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ARTICLE

MANAGERIAL DECISION PROCESS CONCERNING DEVELOPMENT OF ENERGY-SAVING PROGRAMMES AT OIL AND GAS COMPANIES

Miroslava Gennadyevna Salko*, Vera Vladimirovna Plenkina, Alexander Andreevich Zubarev, Olga Gennadyevna Yakunina

Industrial University of Tyumen, Volodarsky's Street, 38, Tyumen, 625000, RUSSIA

ABSTRACT

The problems of energy saving at enterprises of the oil and gas complex require an effective managerial decision process concerning the efficient use of energy. High energy intensity levels in the oil and gas sector bring about the priority of optimising the use of fuel and energy for improved economic performance and competitiveness of the end product in the market. The paper substantiates the relevance of energy saving for industrial production in Russia, providing target references for bringing down energy intensity levels in the GDP and outlining the aspects of the state policy of energy efficiency until 2035. The authors propose a methodological approach for decision-making involved in the development of an enterprise-level energy-saving programme (ESP). The paper proposes to use management by objectives for optimising the content and performance of the ESP. Additional criteria for selecting efficiency proposals are recommended to help improve the energy efficiency of production. The proposed algorithm of development of the ESP based on management by objectives reflects the structural logical sequence of decision-making in the enterprise system of energy management. The authors confirm the significance of the scholarly definition by the conducted practical study of an enterprise of the oil and gas sector. The analysed fragment of an ESP and estimated calculations of its potential performance confirm the applicability of the proposed methods. The alignment of target references of oil and gas enterprises with their strategic objectives helps to identify the most promising solutions to energy efficiency problems in the sector as a whole.

KEY WORDS
energy efficiency, managerial decisions, management by objectives, oil and gas enterprise.

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***Corresponding Author**
Email:
salko.m.g@mail.ru

INTRODUCTION

The energy intensity of GDP in Russia is several times higher than the respective global average and the figures of other countries. The high energy intensity of the Russian economy weakens Russia's energy security and slows down economic growth [1]. The adoption of standards of well-being in Russia as in developed industrial economies amid the intensifying competition and depletion of material resources requires higher efficiency in the use of energy of all types [2]. The priorities of modernization and technological development of the Russian economy are energy efficiency and energy saving.

A key step toward a comprehensive solution of the energy efficiency problem was the adoption of several legislative acts and bylaws, as well as amendments and resolutions by the Government of the Russian Federation. The federal program of measures to raise energy efficiency was adopted, envisaging a reduction of energy intensity levels of the national GDP by 46% by 2035 under the best-case scenario [Fig. 1].

The Ministry of Economic Development of Russia developed four forward-looking scenarios of energy efficiency trends in the Russian economy depending on the robustness of the government's energy-saving and energy efficiency policies [3]:

- Scenario 1 – "conservation" of energy efficiency levels (as in 2016–2018);
- Scenario 2 – extrapolation of technology factor impact;
- Scenario 3 – modernisation of technological capabilities in the economy (progress in energy efficiency levels driven by the world's most advanced technologies by 2035);
- Scenario 4 – advanced modernisation (progress in energy efficiency levels driven by the world's most advanced technologies by 2035).

The Russian "Energy Industry Development" programme until 2024 charts reliable, quality and economically sound approaches to the provision of energy and material needs of the domestic market governed by the principles of energy saving and energy efficiency and honoring overseas contracts. Funding from the federal budget is systemically assigned for energy efficiency efforts in federal subjects of the Russian Federation and stimuli are developed for advancing the private funding market.

In terms of funding, the priority is set for projects at a pre-investment stage with a view to building conditions for attracting investment into the region. Government support measures are aimed at ensuring energy efficiency in the procurement of goods, works, services for providing government and municipal needs, improvement of requirements to energy-saving and energy efficiency programmers, higher energy efficiency levels, transformation of the system of energy surveys and adoption of energy consumption filings by public institutions, development of the state Energy Efficiency information system and others [3]. The extraction sector saw an increase in energy consumption by more than 10% over the past three years. In 2016, the decline in energy intensity levels was driven by the technology factor. The growth in energy consumption over the past two years was due to an increase in high-energy-intensity production [Fig. 2].

