes energy conservation & emission reduction work of Suzhou City generally, and promotes low-carbon economy development in Suzhou City.

Basic Content

Energy Efficiency Star activity means that key energy-consuming units, which meet national industrial policy, consume more than 5,000tce every year, and own relatively advanced energy efficiency levels in the industry, could build themselves into Energy Efficiency Star enterprises in a certain period through voluntariness, agreement,

procedure control, result evaluation, and conclusion and promotion mode. Then the government will guide and publicize the Energy Efficiency Star enterprises and set them as role models.

Take the first stage of Energy Efficiency Star's actual creation work for example. The detailed implementation procedure is as follows: stage one: application and agreement signing. 47 enterprises apply to join in the Energy Efficiency Star program with their energy conservation technology reform projects, and the Energy Conservation Service Center of Suzhou organizes the expert group to conduct preliminary appraisal on spot, check general information, select 24 pilot projects and sign "Voluntary Energy Conservation Agreement to Create 'Energy Efficiency Star' " with them. Stage two: service and implementation. Enterprises implement energy conservation technology reform projects, and the expert group provides inspection, consultation and other technical services if necessary to cater for enterprises' demands and follow up their technology reform project implementation courses. Stage three: evaluation and promotion. Enterprises' technology reform projects are completed with implementation and the expert group conducts field appraisal, passes judgment on energy conservation & emission reduction benefits, assesses the star level according to comprehensive elements like enterprises' energy management levels, and holds the award ceremony.

Energy Conservation Center of Suzhou has developed "'Energy Efficiency Star' Evaluation Standard" based on practical experience, and it covers 49 elements of four respects, namely, energy management, energy efficiency, technical progress and energy performance as shown in the table below.

Table 9: Evaluation Content of Suzhou Energy Efficiency Star

Evaluating object	Key energy-consuming units in Suzhou which meet national industrial policies and own relatively advanced energy efficiency levels in the industry
Evaluator	Suzhou energy conservation department in charge is responsible and entrusts energy conservation supervisory organ to implement: Four-star and five-star enterprises are reported and filed in provincial or national energy conservation departments in charge.
Evaluation indicators	• Energy management (20 points): management responsibility, organizational structure, energy system, applicable laws & provisions, energy analysis; • Energy efficiency (20 points): comprehensive energy consumption per unit of product, energy economic indicator, efficiency of key energy-consuming equipment, indicator of comprehensive resources utilization; • Technology progress (30 points): process technology and equipment level, R & D, product innovation, process technology innovation, technology reform project implementation; • Energy performance (30 points): Energy savings and carbon emission reduction
Evaluation criteria and principle	Grade policy & provision and energy management part according to conformity (full score), basic conformity (50% of full score) and inconformity (0 point); Energy efficiency: grade according to three grading standards, i.e. internationally advanced, domestically advanced and industrially advanced for

	energy consumption per unit of product. E.g. grade according to energy consumption per unit of the enterprise's main product respectively and adopt the mean value; Technology progress automation control level and optimization control level: grade according to main workshop, procedure automation control level and optimization control level of more than one procedure in more than one workshop respectively and adopt the mean value; Calculate scores of energy performance products' energy savings and comprehensive energy saving rates according to relevant national standards, and grade according to the highest standard.
Evaluating method	Comprehensive scoring
Evaluation procedure	I. Enterprises submit applications II. Enterprises and energy conservation departments in charge sign relevant agreements III. Organize field examination and preliminary examination of experts in enterprises IV. Provide free energy conservation services to enterprises involved in implementation V. Evaluate the "Energy efficiency Star program" of enterprises VI. Publish the result to the public and commend excellent ones

The star level of energy-consuming units is subject to accumulative scores of indicators required in the criteria, and the judgment basis is shown in the table below.

Table 10: The Judgment Table of Suzhou Energy Efficiency Star

Star level	One star	Two stars	Three stars	Four stars	Five stars
Score	≥40	≥50	≥60	≥80	≥90

Figure 7: Energy Efficiency Star Label of Suzhou

Promotion Status and Implementation Effects

According to information from Suzhou Economy & Informationization Commission[10], these 24 Energy Star enterprises saved about 702,000 tce and reduced carbon dioxide emission by 1,755,000 tons. In 2011, 126 Energy Star enterprises saved about 1,028,000 tce and cut down carbon dioxide emission by 2,570,000 tons. 22 pilot enterprises involved in first stage Energy Efficiency Star had invested 1.45 billion RMB by the end of 2010 which was spent on 70 technology reform projects, saved about

[10] http://www.suzhou.gov.cn/asite/show.asp?ID=58988.

702,000 tce, reduced carbon dioxide emission by 1,755,000 tons, and yielded economic benefits 700 million RMB every year.

Based on that above, Suzhou City gives a positive push for "'Energy Efficiency Star' Evaluation Standard" to be one of green procurement standards of international purchasers, and invites the MIIT, Provincial Economy & Informationization Commission, U.S. Energy Foundation, British Development Foundation, etc. to extend and evaluate the standard at all levels. Now more than 100 enterprises in Suzhou are involved in the Energy Efficiency Star program, and the program will be promoted in non-industrial enterprises and cover service products in future.

2.3 Japan

With the aim to implement "Rational Energy Utilization Act"[11], Japan has established a set of relatively energy efficiency mechanisms, including energy management designated factory system, energy management contract manager system, Top Runner system, energy efficiency product label system, etc.

Energy management designated factory system targeting at large energy consumers has played a key role in Japanese energy management. It targets at designated factories, fulfills obligations like "implementing rational energy control, appointing energy management personnel, submit energy use reports regularly every year, formulating medium- and long-term plans for energy conservation goals", and realizes 1% energy efficiency goals annually at the same time. Japanese government has authorized relevant sectors to conduct general examinations about designated factories of different industries every year since 2001. Examination results serve as basis for factories to formulate guidance and implement administrative measures such as instructions, announcements, orders and penalties.

Background and Content of Japanese "General Examination of Factories"

Designation system of large energy consumers, namely, the first and second category energy designated factory system should be established according to Japanese energy conservation laws, of which the first category designated factory refers to factories (including hotels, offices and public institutions) with annual gross energy consumption equal to 3,000 kiloliter of standard oil equivalent or 12,000MWh; the second category designated factory refers to factories (including hotels, offices and public institutions) with annual gross energy consumption equal to 1,500 kiloliter of standard oil equivalent or 6,000MWh.

Japanese energy conservation law clearly stipulates energy designated factories should have full-time energy managers to report energy consumption information to Ministry of Economy Trade and Industry (METI) and relevant sectors. If energy

[11] The law was prepared in 1979 and had undergone seven amendments by 2010.

efficiency goals are not realized on schedule and rational improvement plans are not proposed, authorities in charge should have rights to make it public, require the factory to make corrections within the time limits, and impose penalties of certain amounts. Now METI is in charge of energy conservation work of the first and second category designated factories directly.

Table 11: Obligations of the First and Second Category Energy Designated Factories of Japan

Category of Energy management	The first category	The second category
Energy management manager	1-4 energy managers	Energy personnel
Regular report on energy consumption	Regular reports 3-5 year medium- and long-term plan	Regular report
Investigation	General examination of factory	——

In order to further implement energy conservation law, Japan has implemented "General Examination of Factories" in the first category energy management designated factories since 2001. The investigation is comprised of four parts namely regular reports on energy consumption energy efficiency standard compliance, establishment of management standards, factory energy changes, and implementation of energy efficiency measures, as shown in table below.

Table 12: General Information about Japanese "General Examination of Factories"

Object	The first category energy management designated factory
Investigation content	a) The content in "regular reports" (Including energy consumption, greenhouse gas emissions, energy consumption per unit of product/output value, equipment change, etc.) b) Energy-consuming equipment's energy consumption standard compliance and establishment of management standards c) Energy consumption changes of factories (including main reasons for changes) d) Implementation of energy efficiency measures and activities (including energy management organization, etc.)
Evaluation criteria	● Regular report submission and judgment; ● Meet the Energy efficiency standard and management standard refer to relevant decrees, and the coverage rate set by management standards should be 80% of total energy consumption amount; ● Establishment and promotion of energy conservation goals, etc.
Evaluation method	Comprehensive Scoring, full score 100 points
Evaluation rates and measures	● If the score is higher than 80 points, the factory is deemed as abiding by relevant decrees basically; ● If the score is 60-80 points, written guidance should be provided and improvement reports are required. ● If the score is lower than 60 points, on-site examination in factories should be carried out, and guidance should be provided for factories to prepare, propose and implement rational plans for energy consumption.

Notes: According to Japanese energy conservation law, the management standard refers to the equipment operation guide with which whoever operating equipment according to the standard is able to control energy-consuming amount to the almost minimum amount in production activities. The following

item that should be added to management standards include rated standard operating values of equipment (management standards such as excessive air coefficient, waste temperature, waste heat recovery rate and temperature outside of furnace wall), measurement & records (Regular measurement and recording of target equipment running time, energy-consuming amount and temperature), examination & maintenance (implementation and recording of regular examination and repair to maintain high efficiency) and other standards targeting at newly built equipment (such as standards to promote equipment improvement).

The way in which investigators of METI conducted field investigation and technicians of Japanese Energy Conservation Center provided assistance was adopted at first for general examination of Japanese factories, and then Energy Conservation Center is responsible to implement general examination of Japanese factories and report investigation results to METI. The basic procedure is: enterprises fill in questionnaires in advance, then Energy Conservation Center sends engineers to conduct field investigation in factories and report investigation results to METI, and METI transmits measure conclusions such as “reasonable”, “written guidance”, and “examination necessary” according to comprehensive scoring, and informs factories of the results.

Implementation Status

Japan had owned altogether 7,760 first category energy designated factories and 6,972 of the second category by the end of March 2010. 4,315 factories of the first category in total received “general examination of factories” from 2001 to 2007, and the evaluation result was “reasonable”, i.e. 3,939 factories abided by relevant decrees generally, accounting for 91.2%; 7.6% factories had scores ranged from 60 to 80 points, most of which had lower scores due to incomplete management standard establishment; 1.1% had scores lower than 60 points (receiving examination), partly because management standards and energy manager appointment were incomplete.

Table 13: Results of 2001-2007 General Examination of Japanese Factories

Year	Industry	Number of factories receiving examination	Comprehensive scoring results and measures		
			(Lower than 60 points [1]) Undergo on-site examination	(60-80 points) Written guidance	(Higher than 80 points) Reasonable
2001	Iron & steel, nonferrous metal, papermaking	650	10	88	552
2002	Fiber, publishing & printing, chemical, gas supply	785	6	59	720
2003	Petroleum, coal, ceramics, cement and heating supply	428	2	28	398
2004	Plastics, ordinary mechanical tools, electric and mechanical tools, electronic parts, telecommunication equipment	802	6	59	737
2005	About nine industries	546	0	21	525

	namely broadcast communication, lease buildings, national/local institution facilities, retail industry and other industries				
2006	15 industries [2] Enterprises receiving additional investigation	442 100	4 1	15 11	423 88
2007	22 industries [3] Enterprises receiving additional investigation	462 100	17 1	39 9	406 90
2001-2007	65 industries	4315	47	329	3939

Note:

1. The factories with score lower than 50 points should be implemented on-site examination before 2006;
2. The civilian sector are also examination objects, including banking and financial industry, medical treatment industry, warehousing industry, running water industry, etc.
3. Additional investigation by random sampling is conducted to factories undergoing "general examination of factories" after 2006.

2.4 Singapore

About Energy Efficiency National Partnership[12]

The Energy Efficiency National Partnership (EENP) is targeted at companies that are large energy consumers especially those that consume more than 15GWh per year, as well as companies that are interested in improving their energy efficiency and implementing energy management practices.

Sustainable Singapore Blueprint

The Sustainable Singapore Blueprint was released in Apr 2009. It documents the findings and recommendations of the Inter-Ministerial Committee on Sustainable Development that was set up in Jan 2008 to formulate a national strategy for Singapore's sustainable development. In this blueprint, the Government has set a target to achieve a 35% improvement in energy efficiency from the 2005 level by 2030.

The industry sector in Singapore accounts for almost 60% of total energy consumption. A large part of this is from the energy intensive industries such as the petroleum refining, petrochemical, electronics, wafer fabrication, and pharmaceutical industries. The industry sector has substantial scope for adopting cost-effective energy efficiency solutions that would contribute to its economic competitiveness.

From 2013, the Government will be introducing mandatory energy management requirements for large energy users which consume more than 15 GWh in the industry sector under an Energy Conservation Act. These include the appointment of energy managers, reporting of energy use and submission of energy efficiency improvement plans.

The core elements of EENP are:

a) Energy Management System (EnMS)

[12] http://www.e2singapore.gov.sg/industry/eenp_calendar.html。

Companies will be encouraged to adopt an EnMS so that the measurement and management of energy consumption, as well as the identification of energy efficiency improvements is undertaken systematically.

b) EENP Learning Network

The EENP Learning Network aims to provide industry with opportunities to learn and share energy efficient technologies and best practices on various platforms such as high level fora targeted at top management, conferences and technical workshops targeted at senior and middle management teams and technical staff, and learning journeys in the forms of site-visits and roundtable discussions. Energy efficiency technical workshops on industrial systems will also be organized to provide intensive training to engineers and practitioners in energy efficiency so as to develop their capabilities.

The EENP Learning Network will be augmented by energy efficiency benchmarking studies that would be conducted in collaboration with industry, to help companies to determine their energy efficiency improvement potential and identify cost-effective measures that they can implement to improve energy productivity.

c) EENP National Recognition Scheme

EENP Partners who have implemented excellent energy management practices and demonstrated tangible results in improving energy efficiency will be recognized through a national recognition scheme.

