Environmental impact assessment of heating power plant in Trebišov, Slovakia

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Abstract. Environmental impact assessment is well known and often used process in all developed countries. This process identifies, estimates, assesses and provides information on negative and positive effects of the proposed project on the environment and health, and specifies in detail the measures to mitigate the possible negative effects before approving the project and its implementation. The assessment is done for at least two alternatives of the proposed activity in comparison with a zero alternative if no activity is done (present state is kept). In this paper proposal of heating system for Trebišov town in Slovakia is presented and the best alternative is chosen comparing environmental impacts of three alternatives. Evaluation was done using the method of the total indicator of environmental quality. Construction of biomass-fired power plant seems to be the best solution of heating for selected locality.

1. Introduction

Cardiff summit in 1989 created the platform of coordinated action aimed at protecting the environment. The European Commission has progressively focused its attention on the development and integration of environmental aspects into the sectorial policies of transport, energy, industry, agriculture, industry, internal economic policy and fisheries. The first step was decision taking of the first integration strategy in the energy sector adoption in 1999, which was modified in 2001 and presented in Gothenburg, Sweden before the European Council.

Another important document presented by the European Commission was "Green Paper on a secure, competitive and sustainable energy for Europe" [1], which was released in 2006. The aim of the EC was to create an integrated energy policy in Europe. In December 2008 a wide range of measures in the EU were adopted, which were aimed to reducing the impact of the EU states activities to global warming and also reducing negative effects on the global climate, while ensuring adequate and reliable energy supply.

To pursue these goals within a coherent long-term strategy, the EU has formulated targets for 2020, 2030, and 2050. The 2020 Energy Strategy defines the EU's energy priorities between 2010 and 2020. It aims to [2, 3]: reduce greenhouse gases by at least 20%, increase the share of renewable energy in the EU's energy mix to at least 20% of consumption, and improve energy efficiency by at least 20%.
This paper is based on legislative and methodological documents relating to the assessment process of environmental impact – Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 [4]on the assessment of the effects of certain public and private projects on the environment (the Environmental Impact Assessment, or EIA Directive)[4] and exactly Act No. 24/2006 Coll. on Environmental Impact Assessment [5] – national Law in Slovakia. The proposed

activity is construction of new biomass-fired power plant or reconstruction of old one gas power plant in Trebišov town district in Slovakia. The result of the research is a comparison of the proposed activities with the current state of the area using the total indicator of environmental quality method.

2. Material and Methods

2.1 Multicriteria analysis

The In the EIA process is always necessary to consider at least two alternatives of the proposed action: I) zero alternative – if there is no activity (current state of the environment) and II) alternatives of the proposed activity – variants of the activity that usually differ in locality (site of construction), used technology, time of implementation, etc.). The purpose should be to find the optimal solution, in practice a choice called "preferred option". The selection of the optimal alternative is enjoyed by various methods, particularly by multicriteria analysis [6].

Summary quality of the environment for the geographical regions is determined, by substantial (cardinal) properties of the individual components of the environment, the quality of which we can assess by the available analytical and diagnostic indicators. These partial indicators can create a catalog of indicators criteria (character) whose values are precisely determined analytically using the scientific bases of prognosis or experimental estimation [7].

Total indicator of environmental quality (*TIEQ*) method is used to determine the value of the most suitable variant of power plant construction in Trebišov town district.

Total indicator of environmental quality (*TIEQ*) method is used to determine the value of a comprehensive land use in terms of humanly influenced environment quality.
It is calculated according to (1):

$$TIEQ = U_j = \sum_{k=1}^{n} f_j\left(P_j^{(y)}\right) W_j^{(N)} \quad (1)$$

Where U_j is function of benefit, P_j is criterion, W_j is weight [7]. *TIEQ* structure is hierarchical, adaptive and allows to select the preferred option of a conventional set of alternatives or to give a preferential position of alternatives to a given set of criteria.