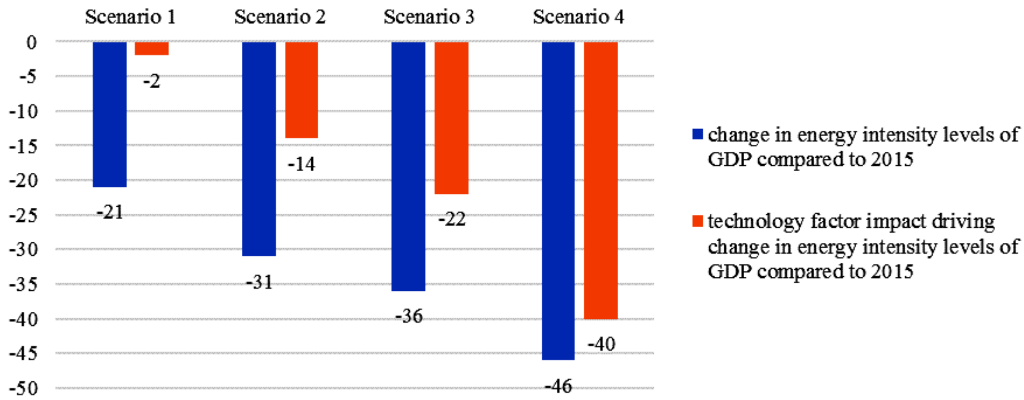

Fig. 1: Estimated reduction in energy intensity of Russian GDP, % [3]

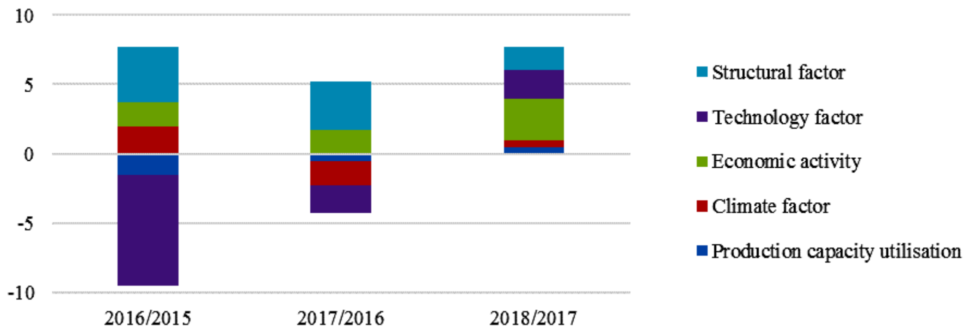

Fig. 2: Trends of factor impact on energy consumption in the extraction sector in the Russian Federation, millions of tons of oil equivalent [3]

The leaders of energy consumption growth in the extractive sector are oil and gas companies. In gas production, the growth in unit energy consumption is observed to grow by 5%, and in oil production, the figure is 1%. According to the biggest oil companies, the increase in energy consumption is mainly caused by technology and climate factors and higher costs of oil and gas extraction.

Overall, energy intensity levels of Russian GDP have by now declined by more than 12%. However, this figure significantly falls short of the target of 40% [3]. This proves the problem of energy efficiency is one of the priorities of government policies in Russia and substantiates the relevance of developing methodological approaches to managerial decision-making in the area for oil and gas companies.

METHODS

Efficient decision-making is facilitated not only by setting straightforward objectives generating energy savings, i. e. the development and adoption of plans and programmes of energy efficiency measures, but also by tracking progress in the implementation of steps on saving energy resources. The founding principle of ESPs is to prioritise measures with optimal cost – effect ratios [4, 5]. However, the process of development of an ESP involves self-balancing and self-organisation, which provides for improved ultimate results in terms of "resources – energy efficiency" compared to the usual "cost-based" planning. Therefore, the following setbacks can be identified in ESP development:

- the system's scorecard does not include analysis or appraisal of labour efforts of the subjects of the energy efficiency programme [6, 7, 8];
- the limited scope of energy efficiency criteria for auxiliary production operations [9];
- uncertain analysis of energy-saving potential;
- incomplete analysis of innovative management engagement in energy-saving processes.