EENP partners can expect the following benefits, such as:

- Leveraging on government incentive schemes such as the Energy Efficiency Improvement Assistance Scheme (EASe), the Grant for Energy Efficient Technologies (GREET) and the Design for Efficiency (DfE) to support their energy efficiency initiatives,
- Networking with other companies and participating in benchmarking studies conducted by government agencies,
- Gaining access to energy efficiency best practices, toolkits and case studies, including participating in study/field trips, and
- Receiving national recognition for achievements in energy efficiency and energy management.
- Key Commitment as an EENP Partner

EENP Partners will work towards adopting in-house EnMS. This will involve appointing energy managers, developing energy policies, establishing energy targets and implementing energy efficiency improvement plans.

About the Awards

The EENP Awards is organized by the National Environment Agency, Energy Market Authority and the Economic Development Board. The EENP Awards aims to foster a culture of sustained energy efficiency improvement in industry, especially the major energy consuming industries. The EENP Awards also aims to encourage companies to adopt a proactive approach towards energy management by identifying and sharing best practices for companies to emulate.

Application for the EENP Awards is open exclusively to EENP partners.

There are three categories for the EENP Awards - Excellence in Energy Management, Best Practices, and Outstanding Energy Managers of the Year.

Table 14: Introduction of Three Categories for the EENP Award of Singapore

Category	Description	Eligibility	Criteria
Excellent Energy management	This award recognizes companies that have demonstrated a high level of commitment to energy management.	Application for the award is open to all local companies that can demonstrate improvement in energy performance of their plants/sites through a corporate-wide energy program.	Candidates are evaluated based on the following: Level of integration of energy management into overall business practices ● Energy policy, energy goal or energy target to be established ● EE training for staff Record of continuous and sustained energy intensity improvements ● Length of time EE improvement plan has been put in place ● Percentage of sustained energy performance improvement
Best practices	This award recognizes corporate teams whose implementation of energy efficiency projects have led to improvements in the energy performance of their facilities.	Application for the award is open to corporate teams that have implemented and completed energy efficiency projects within the past 5 years.	This award will be based on energy efficiency projects completed from 1st Jan 2008 onwards. Project results must be measurable and quantifiable, and supported by qualitative and quantitative data, where applicable. Accomplishments outside of this time period as well as ongoing projects may be mentioned for reference and to demonstrate continuous improvement. Qualifying candidates are evaluated on: The quality of project(s), for example: ● Establishment of project baseline before implementation of project System-wide improvements and integrated solutions, for example: ● Implementation of a single or multi system efficiency improvement project ● Percentage of energy improvement ● Percentage of improved output efficiency ● Improvement in product quality
Outstanding energy managers	This award recognizes outstanding Energy Managers (EMs) within the organization who have demonstrated leadership in driving energy efficiency improvement across the organization, and who have played an instrumental role in promoting energy efficiency initiatives within the organization.	Application for the award is open to all appointed EMs in their respective organizations. Nominated EMs must have been in service with the organization for at least one year and can concurrently perform other duties (i.e. energy manager need not be a full-time post).	Qualifying candidates are evaluated on: ● The number and quality of energy efficiency initiatives/measures implemented across the organization ● The number and quality of energy efficiency initiatives/programmers to raise the level of awareness of energy efficiency across the organization ● Individual achievements and awards in the area of energy efficiency

The implementation of EENP Awards

In 2011, six companies and one energy manager have been selected to receive the EENP Awards[13]. The following table introduces the companies/ energy manager and their achievements in detail.

Table 15: The Companies/Energy Manager to Receive the EENP Awards of Singapore

Category	Recipients	Achievements
Excellence in energy management	Pfizer Asia Pacific Pte Ltd	The designated site energy champion leads a multi-disciplinary team to drive energy management initiatives and raise awareness on energy conservation through regular communication with employees. They have installed energy monitoring and tracking systems to track and quantify the energy savings of their energy efficiency projects.
	Glaxo Wellcome Manufacturing Pte Ltd	The GlaxoSmithKline manufacturing facility in Jurong has in place an annual target to reduce energy usage by 5% in absolute terms since 2008. Since then, it has been exceeding the target every year. These are the results of the various EE projects and initiatives that the cross-functional energy management team at GSK has accomplished, since it was formed in 2002, with the blessing of the management and through the continuous engagement of all employees to save energy. The cross-functional energy management team led by the energy manager meets regularly to identify energy-saving opportunities, and organizes energy conservation campaigns to promote awareness and sharing of best practices amongst staff. They have installed energy monitoring and tracking systems to track and quantify the energy savings of their energy efficiency projects.
Best Practices	Ascendas Land (S) Pte Ltd	Upgrading of chiller plant at The Galen
	City Developments Limited	Retrofitting of chiller plant at the New Tech Park
	Eastman Chemicals Singapore Pte Ltd	Energy optimization of distillation column
	MSD International GmbH	Conversion of motor driven pump to steam turbine unit for chiller water pump
	Pfizer Asia Pacific Pte Ltd	Installation of tri-generation plant to improve energy efficiency
Outstanding Energy Managers of the Year	Mr Yeo Yee Pang, Engineering Manager, Glaxo Wellcome Manufacturing Pte Ltd	The amount of energy that Mr Yeo saved for the company is quantifiable and tracked through the EnMS, and he has a good track record of promoting energy efficiency within and beyond his organization for 11 years

As of 2 April 2012, 107 companies have agreed to participate in the EENP. It will be

[13] http://www.greenbusinesstimes.com/2011/05/24/inaugural-energy-efficiency-national-partnership-eenp-awards-press-releases/.

more groups and energy managers to receive the EENP Awards in the future.

2.5 United States

2.5.1 Superior Energy Performance

About Superior Energy Performance[14]

Superior Energy Performance (SEP) is a certification program that provides industrial facilities and commercial buildings with a roadmap for achieving continual improvement in energy efficiency while maintaining competitiveness. A central element of SEP is implementation of the ISO 50001 energy management standard, with additional requirements to achieve and document energy performance improvements. The program provides a framework for fostering energy efficiency at the plant level and a methodology for measuring and validating energy efficiency/performance improvement.

SEP provides a transparent system for verifying energy performance improvement and energy management practices through the application of an internationally-accepted standard. The Third-party conformity assessment to SEP is accredited by the American National Standards Institute (ANSI) and the ANSI-ASQ National Accreditation Board (ANAB).

The U.S. Department of Energy (U.S.DOE) has partnered with the industrial and commercial buildings sectors to develop the SEP program. The U.S. DOE owns the SEP certification mark and will license the use of the mark accordingly to facilitate delivery of the program through private sector organizations.

SEP is designed to encourage participation among facilities of all sizes and levels of experience in managing energy. The program offers flexibility by offering two tiers: self-declared and ANSI/ANAB-certified. Facilities will select the tier depending on the degree of data validation desired by a facility.

Table 16: Two Program Tiers of SEP

Partner	Certified Partner
Self Declaration Criteria • Conformance to ISO 50001 • Measure and audit energy performance improvement Performance Levels • Energy performance improvement required Method of Verifying Results • Self Declaration	*ANSI/ANAB-accredited certification* Criteria • Conformance to ISO 50001 • Measure, verify, and certify energy performance improvement Performance Levels • Energy performance improvement required, minimum requirements set by program • Two pathways available: Energy Performance or Mature Energy Method of Verifying Results

[14] http://www.superiorenergyperformance.net/.

	• ANSI/ANAB-accredited certification with on-site review

SEP Performance Criteria for Certification Levels and Best Practice Scorecard Credits

To encourage industrial facilities to achieve greater energy performance improvements, SEP offers silver, gold, and platinum designations to Certified Partner applicants based on the level of energy performance improvement attained.

SEP for industry provides two pathways for achieving Certified Partner designation: the "Energy Performance Pathway" and the "Mature Energy Pathway." Most facilities will qualify through the Energy Performance Pathway, which requires facilities to achieve a certain percentage of improvement in energy performance. However, continued achievement of aggressive energy performance improvements will prove to be more challenging for industrial facilities that have a long track record of sustained energy performance improvement. The Mature Energy Pathway is designed for Certified Partner applicants with mature EnMS and requires use of the SEP Industrial Facility Best Practice Scorecard to meet SEP program performance levels.

The SEP Industrial Facility Best Practice Scorecard assesses the maturity of a facility's EnMS and offers credits for EnMS activities, processes, or procedures that are "above and beyond" ISO 50001 requirements. The scorecard's guidance provides details about the credits and approaches that can be implemented to achieve them.

Table 17: Evaluation Criteria of the Two Energy Performance Pathways of SEP

Energy Performance Pathway

Performance Levels: All facilities must meet a minimum energy performance improvement over the 3 years after the baseline period*.

Silver:	5%
Gold:	10%
Platinum:	15%

Mature Energy Pathway

Prerequisite: All facilities must first meet a 15% energy performance improvement over the 10 years after the baseline period*.

Performance Levels: Facilities will apply the SEP Industrial Facility Best Practice Scorecard to receive a score that includes credits for energy management best practices and energy performance beyond the 15% reduction.

SEP Industrial Facility Best Practice Scorecard	Point Requirements		
	Silver	Gold	Platinum
Total Scorecard Points (minimum)	35	61	81
Minimum Energy Management Best Practices Points	30	40	40
Minimum Energy Performance Points	0	10	20

* Facilities may use a shorter time period than 3 years for the Energy Performance Pathway or 10 years for the Mature Energy Pathway (after the baseline period) if specified criteria are met. See the SEP Certification Protocol for details.

Best practice scorecard credits are available in seven major categories that are organized under two major focus areas: Energy Management and Energy Performance Improvement. Energy Management credits can be acquired by implementing best practices.

The seven major categories of best practice credits are:

Focus Areas1: Energy Management Credits (70 total points)
- Energy Data, Monitoring & Measurement (DM)
- Management of Significant Energy Uses (SU)
- Energy Supply Management (ES)
- Management of Energy Performance Improvement Opportunities (EP)
- System Sustainability (SS)

Focus Area 2: Energy Performance Improvement Credit (30 total points)
- Energy Performance Improvement Credit (EPI)
- Innovation in Energy Performance (IEP)

In Focus Area1, each category has a list of prerequisites followed by associated best practice energy management credits. The prerequisites are relevant requirements of the ISO50001 standard for which the associated best practices apply. Each prerequisite is followed by one or more scorecard credits that demonstrate practices beyond the EnMS standard requirements. Table 18 lists the best practice in each category and the total number of points for each category and credit.

Table 18: Best Practice Scorecard Credits of SEP

Energy Data, Monitoring and Measurement(DM)		17 Possible Points
1	Data availability	2 Points
2	Improve data collection and analysis	3 Points
3	EnPI updating	2 Points
4	Establish benchmarks	2 Points
5	Submeters	2-4Points
6	Cost centers	24Points
Significant Energy Uses(SU)		19 possible Points
7	Facility energy balance	2 Points
8	Designation of significant energy uses	2-8 Points
9	Equipment repair and replacement policy	3 Points
10	Utilize energy-efficient design	2 Points
11	Energy-efficient maintenance practices	2 Points
12	EnPIs for significant energy uses	2 Points
Energy Supply(ES)		5 Possible Points
13	Include procurement personnel on energy team	2 Points
14	Demand optimization	3 Points
Management of Energy Projects(EP)		12 Possible Points
15	Regular assessment of significant uses	2 Points

16	Energy system assessment criteria	2 Points
17	Continual improvement tools	2 Points
18	Life cycle costing	2 Points
19	Lower financial barriers	4 Points
System Sustainability(SS)		17 Possible Points
20	Resources: Energy management team	2 Points
21	Awards or incentive program for energy	4 Points
22	Energy professional certifications	2 Points
23	Strategic planning	2-4 Points
24	Preventive action	2 Points
25	Management review of inputs from stakeholders	3 Points
Energy Performance Improvement Credits		30 Possible Points
26	Energy Performance Improvement Credit	2-30 Points
Credits for Energy Performance		23 Possible Points
27	Combined Heat and Power	1-5 Points
28	Renewable Energy Supply	1-5 Points
29	Superior Performance with Benchmarks	1-3 Points
30	GHG Intensity Reduction from On-site Energy Use	2-5 Points
31	Other Innovative Actions	1-5 Points

Texas Pilot Project on Plant Energy-Efficiency Certification

Five industrial facilities in Texas field tested the SEP from 2008-2010 and became the first facilities certified to the SEP Program. These facilities achieved improvements in energy performance, ranging from 6.5 percent to 17 percent over a period of two to three years. The participants and their achievements are listed below:

Table 19: First Facilities Certified to SEP

Plant	Certification Level
Cook Composites and Polymers Co. Houston plant	Gold
Free scale Semiconductor Inc. Oak Hill plant	Silver
Owens Corning Waxahachie plant	Silver
Dow Chemical Company, Texas City manufacturing plant	Platinum
Dow Chemical Company, Texas City energy systems plant	Silver

This diverse group of facilities represented three industrial sectors: insulation, semiconductors and chemicals, and varied in size and experience in energy management. The goal of the pilot project was to verify that the procedures, criteria, and performance criteria under the SEP were practical and achievable while providing benefit to participating plants. To accomplish this, plant staff received coaching support to achieve the following:

- Implement an EnMS conforming to the American National Standard, ANSI/MSE 2000:2008. ISO 50001 was unavailable during pilot testing.
- Test and provide feedback on the ASME System Assessment Criteria prior to their publication.
- Apply the proposed measurement and verification protocol to verify energy performance results.

