



Actions for the greening of power engineering to improve energy efficiency

Tadeusz FIJAŁ

Cracow University of Economics, Poland

Abstract: The greening of power engineering is a component of the ecologically sustainable development strategy being implemented in the world and also a pillar of the EU sustainable energy policy. One of the main fields of activity for the greening of power engineering are actions for improving power generating and use efficiency. Such actions are implemented to improve energy conversion efficiency in power generating processes or to reduce power consumption by end-users. The effect of these actions being carried out at an international level is to reduce fossil fuel consumption, provide energy security of states as well as preventing climate change by reducing greenhouse gas emissions. The aim of this paper is to present main directions of actions for the greening of power engineering related to energy efficiency improvement, and functional principles of the basic systems supporting these activities in Poland.

Keywords: greening of power engineering, energy efficiency, white certificates

JEL codes: Q49, Q58

<https://doi.org/10.25167/ees.2018.45.9>

1. Introduction

The future of power engineering is one of the key problems in both domestic and world politics. This is connected not only with the responsibility of the energy industry for

Correspondence Address: Tadeusz Fijał, Department of Technology and Ecology of Products, Faculty of Commodity Science, Cracow University of Economics, Rakowicka 27, 31-510 Krakow, Poland. Tel.: 12 293 5366

E-mail: fijalt@uek.krakow.pl

progressive climate change on Earth, but – in the first place – with the concern for supplying sufficient energy to meet society's demand in future decades. Energy availability is a fundamental condition for civilization and economic development and long-term predictions indicate that in 2050 humanity will need 2.5 to 3 times more energy than that of 2010 (Nowicki, 2012: 19).

The development of civilization related to technological advancements and increase in energy demand causes an increasing environmental impact of energy generating processes.

The necessity to reduce these adverse effects of energy generation found its expression in the commonly well worldwide established and accepted concept of sustainable development (eco-development) proposed during the UN Conference on Environment and Development held in Rio de Janeiro in 1992.

According to the environmental protection act (Dz. U., 2017), sustainable development is a social and economic process integrating political, economic and social activities while maintaining a natural balance and persistence of the essential natural processes to guarantee that the basic needs of either particular societies and individuals are met for present and future generations.

A significant element for accomplishing this global eco-development strategy as well as a pillar of sustainable energy policy for Europe is undertaking actions for the greening of power engineering aimed mainly at reducing negative impacts of the power generation processes on the environment.

In the greening of power engineering the actions for improving energy efficiency play an important role and allow an increase in energy transformation efficiency of the energy generation processes or a reduction in energy consumption by end users to be reached.

This paper presents the main direction of activities targeted at ecologisation of the power engineering, especially those of energy efficiency improvement as well as operating rules for basic systems supporting activities for energy efficiency improvement and test results aimed at the efficiency and scope of bids for choosing energy efficiency improvement projects completed in Poland in the years 2012-2016.

2. The greening of power engineering

The power generation sector plays a special role in the economy, as national energy security depends on its proper function and performance. Products and services provided by this sector have also a major effect on other economic activities.

Unfortunately, conventional power generation systems based on coal fired power plants create a number of environmental nuisances resulting from burning fossil fuels. These nuisances include (Fijał, 2012: 2):

- greenhouse gas emissions,
- atmospheric pollution due to gas and dust emissions,
- soil deterioration through, for example, excessive soil acidification or toxic substance accumulation,
- forest decline caused mainly by the effect of SO₂ (present in the air or acidified soil),
- water deterioration and contamination due to the effect of gas and dust emissions,
- noise emission,
- electromagnetic field interactions, as well as
- landscape disturbances connected with the construction of large facilities (cooling towers, chimneys).

To reduce negative effects of the energy generation processes, currently pro-ecological global actions are being undertaken on a large scale for the greening of power engineering to have durable effects to improve environmental and human life quality and the development of societies.

The term “greening of power engineering” means a set of activities targeted at reduction of negative impact of the energy generation and consumption processes.

The greening of power engineering is imperative and a necessary condition for creating sustainable power engineering to provide the world energy and environmental security. This requires the model of energy production and technologies creating a threat to the environment to be replaced with environmentally-friendly power generation technologies, i.e. to develop a model of clean energy production, i.e. eco-energy (renewable energy).

At present these actions become a pillar of the EU environmental policy. The aims of these actions include: environmental quality improvement, climate change solution, to ensure the EU member states competitiveness, to improve energy security by diversification of energy sources, and to provide an opportunity for the growth of local communities by local labour market extension (e.g. by using dispersed energy sources based on renewable energy sources).

The basic tool of actions for the greening of power engineering are the processes belonging to the group of clean energy technologies.

Clean Energy Technologies (CET) are being implemented low- (or zero-emission) technologies targeted at radical improvement in environmental impact of power engineering.

