

## Energy Management System Difficulties in development and implementation

Tarasovskiy V.G., Doctor of Science, Associate Professor, Technical Director, GCE-Energy – part of GCE Group,  
Syusyukin A.I., Doctor of Science, Leading Consultant, GCE-Energy  
Yeremeyeva G.I., Head of Energy Management Department, GCE-Energy

In the past decade management of some Russian industrial holdings and enterprises undertook some attempts to develop and to implement a reliable form of organizational and technical structure (system) to manage effective use of energy resources, so called, energy management system<sup>1</sup>. These attempts were hindered by a lack of legislative basis for this type of work in our country. This is despite the fact that some countries have long adopted and implemented national standards for energy management systems – [1,2] as well as the European Union standard [3], as an example. At this time, an international standard ISO 50001 – “Energy Management System – requirements, with user manual” [4] is in its final stage of development and implementation planning stage.

Some large and energy intensive companies in the area of non-ferrous and ferrous metallurgy, petro chemistry, oil and gas production, oil and gas transportation and processing (JSC SIBUR holding, Eurazholding, and others) started to develop and to implement energy management systems without waiting for formal acceptance of ISO 50001. Our company’s first experience in developing and implementing of this type of system at one of Russia’s largest petro chemical enterprises [5] have shown that there is a number of subjective as well as objective difficulties and obstacles that one must overcome. In this article we attempt to review some of the major ones.

1. Ambiguity in how parties (the holding company, the enterprise and the program developer – LLC GCE-Energy) perceive the importance of enterprise’s energy policy development and implementation, in how they perceive the EEMS scope of application, and the scope of documentation within EEMS;

2. Insufficiently developed personnel motivation system for increasing energy efficiency and energy conservation;

3. Untimely establishment of EEMS special management structures and uncertainty in their functional capabilities, especially, during initial stage;

4. Shortcomings in energy efficiency planning system;

5. Lack of reliable TER<sup>1</sup> consumption and consumption efficiency data due to technical (and managerial) equipment insufficiency in TER monitoring.

**Energy policy** – is a formal, written declaration of interest in rational consumption and conservation of TER and in environmental conservation, accompanied by the list of clearly stated goals, plan of actions for achieving these goals, with the list of necessary resources, and clearly delegated rights, responsibilities, and liabilities. In accordance with the requirements of national standards of developed countries [1-2] and international standards [3-4] the energy policy is one of the first and critical components of the EEMS of an enterprise.

A necessity of having an energy policy is not always recognized by the enterprise’s lower and middle management, as well as the upper management. Normally, a general recognition of responsibility and monitoring of TER consumption is considered sufficient. But, if an interest in rational consumption of TER and in energy conservation is expressed only in an informal

fashion, it may entirely vanish or greatly diminish with personnel turnover, whether it is upper management or employees responsible for energy management. Therefore,

- as long as the interest and the responsibility are not formally expressed, there is, in addition, a danger of other temporarily pressing priorities taking over the attention that should be focused on constant control over energy consumption and improvement of its efficiency;
- as long as the responsibilities and the liability for energy consumption are not formally assigned and distributed between all functional areas involved in this process, they will not easily become part of the personnel assessment system.

The role and the meaning of energy policy is described in the following manner in the ISO 50001 international standard: “*An energy policy defines an algorithm of actions for achieving the stated goals and objectives (p. 3.3)*” and “*An energy policy is a moving force necessary to implement an energy management system (p. A.3)*”.

**EEMS Scope of application.** When developing EEMS, some experts think, that it requires involvement of all enterprise’s facilities and all personnel in the EEMS scope of application. Naturally, the ISO 50001 offers for an enterprise to individually “*determine and to confirm the scale and the scope of application of its energy management system*”. However, in practice of establishing EEMS in developed countries, certain limitations are normally used. Only the facilities (systems) and the individuals, who are capable to significantly impact the energy consumption and, as a result, the energy efficiency of an organization, are included in the EEMS scope of application.