2.2 Power plant in the study area

Environmental impact assessment of the proposed activity – power plant for heating in Trebišov town in Slovakia according to Act 24/2006 Coll. as amended was implemented.
A brief description of the technical and technological solution is following. The central energy source of heating for Trebišov town has two possibilities:

- biomass-fired power plant;
- natural gas boiler.

Technological solution of biomass-fired power plant consists of boiler house, a handy storage of straw and technical annex. Individual objects are connected structurally and technologically. Objects of power supply are located in the northern part of the plot [8, 9, 10].

Atmospheric natural gas fired water tube boilers are used in old central boiler houses. These boilers using the combustion gas transfers the heat to the primary heat exchanger, which heats the heating water and consequently the water is cooled to about 120 °C. Then from the primary heat exchanger water is distributed to the secondary circuit and through pipes to the heated objects. At the secondary circuit is installed a heat meter which measures the heat consumption [11] [12]. Convention boilers are designed to produce dry combustion products. These products reach a temperature of 120 °C to 180 °C. The lowest temperature of the water entering the boiler is 60 °C.

3. Results

The assessment is made in two alternatives which are assessed in comparison with zero alternative:

- Alternative 0 – the zero alternative– if no activity is implemented.

- Alternative 1 - the environmental impact assessment of the biomass-fired power plant in Trebišov district.
- Alternative 2 - the environmental impact assessment of the modernized natural gas boiler.

Comparison of alternatives of proposed activity and the proposal of optimal alternative is based on multicriteria method. The first step of this evaluation is creating a set of criteria and determining their importance (weight) for the selection of the optimal alternative. We have defined a totally of nine criteria, which we have divided into four groups according to their character – economic, technical, ecological and social (table 1).

Table 1. Catalogue of criteria.

Criteria / Pi	Alternative 0 / A0	Alternative 1 / A1	Alternative 2 / A2
Total costs of construction/P1	0 € / 9 points	3 800 000 € / 3 points	2 600 000 € / 8 points
Costs of operation per year /P2	0 € / 8 points	535 000 € / 6 points	650 000 € / 5 points
Time of construction/P3	0 months/ 10 points	9 months/ 2 points	3 months/ 8 points
Land occupation/P4	0 m^2 / 8 points	1,981.65 m^2 / 3 points	1,249.35 m^2 / 6 points
Energy output of the boilers/P5	0 MW/ 0 points	14.01 MW/ 9 points	10.03 MW/ 8 points
Waste production/P6	no / 8 points	yes / 5 points	yes / 4 points
Emission production/P7	0% / 7 points	0% / 7 points	6.5% / 6 points
Job opportunities/P8	0 / 0 points	8 / 9 points	6 / 7 points
Extra boiler room construction/P9	yes / 0 points	no / 8 points	no / 8 points

For evaluation and comparison of the alternatives, the sets of nine criteria were established. The selected criteria are divided into qualitative and quantitative ones. A quantitative criterion includes the total cost of construction, annual operation costs, time of construction, land occupation and output of the power plants. A qualitative criterion includes waste production, emissions production, job opportunities and extra boiler room construction.

Under the category of technical and technological perspective three criterions belongs and under environmental and social two criteria belongs.

The ranking method was used to state the weights of criteria. The points (0-10) associated with each criterion were stated based on ten different experts' suggestions with the aim to get the most objective results.

4. Conclusion

The use of biomass in heating systems is beneficial because it uses agricultural, forest, urban and industrial residues and waste to produce heat and electricity with less effect on the environment than fossil fuels.

The ranking method was used to state the weights of criteria. The points (0-10) associated with each criterion were stated based on three different experts' suggestions with the aim to get the most objective results. In this evaluation the highest score is the best possible. Proposals were discussed with professionally qualified persons working in the field of environmental impact assessment as well as civil engineers.

Total indicator of environmental quality (*TIEQ*) was used for determination of the best alternative for heating system in Trebišov town. Using multicriteria analysis prove that the construction of biomass-fired power plant is the most suitable solution chosen from three assessed variants (no activity is implemented, biomass power plant and modernized gas boiler).

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