The project was funded by USA Department of Energy and the Texas State Energy Conservation Office. The Texas Industries of the Future program, located at The University of Texas at Austin, coordinated the pilot project in Texas. Georgia Tech provided assistance on implementation of the ANSI/MSE 2000:2008. Other supporting organizations working under contract to U.S. DOE included Lawrence Berkley National Laboratory and Oak Ridge National Laboratory. The U.S. Council for Energy-Efficient Manufacturing partnership also provided oversight, support, and guidance to the project.

2.5.2 Energy Star

About Energy Star

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) to save money and protect the environment through energy efficient products and practices[15].

In 1992 the EPA introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first labeled products. Through 1995, EPA expanded the label to additional office equipment products and residential heating and cooling equipment. In 1996, EPA partnered with DOE for particular product categories. The ENERGY STAR label is now on major appliances, office equipments, lighting, home electronics, and more. EPA has also extended the label to cover new homes, commercial and industrial buildings. Now ENERGY STAR is the national symbol of energy efficiency recognized by most Americans.

Figure 8: Energy Star Label of USA

Energy Star for Plant

EPA helps industrial departments to distinguish enterprises and implement powerful

[15] http://www.energystar.gov/.

energy strategies, develops tools and resources targeting at manufacturers' demands, provides assistance, establishes and improves enterprises' energy management projects through Energy Star program. Currently about 480 companies which have different scales and belong to different industrial sectors get involved in Energy Star in America.

Energy Star Program provides help to enterprises mainly in the following aspects:

(I) Energy Star energy management guide. This is an energy management guide prepared according to the successful experience of Energy Star partners and applicable for top management of companies. These guides include key components of energy management from successful companies.

(II) Energy project evaluation tool. The tools could evaluate strong and weak points of companies' energy management projects. The self-assessment tool could make comparison between the company's management projects and best energy management practice identified in Energy Star guide. Besides, this tool could help to find out steps and measures necessary in next step so as to improve current energy management level further.

(III) Nationwide energy performance grading system. The system could tell if the factory's energy performance is competitive to factories of the same type in America. US Environmental Protection Agency has a nationwide energy efficiency grading system targeting at American production factories. Production factories of different types are graded according to "Energy Efficiency Indicator" of US Environmental Protection Agency.

(IV) "Focus industry". Annual industrial energy conservation forum is held every year and industrial energy authority in charge will conduct open discussions about energy management issues in the industry and hold telephone meetings and web meetings regularly to exchange experience in energy management and provide more feedback opinions and recommendations.

(V) Energy guide. Conduct technical evaluation on production factories' chances to cut down energy consumption, including energy efficiency measures in respects of process and factories' facilities. Energy guides are provided to all industrial sectors involved. Energy guides are organized and prepared by Lawrence Berkeley National Laboratory and they gather the best practices in the world.

Plant energy performance indicator (EPI)

Energy performance indicator (EPI) is the energy efficiency benchmarking tool targeting at factories which is developed by EPA. Energy Star recommends EPI serve as a key step in strategic energy management. EPI tool is able to help companies to evaluate current energy efficiency levels of their factories, put the prior resources in process that need improvement the most, and track the improvements.

Energy supervisors of factories and companies could get EPI scores or energy efficiency percentage grade. The score range is from 1 to 100, the larger the better. US Environmental Protection Agency defines 50% (50 points) as the mean value of the industrial sector. If the score is equal to or higher than 75% (75 points), it is in the high energy efficiency scope, which represents the result of comparisons with similar factories of the industry. If a factory has EPI score equal to or higher than 75 points and good environmental protection records, then the factory is qualified to apply for energy efficiency and environmental protection label Energy Star.

EPI data is from data of economic census conducted by USA Census Bureau, annual investigation of manufacture industry and other relevant materials based on the statistical model developed by Duke University. Meanwhile, EPI data also gives considerations to different factories in the same industrial sector that may affect energy consumption, such as factories' climate difference, capacity utilization rates, product structure, impact on energy consumption of raw materials, and semi-finished products purchased or sold, and then standardizes production activities or factors that may affect energy consumption so as to grade energy efficiency levels of factories.

All data used to develop EPI basic model is confidential and excluded in EPI tool. EPI users cannot take advantage of EPI to deduce energy efficiency scores of their competitors. The score provided by the model is based on the data input by the user and only the user could see the result given by the model.

EPI is currently available for:

- Cement Manufacturing
- Container Glass Manufacturing Plants
- Cookie & Cracker Bakeries
- Corn Refining
- Flat Glass Manufacturing Plants
- Frozen Fried Potato Processing Plants
- Juice Processing Plants
- Motor Vehicle Manufacturing
- Pharmaceutical Manufacturing
- Pulp and Paper Manufacturing

The cement manufacturing EPI scores the energy efficiency of a cement manufacturing plant based in the United Stated. To use the tool, the following information must be available for a cement plant:

I. Energy purchases: data are needed by type of energy for the current year and a baseline year as defined by user. Electricity , Nonelectric energy use and Energy costs
II. Plant location zip code
III. Total amount of clinker produced during the year
IV. Maximum amount of clinker that can be produced per day

2.6 ASEAN

About ASEAN Energy Management Scheme[16]

ASEAN Energy Management Scheme (AEMAS) is the world's first regional certification system for energy managers and energy end-users. Funded by the European Union under the Switch-Asia Programme, it is currently being implemented by the ASEAN Centre for Energy in eight (8) ASEAN Member States, namely: Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand and Vietnam. The grant from the European Union for the establishment of AEMAS started last February 2010 and will run until January 2014. The AEMAS project is designed under the Steering of the ASEAN Energy Efficiency and Conservation Sub Sector Network (EE&C-SSN) and subsequently endorsed by the ASEAN Ministers on Energy Meeting (AMEM). The Scheme will be a significant contributor to the ASEAN Plan of Action for Energy Cooperation's (APAEC 2010-2015) cumulative target of reducing the region's energy intensity by 8% (based on 2005 level) by the year 2015. AEMAS is the culmination of previous projects under the European Commission-ASEAN Energy Facility (EAEF) cooperation implemented by the ASEAN Centre for Energy (ACE) from 2002 until 2007. During this period, the tools for the implementation of AEMAS was designed and developed such as training curricula, energy management test procedures and simulation.

Coordinated by:

Partners:

Associates:

Co-funded by:

[16] Pierre Cazelles, Director-Partnerships Asia, International Copper Association, The ASEAN Energy Management Scheme, presentation on the Workshop of Energy Performance Evaluation Methodology Development and Promotion in APEC Economies in November 7, 2012, Chinese Taipei.

Approach to energy management

The scheme promotes energy end users to adopt Sustainable Energy Management System (SEMS) as an effective method to improve their energy performance, which is shown in Figure 9, and aims to:

- Build managerial and business skills of Energy Managers through training;
- Improve professional standing and credibility of Energy Managers through accreditation;
- Provide commercial benefits to end-users through certification.

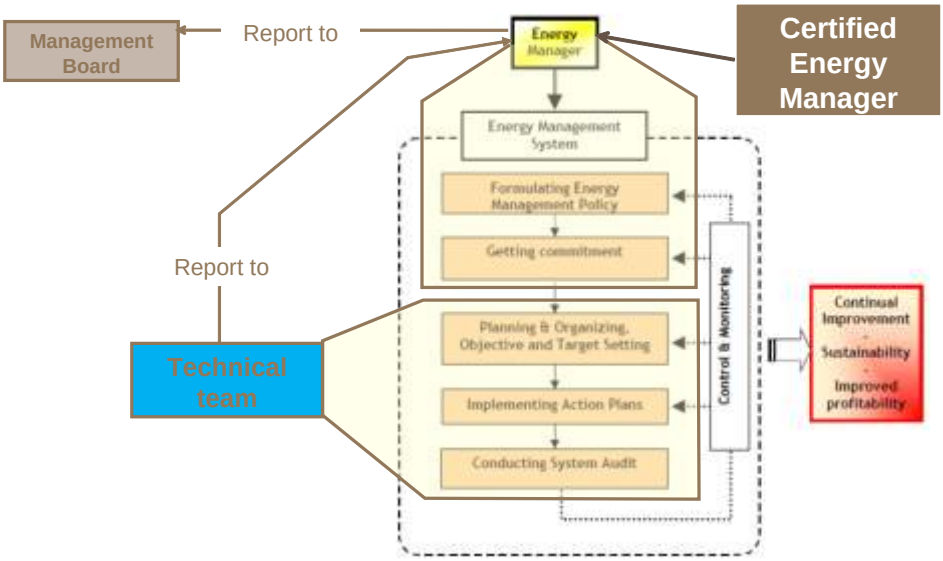


Figure 9: Approach to Energy Management of AEMAS

Training and Certification of Energy Managers

The Energy Manager training curriculum focused EXCLUSIVELY on managerial aspects: teaching energy managers on how to establish, implement, maintain and improving energy management system in their organization. Training curriculum is based on 220-page Energy Management Workbook. There are two levels of certification: Certified Energy Manager and Professional Energy Manager.

The roles of Energy Managers include:

- How to define the energy policy
- How to appraise the energy management performance
- How to set up and manage: energy baseline, EEI, Energy Accounting Centers, Energy Management Committee, Energy Management Working Procedures, Investment Appraisal for Energy Efficiency Projects, Human Resource Development in Energy Management System, Documentation in Energy Management System
- How to establish Energy Target & Plan, including organizing Energy Audit & Analysis, Measurement & Verification

- How to integrate the Energy Management System into Business Practice (working ,monitoring and reporting procedures, other management standards, …)
- Project management and investment
- Energy Management performance review

Energy Management Gold Standard certification

Energy end-users that adopted the scheme will enter into certification process under Energy Management Gold Standard. The certification consists of three (3) levels starting from 1-star, 2-star and 3-star based on ISO 50001 with additional requirements. Three levels of certification to progressively drive towards energy management best practices. The certification aims to empower industries with in-house capabilities to establish and manage the energy management system.

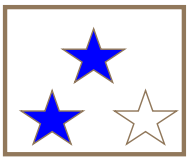
One star Certification 

Criteria: EnMS System in place according to ISO 50001

+ Certified Energy Manager (CEM)
+ Motivation plan for the personal involved in the EnMS
+ Budget allocated for investment in EE measures
+ Procurement policies and internal investment criteria “EE-friendly”

Validity: 2 years

- Cannot be renewed: obligation to achieve 2 star
- In case 2-star certification cannot be achieved within 2 years, the 1-star certificate is withdrawn.
- Companies can re-apply for 1-star after 3 years minimum from the date of withdrawal
- Companies can apply directly for 2-star anytime

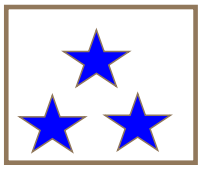
Two star Certification 

Criteria: Same as 1 star + (either one of the following):

- Overall EEI improves by 5% (over 2 years);
- Overall energy consumption decreases by 5%;
- EEI improves by 1% on year-on-year basis over past 3 years;
- EE measures representing at least 50% of the total energy saving potential of recommended measures (internal audit) are implemented and achieving at least 1% overall energy savings;
- EE measures representing at least 50% of the total energy saving potential of recommended measures (external audit by AEMAS certified auditor and approved by senior AEMAS experts) and achieving less 1% overall energy savings are implemented (include cases where NO EE measures are implemented);
- Fuel-switching project implemented (using NG or RE) Projects involving self-generation of electricity implemented;
- One RE project implemented;
- Investment in 5 new EE technologies.

Validity: 2 years

- Renewal gives 3 stars;
- If cannot be renewed: downgrading to 1-star (if criteria met) with only 1 year validity.

Three star Certification 

The three-star certification is open only for 2-star certified companies and acknowledges companies who have reached energy management best practices.

Criteria:

- EMGS 2-star certification for at least 18 months;
- Independent audit report certifying that no more significant EE improvement can be made; verification by EnMS accredited auditor ;

Validity of 3-star:

- 2 years

Current Status

AEMAS structure has been established and local trainers have been accredited in each economy. Till now, 500 energy managers have already been trained and certified. Another 2,500 are to be trained and certified until 2014. 5 companies have been certified as 1-star (including Texas Instrument, Toshiba and San Miguel in the Philippines) and 15 companies are under certification process for 1-star. TUV Nord Thailand has been accredited as EnMS auditor.

3. Comparative Analysis on Energy Performance Evaluation Methodologies and Practices in APEC Economies

The typical energy performance evaluation methodologies in APEC economies are shown in the following table. The similarities and differences of energy performance evaluation methodology between different economies will be summarized and analyzed later.