This approach significantly simplifies the EEMS structure, makes EEMS establishment processes less expensive, and allows EEMS to function without seriously impacting its efficiency. Non-critical components, so called, interference, are simply deleted from the control system (the number of needed data collecting points and data stream channels is reduced, as well as the volume of documents, reports, etc.). Naturally, no one excludes individuals, who are not part of enterprise’s EEMS structure, from suggesting ideas to improve energy efficiency. This provision, as well as the entire energy policy of the enterprise is provided to all personnel with no exception. But for the facilities and the individuals included in the EEMS scope of application this would be their everyday objective and the responsibility, as for the rest of the personnel, this is a voluntary, normally, a onetime activity.

Discussions regarding EEMS scope of application normally arise at the initial work stage, but later, while other EEMS components are being formed, most enterprise’s specialists accept the necessity of establishing a separate entity for this purpose within enterprise’s structure, even those, who initially had a different opinion.

**Personnel motivation.** The experience worldwide demonstrates that energy efficiency could be achieved and retained at the significant level only when personnel, who is largely impacting enterprise’s energy efficiency and energy consumption, is interested and motivated.

Unfortunately, during the period of 1990-s, even previously created enterprises’ motivational systems were eliminated and only now slowly coming back on the smaller scale in some enterprises. The former “socialist competition” systems for TER conservation were dismantled, but the “capitalist competition” systems were not established. The experience of well developed countries and of the leading Russian enterprises demonstrates high efficiency of personnel motivation systems for rational TER consumption and

improved energy efficiency (Rover plant in Longbridge, UK., Dow Chemical Company, JSC Magnitogorskiy MK, Tula Agrimachine Plant in Russia, and others)[8-9].

Here's what ISO 50001 recommends on the matter: "*An enterprise leadership forms employee behavior by authorizing employees' direct participation in operations, through motivational components, by personnel promotions and rewards*". (p. A 2.2) Organization of personnel motivation system is a complicated task that should be decided individually by each enterprise taking into account its specifics in management and HR structure and composition.

It is recommended to begin **establishing EEMS organizational structure** after adopting enterprise's energy policy and by establishing an Energy Management Commission, introducing position of Energy Manager, and establishing of local field energy management groups.

A so-called vertically based with weak horizontal ties production facilities management structures have been currently established. Energy Commissions and Energy Managers would, therefore, enforce horizontal activities.

*An Energy Commission at an enterprise* is a special energy efficiency management body. Its main objective is to solve difficult issues of energy resources consumption management through supporting enterprise's upper management. This support must be exhibited not only through rewarding and stimulating of personnel, but also in a formal fashion, through an oversight body, which encompasses various departments, services and divisions, and, where all upper managers are undertaking the responsibility to operate in accordance with the best energy efficiency practices, as well as to pass this responsibility down to their subordinates. Without this sort of upper management support, the energy efficiency management will remain on the low side of equation. As a result, it won't be recognized by the divisions' managers as something that is part of the daily routine.

Therefore, an Energy Commission must be headed by a Deputy Director and, in some instances, at mid-size enterprises, by a Director, who has sufficient powers to manage the overall enterprise. A specific manning for an Energy Commission is set forth by the order of the head of the enterprise. Normally, the Commission includes heads and deputy heads of various departments and services, as well as heads of most energy intensive units of an enterprise. These people take part in establishing and operating EEMS. A Chairman of an Energy Commission is a representative of the upper management and is primarily responsible for implementation of Energy Policy at the enterprise.

A required number of energy managers, taking into account a certain volume of TER consumption and enterprise's energy equipment complexity, could be determined by calculations [11]. Initially, energy managers could be subordinated to the Chief Energy Specialist of an enterprise. With the further development of energy manager positions, this subordination could be changed. Due to establishment of the energy management structure and establishment of a new functional unit, the following documents should be amended:

- Chief Energy Specialist Service regulations;
- Regulations governing structural units;
- Functional responsibilities, labor agreements and contacts for all individuals, who will be involved in establishment and operation of EEMS.

A formal training of energy management specialists currently began in Russia. A Master Degree Program in Energy Conservation and Energy Efficiency was organized in the Department of Electric Energy Grid and Systems at Tomsk Polytechnic and Research

National University. A special 72-hour training courses for energy managers were organized at Moscow Energy Institute, A.F. Mozhaiskuy Academy, and Engineering Academy (Yekaterinburg).

