Expert assessment of the current state of the energy management system in the company

Anna Minnullina¹ and Rais Abdrazakov²

¹Tyumen Industrial University, Volodarskogo St., 38, Tyumen, 625000, Russia
²Northern Trans-Ural State Agricultural University, Respublika St., 7, Tyumen, 625003, Russia

E-mail: minnullinaay@yandex.ru

Abstract. The authors' expert assessment of the current state of the energy management system in the company is proposed in the article. The experts are invited to assess the status of the energy management system in the following categories: energy policy, organizational structure, training, motivation, control, communication, investment, and energy consumption culture. For the purposes of interpretation of the results of the expert evaluation obtained, a gradation based on a possible range of values is proposed. The expert evaluation allows representing the status of the energy management system in general and at each of its individual levels, which makes it possible to identify the problem areas more accurately. To confirm the applied nature of the proposed methodology, the authors assessed the opinions of 8 experts, employed by the road construction company of the Tyumen Region and related in one way or another to the process of energy consumption in the company due to the nature of their activities.

1. Introduction

In 2009, Russia took the last place in the implementation of 25 recommendations of the International Energy Agency for improvement of the energy efficiency. This served to introduce the drastic changes in the Russian energy resources market both at the level of legislative support and at the level of financial support for the activities [1].

Currently, there are about 70 legal acts in the field of energy saving and energy efficiency in Russia. However, the most significant national initiative is the adoption of the Federal Law No. 261 "On Energy Saving and Energy Efficiency Improvement and on Introduction of Amendments to Certain Legislative Acts of the Russian Federation". In accordance with this, every company that comes within the purview of this law is required to develop, to approve and to implement the program of energy saving and improvement of energy efficiency [2].

The energy saving and energy efficiency improvement program is aimed at fulfillment of the main tasks of the Energy Strategy of Russia, approved in 2009, by 2030 [3]. The annual monitoring of the results of its implementation envisaged by the Energy Strategy of Russia shows that, in general, the main quantitative parameters of development of the energy resources market reach the established ranges of values. Nevertheless, the opposite trend is observed for certain indicators; in particular, with respect to reduction of the energy intensity of the national economy, there is a gap with the reference strategic indicators. This problem cannot be solved without the study of theoretical and methodological support of energy management, which allows implementing on a scientific basis a competent development mechanism for its implementation to improve the energy efficiency of various industries.
in Russia. The theoretical, methodological and practical development of the approaches to the improvement of the energy efficiency of the industry, based on the application of modern management systems, is required.

The creation and implementation of the energy management system in the company can contribute to ensure the positive dynamics in the improvement of the energy efficiency, to identify and to use the reserves of management of the rational consumption of energy resources. The formation of the energy management systems is a priority for the improvement of the energy efficiency of the Russian companies in all spheres of the industrial business in the Russian economy. However, this scientific direction only recently has begun to develop actively in Russian science.

It becomes quite obvious that this direction needs to be studied multilaterally, since it is a complex task requiring the use of multidirectional scientific knowledge. The research in the field of energy management is the unified platform for solving the problem of improvement of the energy efficiency of the company, since only the competent management methodological solutions are able to ensure the interaction of its technical, technological, production, economic, organizational, managerial, psychological, social and other aspects.

The studies in this field are actively carried out by such foreign scientists as E. Pinero, G. Lambert, T. Frank, T.H. Gulbrandsen, N. Nill, R.N. Anderson, Sh. Hensen, D. Weisman, A. Breeden and others [4-8]. Their scientific works are aimed at studying the energy management from the standpoint of theoretical substantiation of its functioning in production systems that meet the strictest requirements of the present. Also, the theoretical aspects of energy management are studied by the Russian scientists V.V. Kharchenko, V.A. Begalov, N.V. Zaitsev, Yu.Yu. Kudryavtseva, T.Yu. Anisimova, S.P Koval, D.G. Trofimov and some others [9-11].

The accumulated domestic and foreign experience in managing the energy saving and energy efficiency of the companies, as well as the development of energy management, has been studied in the scientific papers of D.B. Ponarovkin, A.G. Bebeshev, I.O. Volkova, M.S. Bener, A.V. Loskutov, A.N. Tarasov, S. Buchin, M.M. Brodach, A.V. Zverev, A.P. Khaustov, N.S. Yablonsky, M.M. Redina and others [12-15].

In recent years, the published results of the scientific research increasingly affect the issues of energy saving within the functioning of energy management systems (V.I. Volodin, E.V. Matras, O.V. Sviderskaya, S.V. Artyukh, I.I. Chervonenko, V.L. Chervinsky, L.P. Padalko, etc.) [16,17] and the problems of application of the energy management as a means of improvement of the Ecological safety and energy efficiency of the companies.