Table 20: Typical Energy Performance Evaluation Methodologies in APEC Economies

Economies	Name of Energy Performance Evaluation Program	Links to Energy Policy or Program	Beginning and Ending Time	Evaluation Object	Evaluation Indicator	Evaluation Methods
Canada	Benchmarking	CIPEC	Since 1990s of 20th century	Industrial sectors	① Energy performance ② Energy Best Practices for Technology and management	EEI
	Energy Efficiency Evaluation Tool	—	—	Key industrial Sectors	① Energy efficiency ② Technical Best Practice ③ Best Practice for energy management	Not Mention
China	Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises'	Top 1,000 Enterprises Energy Conservation Action Program	From 2007 till now	Top 1,000 enterprises	① Energy efficiency goal indicator ② Energy efficiency measures indicator	Comprehensive scoring
	Comprehensive Evaluation of Energy Benchmarking	Energy benchmarking	From 2007 till now	Key energy-using units	① Economic indicator ② Management indicator ③ Technical Indicator	—
	Evaluation Criteria of Suzhou Energy Efficiency Star	Energy Efficiency Star of Suzhou	From 2009 till now	Key energy-using units of Suzhou	① Energy management indicator ② Energy efficiency indicator ③ Technology progress indicator ④ Energy performance indicator	Comprehensive scoring
Japan	Comprehensive Evaluation Methodology of "General Examination of Factories"	General Examination of Factories	From 2001 till now	Key energy-using units	① the content in "regular report" ② The establishment and compliance of Energy standards and management standards for energy-using equipments ③ Energy consumption changes of factories ④ Energy conservation activities	Comprehensive scoring
Singapore	Evaluation Methodology of EENP Reward	EENP	From 2010 till now	The large energy consumers	① Excellence energy management ② Best practice ③ Outstanding energy managers	Not Mention

U S A	Best Practice Scorecard	SEP	From 2010 till now	Industrial Plants	① Energy Management ③ Energy Performance Improvement.	Conformity assessment
	EPI	Energy Star	From 1992 till now	Focus Plants	Energy Consumption; Climate difference; Capacity utilization rates.etc.	Comprehensive scoring
ASEAN	Energy Management Gold Standard certification	Energy Management Scheme	From 2010 till now	Energy users	Based on ISO 50001 with additional requirements	Conformity assessment

3.1 Summary on Factors Involved in Energy Performance Evaluation

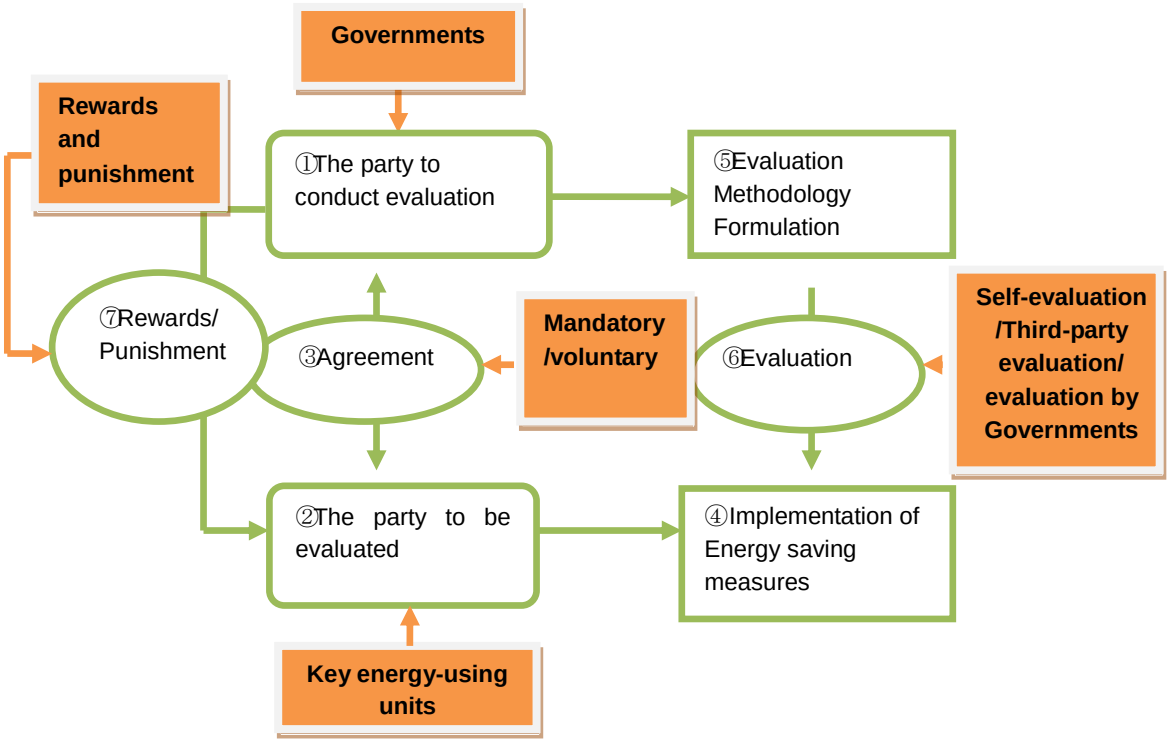


Figure 10: Similarities and Differences of Main Factors Involved in Energy Performance Evaluation in Five Economies

The similarities and differences of main factors involved in energy performance evaluation of five economies are shown as above.

The party to conduct evaluation is generally the energy conservation authority of each economy. For example, China's "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises" is led by National Development and Reform Commission (NDRC); SEP and Energy Star of U.S. are initiated by DOE and EPA; the Ministry of Economy Trade and Industry is in charge of the "General Factory Inspection" in Japan, etc.

The evaluated party is generally the key energy-consuming unit which is classified by annual energy consumption in China, Japan and Singapore. However, annual energy consumption of the evaluated party is not clear in the U.S. and Canada.

As to the agreement by both parties, it falls into two means, mandatory and voluntary. Specifically, "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises" in China and "General Examination of Factories" in Japan are the former. It means that the evaluated party must fulfill specific energy efficiency obligations, while energy performance evaluation in the U.S. and Canada is subject to the principle of voluntariness.

Upon reaching a consensus, the evaluated party will carry out energy efficiency

measures with the support of government departments, and the evaluation party will work out energy performance evaluation methodology to develop the evaluation work. In terms of means of evaluation, it involves self-evaluation, evaluation by a third party, and evaluation by energy conservation authorities (e.g. the SEP of U.S. can choose either self-evaluation or ANSI/ANAB third party evaluation way). Generally speaking, a combination of self-evaluation and evaluation by a third party or a combination of self-evaluation and evaluation by energy conservation authorities will be involved. As to "General Examination of Factories" in Japan, it adopts the combination of self-evaluation by the factory and inspection by Energy Conservation Center; while for "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises" in China, these enterprises are annually examined by personnel authorized by NDRC in addition to submitting annual report on self-inspection by enterprises.

In terms of rewards and punishments measures, a combination of rewards and punishments is generally applied to mandatory energy performance evaluation (e.g. enterprises failing to fulfill energy efficiency goals will be subject to accountability system in China's "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises"); while rewards are applied to a majority of voluntary energy performance evaluation (EENP project in Singapore involves mainly honor rewards, while SEP and Energy Star grant certification labels for rewards).

3.2 Analysis on Energy Performance Evaluation Methodologies in related Economies

A mature energy performance evaluation methodology should include evaluation objects, indicators, criteria, methods and procedure, etc. The similarities of related economies in energy performance evaluation methodologies are shown as below:

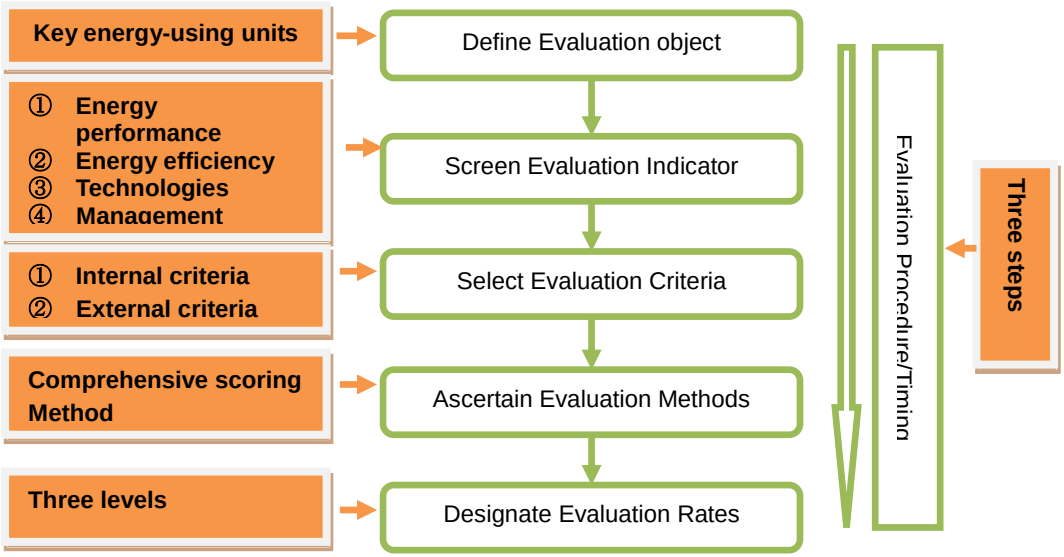


Figure 11: Similarities of Related Economies in Energy Performance Evaluation Methodologies

Evaluation Indicator

The evaluation indicators achieved by analyzing energy performance evaluation methodology of related economies mainly include energy performance indicators, energy efficiency indicators, and technology and management indicators, as shown below:

Table 21: Analysis on Indicators System of Energy Performance Evaluation

Indicator	Sub-indicator
Energy Performance Indicator	Energy savings Emission reduction Energy performance improvement credit Percentage of sustained energy performance improvement, etc.
Energy Efficiency Indicator	energy consumption per unit of product or added value Energy-related economic indicator, etc.
Technology Indicator	Process engineering operation and efficiency of Equipment Investment in R&D Implementation of energy efficiency projects
Management Indicator	Management responsibility Organizational agencies Energy statistics, measurement and monitoring Personnel training, etc.

Evaluation Criteria

Evaluation criteria are applied both internally and externally. Criteria for energy performance evaluation are generally the combination of the both. For instance, the evaluation criteria for "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises" in China take enterprises' fulfillment of annual energy savings and implementation of energy efficiency measures; Best Practice Scorecard of SEP plant uses international standards for EnMS and best practice for energy efficiency improvement as leverage; EPI evaluation methodology of Energy Star uses domestic energy efficiency level as leverage.

Table 22: Examples of Selection of Evaluation Criteria

Internal criteria
Energy efficiency goal of the evaluated party Management goal of the evaluated party Economic and technical goals of the evaluated party
External criteria
Domestic/international technical, management and energy efficiency standards Domestic policies Domestic/international best practice

Evaluation Method

In terms of evaluation methods, comprehensive scoring is almost adopted by all objects subject in the research. To be specific, a score will be gained after quantitative or qualitative indicators being compared with evaluation criteria. The highest theoretical value of each indicator can be considered as its weight. Generally, the

score of energy performance indicator accounts for 30%-40% of the total, such as Energy Efficiency Star evaluation method in Suzhou, and Best Practice Scorecard of US SEP plant.

Evaluation Procedure

Evaluation procedure is generally conducted in three steps: self-inspection of objects subject to evaluation; objects subject to evaluation accept examination of a third party or energy conservation authorities with conclusions drawn; implement reward, punishment measures and propose suggestions for rectification based on results.

Evaluation Rate

The level for evaluation is relatively simple, and is generally divided into three levels:

I. “Top Class” or “Outperformance Class ”,
II. “Middle Class” or “Accomplished Class”
III. “Low Class” or “Unaccomplished Class”

3.3 Practice and Results for Promoting Energy Performance Evaluation

Strictly speaking, because each economy involves different time for implementing energy performance evaluation, it differs from each other in both the maturity and promotion & application of evaluation methodologies.

In terms of the time for applying energy performance evaluation, Energy Star of U.S. and “General Examination of Factories” in Japan are quite mature in both evaluation system/certification system and evaluation methods. In particular, Energy Star has become a project with certain world influence. Up to now, Energy Star has been progressively expanded from USA to Australia; Canada; China; Japan; New Zealand; Chinese Taipei and other economies and regions. USA has held the International Conference on Plans for Energy Star yearly ever since 2001 with a view to facilitate its promotion. “General Examination of Factories” in Japan, taking advantage of such sound systems and executive organizations, has achieved better results.

China’s “Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises” could be seen as a more mature evaluation system. However, the method of evaluation (to be evaluated by energy conservation authorities at present) remains to be discussed. In addition, the indicators should be detailed and the criteria must be clearer.

The Energy Efficiency Star in Suzhou has been influenced by the overall framework and methods of Energy Star of U.S. Its “Energy Efficiency Star’ Evaluation Standard” has emerged the local standard. However, it needs to combine with local energy efficiency policies for further institutional design in terms of project execution and promotion.

As a new certification project, SEP aims to strengthen energy management and constantly improve energy efficiency by promoting energy management system (ISO 50001). SEP is beneficial and forward-looking, and further attempts should be made in institutional design and evaluation methods.

Table 23: Analysis by Examples the Maturity and Promotion of Energy Performance Evaluation in Related Economies

Energy conservation activities or measures	Maturity		Regions/organizations applying energy performance evaluation	Time span for promotion or current application
	Evaluation or certification system	Evaluation method		
Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises (China)	More mature	More mature	Over 1,000 enterprises within China	4 years and more
Energy Efficiency Star in Suzhou (China)	To be mature	More mature	More than 20 enterprises in Suzhou	Pilot project to promotion
SEP (U.S.)	To be mature	To be mature	Some enterprises in Tennessee, USA	Pilot project to promotion
Energy Star (U.S.)	Mature	Mature	US, Canada, EU, Japan and Australia, etc.	20 years
“General Examination of Factories” in Japan (Japan)	Mature	Mature	The first category factories in Japan	10 years and more
Energy Management Scheme(ASEAN)	To be mature	To be mature	ASEAN companies	Pilot project to promotion

4. General Energy Performance Evaluation Methodology for Industrial Enterprises

EnMS could become a useful tool by which the organizations could improve their energy efficiency continually and the energy conversation authorities carry out energy management work successfully. As an important part of the EnMS, energy performance evaluation methodology remains for further development.

The topical energy performance evaluations from economies will build foundation for the development of general energy performance evaluation methodologies for industrial enterprises. This chapter will develop key factors and main content of energy performance evaluation, and also provide advice about promotion of energy performance evaluation in industrial enterprises.