The field of activity of Clean Energy Technologies cover:

- activities related to the energy efficiency improvement of power generating and use processes undertaken to increase energy conversion efficiency or to reduce energy consumption,
- implementation of Clean Coal Technologies (CCT), including: coal enrichment technologies, clean coal burning technologies, exhaust gas cleaning technology, geological sequestration of carbon dioxide and coal conversion into synthesis gas or liquid fuels,
- development of gas-fired power plants that use gas fuels (natural gas, biogas),
- development of renewable power generation based on renewable energy sources being an alternative to conventional non-renewable energy carriers (fossil fuels),
- use of hydrogen-containing fuel cells used to generate clean energy, wherein fuel chemical energy is directly converted into electricity (without burning and generating mechanical energy), as well as
- development of nuclear power engineering, including energy generation from nuclear fission of heavy radioactive nuclei.

The issues of clean power engineering technologies relate to a number of the EU regulations, including:

- Communication from the Commission to the Council and the European Parliament COM(2006)843 - Sustainable power generation from fossil fuels: aiming for near-zero emissions from coal after 2020 (European Commission, 2007),
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (European Commission, 2009a),
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (European Commission, 2009b),
- Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet

the Community's greenhouse gas emission reduction commitments up to 2020 (European Commission, 2009c),

- Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (European Commission, 2009d),
- Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (European Commission, 2010),
- Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (European Commission, 2012),
- Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labeling and repealing Directive 2010/30/EU (European Commission, 2017).

All regulations concerning the greening of power engineering are of great importance for developing clean power engineering technologies and fulfilling obligations resulting from the EU Climate and Energy Package.

Currently, clean power engineering technologies are being developed and implemented on a large scale in the power sector. They allow problems of local environmental pollution to be reduced to a large extent due to a significant reduction in SO₂, NO_x, CO₂ and dust emissions from coal-fired power plants.

The use of integrated technological solutions in coal power plants due to combination of coal enrichment and clean burning as well as exhaust gas cleaning technologies would enable an environmental impact of the energy generation processes to be reduced significantly.

In recent years some changes in the domestic power generation sector have been observed. This includes an increasing contribution of renewable energy sources in electricity generation and electricity production from natural gas in gas-fired power plants.

3. Energy efficiency and activities targeted to improve it

The most important Polish regulations concerning energy efficiency are:

- The Energy Efficiency Act of 20 May 2016 (Dz. U., 2016),
- The Act on support of thermal refurbishment and renovation of 21 November 2008 (Dz. U., 2008),

- The Act of 14 September 2012 on obligation to provide information on energy consumption by energy-using products (Dz. U., 2012),
- The Act of 20 February 2015 on renewable energy sources (Dz. U., 2015),
- The Act of 10 April 1997 Energy Law (Dz. U., 1997),
- Polish Energy Policy until 2030 (MG, 2009),
- National Energy Efficiency Action Plan for Poland (MG, 2014),

The Energy Efficiency Act is the principal Polish legislation act related to energy efficiency. It establishes (Dz. U., 2016):

- the rules for establishing the energy efficiency action plan,
- public sector tasks related to energy efficiency,
- the rules of obligation to make energy savings,
- and the rules for carrying out an energy audit of a company.

The Energy Efficiency Act defines energy efficiency as “the ratio of the achieved utility effect for a particular facility, technical device or plant under typical use or operating conditions to energy used by this facility, technical device or plant or as result of a service rendered necessary to bring about such effect” (Dz. U., 2016).

To achieve energy efficiency targets it is necessary to (Fijał, 2015: 32):

- generate energy savings at the stage of its generation, transmission and usage,
- to reduce fuel consumption and power demand,
- to contribute in enhancing energy security, and
- to reduce the environmental impact of power engineering by reducing pollution emissions.

Another important document related to energy efficiency is Polish Energy Policy until 2030. This comprehensive document defines strategic directions and specified targets as well as suggests activities for each target aimed at reaching energy security, environmental protection and economic development.

According to this document the targets for improving energy efficiency include (MG, 2009):

- to increase electricity generation efficiency by constructing high-performance generating units,
- to double electricity generation by using high efficiency cogeneration until 2020,

- to decrease electric power transmission and distribution losses by modernizing and constructing new networks, replacing poor efficiency transformers and developing distributed generation systems, and
- to increase the efficiency of energy use by end consumers by using energy-saving devices.

The improvement of energy efficiency should generate energy savings at the stage of its generation, transmission and use.

Another important strategic document related to energy efficiency is the National Energy Efficiency Action Plan for Poland 2014 (MG, 2014), prepared in connection with an obligation to submit reports on implementation of Directive 2012/27/UE on energy efficiency to the European Commission (European Commission, 2012).

This document includes:

- description of programs to improve energy efficiency of power lines in individual economy sectors,
- establishing a national energy efficiency target,
- information on achieved energy savings in this energy transmission, supply and use by an end consumer, as well as
- strategy for supporting building renovation containing estimated data on available energy savings due to building reconstruction or repair.

