A C T A U N I V E R S I T A T I S L O D Z I E N S I S
FOLIA OECONOMICA 241, 2010

*Agata Mesjasz-Lech**

ANALYSIS OF ENERGY PRODUCTION PROCESS INFLUENCE ON THE ENVIRONMENT AS THE ELEMENT OF LCA TECHNIQUE

Abstract. Increasing importance of the environmental protection in business activity has contributed to the search for an increasingly wider range of instruments aimed at analysing the undertaken pro-ecological activities. This paper presents principles of the LCA (*Life Cycle Assessment*) Method as a new environmental management method taking into account all factors affecting the natural environment. Special attention was paid to the impact of the electrical energy production on the environment, since this process is particularly burdensome to the environment. Factors related to the energy production process, among others, production raw materials, waste materials and air pollutants were analysed in statistical terms.

Key words: LCA method, energy production process, the environment, R. Gnitecka's procedure

1. LCA METHODOLOGY AS A TOOL FOR POWER-ECOLOGICAL ASSESSMENT OF THE PRODUCTS

The utility function of a product should be accompanied by all environmental impacts determined for its life cycle. The LCA analysis is a tool examining the environmental impact of the product in its whole life cycle, from the acquisition of materials, through production, usage or consumption until its recycling in the post-usage phase (Górzyński J. [2007], p. 180). This analysis allows one to assess both the consumption of raw materials and the environmental impact in the whole life cycle of a process or product (Wittmaier M., Langer S., Sawilla B. [2009], p. 1733). Although the LCA analysis focuses on environmental aspects of the product life cycle, it also constitutes a basis of the decision-making process in respect of (Górzyński J. [2007], p. 180–181):

– determining potential impacts of the product on particular elements of the natural environment in its whole life cycle,

* Ph.D., Częstochowa University of Technology.

– determining relations between the environmental impacts for the purpose of their mutual limitation,

– determining the most important areas of product improvement,

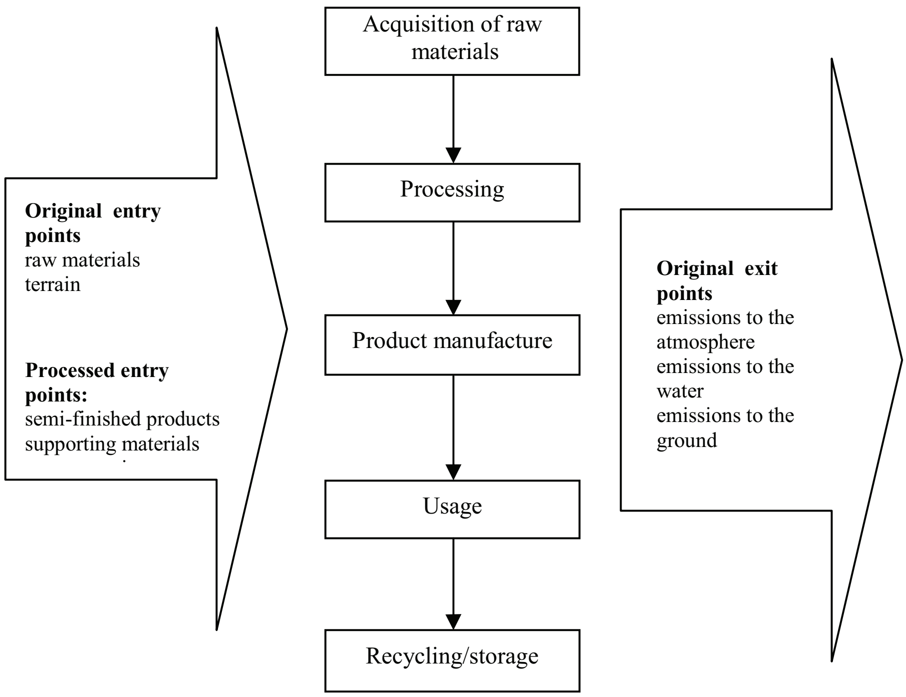
– comparing various solutions to problems related to the performance of the product utility function.

