

# CARBON FOOTPRINT METHOD - A CASE STUDY FOR THERMAL POWER PLANTS IN REPUBLIC OF SERBIA

<sup>1,2</sup>University of Niš, Faculty of Mechanical Engineering, Niš, SERBIA

**Abstract:** There are many methods for the analysis of the negative impact of thermal power plants on the environment. In this paper will be presented a method Carbon footprint. Carbon footprint originated from the Ecological Footprint and independently developed. This method is one of the newer methods. By defining this method the goal is to raise the awareness of citizens about pollution. This method can be applied in other areas, not only in terms of the power plant. Carbon footprint is based on the definition of greenhouse gasses through carbon dioxide equivalent. From there the name of this method Carbon footprint. In this paper, is done research how the work of thermal power plants that use coal as fuel affect emissions. Was analyzed the operation of thermal power plants that use fossil fuels because in the Republic of Serbia the most electricity is obtained from these plants.

**Keywords:** carbon footprint, carbon dioxide, coal, thermal power plants, emission factor

## INTRODUCTION

The tendency of increasing emissions of greenhouse gasses leads to the long-term goal of establishing control of environmental impacts caused by climate change. The carbon footprint has become a widely used concept in emissions assessments [1].

The term carbon footprint is used for greenhouse gas emissions and is generally expressed as CO<sub>2</sub> equivalents (CO<sub>2</sub>e), which consists of emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. These gasses are translated into the amount of CO<sub>2</sub> (this is called the equivalent amount of CO<sub>2</sub>). It is a measure of the total amount of carbon dioxide in the atmosphere in a given time frame which is directly or indirectly transmitted. Carbon footprint helps us to determine the amount of emissions from various sectors, which is useful for quantifying the impact of human activities on the environment and global warming. In the postindustrial era, the concentration of carbon dioxide in the atmosphere is increasing alarmingly.

It is necessary to strive to reduce CO<sub>2</sub> emissions from all sectors but with special emphasis on the reduction of CO<sub>2</sub> emissions from the power plant sector. Approximate values of CO<sub>2</sub> emissions along with few major greenhouse gasses are referred as Carbon Footprint.

Carbon Footprint is a concept which is yet in developing stage. Carbon footprint as an indicator of the environment is used. Carbon footprint quantifies the main sources of emissions and represents an effective tool for environmental protection and energy management.

In the case of thermal power plants the equation to calculate the carbon footprint is [2]:

$$\text{Carbon footprint (tons CO}_2\text{/year)} = \text{Yearly electricity consumption of the plant (MWh/year)} \times \text{Emission factor (tons CO}_2\text{/MWh)}.$$

It is necessary to strive to reduce CO<sub>2</sub> emissions from all sectors but with special emphasis on the reduction of CO<sub>2</sub> emissions from the power plant sector. Approximate values of CO<sub>2</sub> emissions along with few major greenhouse gasses are referred as Carbon Footprint. Carbon Footprint is a concept which is yet in developing stage. Carbon footprint as an indicator of the environment is used. Carbon footprint quantifies the main sources of emissions and represents an effective tool for environmental protection and energy management.

## ANALYSIS OF CARBON FOOTPRINT FROM THE THERMAL POWER PLANTS IN REPUBLIC OF SERBIA

In the Republic of Serbia, the installed power capacity for electricity production is 8 359 MW [3]. Eight power plants with 25 blocks that use lignite as a fuel and the installed capacity of 5.171 MW, two of these power plants are located in Kosovo and Metohija. Cogeneration plant with a total installed capacity of 425 MW of electricity generation, 505MW for the production of thermal energy. From 1 June 1999, the Electric Power Industry of Serbia does not manage its capacity in Kosovo and Metohija.

The energy sector in Serbia has some characteristic weaknesses that contribute to high energy consumption and high emissions of CO<sub>2</sub>. These disadvantages are low efficiency due to outdated technology in the sectors of production and consumption, high losses in electricity distribution. In order to reduce CO<sub>2</sub> emissions is necessary to implement a project that will examine what is possible to improve the thermal power plants to reduce emissions of CO<sub>2</sub> and then put into practice these tests. Any minimal reduction of this gas would bring great benefits to air quality.

Table 1 shows the production of electricity for 2014 by months.

Table 1. Produced electricity by month for the 2014 year from the power plant Nikola Tesla A and B, Kolubara, Morava and Kostolac [3]

The produced electricity in GWh for the 2014 year					
Month	Nikola Tesla A	Nikola Tesla B	Kolubara	Morava	Kostolac
January	1028	847	109	47	
February	968	750	95	48	
March	1005	859	87	53	
April	931	639	65	52	
May	368	335	17	56	
June	440	364	3	18	
July	537	418	11	65	
August	459	415	0	31	
September	510	645	0	0	
October	549	749	23	22	
November	504	757	19	62	
December	550	745	30	35	
In total	7849	7523	459	488	4132

On the basis of the Report on operations for 2014 was obtained data on the total quantity of electricity in thermal power plant Kostolac and it amounts to 4132 GWh. In addition, to calculate the amount of carbon footprint from thermal power plants, it is necessary to know the value of the emission factor. The emission factor is different for each thermal power plant.

Based on the research that has been shown in [4] values for carbon dioxide emission factor for thermal power plants Nikola Tesla A and Nikola Tesla B were used and that values are shown in Table 2.