In the National Energy Efficiency Action Plan for Poland 2014, the following assumptions were set (MG, 2014):

- a policy oriented towards energy efficient economy will be continued thus reducing its energy consumption,
- planned activities relay to a maximum extent on market mechanisms and use to a minimum degree budget financing,
- targets are achieved according to the least cost rule, thus among other things, by using the existing mechanisms and organizational infrastructure to a maximum extent,
- national potential for energy efficiency improvement will be used.

The determination of energy efficiency for the year of 2020 is accomplished by Art. 3 Paragraph 1 of Directive 2012/27/EU. The energy efficiency targets for Poland set according to Directive 2012/27/UE are presented in Table 1.

Table 1. Energy efficiency targets for Poland until 2020

Year	Energy efficiency target	Absolute energy consumption in 2020	
	Reduction in primary energy consumption in the years 2010-2020 (Mtoe)	Final energy consumption in the absolute values (Mtoe)	Primary energy consumption in the absolute values (Mtoe)
2020	13.6	71.6	96.4

Source: MG, 2014: 7.

The energy efficiency target is considered as reaching the reduction in primary energy consumption by 13.6 Mtoe in the years 2010-2020 that indicates also under economic growth conditions an improvement in economy energy efficiency. This target was expressed in the absolute values of primary and final energy used in 2020.

Energy efficiency targets for Poland until 2020 were set based on the data from analyses and predictions carried out for the governmental document “Polish Energy Policy until 2030”. It follows from these analyses that the reduction of primary energy consumption will result from a number of already implemented undertakings as well as the completion of new activities targeted at energy efficiency improvement written in the national energy policy.

The main directions of the activity related to energy efficiency improvement in power engineering and other industry sectors and remaining economic areas shall include (Fijał, 2016: 128):

- modernization (or replacement) of power generation systems to improve power generation efficiency;
- modernization of heat and power distribution networks;
- reduction in power transmission and transformer losses;
- use of high-performance systems based on renewable energy sources and gas power plants;
- use of high efficiency cogeneration coal or gas-fired plants;
- modernization of industrial manufacturing plants to reduce energy intensity of manufacturing processes;
- reducing heat losses (for example, by insulating industrial plants) and waste energy recovery in industrial processes;
- implementing energy saving undertakings in companies (for instance, modernizing lighting systems by using energy-efficient devices);
- rational energy use in public and transportation utilities (for example, modernization of street lighting, use energy-saving public transport systems, use of energy-effective buildings after thermal insulation refurbishing);

- implementing energy-efficiency undertakings in administration sector connected with, among other things, the use of energy-saving office equipment; and
- activities undertaken to increase energy savings by individual energy consumers in households, resulting from the use of energy efficient lighting, domestic appliances and electronic devices.

The energy saving activities are listed in detail in Notice of the Minister of Energy of 23 November 2016 (M. P., 2016).

The main index indicating energy efficiency for heat and electricity generation processes is the efficiency of fuel energy conversion. This efficiency is of utmost importance, especially from the point of view, but also for energy use and ecology. The higher the process efficiency, the lower the fuel consumption, thus also the lower the fuel demand. This translates directly into lower operating costs and lower environmental emissions.

At the stage of energy use, the potential to increase energy efficiency is determined by the difference between “actual losses”, resulting from the managerial skills and state of the art and device operating conditions as well as financial condition of the user, and “unavoidable” energy losses determined for the state-of the art devices and processes (Fryc et al., 2012: 78).

For energy-using products, according to Directive of 2010 on the indication by labeling and standard product information of the consumption of energy and other resources by energy-related products (European Commission, 2010), and the Act of 14 September 2012 on obligation to provide information on energy consumption by energy using products (Dz. U., 2012), all energy using products must be provided with a label containing information on energy efficiency of a device and annual energy consumption.

The above requirements should encourage producers to manufacture products of high energy efficiency. These regulations should also increase enterprise innovation by stimulate them to undertake energy saving activities for their products.

4. The operating rules for activities supporting energy efficiency improvement in Poland

According to the Energy Efficiency Act of 20 May 2016, the main mechanism supporting activities related to energy efficiency improvement is the system of energy efficiency certificate (the so-called “white certificates”). The property-related rights resulting

from these certificates are traded commodities, and are transferable and can be traded at Energy Exchanges.