4.1 Determination for Energy Performance Evaluation Factors

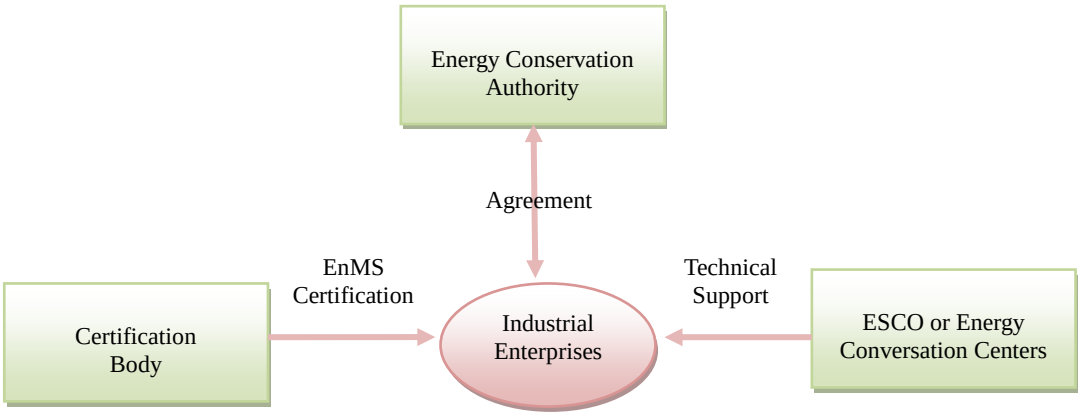


Figure 12: Participants in Energy Performance Evaluation for Industrial Enterprises

The Participant

Table 24: Function of Participants in Energy Performance Evaluation for Industrial Enterprises

Participant	Function
Energy conservation authority	Giving full play to policy leading role, such as incorporating the EnMS gradually into the national energy conversation program, helping develop EnMS standards, and conducting the certification body as well as pushing the enterprise's energy efficiency actions.
Certification Body	Helping to formulate EnMS standards and guidance (harmonious with the international standard) and carrying out energy performance evaluation and EnMS certification.
Industrial Enterprise	Working as a implementation unit to establish EnMS, carrying out energy efficiency projects and being evaluated by the certification body.
Energy Service Companies(ESCO) or Energy Conversation Centers	Working as the third party for energy performance evaluation. They are entrusted by energy conservation authority or certification body, and provide technical support to industrial enterprises and certification body.

Three participants, namely energy conservation authority, certification body and industrial enterprise, involving in energy performance evaluation, have different functions.

- The energy conservation authority should play a leading role to encourage enterprises into active involvement and provide them with policy and fund support.
- Certification body, with huge responsibility, will evaluate the industrial enterprises' energy performance, and implement EnMS certification.
- Industrial enterprises will establish EnMS,, carry out self-evaluated and then be evaluated by the certification body.
- ESCO or Energy Conversation Centers, which is entrusted by energy conservation authority or certification body, will conduct the industrial enterprises to establish EnMS and provide technical support, such as conducting Measurement and Verification (M&V) for certification body.

The Agreement

The voluntary principle is taken for the energy performance evaluation for industrial enterprises when they want to establish EnMS. However, if the economies have fixed their energy efficiency goals and industrial enterprises have responsibility to reach certain energy efficiency goals according to the laws, it is necessary to reach a mandatory agreement. At this moment, the mandatory energy performance evaluation should be carried out, and the energy efficiency indicator should be with veto power for the energy performance evaluation methodology.
The result of energy performance evaluation for an industrial enterprise should become a basis for the enterprise to obtain EnMS certification.

4.2 Content of Energy Performance Evaluation Methodology

Energy performance evaluation methodology for industrial enterprises includes: evaluation object, evaluation indicator, evaluation method, evaluation criteria and evaluation rate, etc.

4.2.1 Evaluation Object

Evaluation objects are industrial enterprises intending to obtain EnMS certification, which should meet the following basic conditions:

I. The equipments/products should be in accordance with national laws, and meet requirements on international/national standards;
II. The enterprises have built energy management institution;
III. The enterprises have qualified energy managers;
IV. The enterprises build energy monitoring, statistics and reporting systems.

4.2.2 Evaluation Goal

I. To measure the enterprise's energy performance after establishing and operating EnMS for a period of time;
II. To determine whether the enterprise meets the basic requirements of EnMS standard or not ;
III. To find the shortage of energy management and energy conservation technology for the enterprise and the main resistance to improve energy efficiency continually.

4.2.3 Evaluation Indicator and Criteria

The evaluation indicator system is established by researching the energy performance evaluation methodologies in APEC region, which can be classified into energy performance indicator, energy efficiency indicator, energy management indicator and energy conservation technologies indicator.

I. Energy performance indicators include energy efficiency goals and carbon emission reduction goals set by industrial enterprises themselves or energy conservation authority. Energy efficiency goals can be described in different ways, such as energy savings, energy saving rate, EEI, etc. Carbon emission reduction goals can be described as emission reductions or decline rate of emission reduction.
II. Energy efficiency indicator can be divided into physical indicator, such as energy efficiency of energy-using equipment, and economic indicator, such as energy consumption per unit of product or process or energy consumption per industrial added value.
III. Energy management is the basic requirement for establishment of EnMS. Energy management indicators should be in accordance with ISO50001 or national EnMS standard which is based on ISO50001, including energy efficiency plans, energy management organizations, energy management teams, energy statistics, monitoring and reporting systems, etc.
IV. Energy conservation technology indicators include research and development (R&D) investment, applying or producing advanced technology or products as well as energy conservation technological transformation projects, etc.

There are quantitative and qualitative indicators to build the indicator system and each indicator has its evaluation criteria. The criteria of quantitative indicators are easier to determine compared with the criteria of qualitative indicators. The following tables are listed examples of quantitative and qualitative indicators and their criteria.

Table 25: Examples of Quantitative Indicator and Criteria

Items	Evaluation Indicator	Criteria
Energy	Energy savings[1]	The target should be proposed after energy audit or

performance		benchmarking to figure out the room for the enterprises to improve energy efficiency. Sometimes, there is a mandatory agreement between energy conservation authorities and industrial enterprises, such as energy savings reach to 5000tce annual year. If the enterprise achieves the target, it will get the maximum score of this item.
Energy efficiency	Energy consumption per unit of product or process	In accordance with the advanced energy efficiency in related national or international standards or best practices. If the enterprise's energy efficiency reaches the advanced indicator[2], it will get the maximum score of this item.

Note: [1]Energy savings should be calculated according to relevant international or national standard.

[2]Sometimes the international advanced indicator is not available or comparable, at this time the national indicator or best practice will become the leveraged indicator.

Table 26: Examples of Qualitative Indicators and Criteria

Items	Evaluation Indicator	Explanation
Energy management		• ISO 50001 • or national EnMS standard
Energy conservation technology	Energy efficiency projects*	• Statistics and calculation of energy consumption; • Energy efficiency benchmarking; • Energy savings agreement; • Energy performance contracting; • Building of energy management center; • Implementation of energy conversation technological transformation.

Note: *The energy efficiency projects should be implemented or are being implemented by enterprises within three years.

The details for the evaluation indicator and criteria system are shown as follows:

Table 27: Evaluation Indicator and Criteria System of Energy Performance Evaluation for Industrial Enterprises

Items	Indicator	Score	Evaluation Criteria
Energy performance (30 points + 10 points)	1. Energy savings	20 points (+5 points)	1) Fulfill the annual energy savings goals, 20 points; complete above 90 % of the target, 15 points; complete above 80 %, 10 points; complete below 80%, no point. If energy saving is a mandatory goal, the target becomes a veto indicator. The enterprise fulfilling the target gets 15 points, or gets no point and the total score is 0. 2) Over-fulfill the annual energy savings goals above 5% (including), plus 5 points.

	2. Carbon emission reductions	10 points (+5 points)	1) Fulfill the annual goals, 10 points; complete above 90% of the target, 7 points; complete above 80%, 4 points; complete below 80%, no point. If emission reduction is a mandatory goal, the target becomes a veto indicator. The enterprise fulfilling the target gets 10 points, or gets no point and the total score is 0. 2) Over-fulfill the annual goals above 5% (including), plus 5 points.
Energy efficiency (15 points + 10 points)	1. energy consumption per product (process)	10 points (+5 points)	1) In accordance with the advanced energy efficiency in related national or international standards or best practices. Reach the national advanced level, 10 points; the national average level, 7 points; below than nation average level 20%, 5 points; 2) Reach the international advanced level, plus 5 points.
	2. energy efficiency of main energy-using equipment	5 points (+5 points)	1) In accordance with the advanced energy efficiency in related national or international standards or best practices. Reach the national advanced level, 5 points; the national average level, 3 points; below than nation average level 20%, 1 point; 2) Reach the international advanced level, plus 5 points.
Energy management (40 points)	1. establishment of energy management organization	7 points	1) Establish the energy management team and hold the relative meetings regularly, 3 points; 2) At least one of energy management team members from enterprises' top management, and all the team members perform their respective functions, 2 points; 3) At least one energy manager with energy professional certification is employed by the enterprise, who have received and passed energy-saving training regularly,1 point; 4) Energy management with the responsibility to formulate and update energy conversation guideline, plan and specification and so on, 1 point.
	2. Set energy conservation goals	7 points	1) Set the medium and long term energy efficiency goals , 1 point; 2) Set and effectively decompose the annual energy efficiency target, 3 points; 3) Make clear assessment requirements on energy efficiency targets and perform the examination, 2 points; 4) Conduct regular analysis and summary for assessment results of energy efficiency targets, 1 point.
	3. Formulate energy conversation specification	7 points	1) The energy metering instruments and management are in accordance with national standard requirements, 2 points; 2) Develop management and technical specifications for main products, equipment, operation and personnel, 2 points; 3) Establish the commendation and reward system, 3 points.

	4. Development of M&V for energy consumption and management	7 points	1) Record of energy types, energy using, as well as Establish the management system for the energy statistical and energy use reports, 2 points; 2) Submit reports of energy statistical data and energy use status regularly and accurately to departments concerned, 2 points; 3) Develop EnMS self-evaluation or third party evaluation, and regularly analyze the energy savings target, energy using and comprehensive energy consumption, etc., 3 points.
	5. Energy efficiency progress and technical reform management	6 points	1) Improve funding proportion of research and development of energy conservation technology year by year, 2 points for above 5%, 3 points for above 8%, 4 points for above 10%; 2) Perform the prophase energy performance evaluation, 1 point; 3) Perform post-evaluation for energy efficiency projects, 1 point.
	6. Energy conservation training management	6 points	1) Energy post personnel attend the training, 2 points; 2) energy managers attend the training, 2 points; 3) Energy management personnel take their posts with certificates, 2 points.
Energy conservation technology (15 points)	1. application of energy conversation technologies	6 points	1) Implement the energy efficiency projects,2 points; 2) Apply to national energy efficiency pilot projects,2 points; 3) Develop the energy management center, 1 point for making the plan, 2 points for actual implementation of the plan.
	2. Production of energy conversation technology and products	4 points	1) Own the energy conservation technology/products with proprietary intellectual property rights, 2 points; 2) Access to the energy efficiency technology and product certification, 2 points.
	3. Phasing out backward production capacity	3 points	1) Equipment repair and replacement,1 point; 2) Phase out backward production capacity as requirement, 2 points.
	4 Exchange and sharing of energy conservation technology	2 points	1) Attend technical exchange meetings annual year, 1 point; 2) Make practices of technology transfer, 1 point.

4.2.4 Evaluation Method

The comprehensive scoring method is adopted for scoring the energy performance of evaluation objects.

The total score of energy performance evaluation is 100 points, where energy performance takes 30 points(10 extra points can be added for over-fulfilling the target task), energy efficiency takes 15 points(10 extra points can be added for reaching the international advanced level), energy management takes 40 points, and energy conservation technology takes 15 points.

4.2.5 Evaluation Procedure

When industrial enterprises apply EnMS certification, energy performance evaluation could be implemented after the enterprise has established and operated EnMS for at least 3 months.

The evaluation procedures are shown as follows.

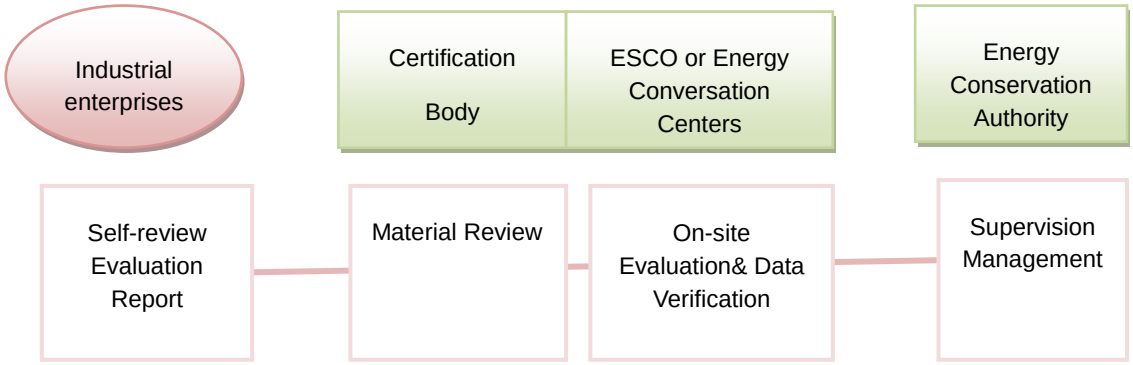


Figure 13: The General Evaluation Procedures for Energy Performance Evaluation

The evaluation methods, including "Self-review + material review + on-site evaluation & data verification +supervision management", are adopted for energy performance evaluation.

