Application of modern energy-saving technologies and improved energy efficiency

V N Turkova¹, G G Konstantinov¹, A N Arkhipova¹, N V Kuznetsova² and R G Ardashev³

¹ Irkutsk National Research Technical University, 83, Lermontova St., Irkutsk, Russia
² Associate professor of the department of finance and financial institutions, 11, Lenina str., Baikal State University, Russian Federation
³ Siberian Law Institute of the Ministry of Internal Affairs of Russia, Krasnoyarsk, Russia

Abstract. The article defines the relevance and problems of modern society on the use of energy resources, which are to solve the problems of preventing the energy crisis by saving resources through the development and implementation of modern energy-saving technologies and energy efficiency. The authors give key ways of saving energy resources in the form of principles: replacing traditional energy carriers with alternative energy sources, the use of secondary energy resources (wind, solar, water and other energy), the introduction of energy-efficient technological processes, rationalization and assessment of the feasibility of using modern energy-saving technologies. The article also analyzes in more detail the principles of increasing energy efficiency and proposes energy-saving measures for energy-intensive industries.

1 Introduction

The rational use of energy resources is one of the most pressing and urgent problems of modern society. Leading research centres, large companies and state corporations are currently working to prevent a large-scale energy crisis that could lead to a global catastrophe. The most effective way to save resources is to develop and implement modern energy saving technologies and increase energy efficiency [2].

Energy-saving technologies are defined as all kinds of industrial and domestic processes designed to reduce the consumption of energy resources and materials per unit of output or energy source production. The energy saving process can be implemented in two ways - to reduce the consumption of traditional energy carriers by replacing them with alternative energy sources increasing the efficiency of their use [4].

Often an equal sign is put between energy saving and energy efficiency. Therefore, it should be noted that the concept of energy efficiency implies a set of characteristics reflecting the ratio of efficiency of energy resources use to the cost of obtaining these resources. The energy saving characteristics include the energy efficiency class, which reflects the degree of usefulness of a product in terms of saving energy resources [6].

* Corresponding author: nikolaevna_uri@mail.ru

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The development and implementation of advanced energy saving and energy efficiency technologies in both the industrial and domestic spheres is, among other things, a crucial step towards solving environmental problems that have never been more pressing, including global climate change, excessive atmospheric pollution and depletion of natural resources.

2 Materials and methods

The main role in increasing the efficiency of energy use belongs to modern energy-saving technologies. Energy-saving technology is a new or improved technological process characterized by a higher coefficient of efficient use of fuel and energy resources [1;5;7].

It is useful to consider the basic principles of saving energy resources (figure 1).

![Principles of saving energy resources](image)

Fig. 1. Principles of saving energy resources.

These principles are as relevant for large industrial enterprises as they are for private households. It is important to note, however, that energy saving is not only based on finding additional ways to generate energy, but also on the rational use and saving of existing resources [8].

3 Results

At present, the use of alternative energy sources is a topical issue. In most cases, renewable energy sources such as solar, water, wind and crustal energy are considered as alternatives, which can to a certain extent replace the traditional energy sources of oil, gas, coal and wood [10].

Solar energy today is used by means of solar panels and collectors. Batteries are special photovoltaic cells that convert the sun's energy directly into electricity. Collectors do not generate electric current, but rather heat the heat transfer medium, which can be used for heating water and other purposes.

Wind power plants, which generate electricity by rotating blades driven by the wind, are now used quite effectively in a number of European countries. Suffice it to say that a third of the electricity consumed in Germany is generated by wind turbines.
As an alternative energy source to water, water is not considered in terms of generating electricity in hydroelectric power plants. Experts have developed heat transfer fluids that convert the heat of lake or pool water to heat homes and provide hot water.

Another equally important energy saving factor is energy recycling. An example of the use of recycled energy is the modernization of a building's ventilation and air conditioning system, which allows a certain proportion of the heat that leaves the building to be recovered. The process is called recuperation [9]. The energy saving in this aspect is expressed in the conservation of the existing heat energy in the building [14]. The principle of the recuperate is quite simple - by means of plates with high thermal conductivity, warm air extracted from the building heats up the cold air streams coming from outside [11;13]. This means that the air that enters the building is not cold, but slightly warmed, thus reducing energy costs for heating by rationally using the available thermal energy. In addition to the plate recuperates described above, there are also other designs [14]. In particular, rotary recuperates with rotating elements and intermediate heat transfer medium are quite common. Introduction of energy efficient processes and equipment. The high importance of implementation of new energy efficient technologies is most evident in industry, construction and households.