The problems of interpreting the requirements of international standards in the field of energy management, their adaptation and creation of the necessary conditions for implementation in Russian practice are considered in the scientific works of such scientists as Yu.Yu. Kudryavtseva, S.V. Khorobrykh, A.A. Vorobiev, G.N. Marchenko, I.G. Akhmetova, V.M. Makarov, R.R. Farkhotdinov, A.A. Osadchiev, V.A. Lukinov, V.A. Syshchikov, A.I. Syusyukin, G.I. Eremeyeva, et al. [18,19,20].

The scientific works of V.A. Begalov, D.G. Trofimov, K.A. Podvigin, V.L. Rednikov, A.V. Kopytova, O.A. Tarasova are aimed at studying the interconnection of the energy management with modern approaches to quality management and sustainable development, treating it as one effective means of its implementation [21,22].

A.V. Babkin, M.P. Melnikova, A.A. Makarov, I.K. Khuzmiev and some others disclose in their scientific papers the issues of improvement of the level of energy saving and ensuring the energy efficiency in the development and implementation of the national and regional government programs [23,24].

At the same time, in modern studies of the Russian scientists, the theoretical and methodological aspects of assessment of the current state of energy management in the company have not been sufficiently developed, presented and structured. So, before recommending the introduction of modern management systems, it is important to identify and assess correctly the problem areas in the energy management system of the company, to determine the possibility of their elimination or reduction of the impact on the level of energy efficiency.
2. Methods
The achievement of the strategic targets in the field of reduction of energy consumption at the company’s internal level can be performed through the implementation of the energy management system in accordance with the requirements of the international and national standards. However, before introducing any innovations to improve energy efficiency, it is important to assess correctly the current state of energy management in the company.

To assess the current state of energy management in the company, the authors recommend conducting the expert assessment, developed on the basis of a special benchmark test (Table 1). The expert assessment is carried out in 8 categories, each of which is evaluated according to 4 characteristics of energy management. The assessment of the categories and characteristics of the state of the energy management in the company is carried out by a group of specialists (experts), which may include senior management, chief power engineer, chief engineer, production department/plant manager and other specialists whose functions are directly or indirectly related to the process of energy consumption and energy saving.

Table 1. The form of presentation of the results of the expert assessment of the state of the energy management system in the company

| Categories                  | Characteristics                                                                 | Score | Experts |
|-----------------------------|--------------------------------------------------------------------------------|-------|---------|
| Energy Policy               | There is a permanent plan as part of the company’s strategy                     | 5     | 1 2 3 ... m |
|                            | There is a formal energy saving and energy consumption program                  | 3     |         |
|                            | There are separate instructions for energy saving                              | 1     |         |
|                            | There is no energy policy and its individual means                             | 0     |         |
| Organizational structure    | There is an energy manager/energy management department, responsible for energy saving and energy consumption | 5     |         |
|                            | There is an employee, who combines the duties of energy manager with other functions | 3     |         |
|                            | The functions of the energy manager are performed by different employees irregularly | 1     |         |
|                            | There are no employees performing energy management functions                  | 0     |         |
| Training                   | A permanently operating energy management information system for all personnel | 5     |         |
|                            | Periodic courses for the Energy Management Group                               | 3     |         |
|                            | Individual topical management meetings                                         | 1     |         |
|                            | Lack of information on energy saving                                           | 0     |         |
| Motivation                 | There is a program of material and non-material motivation of energy saving by the personnel | 5     |         |
|                            | There are periodic motivational payments based on the results of energy audit  | 3     |         |
|                            | There are one-time individual payments to the employees, associated with energy consumption | 1     |         |
|                            | There is no program of material and non-material motivation of energy saving by the personnel | 0     |         |
| Control                    | Complete implementation of the method of targeted monitoring                   | 5     |         |
|                            | Calculation of specific norms without energy efficiency indicators             | 3     |         |
|                            | Only the accounting of the consumed energy resources according to metering devices or the invoices of the supplier | 1     |         |
|                            | No energy accounting                                                          | 0     |         |
| Communications             | Well-established formal and informal channels for information transfer         | 5     |         |
|                            | Reporting to management and contact with major energy consumers               | 3     |         |
|                            | Formal reporting and contact with energy consumers only through the administration of the company | 1     |         |
|                            | There is no reporting and no contact with the consumers                        | 0     |         |
| Investments                | Patronage from the part of administration and support for the energy projects  | 5     |         |
|                            | Short-term investments in energy projects                                      | 3     |         |
|                            | Only low-cost projects are supported                                           | 1     |         |
|                            | No investment in energy efficiency                                             | 0     |         |
| Culture of energy consumption| There is a corporate culture of energy saving, supported by the staff          | 5     |         |
|                            | There are cultural reference points of energy saving, promoted for certain categories of personnel | 3     |         |
|                            | Formal availability of basic cultural values of energy saving                  | 1     |         |
|                            | Lack of a culture of energy consumption                                         | 0     |         |