The LCA analysis is also used in systems of environmental declarations related to industrial products. A scope of research studies covered by the LCA analysis and their detail depend on the type of the problem to be solved.

The LCA analysis covers the following activities (Górzyński J. [2007], p. 181):

1. observation of the full product life cycle,
2. determination of all environmental impacts,
3. aggregation of the impacts from the viewpoint of the determined environmental impacts.

Diagram of material flows in the product system was presented in drawing no. 1.



Drawing no. 1. Diagram of flows at the product system entry and exit points

Source: Górzyński J. [2007], s. 184.

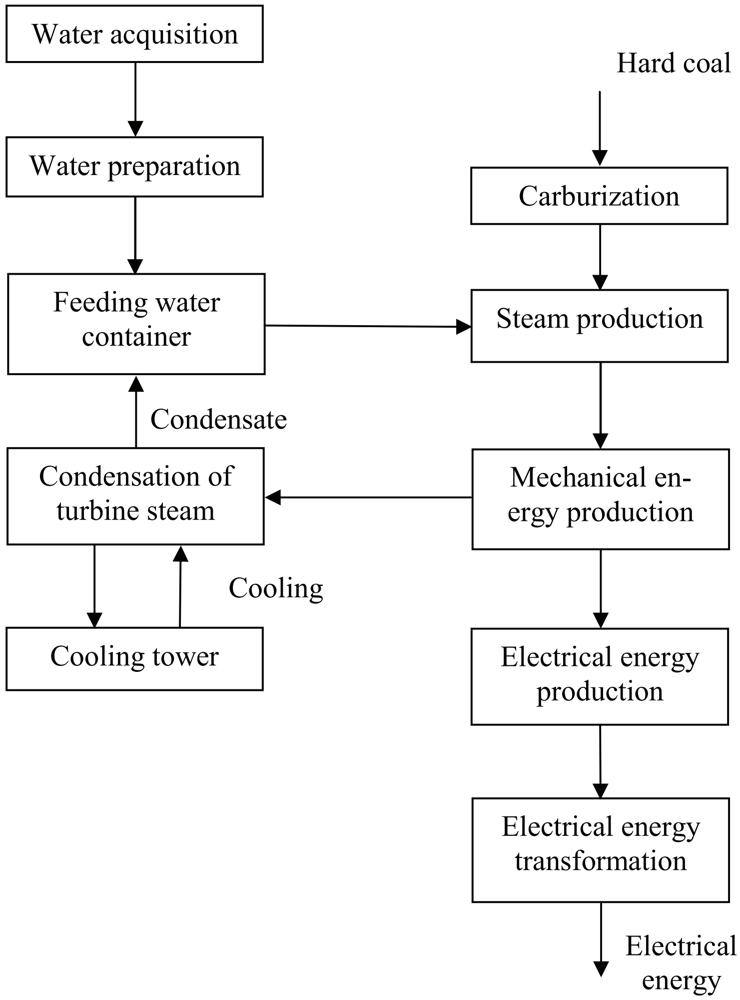
2. IMPACT OF THE ELECTRICAL ENERGY PRODUCTION PROCESS ON THE NATURAL ENVIRONMENT

The main purposes of the national energy policy and strategic directions of state activities in this area are included in the Assumptions of Energy Policy in Poland till 2020. Apart from the energy security, improvement of the energy efficiency, development of the usage of the renewable sources of energy and development of competitive fuel and energy markets, the energy sector was given environmental protection tasks consisting especially in limiting the negative environmental impact of the power engineering industry (Polityka Energetyczna Polski do 2030 roku, pp. 2–6; Założenia Polityki Energetycznej Polski do 2020 roku, p. 6). The purpose of ecological activities is in the first place to eliminate solutions harmful to the environment and to increase effective energy management. Thus these activities constitute a basis of sustainable development. All guidelines related to the state energy policy are consistent with the goals of energy policy of the European Union whose intent is to create a unified electrical energy and gas market.