4 Discussion

Industrial companies are more likely to adopt technologies with a significant energy saving effect. Here are the most effective energy efficiency measures (table 1) [12].

Table 1. Energy efficiency measures.

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<th>No.</th>
<th>Energy efficiency measures</th>
<th>Advantages</th>
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<tbody>
<tr>
<td>1</td>
<td>Basic technologies for industries</td>
<td>Use of heat exchangers, variable speed electric motors, compressed air, steam</td>
</tr>
<tr>
<td>2</td>
<td>Combined heat and power generation</td>
<td>Saving fuel sources and limiting CO₂ emissions</td>
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<td>3</td>
<td>The co-generation of electricity, heat and cold</td>
<td>The possibility of efficient use of recovered heat not only in winter for heating but also in summer for cooling air-conditioning systems or technological processes</td>
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<td>4</td>
<td>Replacing energy-intensive, worn-out equipment with modern, efficient devices</td>
<td>It should be noted that energy-saving modes of operation are particularly relevant for units that operate at a reduced load for a certain period of time. There are solutions to reduce energy losses during operation of industrial electrical equipment - introduction of frequency-controlled drives, use of capacitor units. Variable frequency drives with integrated energy optimisation elements, for example, enable the speed to be adapted to the actual load. This mode of operation allows reducing energy consumption by 30-50%. It is important to note that a Variable Frequency Drive (VFD) often does not require the replacement of the existing electric motor, which allows the modernisation of production without</td>
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significant costs. Currently, variable frequency drives are being actively implemented not only in industrial production facilities, but also in the housing and utilities sector.

### 5 Installation of industrial voltage regulators

Solve the electricity supply problem by replacing the worn-out power grids and outdated transformer substations that supply power to businesses.

The energy efficiency measures presented by the authors will generally increase the production processes of energy-intensive industries through a variety of energy resource applications.

The most energy-intensive industries are metallurgy, machine building and chemical industry. The technological processes in these industries are accompanied by significant energy losses arising from:

- Friction during the operation of mechanical systems.
- Excessive heat losses caused by unproductive heating of the environment.
- Power losses in the process of power transmission over long distances.
- Magnetic losses in the process of transformation of one type of energy into another.

Judging from the experience of foreign countries, the issue of technology promotion requires a comprehensive approach, improvement of existing legislation, development of legal and technical incentives, application of economic and legal mechanisms of influence on homeowners and construction companies [14]:

- Informational measures of influence not only call for the economical use of energy, but also provide specific advice on saving energy, as well as a description of the economic benefits of energy-saving technologies.
- Application by energy companies of preferential tariff grid for buildings with low energy consumption.
- According to the experience of developed countries, effective measures are the right to use tax incentives, obtain subsidies to partially cover the cost of technology implementation and loans with reduced interest rates.
- Introduction of system of control over energy consumption and bringing to responsibility for violation of established norms of buildings construction and exploitation.

### 5 Conclusion

Energy has been a part of human life since man discovered the energy of fire.

At every stage of historical development, the increasing complexity of economic activity and the desire to raise the standard of living inevitably led to a shortage of energy. It is no longer possible to imagine life without electricity. Electric power has invaded all spheres of human activity: industry and agriculture, science and space, our everyday life. It is so widespread because of its specific properties:

- Ability to be transformed into almost all other types of energy (thermal, mechanical, sound, light, etc.).
- Ability to be transmitted relatively easily over long distances and in large quantities.
- Huge speeds of electromagnetic processes; ability to crush energy and form its parameters (change in voltage, frequency).

The problem of energy and energy resources has been and remains one of the most important global problems, in the solution of which all peoples, all countries of the world are interested. Saving energy resources is an issue that is especially important today and
concerns all of us. In turn, the measures, recommendations, systematic approaches to improve energy efficiency, will save energy consumption in all industries several times.

References

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