The obligation to obtain energy efficiency certificates and to submit them for redeeming to the President of the Energy Regulatory Office (URE), is incumbent upon (Dz. U., 2016):

- power utility companies conducting business consisting in generating or trading electrical energy, heat or natural gas and selling electricity, heat or natural gas to end consumers connected to the grid in the territory of the Republic of Poland,
- end consumers connected to the grid in the territory of the Republic of Poland being a commodity exchange member or a member of the market organized by an entity acting in a regulated market on the territory of the Republic of Poland regarding transactions concluded on its own account or in the market organized by this entity,
- end consumers connected to the grid in the territory of the Republic of Poland, who are members of an exchange clearing house with respect to transactions concluded outside of commodity exchanges or a regulated market, and subject to clearing carried out by such a clearing house by a company that runs an exchange clearing house through the Central Securities Depository of Poland,
- end consumers connected to the grid in the territory of the Republic of Poland, who import natural gas for inter-Community acquisition or for their own use, and
- a commodity brokerage house with respect to transactions concluded in a commodity exchange or in a market organized by an entity running a regulated market on the territory of the Republic of Poland, by order of end consumers connected to the grid on the territory of the Republic of Poland.

Each of these entities is obliged to obtain and submit an energy efficiency certificate expressed in tons of oil equivalent (1toe = 41.868 GJ) to the President of the URE for redeeming or to pay a substitution fee that in 2017 is 1500 PLN per ton of oil equivalent. Revenues earned from substitution fees add funds to the account of the National Fund for Environmental Protection and Water Management that participates in co-financing pro-ecological activities, including those related to energy efficiency improvement (Fijał, 2016: 129).

According to the Energy Efficiency Act, the means for improving energy efficiency include (Dz. U., 2016):

- implementing and financing an energy efficiency support activity,

-
- acquiring an appliance, plant or vehicle of low energy consumption and low operating costs,
 - replacing an appliance, plant or vehicle with an appliance, plant or vehicle of low energy consumption and low operating costs,
 - acquiring or renting an energy effective building or its parts that meet at least the minimum energy saving and thermal insulation requirements,
 - implementing thermal insulation refurbishing in the meaning of the act on support of thermal refurbishment and renovation of 21 November 2008, and
 - implementing an environmental management system that meets the EU eco-management and audit scheme (EMAS), confirmed by an entry in the EMAS register.

Any completed activity or activities of the same type for improving energy efficiency and gaining final energy savings expressed in tons of oil equivalent must be confirmed by an energy efficiency audit.

The Energy Efficiency Act defines an energy efficiency audit as “a study containing an analysis of energy use and establishing technical condition of the facility, technical device or plant, including a list of activities supporting energy efficiency of the facility, technical device or plant, as well as an evaluation of its profitability and energy saving opportunities” (Dz. U., 2016).

In practice an energy efficiency audit contains the description of energy efficiency support activities and its location, an assessment of technical condition for a facility, technical device or plant and an analysis of:

- energy consumption by the facility, technical device or plant,
 - planned energy savings from uncompleted energy efficiency improvement activities,
or
 - results of completed energy efficiency improvement activities.
- The entities obliged to obtain and submit an energy efficiency certificate are also obliged to document final energy savings gained in each calendar year.

For an end consumer the documentation containing their declaration regarding the completion of projects in support of energy efficiency and obtained final energy savings along with an energy efficiency audit carried out to confirm the obtained energy savings, is submitted to an energy utility company that sells energy to this user.

The power company that obtained such a declaration with an energy efficiency audit submits this documentation to the President of the URE.

The gained final energy savings due to completed energy efficiency support projects are confirmed by an energy efficiency certificate issued by the President of the URE. The obtained certificates are equivalent to acquiring property-related rights with respect to projects completed by the given entity.

The procedure hitherto applicable for awarding energy efficiency certificates is carried out according to the requirements of the previous Energy Efficiency Act of 2011 (Dz. U., 2011).

According to the Energy Efficiency Act of 15 April 2011, the President of the URE selects energy efficiency support projects for which energy efficiency certificates can be obtained by tenders carried out at least once a year.

The tender is carried out separately for the following energy efficiency support activities (BIP URE, 2014):

- increasing energy savings by end customers,
- increasing energy savings by own use,
- decreasing electricity, heat or natural gas losses in transmission and distribution systems.

An entity that submits to the President of the URE the properly filled out tender declaration along with an energy efficiency audit carried out for energy efficiency support projects defined in this declaration can participate in this tender.

Information on issued energy efficiency certificates along with energy efficiency audit card is published by the President of the URE in Public Information Bulletin of the Energy Regulatory Office.

The winner of the tender conducted by the President of the URE, the chosen entity, submits an application for issuing an energy efficiency certificate that confirms the declared energy savings resulting from targeted energy efficiency improvement.

In the years 2012-2016 the President of the URE announced five tenders and four of them have been completed up to now. The figures related to the offers analyzed in the tender procedures for choosing energy efficiency enhancement projects conducted in the years 2012-2015 are presented in Table 2.

The results of the tenders conducted by the President of the URE for choosing energy efficiency improvement projects enabling energy efficiency certificates to be awarded, which are shown in Table 2, are not encouraging. This refers especially to tender #1 which is characterized by a small number of submitted offers and a large number of rejected ones.

