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The Role of Eco-Inovation in the Energy

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Abstract: *The immediate effect of energy consumption on environment quality is its deterioration. Gas and dust emissions, as products of coal, mazut (heavy fuel oil) or natural gas combustion, continually pollute the atmosphere and have a global effect on climate changes, ozone damage, acid rains, disappearing of sensitive ecosystems, etc. This, directly or indirectly, brings about pollution of soil and fresh water, since energy life cycle begins with mines, oil and gas deposits, and ends with mechanical operations, heating and cooling with the restoration of thermal energy back into the atmosphere. In order to anticipate these negative processes, it is necessary to conduct an array of eco innovations in the entire life cycle of final energy. What this paper will show, on the example of communally-industrial energetics, is methodology of research and realization of eco innovations, as well as assessment of effects on improvement of energetic efficiency, quality of the environment and human life.*

Keywords: *eco-innovation, energy, product life cycle, environment, sustainable development.*

1. INTRODUCTION

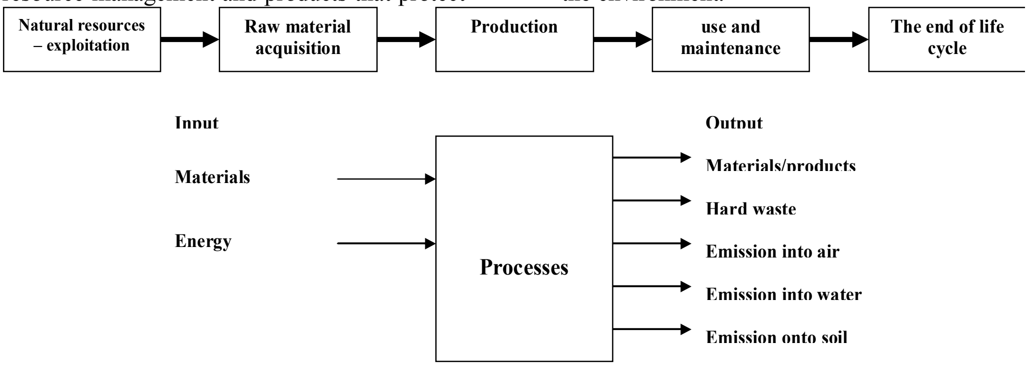
In its announcement on climate changes, the EU Committee has concluded that 50% reduction of greenhouse gas emissions will in the future be accomplished thanks to the improvement of energetic efficiency. All the Member States of the European Union have committed to developing sources of energy that do not emit greenhouse gases: “green” electric energy, biofuels, etc. They have already developed plans for saving energy in key sectors. To accomplish this, the EU has initiated a program, CIP ECO-INNOVATION. The core of this program are eco innovations. What they represent is best illustrated by the following definitions:

(1) Creating new precious competing goods, processes, systems, services and procedures, designed to meet human needs and provide better quality of life for everyone, with the minimal use of natural resources during the life cycle (materials, including energy and land area) per highway unit, and with minimal scattering of toxic substances (the 2008 definition).

Improvement in resources and energetic efficiency is one of the focal points of eco innovations.

(2) Eco-Innovations (OECD and EU experts – 2005):

Consistent activities producing goods and services for measuring, protection, limitation, minimization and correction of damage done to water, air and soil, as well as services related to problems of waste, noise and ecosystems. This includes pure technologies, products and services that reduce the risk to the environment and minimize pollution and resource exploitation. Thus, goods and services are classified into four categories: pollution management, pure technologies and products, resource management and products that protect the environment.



Graphic image 1. Product life cycle evaluation

2. RESEARCH ON ECO-INNOVATIONS IN INDUSTRIAL ENERGETICS

Eco-innovations research encompasses the entire product life cycle, in this case thermal energy, used for heating, and as energy in production processes, with the input being a primary energy-generating product, brown coal, and output being the use of thermal energy. The stages of thermal energy life cycle are:
- Natural resource: brown coal mine (extraction of the mineral – shaft/surface dig)
- Primary energy-generating product acquisition: grinding, separation, drying, storage
- Distribution and transport: to the industrial power plant
- Production: generating thermal energy
- Distribution and transport: to buildings/ apartments/houses in the city
- Use and maintenance: the use of thermal energy during the heating season
- The end of life cycle: heated buildings/ /apartments/houses (release of heat into the surroundings)

2.1 EXTRACTION OF THE MINERAL – BROWN COAL, AND PRIMARY ENERGYGENERATING PRODUCT ACQUISITION

The analysis of the effect that brown coal mines have on the environment has established the following ecological problems:

- consumption of energy from unrenewable sousrces (electricity, oil).
- formation of waste-rock depots, and land occupation
- carbon dust
- methane and carbon dioxide emission
- waste water from mines

The proportions of this impact can be seen from chart tables 1, 2, 3 and 4:

Name of mine	CO_2		CH_4	
	m^3/year	t/ year	m^3/ year	t/ year
Senjski	0,00	0,00	0,00	0,00
Jelovac	0,00	0,00	0,00	0,00
Strmosten	0,00	0,00	0,00	0,00
Soko	1.090.540	1.657.882	1.835.107	1.024.055
Jasenovac	438.665	666.772	0,00	0,00
Štavalj	1.286.668	1.995.736	0,00	0,00
Pljevlja	*n.p.	n.p.	n.p	n.p.
Banovići	n.p.	n.p.	n.p.	n.p.
Đurđevik	n.p.	n.p.	n.p.	n.p.
Totally:	**2.815.874**	**4.320.390**	**1.835.107**	**1.024.055**

*n.p. – data not available

Table 1. The amount of mines that emit gases into the atmosphere during the year

2.2. TRANSPORTETION OF BROWN COAL TO THE INDUSTRIAL POWER PLANT

The research of the effect that brown coal transportation, mainly via road and railroad, has on the environment, has given the following negative effects: consumption of a unrenewable natural resource (oil), exhaust fumes emission (CO_2, CO, NO_x , particles, etc.), motor oils leaking onto the soil, pollution with tire particles due to pneumatic tire wear, and noise.

The distance from the mine to the power plant is between 100 and 430 km.

Element*	Surface mining		Underground mining	
	Alkaline water	Acidic water	Alkaline water	Acidic water
pH	7,6	6	7,7	6
Fe	1.520	45.700	410	135.000
Mn	820	17.700	76	4.900
Sb	6	-	2	2,5
As	3	210	5	23
Be	2	23	-	12
Cd	14	28	14	6
Cr	42	187	49	30
Cu	20	150	14	82
Pb	2,9	323	72	51
Hg	1,09	1,3	0,7	0,51
Ni	115	2.020	57	400
Se	6	17	3	34
Ag	13	-	-	5
Ti	2	2	184	1
Zn	80	6.620	56	510

* Harmful and dangerous elements are given in μg/l (EPA, US 1981/96)

Table 2. The average content of hazardous elements in coal mining water deposits

Type of fuel	Brown coal
Lower thermal power - Nd	(13.000 - 16.000) kJ/kg
Granulation	(0 - 15) mm
Humidity - Wu	(15 - 25) %
The amount of ash	(15 - 25) %
Totally sulfur	<2 %

Table 3. Requested properties of brown coal in the energy

2.3. GENERATING THERMAL ENERGY (THE FINAL ENERGY)

The process of generating thermal energy itself is very complex and dependent on multiple factors:

- coal quality and preparation
- the sort of the boiler, and of the combustion process
- process automation degree
- atmosphere factors

Generating combustion acquired thermal energy is followed by numerous ecological issues: carbon dust and self-ignition of coal in storage, emission into the air (smoke gases, flying ash particles), mercury (Hg) emissions – smoke gases, ash, disposal of large quantities of flying ash and cinder (25-30 thousand tons a year), waste waters, noise, and other highly severe ecological problems.

2.4. TRANSPORTATION OF THERMAL ENERGY TO FINAL CONSUMERS

In this part of life cycle, there are no direct problems related to the environment. However, the losses of thermal energy during transportation and distribution are high, thus the system requires additional quantities of energy. This increases the negative effect on the environment in the previous phases. Heat losses in the distribution network are 40% of the energy delivered to the power plant.

2.5 Building (apartment, house) heating

The focus of research is directed towards heating in buildings (apartments, commercial buildings) and industrial companies. It has been established that the key ecological problem is the enormous consumption of thermal energy. Namely, buildings and factory halls were not built according to modern standards, so little attention was paid to energetic efficiency.