The authors' original methodological propositions are to use a systemic approach and programme-based management of enterprise-level energy savings through the acquisition of new knowledge and development of a new "product" to enhance and advance the energy efficiency programme structure.
Management by objectives is based on the logical breakdown of several stages:

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i. Setting targets;
ii. Development of a comprehensive programme;
iii. Implementation and control of the developed programme.

The main aspect in management by objectives is the development of a hierarchical structure of programme elements to address the interim objectives aimed at the ultimate outcome [10]. Programme elements appear as a set of tools to achieve goals defined as specific measures and methods of their implementation. Another aspect of management by objectives is the possibility of adjustments to the established system of decision-making. The aspects of management by objectives in enterprise-level energy savings are as follows:

- determining the estimated forecast outcomes of ESP implementation and identifying inconsistencies with the set long-term plans and strategic objectives of the enterprise, which helps to set priorities in programme development;
- objective statement of the ESP comprises the line of the solution of the set problems with set deadlines and specific sets of action;
- analysis of resource requirements for energy-saving measures under a complex method taking into account the enterprise-level resource potential rather than individual divisions;
- priorities are assigned to measures based on the principle of maximum productive and economic effects and development of energy-saving potential;
- ESPs are not limited to meet the objectives of a single enterprise but seek to generate industry-level and cross-industry effects;
- every measure in the ESP is viewed as a local management object in the general organisational environment;
- energy efficiency measures can be excluded from the programme or rescheduled in case the enterprise's targets or priorities change.

The programming of the algorithm in the development and implementation of energy-saving measures should take into account several rules underlying the performance and functional aspects of management by objectives:

i. development of the ESP structure and sequence taking into account national and industry trends of the Energy Strategy of Russia [11];
ii. determining the procedure for justifying the planned measures of energy savings included in the programme;
iii. development of the mechanism of implementation of energy-saving measures, scheduling procedure and appointment of responsible officials;
iv. development of implementation performance criteria, including factor analysis of potential underperformance on targets across the stages of programme implementation;
v. development of the algorithm of making adjustments to the programme in case of significant inconsistencies with the planned performance targets in the implemented measures.

The formal procedure of the above functions is rendered as an algorithm taking into account the targets, objectives and sequence of development and implementation of energy-saving measures, as well as the practice of oil and gas companies in running energy efficiency programmes [Fig. 3].

The planning of the ESP is based on determining the potential of energy saving in retrospective [12]. One of the main lines in structuring the programme is the alignment of coordination between energy-saving policy management and the industrial operations. The focus of running an energy-saving policy should be aligned with the main goal of the enterprise, i. e. ensuring reliable productive operations and economic potential in the industry [13].

The concept of an ESP focuses on identifying the aspects of its content and selecting the most flexible option of using energy resources in the context of enterprise operations [14].
Successful development and implementation of energy-saving measures are largely dependent on employees' commitment. Accordingly, the authors propose the following indicators as additional performance criteria for the ESP:

i. employees' awareness of the ESP (understanding of the structural elements of the programme and currently implemented energy-saving measures, etc.);
ii. loyalty to the programme measured as the percentage of employees approving it;
iii. growth rate of efficiency proposals on energy saving (EP):

$$EP = \frac{V_0}{V_1} \cdot 100\% \quad (1)$$

where V0 and V1 are the number of efficiency proposals on energy saving in the base and reporting year, respectively;