Table 2. Figures related to offers placed in tenders conducted by the President of the URE in the years 2012-2015

Announced tender	Submitted offers (pcs)	Chosen offers (pcs)	Rejected offers (pcs)
Tender #1 (2012)	212	102	110
Tender #2 (2013)	484	302	182
Tender #3 (2014)	735	502	233
Tender #4 (2015)	1120	983	137

Source: Author's own elaboration based on the URE reports on the course of the conducted tenders

The poor interest in tender #1 can be explained by the fact that some of the entities consciously decided not to participate in this tender, willing to take advantage of the experience of other participants for later use. In addition, the results of this tender indicated that the legal formal requirements for participating in a tender for choosing energy efficiency improvement projects are a significant barrier to potential system beneficiaries (Kołodziej, 2014: 44).

More than half of the offers rejected in tender #1 indicated that the conditions for participation in the tender were hard to understand for many entities (Adamczyk, 2014: 18). The most often applied prerequisites for offer rejection were: tender declaration improperly filled in, energy efficiency audit card improperly filled in, lack of data or data inconsistency, submitting projects not fulfilling conditions specified in the Act.

There was significantly increased interest of entities in consecutive tenders for choosing energy efficiency improvement projects, as indicated by the increasing number of submitted offers that reached 1120 in 2015. At the same time the percentage of the rejected offers systematically decreased in consecutive tenders, that was 38%, 32% and 12% in the second, the third and the fourth tender, respectively.

Aggregated data related to the results of tenders for choosing energy efficiency improvement projects completed in the years 2012-2016 are presented in Table 3.

Table 3. Aggregated results of tenders for choosing energy efficiency improvement projects conducted by the URE in the years 2012-2016

Announced tender	Value of energy efficiency certificates expected to be issued (toe)	Value of energy efficiency certificates applied for by winning entities (toe)	Share of awarded certificates in expected ones (%)
Tender #1 (2012)	550 000.0	20 698.7	3.8
Tender #2 (2013)	1 368 296.0	57 180.1	4.2
Tender #3 (2014)	2 179 481.0	149 886.2	6.9
Tender #4 (2015)	1 973 560.0	495 023.3	25.1
Tender #5 (2016)	1 477 956.0	Lack of data (tender in progress)	

Source: Author's own elaboration based on the data provided by the Energy Regulatory Office

A continuous increase in awarding white certificates is observed among entities in the period under consideration. It is clearly evident that the value of energy efficiency certificates of entities that won tenders increased. There is also a growing share of the value of certificates granted, in the pool of values of certificates to be issued in the tender.

The aggregated data related to energy efficiency certificates issued in the years 2013-2016 and related energy efficiency improvement projects are listed in Table 4.

Table 4. Aggregated data considering energy efficiency certificates issued in the years 2013-2016 and related energy efficiency improvement projects (as of the end of the year)

Year	Number of energy efficiency certificates issued (pcs)	Value of issued energy efficiency certificates (toe)	Total declared final energy savings within the period of energy savings (toe)	Total estimated CO ₂ emission reduction within the period of energy savings (Mg)
2013	37	6 723.63	70 089.31	444 510.98
2014	101	20 518.73	213 183.82	1 261 602.43
2015	895	226 730.33	1 600 661.72	268 900 942.26
2016	1842	702 742.02	3 268 126.00	278 830 777.10

Source: Author's own elaboration based on the data published in Public Information Bulletin of the Energy Regulatory Office

As it follows from the data presented in Table 4, there was a systematic increase in the number of issued energy efficiency certificate during the four years. The highest increase in the number of URE certificates was in 2016, when 947 white certificates were issued. Also the total value of the issued energy efficiency certificates significantly increased and in the year of 2016 it was more than 100 times the value reached in 2013.

The projects supporting energy efficiency improvement completed within the framework of these certificates allowed the entities applying for energy efficiency certificates to gain both ecological and economic advantages. The effect of energy efficiency certificate issued in the years 2013-2016 (1 842 in total) is a significant energy saving of 3 268 126 toe (136 829 899.4 GJ) and the total estimated value of CO₂ emission reduction of 278 830 777.1 Mg.

Experiences over the last years concerning the URE tenders for choosing energy efficiency improvement projects allow one to conclude that they played an important role in supporting pro-ecological activities related to energy efficiency improvement in energy production, distribution and use. The pro-ecological projects completed in connection with participation in tenders allowed final energy use as well as the carbon dioxide emission into the atmosphere to be significantly reduced.

The fifth tender announced by the President of URE on 21 September 2016 was the last tender for choosing energy efficiency improvement projects due to changes in legal conditions contained in the new Energy Efficiency Act of 2016.

The Energy Efficiency Act of 20 May 2016 cancels the obligation to conduct a tender to choose energy efficiency improvement projects by the President of the URE for which energy efficiency certificates could be obtained. Thus, this act modified the currently applicable white certificate system.