I. Self-review is made by enterprises, including the review of energy management, energy using, energy supply, energy consumption, and energy efficiency projects, etc.
II. Material review is organized by certification body. Certification body with experts from ESCO or energy conversation center conduct materials review to the enterprises, including self-review paper, and the integrity of procedure paper and record, etc.
III. On-site evaluation and data verification are also organized by certification body. Certification body and expert from ESCO or energy conversation center perform on-site evaluation and data verification for the enterprise, and form on-site review reports. If the enterprise wants to obtain EnMS certification, the on-site evaluation and data verification are necessary.
IV. Supervision management is not necessary if small and medium-sized enterprises or the enterprises do not have responsibility for improving energy efficiency according to the national laws or policies. Otherwise energy conservation authority should organize an expert team to supervise and confirm the EnMS effectiveness, using the combination method of document review and on-site evaluation.

4.2.6 Evaluation Rate

The enterprises with evaluation results as follows.

- More than and 80 points are excellent enterprises;
- From 60 to 80 points are standard enterprises;
- Below 60 points are substandard enterprises

4.2.7 Reward and Punishment

I. The industrial enterprises obtaining the "excellent enterprises for energy management" will be given formal commendation by energy conservation authority, and provided with fund support in energy conservation financing, and other aspects;
II. The enterprises getting 60 and above points could be considered as meeting the basic condition to obtain EnMS certification;
III. The enterprises with fraudulent self-review and actions on purpose during energy performance evaluation work will be published by certification body and will not be allowed to apply EnMS certification in at least 2 years.

5. Case Study

In this section, a case study will be conducted on an energy performance evaluation practice by a cement plant. A customized methodology for energy performance evaluation will be developed and applied to this cement plant, while the methodology complies with the general methodology proposed in section 5. This case study will provide reference for industrial enterprises to develop detailed evaluation program and carry out energy performance evaluation by itself or a third party.

For the sake of confidentiality, the name of the cement plant has been ignored. However, the basic information of the cement plant is briefly provided below and more energy efficiency information is in section 5.2.

The cement plant has a capacity of 5,000 ton clinker per day with two new dry process cement production line. The energy use includes bituminous coal, electricity, diesel oil and gasoline. In 2010, the comprehensive energy consumption of the enterprise is around 230,000 tce, among which bituminous coal accounts for 91%, and electricity accounts for 9%. The energy cost in 2010 is around 306 million RMB yuan.

Since the cement plant had implemented a lot of energy efficiency technical measures during the 11th Five-year Plan period, including technical transformation projects, its energy saving potential in technical aspect is limited. In this context, energy management improvement has been taken as an effective approach to realize energy efficiency target. The cement plant has got national energy management system certification in last several years. The energy goal of the cement plant includes ensuring the achievement of its energy efficiency target during the 12th Five-year Plan period and the energy performance reaching the national standard GB16780. In the implementation and maintenance of energy management system, energy performance evaluation has been undertaken for several times by a third-party consulting agency, identifying energy performance improvement and putting forward energy efficiency measures suggestion. In its energy performance evaluation practice, a specific evaluation method has been developed based on its energy efficiency situation and goal. According to evaluation results, energy performance improvement has been identified, which may serve as the basis for target responsibility examination of the plant's management and all energy efficiency related department, workshop, working group and individuals. Meanwhile, energy performance improvement measures that shall be taken in next steps are also recognized and proposed.

5.1 Evaluation Method for Cement Plant

Following the general methodology which includes management, technology and performance aspects, the evaluation program for cement plant is as follow.

Table 28: Energy performance evaluation program for cement plant

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
1.Management (15+3.5 points)	Organization leadership	2	Management of companies regularly (the longest time interval is 3 months) carry out energy conservation work, analyze and decide energy policies, strategies, objectives and their implementation(0.5 points).	Materials within one year before declaring including meeting minutes, energy management approach, target file and implemented records of measures signed and released.	Access to relevant documents, record evidence, meeting minutes and other information and develop on-site investigation.
			Appoint qualified person in charge of energy management, clear responsibilities and keep records in the local energy conservation authorities (0.5 points).	Appointment and duty file of person in charge of energy management released; keep record of supporting materials which include relevant academic qualifications, titles, positions and responsibilities of the person in charge of energy management.	
			Establish energy management agencies and positions in accordance with the relevant requirements. Energy management positions should include at least four aspects: energy measurement, statistical analysis, technical and integrated management. Arrange energy conservation management personnel and clear responsibilities on the processes of raw material grinding, firing system and cement forming, etc (1 point).	Corporate organization chart; Setup and responsibilities documents of departments and positions released and implemented; relevant supporting documents on responsibilities of energy management positions.	
	Objective examination	2	Formulate medium-and-long term energy conservation plan in accordance with the “General Rules for Establishing Energy Conservation Planning in Enterprises”（GB/T 25329）, which includes basic situation of enterprises, enterprise energy consumption analysis, preparation basis and energy-conservation laws and regulations, energy savings target, power consumption of cement and	Energy conservation planning documents during the “12th Five-Year” completed, released and implemented, which should include the entire contents required in the “General Rules for Establishing Energy Conservation Planning in Enterprises”（GB/T 25329）.	Inspect enterprises’ energy-conservation planning, energy conservation goal set, the relevant institution documents of distribution and assessment, and

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			clinker products, coal consumption and energy consumption indicators, energy conservation research and technological progress, energy conservation measures as well as relevant supporting measures(1 point).		implementation records. If necessary, site inquiries should be taken.
			Establish annual energy conservation target indicators based on the requirements of Energy Conservation Planning, which should include comparable clinker integrated coal consumption, comparable clinker integrated electricity consumption, comparable cement integrated electricity consumption, comparable clinker integrated energy consumption, comparable cement integrated energy consumption, annual energy savings targets. These target indicators should be distributed effectively to every workshop, team and position (0.5 points).	Documents of energy-conservation goals promulgated and distributed during the previous year (the natural year before the date of application, hereinafter the same).	
			Assess, analyze and summarize the energy-conservation goals implemented regularly (the time interval cannot be less than three months), and find out the reasons and develop improvement measures (0.5 points).	The records of assessment as well as analysis and the documents or records of measures implemented to improve which is targeted to indicators during the whole year from the date of application.	
	Process management	6	Don't utilize the equipments, processes and productions which should be eliminated in national laws and regulations (2 points); Establish eliminating plan (1 point).	Monitoring documents from inspection departments on municipal level or above and eliminating plans.	Inspect relevant documents and records of the procurement, management, detection test reports, equipment ledgers and equipment specification. Spot check of the
			Transformers, motors, fans and other production equipments purchased in the past three years are all energy-efficient equipments (1 point).	Explanatory materials, contracts, invoices, and other materials of purchasing production equipments during the three years from the date of application (three natural years before application, hereinafter the same)	

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			Develop and implement scientific and rational coal procurement standards, coal quality testing, measurement and storage management procedures (0.5 points).	Coal procurement, testing, measurement and storage management documents released and implemented for more than a year.	equipments will be taken randomly on site.
			Develop and implement coal and electricity quota management system in the major processes such as raw material grinding, clinker burning, cement forming and others (0.5 points).	Quota management system documents for major processes (equipments) released and implemented for more than one year.	
			Conduct energy use monitoring for general equipments such as transformers, fans and pumps at least every two years (1 point). Conduct energy balance tests to cement furnace at least every three years (1 point).	Monitoring reports, efficiency testing reports and energy balance test reports of major energy-using equipments within two years.	
	Measurement, statistics and monitoring	3	Energy measuring instruments and management comply with the requirements “Equipment and Management General Principles of Energy Measurement Instruments for Energy-using Units” (GB 17167), and “Equipment and Management Requirements of Energy Measurement Instruments in Building Materials Industry "(GB/T 24851) (1 point).	Current equipment illustration of energy measuring instruments, management system documents of energy measuring instruments, network diagram of energy measurement, ledgers, files, management and verification documents and proof materials of energy measuring instruments, etc.	Audit the situation of equipment and online monitoring; consult documents, records, statistical and analysis reports, qualification certificate, etc.
			Establish and improve coal, electricity consumption records and statistical ledgers, carry out monthly energy consumption data analysis, develop and implement relevant measures (0.5).	The reports of energy consumption data analysis conducted regularly during the previous year.	

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			Implement online monitoring measures for coal-fired electricity consumption and waste heat and energy use to measure, count and account energy utilization (1 point).	Related documentations of online energy monitoring	
			Submit energy statistics and energy utilization reports regularly in three consecutive years (0.5 points).	Energy consumption statements and energy utilization reports submitted to the relevant departments in three consecutive years.	
	Energy audits and benchmarking	1+1	Carry out at least a comprehensive energy audit activity and implement corrective actions in accordance with the recommendations in three years (1 point).	Energy audit reports and improvement descriptions based on the "General Principles of Energy Auditing Techniques in Enterprise (GB/T17166)"	Inspect relevant audit reports, reports and records of benchmarking analysis and improvement descriptions.
			★Establish energy efficiency benchmarking management system, annually organize energy efficiency benchmarking activities and achieve results in accordance with energy efficiency benchmark indicators of clinker and cement electricity consumption, coal consumption and comprehensive energy consumption released nationally (+1 point).	Energy efficiency benchmarking management documents, activity documents and records released and implemented.	
	Training and commendation	1+0.5	The person in charge of energy management should accept energy conservation trainings organized by national or local energy conservation authorities (0.5 points).	Training documents, such as certificates; annual training plans and training materials.	Inspect documents/certificates and records of relevant trainings, rewards and punishments, and investigate and inquiry on site.
			★Energy management staff engaged in energy conservation technology, measurement, statistics, and other fields should participate in energy conservation trainings organized by the national,	Training documents, such as certificates.	

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			provincial and municipal energy conservation authorities or industry associations. (+0.5 points).		
			Establish and implement energy conservation commendation and reward system (0.5).	Energy conservation reward and punishment documents and records released and implemented for more than one year.	
	Energy Management System	+2	★Establish and implement energy management system, and prepare management manuals and program files (+1).	Energy management system manuals and program files published and implemented for more than six months	Inspect supporting materials including energy management system, certification and evaluation, inquiry on site.
			★Pass the management system certification or evaluation of energy conservation authorities (+1).	Supporting materials including certifications or evaluation reports.	
2.Technical energy conservation (20 points)	Research and development of energy-conservation technologies	9	The percentage of investment for technology research and development and energy efficiency projects is 0.5% (or more) in operating income (1 point); 1% (inclusive) or more (2 points).	Documents of enterprises' operating income for three consecutive years and the use of funds for technology research and development and investment in energy-conservation projects (three-year average score).	Check the supporting materials of funds using plans and capital flows; verify the situation of energy-conservation investment, technical center operation, projects accepting inspection consult supporting materials of patents, technology centers and project approval.
			Patents related to cement production process and equipment invention or utility model patents: get 1 point for each invention patent; get 0.5 points for each utility model patent. Note: The highest score of this indicator is 3 points.	Patent certificates/ supporting documents obtained by enterprises or patent certification materials provided by group companies which prove applying enterprise personnel are involved in research work.	
			Identified as national-level enterprise technical center(2 points); Identified as provincial technical centers (1point). Note: This indicator is calculated to score of highest target, not cumulative.	Supporting documents of Enterprise Technology Center which has been approved.	

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			Nearly three years, implement one (or more) energy conservation research and development projects nationally accepted and identified (2 points); Nearly three years, implement one (or more) energy conservation research and development projects provincially accepted and identified (1 point). Note: This indicator is calculated to score of highest target, not cumulative.	Supporting documents of energy conservation research and development projects which have been accepted and identified.	
	Energy-conservation technological transformation	11	Production technologies or equipments implemented energy-conservation technological transform: under construction (1 point), built and run (3 points).	Supporting documents proving projects are under construction or run, such as project application, construction contracts, and inspection reports.	Inspect the documents and records of project application, run management, analysis reporting; check the project operation on site.
			Energy-conservation technological transformation projects implemented within three years can annually save energy 2000 tons of tec (inclusive) or more (2 points); annually save energy 5,000 tons of tce (inclusive) or more (5 points).	Prepare documentations to explain calculation of energy savings of energy conservation technological transformation projects in accordance with relevant national energy saving audit requirements of energy-conservation technological transformation projects, which should include the project introduction, project approval, project boundary, advanced technology, energy savings calculation formula and process and inspection reports from relevant qualification department.	
			Carry out energy conservation assessments and acceptance of the fixed assets investment projects (2 points).	Energy efficiency assessment reports completed by energy efficiency assessment agencies, energy efficiency approval documents replied by energy conservation authorities and inspection reports.	

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			Carry out evaluation in the later stage of energy-conservation technological transformation projects, analyze energy consumption situation after transformation, and evaluate energy-saving effect and economic benefits (1 point).	Assessment reports and inspection reports completed by the company or related technical institutions after the transformation projects.	
3.Energy efficiency level (65 points)	Energy saving rate	10	Compared with the average industry level, the enterprises' annual average energy consumption of cement clinker benchmark in 2012 reduced by 1% (inclusive) or more (5 points), 1.5% (inclusive) or more (8 points), 2%(inclusive) or more (10 points) compared by benchmark energy consumption (cement clinker comprehensive energy consumption is 115 kgce/t)	Calculation and explanation documentations of energy consumption per unit product in 2012 in accordance with "the General Principles of Calculation for Comprehensive Energy Consumption" (GB/T 2589), "Energy Consumption Norms of per Unit Product in Cement Industry" (GB 16780).	Collect the energy consumption data on site to calculate and verify.
		10	Compared with the enterprises' own level, the enterprises' annual average ton of cement clinker comprehensive energy consumption in 2012 reduced by 1% (inclusive) or more (5 points), 1.5% (inclusive) or more (8 points), 2%(inclusive) or more (10 points) compared by that in 2011.	Calculation and explanation documentations of energy consumption per unit product in 2010 and 2012 in accordance with "the General Principles of Calculation for Comprehensive Energy Consumption" (GB/T 2589), "Energy Consumption Norms of per Unit Product in Cement Industry" (GB 16780).	Collect the energy consumption data on site to calculate and verify.
	Energy consumption level	40	The evaluation requirements of 5 indicators including comparable clinker integrated coal consumption, comparable clinker integrated electricity consumption, comparable cement integrated electricity consumption, comparable clinker integrated energy consumption, comparable cement integrated energy consumption based on national standards(GB16780) are as follows: – Two indicators achieve the requirements of access value, the other three indicators reach the requirements of advanced value (30 points);	Calculation and explanation documentations for production energy consumption limit indicators in 12 months of continuous production and stable operation within two years (such as July 2011-June 2012), which is based on limit standard.	Collect and calculate energy consumption data on site to compare with the national standards.