One of the entities of the energy sector are thermal power stations. Thermal power stations produce electrical and thermal energy. The technological cycle of the thermal power station consists usually of (Kucowski J., Laudyn D., Przekwas M. [1997], p. 16; Laudyn D., Pawlik M., Strzelczyk F. [2000], p. 30):

- fuel cycle,
- steam cycle,
- water cycle,
- electrical cycle.

In the fuel cycle we deal with the delivery of production fuel. Since the fuel quality has an impact on the environment, the fuel cycle includes: removal and cleaning of the flue gases, removal of the fly ash caught by gas collectors, removal of slag from under the furnaces and removal of the waste materials. The steam cycle is a closed cycle refilled with additional water. The water cycle is connected with the steam cycle. It includes, apart from a cooling water cycle, a system of additional water, refilling the steam cycle and a closed cooling water cycle. The electrical cycle produces electrical and thermal energy. Diagram of electrical energy production in a thermal power plant is presented in drawing no. 2.



Drawing no. 2 Diagram of electrical energy production in a thermal power plant
Source: Górzyński J. [2007], p. 48.

Hard coal constitutes the fuel basis of traditional thermal power plants. It consists of organic matter, mineral matter and water (Kucowski J., Laudyn D., Przekwas M. [1997], p. 16). Clean organic matter, with no contaminations and water is called water-free coal, ash-free coal or coal combustible. On the other hand mineral matter and water develop the so-called ballast. Mineral matter is called ash; matter lifted in the air after burning the coal from the furnace by the flue gas is called fly ash, and matter removed in a solid or liquid state from the furnace bottom – slag. Power coal is characterized by:

– calorific value. i.e. gross calorific value and calorific value,
– humidity,
– content of combustible elements,
– ash content,
– content of sulphur and other trace elements,
– grindability.

As far as the environmental protection is concerned the following matters: calorific value, ash and sulphur content and content of the so-called trace and radioactive elements. Calorific value determines the amount of coal to be burned for the purpose of producing a specific amount of electrical and thermal energy. Ash content, on the other hand, decides on flue gas content, dustfall into the ground and content of dust suspended in the air as well as on the amount of the removed slag. Sulphur content decides on sulfating the atmosphere; content of trace and radioactive elements – on additional harmfulness of the dustfall to the ground and dust suspended in the air. After the burning of the coal, the trace elements become part of the fly ash and slag content.

In case of thermal power plants it is the fuel burning products, i.e. products coming from the fuel cycle that have the biggest impact on the environment:

– flue gas containing fly ash (dust) not caught by dust collectors,
– sulphur dioxide,
– nitric oxides, carbon monoxide and dioxide, fly ash caught by gas collectors,
– slag from under the furnace,
– waste materials and sewage from the flue gas desulphurization system.

Unfortunately hard and brown coal still constitute and will constitute the basic source of energy in the electrical energy production process (Badyda K., Lewandowski J. [2008], p. 167).

Having in mind the economic performance, one should try to achieve such a level of particular pollutants, so that the costs involved in their reduction would be the lowest and would not exceed the external costs. New pollution reduction technologies and introduction of new cleaner production systems might be helpful in this case. Besides, each polluting economic activity, including power plants, is obliged to observe the environmental protection policy rules, whose purpose is to prevent negative results of their activities.

3. ANALYSIS OF ELECTRICAL ENERGY PROCESS IN THE ASPECT OF THE LCA METHODOLOGY

The first stage of the LCA analysis consists in the determination of the goal and scope of research and the functional unit. The purpose of the research is to determine the environmental impact of the energy produced in one of power plants in the Silesian province, hereinafter referred to as the Power Plant. The scope of research includes thermal and electrical energy production process in six consecutive years. The functional unit, according to which comparisons between the particular years were made, was 1MWh of electrical energy.