In the course of the expert assessment, the degree of consistency of the expert opinions should be determined using the Kendall Concordance Ratio (W) according to the formula (1):
\[ W = \frac{12S}{m^2(n^2-n)} , \]  

(1)

\( m \) is the number of experts in the group;  
\( n \) is the number of analyzed categories;  
\( S \) is the sum of squares of differences of the ranks (deviations), calculated by formula (2):

\[ S = \sum_{j=1}^{n} \left( \sum_{i=1}^{m} A_{ij} - \frac{1}{2} m(n+1) \right)^2 , \]  

(2)

\( A_{ij} \) is the rank assigned by the \( j \)-th expert to the \( i \)-th criterion.

The value of the concordance coefficient can be in the range from 0 to 1. If \( W = 0 \), the opinions of the experts are recognized as inconsistent. If \( W = 1 \), then the expert assessments are considered fully consistent.

The expert assessment by category (the average score) is calculated as the arithmetic average, which makes it possible to assess the current state of an individual element of energy management. The total expert assessment in all categories reflects the state of the energy management system in the company as a whole.

The advantage of the proposed methodology is the consideration of the energy management system in general and at each of its individual levels, which allows performing a balanced assessment and identifying specific shortcomings in problem areas.

The obtained results of the total expert assessment can be interpreted as follows:

1. "Success" (the total average score is in the range of 33-40) – the energy management has the highest priority in the company. It is recommended to continue the work with the periodic monitoring of energy consumption. It is also important to keep abreast of the latest advances in energy-saving technologies and energy management, and to introduce them into the practice of the company as necessary.

2. "Good result" (the total average score is in the range of 25-32) – the energy management is of interest to the company as a whole, but the management attributes the energy management to the technical issues rather than to general management. It is recommended to revise the basic aspects of the company, to include the effective energy management in the priority areas of cost control, to improve the structure and procedure of energy management as necessary.

3. "Mediocre result" (the total average score is in the range of 17-24) – the energy management is inconsistent. The company's management attributes the energy management to the engineering and technical tasks. The potential of the energy manager is poorly used. The main task is to raise the prestige of the energy manager, to introduce all aspects of the targeted monitoring into practice, thereby increasing the return on his work.

4. "Requires attention" (the total average score is in the range of 9-16) – there are some elements of energy management, probably implemented in different groups, mainly engaged in the operation of the equipment. The power management capabilities are poorly used. It is necessary to identify the main obstacles that hamper the development of the energy management system and to eliminate them. Substantial efforts are required to integrate the energy management into the company's management structure.

5. "Urgently requires action" (the total average score is in the range of 0-8) – the energy management is missing or is in its infancy. The company bears losses from inefficient use of energy – perhaps 20% or more of its cost. Urgent measures should be taken: to improve systematically the energy consumption management system in all its aspects: technical equipment, creation of a structure and procedure, training of personnel.

The results and conclusions of the expert assessment allow identifying several key areas for development of the energy management to increase the energy efficiency of the company's operations:

1) clear regulation of the responsibility of the administration and the managers of the company in
matters of energy saving and energy efficiency;
2) the increase in the level of qualification of the personnel engaged in the process of energy consumption in the company;
3) the increase in the level of energy consumption culture and the creation of the understanding of the energy saving opportunities among the company's employees;
4) material and non-material motivation of the personnel for achievement of a higher level of energy saving;
5) the introduction of the position of an energy manager / energy management department;
6) the improvement of the system of energy resources accounting through new technologies, equipment, etc.;
7) registration and regulation of all procedures and processes related to the improvement of energy efficiency in the company with mandatory provision of public access to all information.

3. Assessment and Results
In order to confirm the applied nature of the recommendations, the expert assessment of the state of the energy management system in the road-construction company "TODEP" AO of Tyumen, Russia is performed. "TODEP" AO has 7 branches, among which the main production capacities (including the asphalt-concrete plant) are: Tyumenskoe DRSU, Zavodoukovskoe DRSU, Vagayskoe DRSU, Yalutorovskoe DRSU and Ishimskoe DRSU. The basis of the efficient production activity of "TODEP" AO is the manufactured products (in particular, road construction works, asphalt, asphalt-concrete, sand-gravel mix, etc.) that meet the needs of consumers [25].