The experience of operating Energy Management Programs in developed countries demonstrates [7-8], that in order to achieve the objectives for significant TER cost reduction, one must not only establish Energy Commission and make energy managers part of the enterprise's overall management system, but also to involve in the process a sufficient number of employees from the units that consume the most TER and, therefore, are able to significantly impact the enterprise's energy efficiency. The heads of these units jointly with energy managers will have to establish *local field energy management groups*.

These groups must meet regularly (2-4 times per month) to discuss ways and measures to improve energy efficiency and to implement plans, as well as to disseminate information on status of energy management in the unit and in overall enterprise. They are also tasked with the responsibility for collecting suggestions for TER consumption efficiency improvements for its subsequent review by energy managers and other experts and for making decisions on its acceptance and implementation or on reasoned rejection.

The ISO 50001 states the following regarding the items listed above: “A *successful implementation of energy management system largely depends on involvement of all management levels and, especially, on involvement of upper management*” (Introduction).

Normally, the enterprise agrees to implement all of these ideas and suggestions. They establish the Energy Commission and create local field groups, but it takes a while to implement positions of Energy Managers. Everyone used to deal lately with downsizing of personnel and the idea of introducing new positions always being met with resistance. So far, there is no experience of operating these systems in Russia. As a rule, the enterprise's upper management is not confident in that this will produce significant positive gains. But without the employees, whose responsibility is to deal exclusively with energy efficiency and energy conservation issues all day long, the situation will remain at the same state as was prior to making the decision to establish and to implement EEMS.

**Documenting EEMS.** EEMS development experience shows a wide range of expert opinions regarding EEMS documentation – the volume of required documentation, the scope of depth, and who is responsible for developing of documents. However, most of these issues are clearly addressed in international management standards. Regarding the volume of documents, we have discovered the following:

- in [10]: “*An organization must determine the volume of required management system documentation on the basis of process analysis... The process of documentation should not become an ultimate goal*” (p. 5.2);

- in [4]: “*Not all procedures require documented confirmation. Procedures requiring mandatory documentation are: internal audit, documents about control over energy efficiency indicators, procedures, and others. An organization independently determines and develops documents, which, in its opinion, will most fully reflect energy efficiency and EEMS operation*” (A 5.2.1);

- in [10]: “*When necessary, and in order to limit volume of the required documents, one must reference currently accepted standards and other management system documents available to users*” ... (p. 5.2)

Some enterprises, which even prior to EEMS implementation, dealt with energy efficiency issues, have a whole range of documents necessary to regulate these processes. In our experience, for example, prior to EEMS documentation development, we already had

some documents on this topic (enterprise standards - 15, regulations on structural units and some types of activity – 20, general procedures – 13). This largely defined the list and the level of detail for the EEMS required documentation that had to be developed by an external organization.

Who shall develop required EEMS documentation? According to many enterprise specialists in Russia, all documents related to EEMS procedures should be developed by an external organization. According to GCE-Energy experts, only some fundamental required documents should be developed, taking into account international standards requirements, by an external organization. The rest of the EEMS documentation activity should be performed by an enterprise's personnel, involved in EEMS operations. For example, for activities, mentioned above [5], taking into consideration the required documents that already existed at an enterprise, we have developed the following required documentation:

- “Organization's Energy Efficiency Management System” – a basic manual for principles, systems, and methodology to ensure functioning;
- Custom Integrated Program for Energy Conservation and Energy Efficiency (CIPECEE);
  - Regulation on Energy Commission;
  - Regulation on Chief Energy Specialist Service (revision);
  - Regulation on establishing, financing, implementing, and monitoring IPECEE;
  - Regulation on Personnel Motivation System for rational and effective use of energy resources;
  - Energy Manager Position Responsibilities (project).

Current required documentation will have to be amended by the enterprise's personnel. This is completely in-line with international management standards recommendations, specifically:

- in [10]: “*Management system documentation... must be developed by the personnel and implemented for use within the processes and activities*”. This is necessary in order to maintain the degree of personnel involvement and interest, as well as for better understanding of the requirements by staff members (p.5.1);
- in [10]: “*An organization should conduct training of personnel involved in developing of documents; the training program must include procedures for documenting, training for management system standards, and adhere to other necessary requirements*” (p. 5.2).