Next stage of the LCA analysis consisted in the identification of all elements on the system entry and exit points affecting the environment, that is determination of resources feeding the energy production process and of the pollution emitted as a result of its implementation.

The resources include: energetic resources: coal and mazout and non-energetic resources: water. Pollution generated in the examined Power Plant has been divided into three groups:

1) gaseous air pollution (SO_2, NO_x, CO_2, CO, Cl),
2) solid air pollution (dust, Cu, Cr, Pb, F, B-a-p),
3) other waste materials (slag ashes, waste materials from the Gas Desulphurization Installation, sewage).

Data on the level of gaseous and solid air pollution emissions and on the amount of waste materials produced in relation to the production unit have been drawn up in table 1. The research period covered six consecutive years in which the pro-ecological activity of the examined Power Plant has brought first results in the form of reduced pollution.

The mount of pollution emitted by the examined Power Plant is being limited by organizational and technological methods applied since the early nineties. This results in an increasingly lower level of pollution emissions, both gaseous and solid ones. Air pollution consists mostly of gaseous pollution. It constitutes over 90% of all air pollution. Because of this, the pro-ecological activity of the examined Power Plant focused mainly on gaseous air pollution. As a result of the following activities taken for the purpose of protecting the atmospheric air:

– purchase of coal of the possibly low sulphur content,
– installation of a semi-dry method of flue gas desulphurization,
– installation of low-emission burners,
– implementation of a flue gas denitriding project,
– combined production of electrical and thermal electrical energy,

aimed in the first place at lowering the level of sulphur dioxide, nitric oxides, carbon monoxide and dioxide emissions, it was possible to reduce the overall emission of gaseous pollution in the sixth examined year by about 24% compared to the first year.

Table 1. Consumption of power and materials in the electrical energy production and emission of basic pollutants (per production unit)

		Year	6	5	4	3	2	1
Kind	Amount	Unit	Amount/ PU	Amount/ PU	Amount/ PU	Amount/ PU	Kind	Amount
Power consumption	Mazout	Mg	0.0023	0.0017	0.0019	0.0014	0.0016	0.0016
	Hard coal	Mg	0.4363	0.4275	0.4214	0.4396	0.4516	0.4524
	Total energy	Mg	0.4386	0.4292	0.4234	0.4410	0.4532	0.4540
Consumption of non-energetic resources	Water	m^3	2.3562	2.1918	2.1198	1.7660	1.7350	1.6389
Emissions to the air	dust	kg	0.1556	0.2291	0.3323	0.3789	0.3983	0.5973
	SO_2	kg	3. 9476	4.2365	4.6200	4.3739	4.9788	5.8155
	NO_x	kg	1.7937	1.8251	1.7453	1.5816	1.7013	2.0530
	CO_2	Mg	0.8568	0.8505	0.8255	0.8389	0.8501	0.8555
	CO	kg	0.2015	0.2386	0.2040	0.2316	0.2357	0.2249
	Chlorine	kg	0.0024	0.0024	0.0139	0.0461	0.0529	0.0099
	Cu	kg	5.757E–05	8.477E–05	0.0001229	0.00014	0.0001	0.00022
	Cr	kg	1.556E–05	2.291E–05	3.323E–05	3.789E–05	4E-05	5.973E–05
	Pb	kg	1.867E–05	2.749E–05	3.987E–05	4.547E–05	5E-05	7.168E–05
	F	kg	3.578E–06	5.27E-06	7.642E–06	8.715E-06	9E-06	1.374E-05
	B-a-p	kg	4.386E-06	4.222E-06	4.217E-06	4.403E-06	5E-06	5.6E-06
Emissions to the water	sewage	m^3	0.0602	0.0638	0.0508	0.0658	0.0617	0.1124
Solid waste materials	slag ashes	Mg	0.0806	0.0776	0.0865	0.0958	0.0957	0.0984
	waste materials from IOS	Mg	0.0123	0.0079	0.0081	0.0061	0.0092	0.0060

Source: author's own calculations.