The results of the expert assessment of the state of the energy management system in "TODEP" AO are presented in Table 2. The formalized designations of the experts: A – General Manager; B – Chief Power Engineer; C – Head of the asphalt plant; D – senior mechanic; E – General Manager of DRSU-1; F – General Manager of the Vagayskoe DRSU, G – Yalutorovskoye DRSU, H – Zavodoukovskoe DRSU, J – Ishimskoe DRSU.

| Categories              | Characteristics                                                                 | Score | Experts | the total score |
|-------------------------|----------------------------------------------------------------------------------|-------|---------|-----------------|
|                         |                                                                                  |       | A       | B               | C               | D               | E               | F               | G               | H               | average         |
| Energy Policy           | There is a permanent plan as part of the company's strategy                      | 5     | 5       | 5               |                 |                 |                 |                 |                 |                 |                 |
|                         | There is a formal energy saving and energy consumption program                   | 3     | 3       | 3               | 3               | 3               | 3               |                 |                 |                 | 3.5              |
|                         | There are separate instructions for energy saving                                 | 1     |         |                 |                 |                 |                 |                 |                 |                 | 1                |
| Organizational structure| There is no energy policy and its individual means                                | 0     |         |                 |                 |                 |                 |                 |                 |                 | 3.5              |
|                         | There is an energy manager/energy management department, responsible for energy  | 5     |         |                 |                 |                 |                 |                 |                 |                 | 3.5              |
|                         | saving and energy consumption                                                    |       |         |                 |                 |                 |                 |                 |                 |                 |                   |
|                         | The functions of the energy manager are performed by different employees         | 1     | 1       | 1               | 1               |                 |                 |                 |                 |                 | 1.75             |
|                         | irregularly                                                                       |       |         |                 |                 |                 |                 |                 |                 |                 |                   |
| Training                | A permanently operating energy management information system for all personnel   | 5     | 5       | 5               |                 |                 |                 |                 |                 |                 | 1.75             |
|                         | Periodic courses for the Energy Management Group                                  | 3     | 3       | 3               | 3               | 3               |                 |                 |                 |                 | 3                |
|                         | Individual topical management meetings                                            | 1     |         | 1               | 1               |                 |                 |                 |                 |                 | 1                |
|                         | Lack of information on energy saving                                             | 0     |         |                 |                 |                 |                 |                 |                 |                 | 3                |
| Motivation              | There is a program of material and non-material motivation                         | 5     | 5       | 5               | 5               | 5               | 5               |                 |                 |                 | 5                |
|                         | of energy saving by the personnel                                                |       |         |                 |                 |                 |                 |                 |                 |                 |                   |
|                         | There are periodic motivational payments based on the results of energy audit     | 3     | 3       | 3               | 3               |                 |                 |                 |                 |                 |                   |
|                         | There are one-time individual payments to the employees, associated with energy   | 1     |         |                 |                 |                 |                 |                 |                 |                 |                   |
|                         | consumption                                                                       |       |         |                 |                 |                 |                 |                 |                 |                 |                   |
|                         | There is no program of material and non-material motivation of energy saving by   | 0     |         |                 |                 |                 |                 |                 |                 |                 | 4.25             |
|                         | the personnel                                                                     |       |         |                 |                 |                 |                 |                 |                 |                 |                   |
| Control                 | Complete implementation of the method of targeted monitoring                      | 5     |         |                 |                 |                 |                 |                 |                 |                 | 2.75             |
### Calculation of Specific Norms without Energy Efficiency Indicators

| Category                             | Score |
|--------------------------------------|-------|
| Only the accounting of the consumed energy resources according to metering devices or the invoices of the supplier | 3     |
| No energy accounting                 | 1     |
| Well-established formal and informal channels for information transfer | 5     |
| Reporting to management and contact with major energy consumers | 3     |
| Formal reporting and contact with energy consumers only through the administration of the company | 1     |
| There is no reporting and no contact with the consumers | 0     |

### Communication

| Score |
|-------|
| 5     |
| 3     |
| 3     |
| 3     |
| 3     |
| 3     |
| 3     |

### Investments

| Score |
|-------|
| 5     |
| 3     |
| 3     |
| 3     |
| 3     |
| 1     |
| 1     |
| 1     |
| 1     |

### Culture of Energy Consumption

| Score |
|-------|
| 5     |
| 3     |
| 3     |
| 3     |
| 3     |
| 2.5   |
| 2.5   |
| 2.5   |

### Total Expert Assessment

| Score |
|-------|
| 23.2  |
| 5     |

As a result of the expert assessment of the energy management state in "TODEP" AO, the following shortcomings were found in the energy management system:

1) the lack of the organizational structure, presuming the concentration of energy management functions in certain officials;
2) the investment policy for the projects aimed at the improvement of the energy efficiency;
3) the lack of the corporate culture of energy consumption in the company promoted for all personnel;
4) the weak control over the energy consumption without taking into account the energy efficiency indicators.