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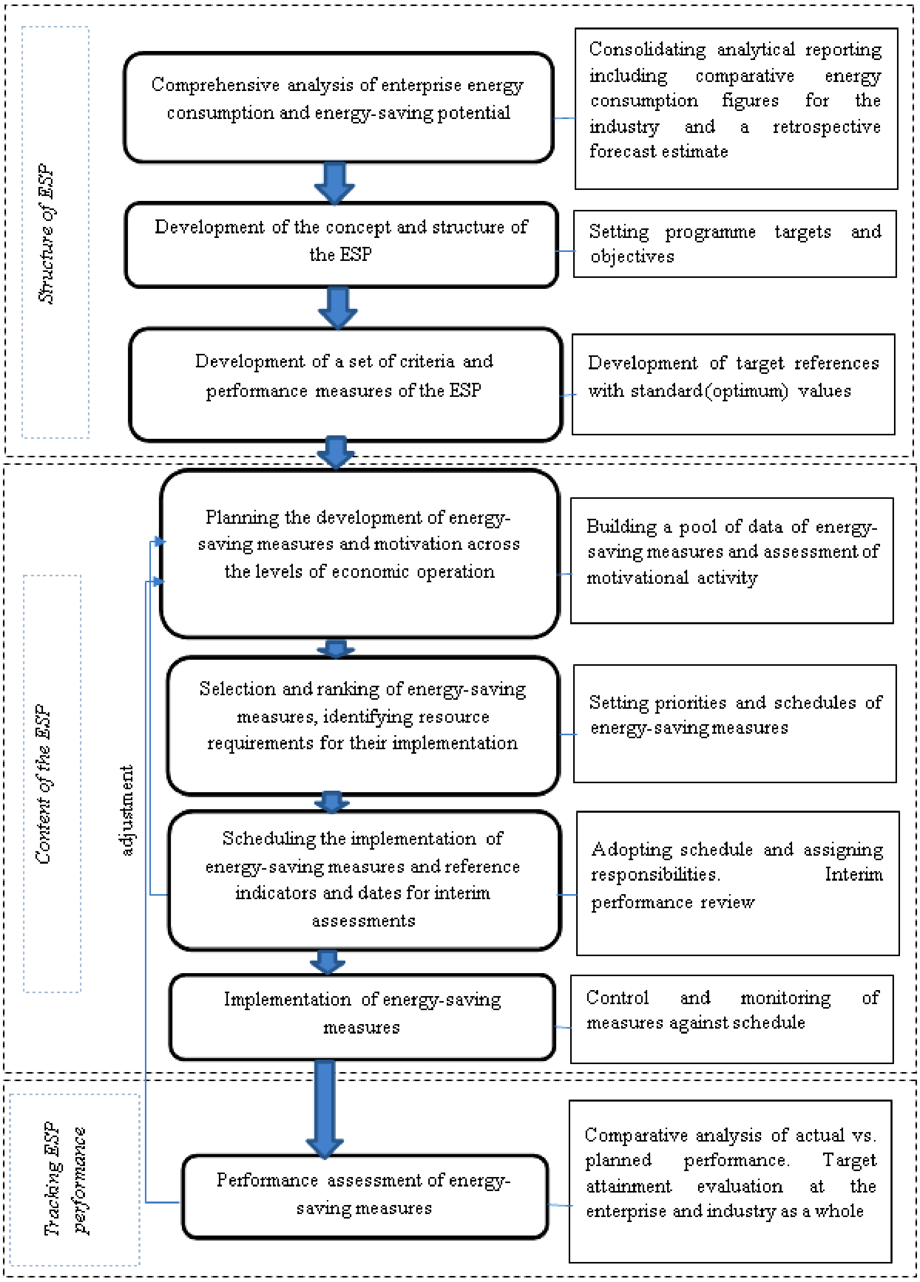

Fig. 3: Algorithm of development of ESP based on management by objectives

- share of efficiency proposals adapted in the ESP (EPad):

$$EP_{ad} = \frac{V_{ad}}{V_{total}} \cdot 100\% \quad (2)$$

where V_{total} and V_{ad} are the total efficiency proposals and approved efficiency proposals on energy saving, respectively.

Boosting the motivational activity of employees in the development and implementation of energy-saving measures involves the adoption of internal company regulations:

- regulations on incentives for energy saving including bonuses for employees based on their attainment of energy consumption reductions;
- introduction of fines for imprudent use of energy resources where standards are set.