As a result of the undertaken pro-ecological activities the examined power plant was able to reduce the amount of solid waste materials and sewage. In the sixth examined year the amount of produced waste materials per unit of produced electrical and thermal energy was reduced compared to the first year by 18.1% in case of slag ashes and by 46.4% in case of sewage. The amount of waste materials from the gas desulphurization installation doubled in these years – it was caused by fitting installations in the subsequent production blocks.

On the basis of collected data on the consumption of resources and pollution emission, the impact categories were identified. They correspond to recognized environmental impacts and are presented in table no. 2. Values for particular categories were calculated on the basis of indices of accumulated sustainable environmental impact available in the literature. The identified impact categories do not include all environmental impacts of the electrical energy production process. Impact of the production process on the remaining categories, e.g. the ozone hole, water and soil contamination is relatively small, and that is why these categories have been omitted.

Table 2. Selected elements of power and ecologic profile of electrical energy (per production unit)

Categories of impact		Categories of impact	5	4	3	2	1
Depletion of energetic resources	Primary energy consumption	0.439	0.429	0.423	0.441	0.453	0.454
Depletion of non-energetic resources	Water consumption	2.356	2.192	2.120	1.766	1.735	1.639
Climatic changes	Greenhouse effect	0.857	0.850	0.826	0.839	0.850	0.855
Harmfulness to the environment	Acidification	5.203	5.514	5.842	5.481	6.170	7.253
	Photochemical oxidation in the troposphere	0.195	0.210	0.227	0.216	0.245	0.285
	Environmental eutrophication	0.233	0.237	0.227	0.206	0.221	0.267
	Amount of industrial waste	0.093	0.086	0.095	0.102	0.105	0.104

Source: author's own calculations.

Primary energy consumption was defined as a full consumption of coal and mazout. In the examined period one can observe slight fluctuations in the consumption of energetic resources per one functional unit. One can observe a slight decline in the consumption of energetic resources in the sixth examined year by 3.3% compared to the first year. Unfortunately water consumption per production unit has been on a steady increase in the examined period (average annual rate of changes is 7.5%). Small differences can also be noticed in case of greenhouse effect, with a fluctuation in the examined years between 0.826 and 0.857. Greater differences can be observed in case of harmfulness of the electrical energy production process to the environment, especially:

– acidification which has been on the decrease each year by average 6.5% in the examined period,

– photochemical oxidation in the troposphere which has been decreasing each year by average 7.3% in the examined period.

In case of environmental eutrophication and amount of waste materials, the average annual rate of changes is respectively –2.8% and –2.2%.

The obtained results of the power and ecologic analysis may constitute a basis for a verification of applied methods of reducing the negative impact of the electrical and thermal energy production process on the natural environment.

4. APPLICATION OF STATISTICAL METHOD IN DEFINING THE RELATIONS BETWEEN THE ENVIRONMENTAL IMPACTS

Defining relations between the environmental impacts is one of the tasks of the LCA methodology. R. Gnietecka's procedure can be used to define such relations. This procedure allows one to identify groups of positively correlated features or strongly positively correlated features in a set of features (Kolenda M. [2006], p. 126). Thus the aim of this procedure is to assess the features in relation to their interdependence. This procedure leads to the identification of the so called "resistant aggregates", i.e. a set of stimulant features positively correlated with a synthetic variable. The features in separated resistant aggregates are generally positively correlated within the aggregate and negatively correlated with the features of another aggregate. Identification from a set of features of such groups in which the features are antagonistically correlated in relation to one another will enable one to increase the efficiency of the undertaken activities, since it will be known what negative effect will result from activities leading to the increase of values of features from one of the sets.