**Planning within energy management system.** The key point in planning activities to improve energy efficiency at the stage of developing energy management system is developing a mid-term Integrated Program for Energy Conservation and Energy Efficiency (IPECEE). In order to develop this program an Integrated Enterprise Energy Audit must be performed as opposed to typical energy audit. In the above mentioned project [5] an Express Audit was scheduled and this led to a certain difficulties when developing IPECEE.

IPECEE calls for implementation of a range of measures and, therefore, it should be divided into three sections: organizational, technical and process related, and commercial or economic measures. Normally, the TER conservation programs, which are currently developed by traditional methods, are either lacking the first and the last section or they are not sufficiently detailed. An unusual level of detail and the content of IPECEE used in this project could be explained by a systemic approach to an audit and the way ESS<sup>1</sup> is operated at this enterprise.

Having organizational measures in IPECEE is dictated by the fact that ESS is a complex human-machine interface, and, therefore, the audit and the improvements must apply not only to a machine side of equation, but to a human one as well. Activities such as the establishment and the operation of the energy management system could qualify as organizational measures, i.e.:

- development, implementation and compliance with the Enterprise's Energy Policy;
- establishment and implementation of special EEMS organizational structure;
- determination of energy basis of the enterprise;
- documentation of EEMS;
- establishment of personnel motivation system directed to improve energy conservation and energy efficiency;
- establishment of personnel training system for personnel involved in EEMS for energy conservation and energy efficiency;
- performance of internal and external energy audits according to the schedule (internal audits – for facilities significantly impacting energy efficiency – once per year, external – for overall enterprise – once every 5 years);
- formally documenting and implementing of IPECEE, as well as developing of annual energy conservation and energy efficiency programs.

The experience of developed countries shows that only by performing a series of organizational measures one could significantly improve TER consumption efficiency. This improvement, according to [8-9] could reach 5-10% and more of total TER consumption by facility.

Developing of second IPECEE section, normally, does not present any special difficulties since it includes technical and process measures, which are similar to traditional methodology of developing energy conservation programs. The key measure in this section for most of Russian enterprises is establishment of technical metering system.

Development of third IPECEE section should be based on the results of additional research. The first two IPECEE sections concern, for the most part, measures, that take into consideration organizational issues and enterprise's internal policies, as well as environmental effects. The third section encompasses the area of external economics and energy environment, as well as the issues of enterprise's energy security and industrial safety. The third IPECEE section should primarily include measures to minimize cost of consumed TER due to harmonizing relations with TER suppliers, consumers, and subscribers. In addition, this section should include measures to mitigate negative effects of some legal, economic, organizational, and technical implications on the scale of a region and a country overall.

This section should include review and planning of measures on the following topics:

- Structure optimization for TER, consumed by specific departments of an enterprise;
- Selection of TER suppliers (when possible) and types of agreements with suppliers, as well as applicable rates and tariffs;
- Substantiation for receiving of regional and federal level discounts set forth by the Federal Law "On energy conservation and improving of energy efficiency" (loans, discounted credits, tax benefits, expedited equipment and facilities amortization, and other) on the condition of IPECEE implementation;

- Substantiation of necessity, technical feasibility, and commercial efficacy of building own energy sources, including for the purpose of providing reliable electric power supply for essential consumers (1-st and special categories), as well as, in some cases, to provide energy security for the overall enterprise.

Some measures, included in this section, could be only be performed by a joint effort of a group of TER consumers. This, as an example, applies to the following measures:

- Measures to eliminate inequality in rates and tariffs for consumers of TER, as well as conditions of connecting to the electric grid set forth by a number of legislative acts, which contradict the law on electric energy. In addition, measures to initiate legislative acts directed to protect TER consumers' rights;
- Measures to establish monitoring of external economic conditions in the region and in the country in order to use various preferences set forth by laws and other regulatory acts on the federal and the regional level, measures to attract additional means and resources to improve enterprise's energy efficiency;
- Measures to organize participation in trading of harmful atmospheric emissions quotes, in accordance with Kyoto Agreement, due to reduction in TER consumption as a result of IPECEE implementation;
- Measures to substantiate establishment of or participation in various TER consumer organizations tasked with protection of consumers' rights.