Building a pool of measures provides the potential for choosing the most promising measures and ranking them by practicability and economic efficiency as follows [15]:

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i. zero-cost and low-cost measures implemented routinely as part of the current operation;
ii. mid-size measures funded from local sources;
iii. costly expensive measures requiring additional funding or investment and implemented with the use of loans and borrowings.

Scheduling of measures takes into account the selected programme scenario:

i. all energy-saving measures are adopted simultaneously – this option is realised in case of optimistic forecasts and completely supported by the enterprise's internal funding;
ii. lower-resource measures are prioritised before other measures with a higher level of resource requirements. The programme is implemented largely with borrowed funding;
iii. most energy-saving measures are implemented with the use of both internal sources and liabilities.

Subject to changes in the scenario of the ESP due to force majeure, the schedule of implementation may be adjusted.

Control of the ESP is performed against the schedule and target attainment:

i. investment size (capital expenditure);
ii. annual energy-saving effects from the respective measure;
iii. payback period for the measure;
iv. energy efficiency of the measure: energy cost savings per 1 ruble of capital expenditure;
v. cost savings on energy consumption (based on the applicable tariffs);
vi. value-for-money coefficient:

$$C_{vfm} = \frac{C_{red}/100}{P_{meas}} \quad (3)$$

where Cred is the potential reduction in energy consumption, %,
Pmeas is the price of the energy-saving measure (total cost), RUB;

- Other indicators characterizing the economic efficiency of the investment.

A comparative analysis of target attainment in energy-saving performance aims to identify potential reserves to improve efficiency and make adjustments in the future.

Managing the ESP by objectives opens the way for setting its role and place in the overall strategic domain for the Organisation, which results in improved efficiency in managing operations in general. Moreover, objective-driven programmes help to consolidate resources in the priority domains, which provides for high efficiency of the proposed methodological tools used for planning the ESP.

RESULTS AND DISCUSSION

Formation of a program of measures for energy saving of an oil pipeline transport enterprise

The above methodological proposals were tested for an enterprise in midstream oil operations. A central part of an ESP in the sector consists of analytical reporting on the trends and structure and forecast estimates of energy consumption to determine the energy-saving potential. The structure of energy consumption at the enterprise is laid out in [Fig. 4].

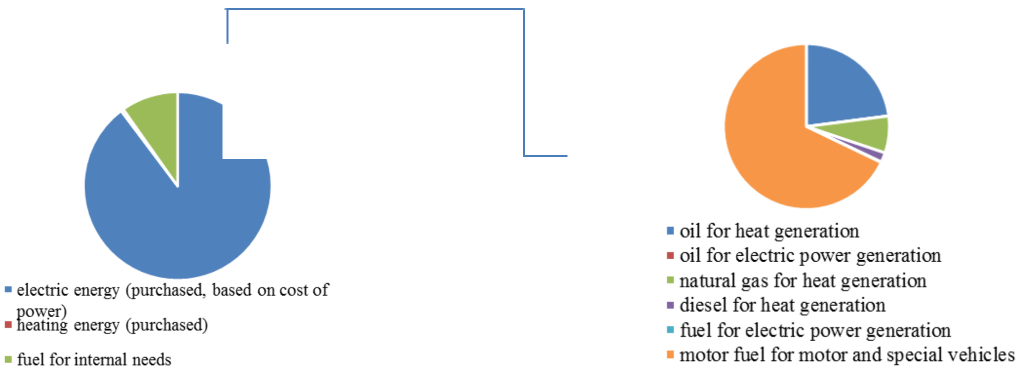

Fig. 4: Structure of energy consumption at a midstream oil enterprise in the reporting year, % (developed by the authors based on the enterprise's data)

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The energy consumption structure by the types shows that the biggest energy-saving potential can be realised not in purchased electricity but fuel for internal use, specifically motor fuel for motor and special vehicles.