R Gnitecka's procedure was applied to a set of features determining particular environmental impacts of the electrical and thermal energy production process in the examined Power Plant, presented in table 1. The examination covered monthly values of particular features from the six examined years. The results were presented in table 3 and 4.

Separated aggregates meeting the condition q>0.5 were shown in table 3. The $q \in (0, 1)$ parameter defines the lower border for the first eigenvalue of the correlation matrix. Since the first eigenvalue of the matrix depends on the size of the correlation matrix the following quotient is introduced:

$$\frac{\lambda}{m} \geq q,$$

where:

λ – first eigenvalue of the correlation matrix,

m – number of features,

q – parameter from the range (0. 1).

While analyzing the data included in table 3. the following conclusions can be drawn:

– two sets of resistant aggregates were identified in a set of features defining the impact of the electrical energy production process,

– there is no strong negative correlation between the features of the first and the second group, thus features of these groups are in a neutral relationship towards one another.

Table 3. Resistant aggregates

	Cr	dust	Pb	F	Cu	SO_2	slag ashes	sewage	B-a-p	coal consum-ption	NO_x	chlorine	CO	water consum-ption	waste materials from IOS	CO_2	mazout consum-ption
Cr	1.000	1.000	1.000	1.000	1.000	0.758	0.592	0.531	0.316	0.108	0.231	0.227	0.148	–0.672	–0.608	–0.083	–0.311
dust	1.000	1.000	1.000	1.000	1.000	0.758	0.592	0.531	0.316	0.108	0.231	0.227	0.148	–0.672	–0.608	–0.083	–0.311
Pb	1.000	1.000	1.000	1.000	1.000	0.758	0.592	0.531	0.316	0.108	0.231	0.227	0.148	–0.672	–0.608	–0.083	–0.311
F	1.000	1.000	1.000	1.000	1.000	0.758	0.592	0.531	0.316	0.108	0.231	0.227	0.148	–0.672	–0.608	–0.083	–0.311
Cu	1.000	1.000	1.000	1.000	1.000	0.758	0.592	0.531	0.316	0.108	0.231	0.227	0.148	–0.672	–0.608	–0.083	–0.311
SO_2	0.758	0.758	0.758	0.758	0.758	1.000	0.495	0.407	0.454	0.357	0.431	0.091	0.241	–0.329	–0.446	0.258	–0.004
slag ashes	0.592	0.592	0.592	0.592	0.592	0.495	1.000	0.410	0.574	0.681	0.096	0.556	0.210	–0.380	–0.051	0.415	–0.229
sewage	0.531	0.531	0.531	0.531	0.531	0.407	0.410	1.000	0.396	0.383	0.236	–0.028	0.163	–0.134	–0.015	0.220	–0.124
B-a-p	0.316	0.316	0.316	0.316	0.316	0.454	0.574	0.396	1.000	0.641	0.404	0.187	0.299	–0.002	0.140	0.664	0.002
coal consumption	0.108	0.108	0.108	0.108	0.108	0.357	0.681	0.383	0.641	1.000	0.250	0.315	0.317	0.195	0.343	0.831	0.060
NO_x	0.231	0.231	0.231	0.231	0.231	0.431	0.096	0.236	0.404	0.250	1.000	–0.374	0.064	0.059	–0.131	0.329	0.018
chlorine	0.227	0.227	0.227	0.227	0.227	0.091	0.556	–0.028	0.187	0.315	–0.374	1.000	0.216	–0.347	–0.029	0.079	–0.200
CO	0.148	0.148	0.148	0.148	0.148	0.241	0.210	0.163	0.299	0.317	0.064	0.216	1.000	0.021	–0.095	0.411	0.020
water consumption	–0.672	–0.672	–0.672	–0.672	–0.672	–0.329	–0.380	–0.134	–0.002	0.195	0.059	–0.347	0.021	1.000	0.538	0.437	0.438
waste materials from IOS	–0.608	–0.608	–0.608	–0.608	–0.608	–0.446	–0.051	–0.015	0.140	0.343	–0.131	–0.029	–0.095	0.538	1.000	0.331	0.296
CO_2	–0.083	–0.083	–0.083	–0.083	–0.083	0.258	0.415	0.220	0.664	0.831	0.329	0.079	0.411	0.437	0.331	1.000	0.123
mazout consumption	–0.311	–0.311	–0.311	–0.311	–0.311	–0.004	–0.229	–0.124	0.002	0.060	0.018	–0.200	0.020	0.438	0.296	0.123	1.000