Evaluation items		Score	Indicator and criteria	Document evidence requirement	Spot verification requirement
			– An indicator achieve the requirements of access value, four indicators reach the requirements of advanced value (35 points); – Five indicators all reach the requirements of advanced value (40 points).		
	Use of waste heat and energy	5	The corporate waste heat and energy are used for power generation (5).	Evidence of cogeneration.	Count and calculate the electricity quantities including self-generating and whole amount on site.

Notes:

1. The total scores of evaluation index are 100 points. The indicators with ★mark are bonus items, and highest cumulative scores of which are 4 points;

2. Evaluation is rated according to the following criteria:

——if the index meets the basic requirements but need further improvement, score 50% of index grade;

——if the index meets the basic requirements and the supporting materials are complete and effective, score 100% of index grade;

——if the index doesn't meet the score standards and requirements of supporting materials, score 0.

——the quantitative evaluation index is rated according to the actual results of statistics and calculation.

5.2 Energy Efficiency Situation of the Plant

The cement plant consumed energy of 231,269 tce totally in 2011[17]. The energy categories are shown in Table 29. In 2011, the annual cement production is 950,000t and the annual clinker production is 1,800,000t.

Table 29: Energy categories of the cement plant

Energy	Quantity	Equivalent value	
		Tce	%
Bituminous coal(t)	280,000	210,000	90.80
Electricity(kWh)	168,000,000	20,650	8.93
Diesel(t)	400	582	0.25
Gasoline(t)	25	37	0.02
Total		231,269	100

The percentage of energy cost is shown in Table 30.

Table 30: Percentage of energy cost of the cement plant

Production	Total cost (Million RMB yuan)	Energy cost (Million RMB yuan)	%
Cement	324.00	230.00	70.99
Clinker	148.00	76.00	51.35

The energy efficiency of the cement plant is shown in Table .

Table 31: Energy efficiency of the cement plant

	Comparable comprehensive standard coal consumption of clinker (kgce/t)	Comparable comprehensive electricity consumption of clinker[a] (kWh/t)	Comparable comprehensive electricity consumption of cement[b] (kWh/t)	Comparable comprehensive energy consumption of clinker (kgce/t)	Comparable comprehensive energy consumption of cement (kgce/t)
The cement plant	106.10	61.23	86.80	113.78	92.89

For evaluation, the norm of energy consumption per unit products of existing cement enterprise (GB16780-2007) is shown in tables below.

Table 32: The limit value of energy consumption per unit products of existing cement enterprise

Production	The limit value of comparable comprehensive standard coal consumption of clinker (kgce/t)	The limit value of comparable comprehensive electricity consumption of clinker[a] (kWh/t)	The limit value of comparable comprehensive electricity consumption of cement[b] (kWh/t)	The limit value of comparable comprehensive energy consumption of clinker (kgce/t)	The limit value of comparable comprehensive energy consumption of cement (kgce/t)

[17] The case study is to show the evaluation process. All data have been rounded and processed.

P≥4000t/d	≤120	≤68	≤105	≤128	≤105
2000t/d≤P < 4000t/d	≤125	≤73	≤110	≤134	≤109
1000t/d≤P < 2000t/d	≤130	≤76	≤115	≤139	≤114
P < 1000t/d	≤135	≤78	≤120	≤145	≤118
Cement grinding plant	--	--	≤45	--	--
a. For cement plant only producing clinker; b. For cement plant (including cement grinding enterprise).					

Table 33: The advance value of energy consumption per unit products of existing cement enterprise

Production	The advanced value of comparable comprehensive standard coal consumption of clinker (kgce/t)	The advanced value of comparable comprehensive electricity consumption of clinker[a] (kWh/t)	The advanced value of comparable comprehensive electricity consumption of cement[b] (kWh/t)	The advanced value of comparable comprehensive energy consumption of clinker (kgce/t)	The advanced value of comparable comprehensive energy consumption of cement (kgce/t)
P≥4000t/d	≤107	≤60	≤85	≤114	≤93
2000t/d≤P < 4000t/d	≤112	≤62	≤90	≤120	≤97
Cement grinding plant	--	--	≤34	--	--
a. For cement plant only producing clinker; b. For cement plant (including cement grinding enterprise).					

5.3 Evaluation Process and Result

During the maintenance of energy management system of the cement plant, energy performance evaluation is regularly conducted by the third party certification institution. Following is one energy performance evaluation case in 2012. In this case, a working group that consisted of three consultants in fields of energy management and energy efficiency technology from the certification institution was formed to carry out the evaluation, include making evaluation plan, materials review, spot inspection, evaluation results report, etc. The whole evaluation process lasted four weeks.

Table 34: Energy performance evaluation of the cement plant

Evaluation items	Standard score	Plant's practice	Actual score

Evaluation items		Standard score	Plant's practice	Actual score
1.Management (15+3.5 points)	Organization leadership	2	The management regularly reviews energy conservation work on a meeting every two months.	0.5
			The top management has appointed one deputy director of the plant to be responsible for the overall energy efficiency work. However, the person has not been registered in local energy conservation authorities according to the Energy Conservation Law of China.	0.3
			An energy efficiency working group has been established with an energy efficiency office providing daily support. The working group include relevant personnel concerning energy measurement, statistical analysis, technical and integrated management, and they all have been trained.	1
	Objective examination	2	A medium-and-long term energy conservation plan has been developed in 2011 integrated with its energy efficiency target during the 12th Five-year Plan period, in accordance with GB/T 25329.	1
			Annual energy conservation targets were determined based on the energy efficiency target during the 12th Five-year Plan period. At the beginning of the year, the energy conservation targets will be broken down to each department, workshop, working group and individual. Target responsibility agreement will be signed level by level.	0.5
			Each quarter, energy conservation goals will be reviewed and evaluated at all levels. Improvement measures will be put forward.	0.5
	Process management	6	All equipments, processes and productions are legally qualified to be utilized.	2
			Most transformers, motors, fans and other production equipments purchased in the past three years are energy-efficient equipments.	0.8
			A specific coal quality standard has been developed for coal procurement, while storage management is weak.	0.4
			The plant has established coal and electricity quota for all major processes, and these quota is subject to be updated once a year.	0.5
			In the last two years, energy use monitoring and energy balance test have been conducted in cooperation with an ESCo.	2

Evaluation items		Standard score	Plant's practice	Actual score
	Measurement, statistics and monitoring	3	The deployment of energy measuring instruments and their management comply with GB 17167 and GB/T 24851.	1
			Energy data are collected, transformed and analyzed daily through energy management and control system.	0.5
			The energy management and control system includes online monitoring of these energy consumption.	1
			According to energy efficiency administration's requirement, energy statistics and utilization reports have been submitted timely.	0.5
	Energy audits and benchmarking	1+1	The plant has accomplished energy audit in response to China's Top-10000 Enterprises Energy Efficiency and Low Carbon Action.	1
			An energy efficiency benchmarking management system has been established.	1
	Training and commendation	1+0.5	The deputy director in charge of energy management has participated in the energy manager training organized by local authority.	0.5
			Energy management staff actively participated in relevant trainings.	0.5
			The energy efficiency office evaluates energy efficiency target responsibility quarterly, and 1000~3000 RMB yuan will be rewarded to energy efficiency excellent departments. For departments that have not fulfilled the energy efficiency target for two consecutive quarters, the department director shall resign and the staff shall be punished.	0.5
	Energy Management System	+2	The plant has established energy management system certification.	1
			The plant has obtained energy management system certification.	1
2.Technical energy conservation (20 points)	Research and development of energy-conservation technologies	9	The energy efficiency technical investment in 2011 is over 50 million RMB yuan, which accounts for 0.6% of operating income.	1
			1 invention patent regarding cement production process has been obtained in 2011.	1
			Neither national level nor provincial level technical centers.	0
			Undertook waste heat integrated utilization research project which has been nationally accepted in 2011.	2
	Energy-conservation technological	11	All existing national advanced technological transformations have been implemented in the plant.	3

Evaluation items		Standard score	Plant's practice	Actual score
	transformation		Energy savings by implementing technical transformation projects in 2011 is over 4,000 tce.	4
			Strictly abide by national regulation on energy efficiency assessment of the fixed assets investment projects.	2
			The energy savings effect of energy efficiency measures is monitored and evaluated.	1
3.Energy efficiency level (65 points)	Energy saving rate	10	The cement clinker comprehensive energy consumption in 2011 is 113.78 kgce/ton, which is 1.06% lower than the average industry level.	5
		10	The cement clinker comprehensive energy consumption in 2011 is reduced by 1.10% compared with 2010, which is 115.04 kgce/ton.	5
	Energy efficiency level	40	Three indicators reach the requirements of advanced value and two indicators only reach limit value.	30
	Use of waste heat and energy	5	The plant has accomplished the waste heat and energy utilization transformation to generate power.	5

5.4 Problems Identification and Suggestion

According to the Table above, the comprehensive evaluation result (score) of the cement plant is 77, which is a relatively high value. That is to say, the energy performance of the cement plant is better than most counterparts, while there is still a gap with the advanced energy efficiency cement plants.

Based on the comparison results of evaluation indicators, energy efficiency potential can be identified and improvement suggestion shall be provided, which is also the objective of energy performance evaluation. Main suggestions and recommendations for the continuous improvement of energy performance include:

(1) Reduce electricity consumption

From the five energy efficiency indicators, the potential for electricity saving is still big. It is recommended that the plant shall apply frequency conversion technology on the crushers and kiln blowers based on the actual situation of the plant, increase the coordination between the blowers and production requirement, and further reduce the electricity consumption as well as the energy consumption.

(2) Strengthen research and development of energy conservation technologies

The cement plant shall allocate more resources to strengthen the research and development of energy conservation technologies, and strive for the establishment and recognition of provincial technical centers or national-level enterprise technical

center.

6. Harmonization and Implementation Suggestion

6.1 General Suggestion

In December 7, 2012, a Workshop of Energy Performance Evaluation Methodology Development and Promotion in APEC Economies was hosted alongside the APEC EGEE&C 40th meeting in Chinese Taipei. The agenda of the workshop is attached in the Annex. Over 20 participants from APEC economies including Australia, China, Chinese Taipei, Hong Kong, Japan, Korea, New Zealand, Singapore, Thailand, USA, and regional institutions, including APEC Secretariat, CLASP, International Copper Association, attended the workshop. In the workshop, draft project outputs have been deeply discussed, and four participants made presentations respectively on ASEAN Energy Management Scheme (AEMAS), US Energy Star-Industry Program, China's Energy Performance Evaluation Practices, and Industrial Energy Audits Progress in Chinese Taipei. Participants extensively shared experiences and opinions, and exchanged views in terms of energy performance evaluation. In the focus group discussion, participants have been divided into three groups, and the harmonization and implementation suggestions for future post-project steps on promotion energy performance evaluation programs in APEC economies have been discussed and proposed, respectively from the perspectives of technical aspect, policy and regional cooperation. The suggestions have been summarized and provided in following section.

6.1.1 Technical aspect

Starting point

The energy performance evaluation needs for a starting point or baseline. The energy efficiency status of industrial enterprises varies much across economies, industries and enterprises. Is the energy performance evaluation applicable and effective for all enterprises ranging from the least energy efficiency to the most energy efficiency? The answer is yes. Enterprises may have two options, one is to set the energy performance of previous years as the starting point or baseline, and the other is just simply to compare with the average level in the industry. Enterprises may choose either approach or integrate the two options to carry out the energy performance evaluation.

Common metrics

As indicated in this report, a common metrics to evaluate energy performance of enterprises has been developed which provide a reference for economies and industries to develop or implement energy performance evaluation. However, the common metrics cannot be directly adopted due to the neglect of the characteristics of specific industrial sectors. Thus the common metrics may serve as a basis for economies or industries to redesign and develop a more detailed, targeted and feasible energy performance evaluation program.

Focus on the how-rather than what

The report intends to provide a technical approach to let policymakers, enterprises management and third party consulting agencies get a general understanding on energy performance evaluation. We want to share experiences within APEC economies and promote this effective mechanism to improve energy efficiency. Although energy performance evaluation is rather a new word for many economies or enterprises, besides telling people what the energy performance evaluation is, we focus more on details regarding how the evaluation indicators and criteria may be set up and how the evaluation may be carried out, which we think economies may also pay more attention to.

Resources – People and expertise

On one hand, the leadership attention is the prerequisite for promoting energy performance evaluation, including both policy makers and enterprises management. A system based on comparing to industrial best practices, like in SEP, requires huge financial resources from the government to conduct regular studies in each industry sector to determine benchmark. Only if the leaders have high awareness and attach great importance, adequate resources and incentives may be provided to support the implementation of energy performance evaluation. On the other hand, energy performance evaluation concerns energy management, technologies and energy efficiency. The evaluators shall obtain comprehensive knowledge background covering energy management system, energy efficiency technology, energy saving measurement and verification, etc. Thus capacity building for leaders and practitioners shall be delivered as the basis for formally conducting energy performance evaluation.