Year	burn coal (t/year)	ash (t/ year)	noburn coal (slag) (t/ year)	ash emissions (t/ year)
1989.	**211.500**	**63.450**	**6.345**	**3.173**
1990.	**221.200**	**66.360**	**6.636**	**3.318**
1991.	**181.800**	**54.540**	**5.454**	**2.727**
1992.	**140.700**	**42.210**	**4.221**	**2.111**
1993.	**127.400**	**38.220**	**3.822**	**1.911**
1994.	**96.400**	**28.920**	**2.892**	**1.446**
1995.	**148.200**	**44.460**	**4.446**	**2.223**
1996.	**100.000**	**30.000**	**3.000**	**1.500**
1997.	**130.000**	**39.000**	**3.900**	**1.950**
1998.	**152.000**	**45.600**	**4.560**	**2.280**
1999.	**114.000**	**34.200**	**3.420**	**1.710**
2000.	**112.206**	**33.662**	**3.366**	**1.683**
2001.	**117.400**	**35.220**	**3.522**	**1.761**
2002.	**80.400**	**24.120**	**2.412**	**1.206**
2003.	**81.800**	**24.540**	**2.454**	**1.227**
2004.	**78.100**	**23.430**	**2.343**	**1.172**
2005.	**92.400**	**27.720**	**2.772**	**1.386**
2006.	**89.000**	**26.700**	**2.670**	**1.335**
2007.	**78.000**	**23.400**	**2.340**	**1.170**
2008.	**78.000**	**23.400**	**2.340**	**1.170**
Total	2.430.506	665.702	72.915	36.458
Annual Averages	121.525	33.285	3.646	1.823

Table 4. Quantity of coal, ash in the energy in the period of 1989. until 2008.

3. INNOVATIONS AND THE INCREASE OF SYSTEM ENERGETIC AND ECO-EFFICIENCY

What is considered here is a group of innovations that are to be realized in the entire product life cycle. A developed study has shown the necessity of the following innovations:

- compulsory filtration of mine waste waters,
- methane combustion in mines for acquiring thermal and electric energy,
- improvement of brown coal preparation in mines in the purpose of boosting the quality of energy-generating products,
- focusing on nearest coal mines and railroad transportation,
- homogenization of stored coal in the purpose of equaling its quality,
- production of commercialized products made of combustion by-products (ash, cinder)

- sulfur disposal, by introducing technologies for coal desulphurization,
- removal of Mercury (Hg) from by-products of combustion (smoke gases, ash),
- introducing pretreatments for process waste waters,
- building modern depots for ash and cinder storage, and sanitation of the existing,
- reconstruction of distribution network and substations and/or building new ones
- reconstruction of existing buildings, primarily by installing insulation of outside walls, window and external door replacement, terrace adaptation,
- new building construction according to EU standards, with the compulsory certification from the aspect of building's energetic features
- automation of energy production and consumption management,
- installing cogeneration systems on all available boilers of the power plant (raising energetic efficiency by over 30%, increase of ecological efficiency)
- the use of renewable sources of energy (biomass, solar energy) for power plant requirements, and for hybrid energy systems in buildings (central heating, thermal solar energy, passive solar energy, etc.)

The application of stated innovations during a reasonable time span achieves the following:

- high energetic efficiency of the entire system (not only of the power plant or the building, as it has been the custom),
- high ecological efficiency of the entire system (the framework of this paper does not allow further elaboration),
- high economic efficiency of heating systems,
- natural resource preservation (brown coal supplies),
- production of significant amounts of electric energy (for city and industry requirements),
- energetic dependency reduction (import of energy-generating products)

However, the Study has also initiated a discussion on further strategic orientations in Power Plant development:

(1) Transition from brown coal to natural gas as primary energy-generating product (ecologically more efficient, transportation costs are drastically reduced, but thus becoming dependent on import).

(2) Introduction of pure coal technologies (ecologically efficient, leading to development of production side programs, with its own resources, high investments, safe future).

(3) Development of city heating distributed system (a number of smaller heating stations – mainly on natural gas, with insignificant losses in energy distribution, and with the building being provided with electric energy through cogeneration).

(4) Construction of individual heating systems – a variety of energy-generating products (a building, a private home), as a preparation for mass application of hydrogen energy.

(5) Mass application of all renewable sources of energy with their combining (heating, electric energy) and/or in combination with traditional energetic resources.

4. CONCLUSION

The analysis of the entire life cycle of final energy, from mineral extraction (coal, lignite, etc.), all the way to the ending of its life (a heated room, performed services), gives us a complete image of the state of its energetic and eco efficiency. A partial approach, most often applied to final energy analysis only relating to the processes in a power plant, does not provide a complete image of energetic and ecological features. For instance, both energetic and ecological parameters of final energy production in a power plant can be on a very high level, with production parameters of primary energy-generating products and those of final energy consumption being very low. This paper accentuates the entire life cycle and eco-innovation research during the entire final energy life cycle (with the example of thermal energy acquired through coal combustion). Thus, with the realization of researched eco-innovations in mines, oil fields, natural gas findings, and then on, in the transportation of primary energy-generating products, production and distribution of final energy, and finally, with the application of a group of eco-innovations by the energy consumers (materials, the product, processes, the use of products), what is accomplished is an essential effect in the field of energetic and eco efficiency. This way, the responsibility for natural resources, environment and planet Earth preservation is spread onto all the members in the chain of final energy production and consumption.

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