According to this new Act, obliged entities (companies selling electricity, heat or gas fuels to end customers) should (ME, 2016):

- implement energy efficiency improvement at a final customer, and
- obtain (or buy) white certificates and submit them for redeeming to the President of the Energy Regulatory Office.

In particular cases, the obligation to obtain certificates can be settled with a substitution fee, however this way will be gradually eliminated (substitution fee will apply to 20% of the obligation in 2017, 10% in 2018).

To obtain white certificates it is necessary to submit an application for energy efficiency certificate along with energy efficiency audit to the President of the URE.

This white certificate system, modified by the new Act, is a significant simplification of the energy efficiency certificate issuance procedure. Instead of tenders conducted once a year and announced by the President of the URE, applications will be collected continuously and the decision to award the energy efficiency certificate will be taken within 45 days.

Another important component of the system supporting pro-ecological activities related to energy efficiency improvement in energy production, distribution and use is a company energy audit.

This term has been introduced by the Energy Efficiency Act of 20 May 2016, following Directive 2012/27/UE on energy efficiency.

According to the Act, “company energy audit is a procedure aimed at performing detailed and confirmed calculations related to the proposed activities supporting energy efficiency improvement and providing information on potential energy savings” (Dz. U., 2016). This audit is carried out every four years.

The entity obliged to carry out a company energy audit or to order such an audit is an enterprise (excluding micro-, small- or medium-sized enterprises) which in last two years: employed at least 250 employees, annually averaged or achieved an annual net income from

sale of goods, products and services and financial operations exceeding PLN equivalent of 50 million Euro, and total assets of his annual balance sheet at the end of one of these years exceeded PLN equivalent of 43 million Euro (URE, 2016).

This obligation does not apply to enterprises that have implemented an energy management system according to PN-EN ISO 50001:2012 or an environmental management system EMAS compliant with the Regulation (EC) No. 1221/2009 of the European Parliament and of the Council of 25 November 2009, provided that a company energy audit was carried out within the framework of these systems.

According to the Energy Efficiency Act of 20 May 2016, energy audits are based on the following guidelines (Dz. U., 2016):

- the audit should be carried out on actual, representative, measurable and traceable data regarding energy consumption, and for electricity, power demand,
- the audit must contain a detailed review of energy consumption in buildings or building complexes, industrial plants and transportation that corresponds to 90% of the total energy consumption by this company,
- the audit should be based rather on life cycle cost analysis for building or built complexes and industrial plants, not on recovery period so that energy savings in a longer period, residual values of long-term investments and discount rate could be taken into account.

A company energy audit is carried out by an entity independent of the audited enterprise, having knowledge and necessary professional experience to perform such an audit, or by an expert of the audited enterprise if they are not directly engaged in the audited activity of this enterprise.

The first audit should be carried out by 30 September 2017, i.e. within 12 months from the entry into force of the Energy Efficiency Act of 20 May 2016 (ME, 2016).

When the audit has been completed, the entrepreneur notifies the President of the URE of the performed company energy audit within 30 days. This notification should be accompanied by information about possible energy savings resulting from the performed company energy audit.

The President of the URE is obliged to inform the Minister of Energy about the number of company energy audits, number of entrepreneurs who performed such audits and possible energy savings resulting from company energy audits by 31 January of the next year in which the enterprise sent in related information.

For failing to perform the obligation to carry out a company energy audit the President of the URE, by way of his decision, imposes a financial penalty that should not exceed 5% of the income gained by the penalized enterprise in the preceding tax year. When setting the amount of penalty the President of the URE considers the extent of infringements, infringement repeatability and financial capabilities of the penalized entity.

A company energy audit is an important link of the system supporting energy efficiency improvement activities. Due to such audits the company gains additional information on possible energy savings. In addition, the result of the audit can be used in analyses and inspections performed in the company.

5. Conclusion

Activities related to energy efficiency improvement in the processes of energy generation and use are an important part of projects undertaken within the framework of clean energy technologies. These activities can be implemented in various areas of the economy.

In the power sector, modernization investments are necessary to increase energy efficiency, because in Poland above 60% of the energy is produced in power blocks installed more than 25 years ago.

Energy efficiency improvement in power generation systems in the power sector and the optimization of industrial processes in other industries as well as rationalization of final energy use should bring a number of benefits, including energy savings generated at the stage of generation, transmission and use.

The system of white certificates is an important mechanism supporting activities related to energy efficiency improvement. The procedure of white certificate issuance requires energy efficiency audits to be carried out to confirm the completed energy efficiency improvement projects and to obtain final energy savings.