Agreement on identification of units – intra industry comparison

As for the common methodology, especially evaluation indicators such as energy consumption per unit product, the identification of units is critical to make comparison reasonable. That is to say, the boundary of the units, energy categories, inputs and outputs, and related definitions shall be clarified and agreed. Only in this context, the intra industry comparison between enterprises may make sense.

Harmonizing process important for comparability – BUT- context still important as materials feeding into the process vary across economies

Like US Superior Energy Performance (SEP) program, economies may develop their own energy performance evaluation programs based on their particular energy efficiency status. With the increasing attention on energy efficiency by stakeholders, enterprises' energy performance may become a considerable factor in the market. Thus the harmonization between different programs shall be addressed. As we know, in the same production process, if the quality of the materials varies, the energy consumption of the process varies accordingly. Especially the materials feeding into the process vary across economies much. To deal with this problem, correction factors may be applied on the basis of the materials applied and other factors as well, which may enable evaluation results harmonization and learning transfer.

Scoring system

Scoring system is useful for applicants in knowing what to do, which is also a guide for applicants to continuously improve energy performance. So the determination of scoring criteria is critical. As shown in the report, some criteria in scoring system might be of utmost importance yet companies could reach the minimum level without meeting some specific requirements. Thus a weighting system or a list of strict requirements to be met in addition to the minimum level of points to be achieved could be designed. Some criteria should be met on a compulsory basis, in addition to the total number of points. Economies can make their own choice according to their intention and energy efficiency maturity.

6.1.2 Policy aspect

National priorities

The ultimate objective of energy performance evaluation program is to achieve energy efficiency. So first of all, energy efficiency shall become one of the national priorities. For example, in China, energy efficiency has been regarded as a basic national strategy and highly emphasized since the 11th Five-year Plan period. Energy efficiency targets have been set up and break down from government to enterprises level by level. In recent Top10000 Enterprises Energy Efficiency and Low Carbon Action, it is required that all enterprises shall establish and improve energy management system which is a basic measure to promote energy efficiency in Top10000 enterprises. In this context, energy performance evaluation has been adopted as an approach to evaluate the energy efficiency achievements of enterprises, especially the performance of energy management system, which is also related to the energy efficiency target responsibility examination by relevant energy efficiency administration.

Tie in ancillary benefits

For enterprises, energy performance evaluation can be a way to support and demonstrate the improvement of energy efficiency. However, whether energy performance evaluation is delivered as a government program supported and promoted by relevant administrations, or as a market program hosted by market players, besides the energy efficiency and cost reduction benefits, those excellent enterprises often need to be driven or stimulated with ancillary benefits, or at least tie in ancillary benefits, such as financial subsidy or award, energy efficiency award or prize (recognized by program manager), access to other energy efficiency preferential policy, etc. With these benefits, enterprises may have more enthusiasm and motivation to participate in or implement energy performance evaluation.

6.1.3 Regional cooperation

Promote lessons learning

Some APEC economies have initiated energy performance evaluation ahead of other economies. They have achieved rich experiences in designing, running and conducting energy performance evaluation programs. Economies with little experience need to extract learning from more experienced economies. It is also critical for

developing economies to learn from others.

More forums on energy performance evaluation

Without doubt, energy performance evaluation is a new and hot topic in the context of the promotion of energy management system international standard ISO50001. More forums on energy performance evaluation shall be hosted to exchange progress, views, technical methods, achievements, and sharing information and resources.

Agreement on a basic strategic framework

In view of the high attention drawn on energy performance evaluation programs globally, energy performance evaluation will play a major role in establishing a market-based mechanism to improve energy efficiency. To ensure its healthy and constant development, economies shall sit down together to work out a commonly-agreed basic strategic framework to promote energy performance evaluation regionally. The framework shall clarify what shall be done in regional level and what shall be done by economies. A draft strategic framework is provided below for reference.

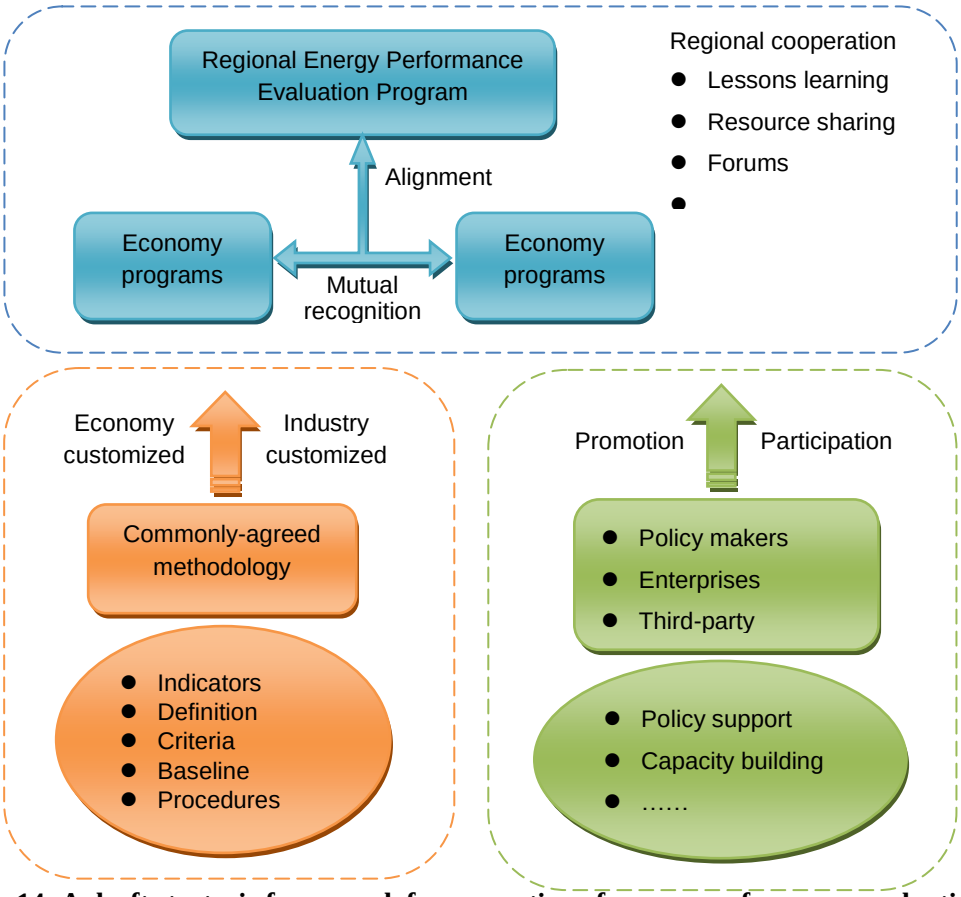


Figure 14: A draft strategic framework for promotion of energy performance evaluation

6.2 Supporting Measures

While developing energy performance evaluation program, some supporting measures shall be considered to support the implementation of energy performance

evaluation program. These supporting measures include strengthening the foundation, ensuring the authority and low-cost, and developing third-party evaluation institution.

6.2.1 Strengthening the Foundation for Energy Performance Evaluation

At present, Energy performance evaluation is still at the initial stage, so it is necessary to strength basic work, such as:

I. Develop and perfect the EnMS standard/specification;
II. Develop related standard/specification for energy performance evaluation;
III. Formulate M&V standards;
IV. Develop the training materials and the training agency;
V. Conduct and implement pilot projects;
VI. Establish a specific foundation to solve the shortage of fund for small and medium-sized enterprises carrying out energy performance evaluation;
VII. Develop the work route chart of energy performance evaluation.

6.2.2 Ensuring the Authority and Low-Cost of Energy Performance Evaluation

The energy performance evaluation should feature the authority and specialization in order to attract enterprises. It should be pertinent in order to provide guidance for energy management work. The evaluation result should be approved by energy conservation authorities and related international authoritative institutions.

If enterprises are responsible for costs of energy performance evaluation, the costs hereby should be controlled within the extent acceptable by enterprises. There are some methods to reduce the evaluation cost.

- The enterprise with a good energy management team can do self-review well;
- The on-site evaluation is not necessary if the enterprise has built the energy management center;
- The enterprise could apply fund from governments to finish the evaluation work.

6.2.3 Developing Third Party Evaluation Institution

The development of third party evaluation institution contains institution development and personnel training.

The third party evaluation institution can be selected from energy conservation centers, ESCO. To ensure authority and normalization of the evaluation work, energy conservation authority shall make policy for the selection and record of third party evaluation institution. During the pilot stage of energy performance evaluation, the energy conservation authority and certification body should fully cooperate with third party evaluation institution and provide fund support for development of the third party institution.

7. Conclusion

I Energy performance evaluation is a link for Energy efficiency measures or major energy efficiency activities and a good institutional design is a critical guarantee for developing performance evaluation successfully.

Energy performance evaluation is generally a part of energy efficiency policies and measures or major energy efficiency programs. For instance, China's "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises" is a part of "Top1,000 Enterprises Energy Conservation Action Program", and EPI is considered an important means for industrial enterprises to develop assessment on Energy Star of U.S.

Mandatory energy performance evaluation has received remarkable results as an energy conservation policy and measure dominated by the government, such as "General Examination of Factories" in Japan. Meantime, voluntary energy performance evaluation must be attractive enough (e.g. granting "certification label" and providing financing support) so as to expand participation and enhance the initiative of the evaluated party.

In terms of method of evaluation, although self-evaluation can reduce costs, it lacks authority and authenticity. The combination of self-evaluation and evaluation by a third party is therefore recommended because it has guaranteed the expertise and a relatively low cost for evaluation, and has ensured participation by more parties for fair and objective evaluation results.

II Energy performance evaluation methodology is the foundation for implementation the evaluation, and indicator selection and criteria determination are focuses and difficulties in doing so.

During the implementation of evaluation, energy performance evaluation methodology is the foundation, indicator selection is the focus, and criteria determination is the difficulty.

Because energy-using systems are complex and involve many types of indicator, evaluation indicators should be target-oriented, measurable, accessible and relative simple as far as possible based on the evaluation goals. Indicators of general energy performance evaluation include those for energy performance, energy efficiency, technology and management. Energy performance and energy efficiency indicators can be easily quantified, while the others have to be subject to qualitative description. As economies and regions concern are becoming more important in energy management, indicator is playing an increasingly important role in both indicator quantity and weight.

Another difficulty for energy performance evaluation is the determination of evaluation

criteria, which are highlighted by authority and scientific. Such criteria are for both internal and external application. The former is worked out by the evaluated party according to its own energy efficiency potential and goals, while the latter may be relevant international/domestic/industrial standards. Management, technical and other qualitative indicators can be evaluated according to related national policies or best practices. It is notable that such evaluation criteria should be dynamic, able to be updated along with the revision to related standards or specifications.

Comprehensive scoring is considered as a relatively effective means for assessment. Generally, energy performance indicator is provided with a higher weight, and can even serve as a veto indicator in some of the energy performance evaluation. Taking China's "Evaluation System of Responsibility for Achieving Energy Efficiency Goals of Top 1,000 Enterprises" for example, the scoring level will be "unaccomplished class" regardless of the scores of its energy management and technologies concerned if the annual indicator for energy savings fails to be reached.

Besides, it is necessary to provide clear levels for energy performance evaluation, which should be simple in order to provide basis for the further rewards and punishments measures.

III Energy performance evaluation will be increasingly applied in EnMS certification and the establishment of energy performance evaluation will become the focus for related studies. In addition, Measurement and Verification (M&V) should also be promoted to ensure a complete energy performance evaluation.

Economies like China, U.S., Singapore and Canada all responded to the introduction of international standards for EnMS(ISO50001), such as EnMS certification pilot in China, EENP in Singapore and SEP in USA, and As a part of EnMS, the studies and application of energy performance evaluation are continually increasing. Additionally, in order to guarantee the effects and completeness of energy performance evaluation, it is also essential to enhance M&V over related indicator data (such as means for the third party to collect and test the data, as well as the self-inspection report from the evaluated party), and include all these into energy performance evaluation.

Annex: Workshop Agenda

Workshop of Energy Performance Evaluation Methodology Development and Promotion in APEC Economies (EWG 14 2011T)
Agenda

Wednesday, 7 November 2012

Session	Time	Topic
1	9:00-9:20	Opening remarks by introductions & agenda (Chair)
2	9:20-9:40	Setting the Scene – An introduction in to the topic, some past work and issues leading to current workshop
3	9:40 -10:10	**Report on project outputs:** Energy Performance Evaluation Methodology Development and Promotion in APEC Economies (Lu Xiaojian of CIEE, China)
4	10:10-10:30	Comments on the project output
-	10:30 -11:00	Morning tea
5	11:00 -12:30	**ASEAN Energy Management Scheme(AEMAS)** *By Mr. Pierre Cazelles, International Copper Association;* **US Energy Star-Industry Program** *By Mr. Derek Greenauer, Environment & Verification Services, Underwriters Laboratories;* **China's Energy Performance Evaluation Practice** *By Mr. Lu Xiaojian, Center for Industrial Energy Efficiency;*
-	12:30-14:00	Lunch
6	14:00-14:30	**Industrial Energy Audits Program in Chinese Taipei** *By Dr. Yih-Liang Chan, Green Energy and Environment Laboratories, Industrial Technology and Research Institute, Chinese Taipei;*
7	14:30-15:30	**Focus group discussion:** Divide the audience into groups and ask the groups to discuss 3 questions. After 30 minutes of discussion groups need to report back Questions may be based on the items mentioned below. Suggestions and recommendations of action plans for future post-project steps on promoting energy performance evaluation programs in APEC economies (all participants)
-	15:30-16:00	Afternoon tea
8	16:00-16:45	**Quick summary** of prior session followed up by

		discussion aimed at generating a common view on the issues generated by the project.
9	16:45-17:00	Meeting Summary (Chair/ Secretariat to lead)

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