Table 2. Carbon dioxide emission factor

Power plant	The mean value of CO <sub>2</sub> emission factor [kg CO <sub>2</sub> /kWh]
Nikola Tesla A	1,16
Nikola Tesla B	1,09

Due to lack of data on the mean value of CO<sub>2</sub> emission factor for others power plants in the Republic of Serbia, a value 1.15 [kg CO<sub>2</sub> / kWh] was used. Based on the known production of electricity and the value of CO<sub>2</sub> emission factor can be calculated the carbon footprint of power plants whose values are shown in Table 3 and Figure 1.

Table 3. Carbon footprint from thermal power plants for the 2014 year

Termoelektrana	Carbon footprint [t CO <sub>2</sub> /year]
Nikola Tesla A	9 104 840
Nikola Tesla B	8 200 070
Kolubara	527 850
Morava	561 200
Kostolac	4 751 800
Ukupno	23 145 760

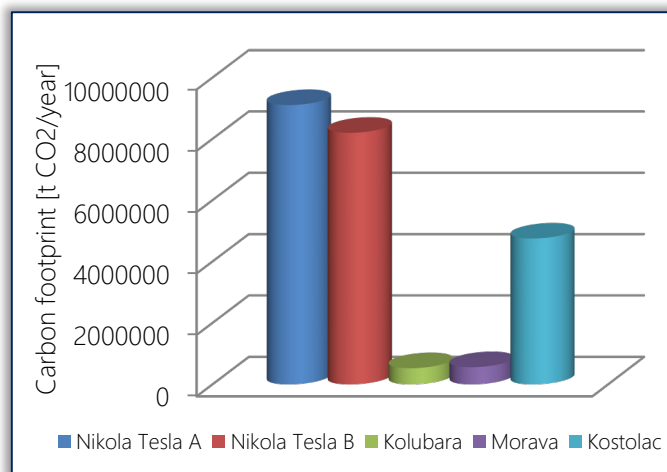


Figure 1. Carbon footprint from thermal power plants for the 2014 year

From the table above, and the Figure 1 can be concluded that the thermal power plants Nikola Tesla A and B produce the greatest amount of CO<sub>2</sub> e. The reason is that these plants are the biggest producers of electricity in the Republic of Serbia. It is necessary to improve individual systems in these thermal power plants in order to reduce the overall pollution which they produce. These thermal power plants constantly improve their systems and have environmental protection projects. Projects that are currently open in thermal power plants Nikola Tesla are [5]:

- » reconstruction of electrostatic precipitator
- » improvement of the system for transport and disposal of ash and slag
- » construction of desulphurization and reduction of NO<sub>x</sub> primary measures
- » continuous measurement of emissions of hazardous and harmful substances in the blocks
- » eliminating the negative impact of waste on land and water
- » reduction of the impact of ash on the environment

In addition to these projects carried out within the thermal power plant Nikola Tesla with the goal of reducing greenhouse gas emissions and reduce the impact on global warming from the energy sector is necessary to implement and renewable energy sources for electricity production.

## CONCLUSIONS

Fossil fuels are closely related to environmental pollution. It pollutes environmental on the direct or indirect way by using fossil fuels in the exploitation, processing, or their consumption. The threat of global warming requires more efficient technologies for the use of fossil fuels and other sources of energy that do not produce carbon dioxide. The environment can be protected using various measures and methods.

In this paper a method Carbon Footprint is presented. Carbon footprint has appeared as a strong and popular indicator of greenhouse gasses with special emphasis on carbon dioxide. This method confirms that the power plants are big polluters

and that the work of thermal power plants using fossil fuel impacts negatively on global warming.

Discussed the specific case of the Republic of Serbia because there most of the electricity is produced from fossil fuels. This study found that in the near future must be more intensive work on the modernization and improvement of electrostatic precipitators and systems for gas emissions in order to reduce the negative impact.

As shown methods Carbon footprint is directly related to the production of electricity. People are becoming more dependent on electricity, which will cause the increase in capacity for the production of electricity and with that increase, if we continue with this trend, there will be an increase in carbon dioxide emissions. It is necessary to consider the application of alternative energy sources. In order to maintain climatic conditions, it is necessary to continue to invest in energy-efficient systems that make better use of energy.

#### Note

This paper is based on the paper presented at 13th International Conference on Accomplishments in Mechanical and Industrial Engineering – DEMI 2017, organized by University of Banja Luka, Faculty of Mechanical Engineering, in Banja Luka, BOSNIA & HERZEGOVINA, 26 – 27 May 2017.

#### References

- [1] Andri et al. Environmental performance assessment of retrofitting existing coal fired power plants to co-firing with biomass: carbon footprint and emergy approach, Journal of Cleaner Production 103 (2015) 13-27
- [2] Chrysi Laspidou et al., Carbon Footprint Calculation Of Desalination Units In Greece, Fresenius Environmental Bulletin, Volume 21, No. 8b, January 2012
- [3] www.eps.rs, accessed on 2017-03-25.
- [4] Marković et al., Determination of the Specific Carbon Dioxide Emission Factor from Thermal Power Plants Nikola Tesla A and B, Full Papers Proceeding of International Conference "Power Plants 2014", 28-31.October, 2014, Zlatibor Serbia, ISBN 978-86-7877-024-1
- [5] www.tent.rs, accessed on 2017-03-26



ISSN: 2067-3809

copyright © University POLITEHNICA Timisoara,  
Faculty of Engineering Hunedoara,  
5, Revolutiei, 331128, Hunedoara, ROMANIA  
<http://acta.fih.upt.ro>