Source: author's own calculations.

The following elements were presented in table 4:

– correlation coefficient $r(U1, X_i)$ between the first main component ($U1$) and particular features in the identified aggregate,

– values of the first eigenvector (w_i) and the first eigenvalue (λ) of the correlation matrix,

– q_1 i q_2 meters constructed on the basis of correlation matrix and used for the set assessment,

– $s^2(G)$ – variance of synthetic variable G with elements g_i, where: $q_i = \frac{1}{\sqrt{m}} \sum_{j=1}^{m} x'_{i,j}$ (i = 1, 2, …, n

– objects, m – number of features, $x'_{i,j}$ – standardised values of features).

q_1 meter is calculated on the basis of the following formula:

$$q_1 = \frac{\lambda}{m},$$

where:

λ – the first eigenvalue of the correlation matrix,

m – number of features.

Its value can be approximated with by means of the arithmetic mean from a module of all elements of the correlation matrix.

The q_2 meter is the arithmetic mean of all elements of the correlation matrix, including the numbers "one" on the main diagonal:

$$q_2 = \bar{r},$$

where: $\bar{r} = \frac{1}{m^2} \sum_{i=1}^{m} \sum_{j=1}^{m} r_{i,j}$.

The last row of table 4 includes a calculation of values of meters on the basis of all features of the set. The difference between the values of q_1 and q_2 meters results from the variance of the first main component and the synthetic feature. The smaller the variance of the elements of the correlation matrix ($r_{i,j}$), the smaller the difference between the values of both meters. A big difference in the value of meters indicates a presence of distinct groups of features correlated antagonistically. Variance of the synthetic feature for the whole set (4.339) is smaller than the variance for the first aggregate (6.081), but greater than the variance of the second aggregate (2.081). Thus the diversification within a set of all features is smaller than in the first aggregate, but greater than in the second aggregate.

Table 4. Resistant aggregates – information

	AGR	R	w	lambda	q_1	q_2	V(G)
Cr	1	0.957	0.366	6.853	0.527	0.468	6.081
dust	1	0.957	0.366				
Pb	1	0.957	0.366				
F	1	0.957	0.366				
Cu	1	0.957	0.366				
SO_2	1	0.957	0.316				
Slag ashes	1	0.827	0.280				
sewage	1	0.733	0.237				
B-a-p	1	0.621	0.199				
coal	1	0.522	0.140				
NO_x	1	0.366	0.123				
Chlorine	1	0.323	0.111				
CO	1	0.291	0.099				
water consumption	2	0.259	0.593	2.113	0.528	0.520	2.081
waste materials from IOS	2	0.862	0.529				
CO_2	2	0.769	0.437				
mazout consumption	2	0.635	0.422				
For the whole set of features				7.594	0.447	0.255	4.339

Source: author's own calculations.

While ordering particular periods in relation to the level of negative impact of the electrical energy production process on the natural environment with the use of linear ordering methods, one can see that the examined months were very varied. The highest value of the synthetic meter was 0.66. the lowest one was 0.22. Assuming that the identified variables are of stimulant nature (increase in the value of a given variable indicates an increase in the negative impact on the environment), the highest values of the synthetic meter indicate periods during which the negative impact on the environment was the biggest. While analyzing the values of the synthetic meter one can notice that its highest values were recorded for the months of the first two examined years. So one can notice measurable effects of activities aimed at reducing the negative impact of the production process on the natural environment, implemented by the examined Power Plant.