The target references for the midstream enterprise's energy-saving and energy efficiency programme are:

- reduction of unit electric energy consumption in transhipment, acceptance, handling and dispatching of oil and oil products;
- reduction of energy consumption for usage in serving local and technological needs in providing oil and oil product transportation services along trunk lines.

Last year's underperformance falling short of the targets of the ESP indicates that there is more room for raising the enterprise's energy potential [Fig. 5].

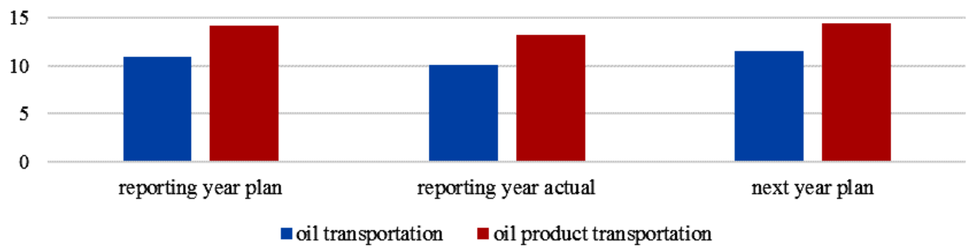

Fig. 5: Unit electric energy consumption under the ESP of the midstream oil enterprise

The programme block includes organizational and technical measures, a list of R&D efforts in energy saving and a list of priority objects in developing energy efficiency demonstration zones. The realization of employees' motivational activities is envisaged through the support of training and retraining in energy saving across the ranks and spreading the ideas of energy saving. Moreover, by integrating some regulations of the Energy-saving initiative in job descriptions across the ranks (primarily in the chief power engineer's department), the enterprise could improve the quality of the proposed measures.

Another proposition is to attach a separate addendum on energy saving to job descriptions relating to occupational, industrial and environmental safety.

The selection and ranking of efficiency proposals in energy saving submitted by employees for the planned period were conducted under the set criteria. A fragment of the ESP of the midstream oil and oil product enterprise is provided in [Table 1].

Table 1: Energy-saving action plan at the midstream oil enterprise (a fragment)

Measures	Funding size by the years, RUB million				
	2021	2022	2023	2024	2025
1. Pumping process optimisation:					
- modernisation of the pumping fleet for improved efficiencies	4.1	5.6	3.2	2.8	2.4
…	…	…	…	…	…
2. Energy savings in electric equipment:					
- application of digital synchronous motor field regulators	0.8	0.2	-	-	-
…	…	…	…	…	…
3. Process optimisation of oil storage:					
- equipping tanks with pontoons and floating roofs	1.2	1.9	-	-	0.4
…	…	…	…	…	…
4) Energy savings in heating energy generation:					
- modernisation of boiler equipment	0.4	2.2	2.4	1.8	1.1
…	…	…	…	…	…
5) Energy savings in heat and water supply systems:					
- adoption of high efficiency boilers	0.1	0.4	-	0.2	-
…	…	…	…	…	…
6) Energy savings in motor vehicle operations:					
- modernisation of vehicle fleet	2.4	2.9	4.0	3.8	1.2
…	…	…	…	…	…

The structure of the ESP includes technical and technological and organisational activities [16]. Each group includes subgroups of approved activities by the years and funding size. The amount of funding for each activity is substantiated by calculations of capital expenditures on their implementation and by indicators of the production programme, such as the amount of pumping of oil and oil products, operational capacity utilisation, construction and capital repairs of pipelines, reconstruction of pumping stations and other operational capabilities, etc. The funding schedule is aligned with the cost budget of the midstream enterprise for several years.

The projected implementation of the measures taking into account employees' activity in putting forth efficiency proposals is shown in [Fig. 6].