In general, the assessment of the current state of energy management showed a "mediocre result" (the total expert assessment is in the range of 17-24), which requires the improvement of the energy management system of "TODEP" AO.

### 4. Conclusions

The proposed procedure for the expert assessment of the current state of the energy management system in the company is based on a scoring characteristic of 8 categories reflecting certain directions of energy management. The results of the expert assessment allow assessing the level of performance of the energy management functions in the company and the need for their expansion and improvement. The calculation estimate can be carried out by comparing the results obtained in the dynamics (in comparison with the previous periods) or using the best indicators of the similar companies in the industry as a benchmark. It is important to emphasize that the implementation of this method is possible both within the framework of one company and to reflect the results of the comparative characteristics of the energy management system of several companies.

To confirm the applied nature of the author's recommendations, the expert assessment of the current state of the energy management system in the road-construction company "TODEP" AO was performed based on the opinions of 8 experts. As a result of the expert assessment, the following shortcomings of the energy management system and the "mediocre result" were revealed, confirming the need to improve the energy management system of "TODEP" AO. The proposed expert assessment of the current state of the energy management system in the company has shown the convenience and simplicity of its application in practice. However, the reliable results of expert assessment can be obtained only if the expert is frank and takes the initiative.

Thus, the successful introduction of energy management largely depends on the attitude of the administration of the company to it. It is necessary to systematically improve the energy management
system in all its aspects: technical equipment of the company, creation of an organizational structure and procedure for energy management, staff training and its motivation in the field of energy consumption, etc.

References

[1] Energy Efficiency Policy Recommendations 2009 OECD/IEA

[2] The Federal Law of the Russian Federation "On Energy Saving and Introduction of Changes to Certain Legislative Acts of the Russian Federation" No. 261-FZ, URL: http://www.consultant.ru/document/cons_doc_LAW_93978/

[3] Draft of the Energy Strategy of Russia until 2035 URL: http://www.energystrategy.ru/ab_ins/source/ES-2035_09_2015.pdf

[4] Pinero E 2009 ISO Focus+ pp.18-20

[5] Pinero E 2011 ISO Focus+ pp. 8-10

[6] Lambert G 2011 ISO Focus+ pp 11-14

[7] Gulbrandsen T 2010 Energy efficiency and energy management 240 pp

[8] Frank T 2006 Energy saving 3 32-35

[9] Begalov V Energy management framework for implementation of energy service contracts URL: http://portal-energo.ru/articles/details/id/400.

[10] Kudryavtsev Yu 2011 Power supervising-Inform 2(48) pp 18-20

[11] Anisimova T 2008 Theoretical bases resource saving in modern conditions, 164 pp.

[12] Volkova I 2010 Standards and quality 2 pp 66-68

[13] Bebeshev A 2015 Nauka-rastudent 6(18) pp 6-10

[14] Berner M 2008 Energy saving 3 pp 44-47

[15] Zverev A 2011 Energy efficiency and conservation: international experience for Russia 175

[16] Volodin V 2014 Energy saving 4 pp 62-66

[17] Mataras E 2007 Student Bulletin 10 URL: http://www.bru.mogilev.by/science/vesnik/Papers2007/17.pdf.

[18] Marchenko G 2012 Energy problems 9-10 pp 135-140

[19] Osadchive A, Fadeeva E 2012 Certification 1 pp 12-16

[20] Syschikov V 2012 Fundamental research 9-3 pp 750-753

[21] Trofimov D, Podvigin K, Energy management, URL: http://nmoekproekt.com/viduslug/energosberezhzenie-i-energoeffektivnost/energeticheskyy-menedzhment

[22] Kopytova A 2016 Procedia Engineering 165 1132 pp

[23] Makarov V, Novikova O 2008 Scientific-technical Bulletin of Saint-Petersburg state Polytechnical University 2(54) pp 108-113

[24] Huzmiev I 2003 The energy regulation of natural monopolies and energy management 241 pp

[25] Minnullina A 2014 Economics and Entrepreneurship 5-2 pp 734