5. CONCLUSIONS

The LCA methodology may support the implementation of ecological assumptions for the energy sector, and especially for electrical and thermal energy manufacturers. Its aim is to describe the environmental impact of the energy production process during the whole life cycle. Bearing in mind a fact that the energy production process is very harmful to the environment. taking pro-ecological activities by power plants constitutes an important element of their ecological policy. One of the stages of the LCA analysis is to identify streams of resources feeding the electrical energy production process and streams of pollution created as a result of its implementation. Identification of mutual relations between particular impacts is an element of the LCA analysis. Methods of statistical analysis of multifeature objects can be useful in this case. Results of conducted analyses may constitute a basis in the decision-making process with relation to a further application of current or new methods of reducing the negative impact of the electrical and thermal energy production process on the environment.

REFERENCES

Badyda K., Lewandowski J.: *Uwarunkowania rozwoju w Polsce energetyki wykorzystującej węgiel* [*Conditions of developing coal-based power engineering in Poland*], "Energetyka", March 2008

Górzyński J.: *Podstawy analizy środowiskowej wyrobów i obiektów* [*The basis of environmental analysis of products and objects*], Wydawnictwo Naukowo-Techniczne, Warszawa 2007

Kolenda M.: *Taksonomia numeryczna. Klasyfikacja. porządkowanie i analiza obiektów wielocechowych* [*Numerical Taxonomy. Classification. ordering and analysis of multifeature objects*], Publication of Akademia Ekonomiczna im. Oskara Langego in Wrocław [Oskar Lange Wroclaw University of Economics], Wrocław 2006

Kucowski J., Laudyn D., Przekwas M.: *Energetyka a ochrona środowiska* [*Power engineering vs. environmental protection*], Wydawnictwo Naukowo-Techniczne, Warszawa 1997

Laudyn D., Pawlik M., Strzelczyk F.: *Elektrownie* [*Power plants*], Wydawnictwo Naukowo-Techniczne, Warszawa 2000

Polityka Energetyczna Polski do 2030 roku [*Energy policy of Poland till 2030*], Project, version no. 2 of September 4 2008,Ministry of Economy, Warszawa [Warsaw], September 2007

Wittmaier M., Langer S., Sawilla B., *Possibilities and limitations of life cycle assessment (LCA) in the development of waste utilization systems – Applied examples for a region in North Germany*, "Waste Management", 2009, 29

Założenia Polityki Energetycznej Polski do 2020 roku [*Assumptions of Energy Policy in Poland till 2020*], Project, version no. 7 of February 15 2000, Ministry of Economy, Warszawa [Warsaw], February 2000

Agata Mesjasz-Lech

ANALIZA ODDZIAŁYWANIA PROCESU WYTWARZANIA ENERGII ELEKTRYCZNEJ I CIEPLNEJ NA ŚRODOWISKO NATURALNE JAKO ELEMENT TECHNIKI LCA

Wzrost znaczenia ochrony środowiska w działalności gospodarczej przyczynił się do poszukiwania coraz szerszego instrumentarium służącego analizie podjętych działań proekologicznych. W artykule przedstawiono podstawy techniki LCA (*Life Cycle Assessment*) jako nowej techniki zarządzania środowiskowego uwzględniającej wszystkie czynniki wpływające na środowisko naturalne. Szczególną uwagę zwrócono na oddziaływania procesu wytwarzania energii elektrycznej na środowisko, gdyż proces ten jest szczególnie dla niego uciążliwy. Analizie statystycznej poddano czynniki związane z procesem wytwarzania energii, m. in. surowce produkcyjne, odpady, polutanty powietrza.

Słowa kluczowe: technika LCA, proces wytwarzania energii, środowisko naturalne, procedura R. Gniteckiej.