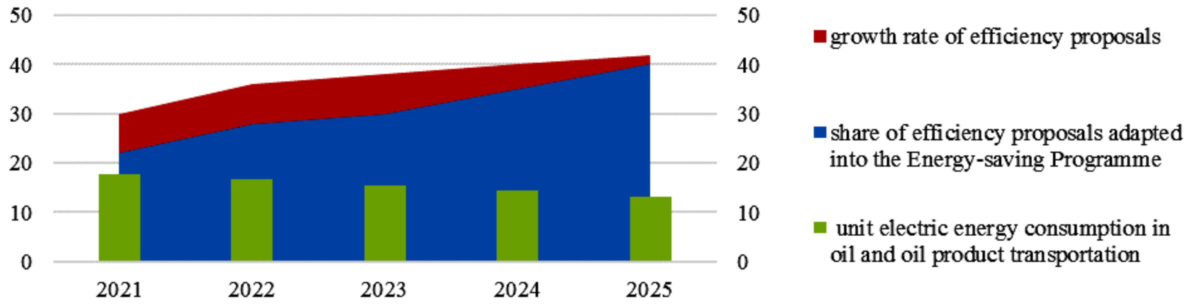

Fig. 6: Projected implementation of energy-saving measures taking into account employees' activity at the midstream enterprise

The proposed ESP integrates several measures put forth by employees as ways to rationalise energy saving at the enterprise. This approach helped to identify the relationship between the amount of proposed and implemented measures and maximum efficiency of energy savings. The chart [Fig. 6] indicates growth in employees' activity and the number of efficiency proposals integrated into the ESP. Meanwhile, the target level of unit electric energy consumption shows a steady trend of decline, which confirms the practicability and significance of the authors' propositions.

Development of guidelines for the ESP formation

The authors' proposed algorithm of developing the ESP based on the method of management by objectives is rendered as a unified structure. The algorithm can be adapted by setting narrower objectives and functions in the decision-making system. The specifics of ESP development at oil and gas enterprises can be also identified across the stages of the algorithm. For example, the analysis of energy use can be extended beyond a single enterprise to the industry as a whole to assess the share of energy-saving potential of individual entities [17].

An important element of the programme for oil and gas enterprises is the development of the underlying concept given the dual nature of use and production of energy resources. The goals and objectives of ESPs for companies of the fuel and energy sector should take into account national and international balances of use and generation of energy [18].

Introducing the metrics of employees' engagement among the performance criteria of ESPs is the key element of raising social responsibility both in the organisation and society as a whole. An efficient motivation system in energy savings helps to broaden the range of efficiency proposals across the ranks of the production cycle. With the broad selection of energy-saving measures at hand, the company can select and systematise the most efficient ones by the lines of operation and provide for a complex outcome from their integration.

In the further development of the authors' propositions, there could be wider engagement in joint energy-saving initiatives between different industry structures committed to cost savings and adoption of renewable energy technologies. This approach is aimed at the rationalisation of the use of energy resources and the development of technologies for energy-generating operations [19, 20]. The priority is technologies with the best energy efficiency and environmental credentials.

CONCLUSION

Improving the efficiency of managerial decision-making across the stages of such programme development would not only significantly contribute to lowering energy consumption levels but would help to improve the quality of solutions to the set problems.

The proposed approach to ESP development employing management by objectives would provide the following results:

- lower energy consumption levels across the operational cycle at oil and gas enterprises;
- justified implementation of energy-saving measures with maximum efficiency;
- objectivity and complex evaluation of the ESP for efficient decision-making in bringing down energy consumption;

- improved commitment and engagement of the employees as a result of modifications of motivational policies to use energy-efficient technologies;
- cost optimisation in ESPs as a result of the alignment of energy-saving measures with strategic priorities of oil and gas enterprises and the sector as a whole;
- quality planning system and timely implementation of energy-saving measures supported by target references and analytical performance indicators of the programme;
- improved efficiencies of energy-saving technologies providing for the rational use of resources and development of clean operations.

The practical significance of the proposed systemic approach to raising the efficiency of energy-saving processes is associated with the potential to uncover hidden reserves for more efficient use of fuel and energy resources. Steering energy savings toward strategic priorities of the oil and gas sector would provide for rational use of fuel and energy resources in the country and globally.

CONFLICT OF INTEREST

There is no conflict of interest.

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#*English translations of the references are presented.*