It follows from the study that activities related to energy efficiency improvement undertaken by power companies engaged in energy generation, electricity, heat or natural gas distribution and selling electricity, heat or natural gas to final customers and by broadly understood final energy users connected to the grid on the territory of the Republic of Poland allow to gain both ecological and economic quantifiable outcomes connected with reduction of final energy consumption and carbon dioxide emission into the atmosphere.

A company energy audit is also an important element supporting activities targeted at energy efficiency improvement. The aim of this audit is to make detailed and confirmed

calculations regarding the proposed activities for improving energy efficiency and to provide information on potential energy savings.

Within the scope of company energy audit, a detailed review of energy consumption should be carried out comprising at least 90% of total energy used by the company in connection with its business activity. This review includes energy consumption in building, industrial plants and transport.

Energy efficiency improvement in energy generation and use systems is one of the main direction of activity to reach the targets of the EU climatic and energy guidelines, including Poland. Accomplishing these guidelines requires implementation of integrated energy policy rules that indicate the need for a new industrial revolution leading to changes in energy production methods and to its effective use.

Literature

- Adamczyk, J. (2014). Znaczenie „białych certyfikatów” w poprawie efektywności energetycznej przedsiębiorstw (The meaning of „white certificates” in improving the energy efficiency of enterprises). In: Milewska E.; Żabińska I. (eds.). *Systemy wspomaganie w inżynierii produkcji - Inżynieria systemów technicznych* (Support systems in production engineering - Engineering of technical systems): 11-20. Gliwice: P.A. NOVA S.A.
- BIP URE (2014). *Zestawienie podstawowych informacji dotyczących przetargów na wybór przedsięwzięć służących poprawie efektywności energetycznej, za które można uzyskać świadectwa efektywności energetycznej z dnia 15 stycznia 2014 r.* (The compilation of basic information on tenders for choosing energy efficiency enhancement projects qualified to be awarded an energy efficiency certificate of 15 January 2014). Warszawa: BIP URE. Available at: <http://bip.ure.gov.pl/bip/efektywnosc-energetyczn/przetargi/1108,Zestawienie-podstawowych-informacji-dotyczacych-przetargow-na-wybor-przedstawie.html>. Accessed 16 June 2017.
- Dz. U. (1997). Ustawa z dnia 10 kwietnia 1997 roku - Prawo energetyczne (The Act of 10 April 1997 Energy Law) (Dz. U. 1997, No. 54, item 348).
- Dz. U. (2008). Ustawa z dnia 21 listopada 2008 r. o wspieraniu termomodernizacji i remontów (The Act on support of thermal refurbishment and renovation of 21 November 2008) (Dz. U. 2008, No. 223, item 1459).
- Dz. U. (2011). Ustawa z dnia 15 kwietnia 2011 r. o efektywności energetycznej (The Energy Efficiency Act of 15 April 2011) (Dz. U. 2011, No. 94, item 551).
- Dz. U. (2012). Ustawa z dnia 14 września 2012 r. o obowiązkach w zakresie informowania o zużyciu energii przez produkty wykorzystujące energię (The Act of 14 September 2012 on obligation to provide information on energy consumption by energy-using products) (Dz. U. 2012, item 1203).
- Dz. U. (2015). Ustawa z dnia 20 lutego 2015 r. o odnawialnych źródłach energii (The Act of 20 February 2015 on renewable energy sources) (Dz. U. 2015, item 478).

- Dz. U. (2016). Ustawa z dnia 20 maja 2016 r. o efektywności energetycznej (The Energy Efficiency Act of 20 May 2016) (Dz. U. 2016, item 831).
- Dz. U. (2017). Obwieszczenie Marszałka Sejmu Rzeczypospolitej Polskiej z dnia 10 lutego 2017 r. w sprawie ogłoszenia jednolitego tekstu ustawy - Prawo ochrony środowiska (The announcement of the Marshal of the Polish Parliament of 10 February 2017 on disclosure of consolidated text of the Environmental Protection Act) (Dz. U. 2017, item 519).
- European Commission (2007). Communication from the Commission to the Council and the European Parliament - *Sustainable power generation from fossil fuels: aiming for near-zero emissions from coal after 2020*. Brussels, 10.01.2007. COM(2006) 843 final.
- European Commission (2009a). Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Official Journal of the European Union L 140, 05.06.2009, p. 16-62).
- European Commission (2009b). Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (Official Journal of the European Union L 140, 05.06.2009, p. 63-87).
- European Commission (2009c). Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (Official Journal of the European Union L 140, 05.06.2009, p. 136-148).
- European Commission (2009d). Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (Official Journal of the European Union L 211, 14.08.2009, p. 55-93).
- European Commission (2010). Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (Official Journal of the European Union L 153, 18.06.2010, p. 13-35).
- European Commission (2012). Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (Official Journal of the European Union L 315, 14.11.2012, pp. 1-56).
- European Commission (2017). Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU (Official Journal of the European Union L 198, 28.07.2017, p. 1-23).
- Fijał, T. (2012). Possibilities for improving energy efficiency in business activity in Poland. In: Merli, R. (ed.). *Technology and Innovation for a Sustainable Future: a Commodity Science Perspective*: 1-10. Rome: Roma Tre University.
- Fijał, T. (2015). Poprawa efektywności energetycznej jako obszar działań czystych technologii energetycznych (Improvement of energy efficiency as an area of application of clean power technologies). In: Gienza, M.; Sikora, T. (eds.). *Wielowymiarowość systemów zarządzania* (Multidimensionality of management system): 29-46. Kraków: Wydawnictwo Naukowe PTTŻ.