Since, in accordance with the current law, an energy audit must be performed at least once in 5 years, IPECEE should encompass the same period. An annual Energy Conservation and Energy Efficiency Program must be developed and implemented each fiscal year on the basis of IPECEE.

**Technical (managerial) monitoring of TER.** In order to correctly organize the operations planning process for energy conservation and improving of energy efficiency, one must precisely determine enterprise's *energy basis* i.e., a threshold where the operations to implement EEMS begin and against which EEMS assessment of success and effectiveness will be made in the future. Previously, we spoke on the issue of determination of EEMS facilities and subjects. Then, there are normally difficulties to determine indicators of energy efficiency and determining their factual values for the initial period, as well as determining the factors, significantly impacting these values.

The most common energy efficiency indicator is a specific value of TER consumption per unit of product produced (service, etc.), if this is an acceptable indicator for the facility in question. At this point, the main problem is the issue of measuring it. For Russian enterprises, this is not always possible due to the lack of appropriate control and measurement systems (technical, managerial accounting). For some facilities this indicator is possible at all. For example, an energy efficiency of energy supplying facilities (electric and thermal energy supply) in regards to TER losses in main feed and distribution energy grids. In this case we must introduce different indicators. It could be similar to large electric grid companies – TER process consumption for TER transportation within enterprise's distribution grid, for their facilities, and within the area of their operational responsibility. Once again we are faced with the issue of measuring it. In some instances, in order to find an acceptable and measurable energy efficiency indicator, we must divide the facility into several subsystems and use different methodology.

In most cases, energy efficiency indicators depend on a number of factors, which significantly impact its values – facility productivity rate, ambient temperature, and others, for example. Normally, the range of these factors could be determined without any problems

jointly by energy auditors and by enterprise experts. As far as verification of its accuracy and validity by statistical methods goes, – the problem is in insufficient data on energy consumption for the previous period (at least, for 2-3 previous years), or in data being unreliable because the data was not based on instrument measurements. Therefore, most of EEMS development and successful implementation issues depend on having at the enterprise a technical monitoring system, which, in some publications being referred to as Targeted Energy Monitoring System (TEMS) [7]. In GCE - Energy project [5] this system was called IAS – Information Analytical System.

Based on this, development and implementation of EEMS in most Russian enterprises ideally should start after implementation of Technical Monitoring System (TEMS or IAS) or, at least, at the same time. Without this system an effective energy management system operation is not possible since, it should be based on sufficient and reliable data on fuel and energy resources consumption and consumption efficiency data.

We believe that there will be significantly fewer difficulties and obstacles for implementation of EEMS with the development of national standards for required documentation and / or implementation of international energy management standards in Russia, as well as with gaining of experience in this area by leading Russian enterprises and taking into account experience of developed countries.

## References

1. U.S. Standard ANSI/MSE 2000:2005, Energy Management System.
2. South Korean Standard KSA 4000:2007, Energy Management System.
3. EU Standard EN 16001: 2009, Energy Management System – Requirement and User Manual.
4. ISO/DIS 50001 (international standard project). Energy Management Requirements and User Manual.
5. Yeremeyeva “GCE-Energy experience on development and implementation of Energy Management System (standard ISO 50001) at industrial enterprises”. Energy Efficiency Improvement for Energy Facilities at Mining and Metallurgical Enterprises – seminar materials.
6. Syusyukin, Tarasovskiy “Concepts of establishing of Rational Consumption and Energy Conservation System at Enterprise” *Elektrika* - 2009. – № 6.– pages 33–39..
7. “Fundamentals of Targeted Energy Monitoring” – course textbook. – М.: ЭНИЗАН, АСЭМ, 1997. – 38 p.
8. Berner M.S., Loskutov A.V., Ponarovkin D.B., Tarasova A.N. Foreign Experience in Motivation to Conserve Energy // *ЭСКО*, 2008, № 6.
9. Reference document on Best Available Techniques for Energy Efficiency – Geneva: European Integrated Pollution Prevention and Control Bureau (IPPC) 2009 – 489 pages.
10. GOST-R ISO/TO 10013-2007. Organization Management. Manual for documenting quality management system.
11. Fundamentals of Energy Management: Energy Management Library. – М.: ЭНИЗАН, АСЭМ, 1997. – 87 pages.