- Fijał, T. (2016). Mechanizm wsparcia działań związanych z poprawą efektywności energetycznej warunkującą wzrost jakości ekologicznej procesów wytwarzania i wykorzystania energii (Mechanism to support activities related to improving the energy efficiency of manufacturing processes and energy use). *Research on Enterprise in Modern Economy - Theory and Practice* 2(17): 125-136.
- Fryc, E.; Kochel, Z.; Krakowiak, J.; Ziarno, R. (2012). Możliwości poprawy efektywności wykorzystania energii elektrycznej czynnej i biernej (Opportunities for improving efficiency of the use of electrical active and reactive power). *Elektroenergetyka - Współczesność i Rozwój* 1-2: 78-95.
- Kołodziej, R. (2014). Doświadczenia z pierwszego przetargu na białe certyfikaty (Experiences from the first tender for white certificates). *Energetyka Ciepła i Zawodowa* 2: 44-48.
- M. P. (2016). Obwieszczenie Ministra Energii z dnia 23 listopada 2016 r. w sprawie szczegółowego wykazu przedsięwzięć służących poprawie efektywności energetycznej (Notice of the Minister of Energy of 23 November 2016 on detailed list of activities for improving energy efficiency) (M. P. 2016, item 1184).
- ME (2016). *Efektywność energetyczna* (Energy efficiency). Warszawa: ME. Available at: (<http://www.me.gov.pl/Energetyka/Efektywnosc+energetyczna>). Accessed 18 June 2017.
- MG (2009). *Polityka energetyczna Polski do 2030 roku* (Polish Energy Policy until 2030). Warszawa: MG.
- MG (2014). *Krajowy Plan Działań dotyczący efektywności energetycznej dla Polski 2014* (National Energy Efficiency Action Plan for Poland 2014). Warszawa: MG.
- Nowicki, M. (2012). Niewyczerpalna energia w świecie wyczerpywalnych kopalin (Inexhaustible energy in the world of depletable fossils). *Pomorski Przegląd Gospodarczy* 2: 19-23.
- URE (2016). *Informacja Prezesa Urzędu Regulacji Energetyki nr 46/2016 dotycząca obowiązku sporządzenia audytu energetycznego przedsiębiorstwa, wynikającego z wejścia w życie w dniu 1 października 2016 r. ustawy z dnia 20 maja 2016 r. o efektywności energetycznej* (Information No. 46/2016 of the President of the Energy Regulatory Office on the obligation to carry out company energy audits resulting from the entry into force the Energy Efficiency Act of 20 May 2016 on 1 October 2016). Warszawa: URE.

DZIAŁANIA NA RZECZ EKOLOGIZACJI ENERGETYKI W ZAKRESIE POPRAWY EFEKTYWNOŚCI ENERGETYCZNEJ

Streszczenie

Ekologizacja energetyki jest elementem powszechnie realizowanej w świecie strategii ekorozwoju, a także filarem zrównoważonej polityki energetycznej Unii Europejskiej. Jednym z podstawowych obszarów działań na rzecz ekologizacji energetyki, są działania związane z poprawą efektywności energetycznej procesów wytwarzania i wykorzystania energii. Działania te są realizowane w celu zwiększenia sprawności przemiany energetycznej procesów wytwarzania energii lub ograniczenia zużycia energii przez odbiorców końcowych. Efektem tych działań realizowanych na płaszczyźnie międzynarodowej jest ograniczenie zużycia paliw kopalnych, zapewnienie bezpieczeństwa energetycznego państw, a także zapobieganie zmianom klimatycznym poprzez redukcję emisji gazów cieplarnianych. W artykule przedstawiono główne kierunki działań w obszarze ekologizacji energetyki związane z poprawą efektywności energetycznej oraz zasady funkcjonowania w Polsce podstawowych systemów wsparcia działań, a także wyniki badań, których celem była ocena skuteczności i zasięgu działań, związanych z realizacją w Polsce w latach 2012-2016, przetargów na wybór przedsięwzięć służących poprawie efektywności energetycznej.

Słowa kluczowe: ekologizacja energetyki, efektywność energetyczna, białe certyfikaty.

Kody JEL: Q49, Q58

<https://doi.org/10.25167/ees.2018.45.9>