LCA Case Study: Solid Recovered Fuel for Energy Sector in Declining Coal Region Part II: Replacement of Coal Within the Regional Energy Strategy

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Introduction

The energy sector in Europe suffers an inevitable transition. The goals of the European Commission are met in several regions, while other regions, especially the coal and post-coal ones, find it critically difficult to contribute to set goals in due time [1]. The need to utilise any non-fossil resources is great, but economic and environmental reasons often stand against it. The Moravian-Silesian region (MSK – Moravskoslezský kraj), Czech Republic, is a post-coal region where, until now, the energy mix is dominated by coal and gases from coal-processing/utilising facilities, while the nuclear energy source is missing.

In 2020, 30371.8 TJ of heat energy and 3583.9 GWh of electric energy were generated in the MSK region. With approximately 70%, the major share of energy production is in fossil resources [2]. A specific share of energy generation per utilised energy source is presented in the graphs in Figure. 1.

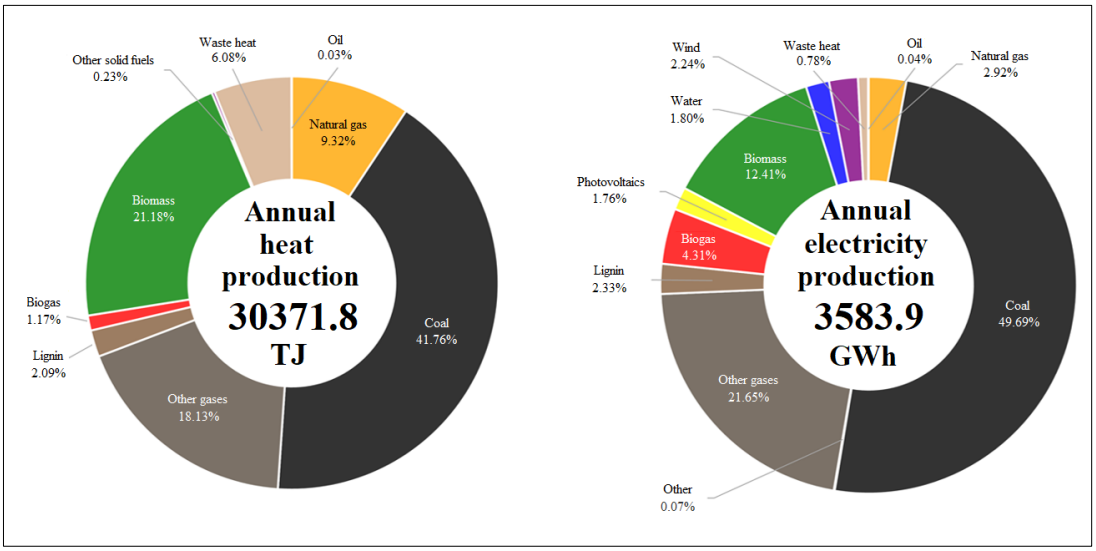

Figure 1. Annual production of heat and electricity with respect to sources.

In the MSK region, solid recovered fuel is being produced in large quantities by OZO Ostrava a.s. company. This fuel has declared properties, such as the lower heating value equal to 19.1 $MJ \cdot kg^{-1}$ or moisture content below $8\%_{wt.}$ [3]. The waste-to-energy (WtE) approach has defined values of gross energy efficiency to be ranging between 25 and 35% and heat energy to be ranging between 70 and 91%. The yearly amount of the possible produced energy from solid recovered fuel (SRF) in the MSK region is equal to 7234 TJ of heat (in the region) and 1191 GWh of electricity (23.82% and 33.23%, respectively, in the region) [2].

Materials and Methods

LCA analysis

The impact of coal replacement by SRF within the regional energy mix was determined by Product Environmental Footprint – PEF 3.0 method, using the OpenLCA software with inventory dataset databases of EF 3.0, ELCD and Ecoinvent 3.8. A total of 29 environmental categories were monitored. The boundaries of the LCA analysis include transportation of this material within 100 – 200 km distance (EURO truck) from the place of production to the place of utilisation and the energetic utilisation itself. The functional unit is 1 ton of SRF.

Considerations

-The considered SRF incineration model was based on incineration models of the individual compounds: plastics (general), untreated wood, paper, textile and inert.

-The EF database was utilised for heat and electricity production.
-The environmental footprint of the SRF production is dealt with in Part I of this study.
-Four scenarios were selected:

Scenario A) MSW incineration in WtE with a maximum of 5 and 50% of estimated electricity and heat production, respectively;

Scenario B) MSW incineration in WtE with a maximum of 10 and 60% of estimated electricity and heat production, respectively;

Scenario C) Production of SRF from MSW and the following utilisation as secondary fuel in a combined heat and power production facility with a maximum of 15 and 70% of estimated electricity and heat production;

Scenario D) Production of SRF from MSW and the following utilisation as primary fuel in a combined heat and power production facility with a maximum of 30 and 90% of estimated electricity and heat production;

Results and discussion

The results of the Environmental footprint analysis define the most crucial categories affected by the application of SRF in the energy mix of the MSK region. Those categories are “Climate change”, “Acidification”, “Ecotoxicity, freshwater”, “Particulate matter”, “Eutrophication marine”, “Eutrophication terrestrial”, “Land use”, “Photochemical ozone formation – human health”, and “Resource use, fossils”. The overall footprint for heat and electricity production was $1.75 \cdot 10^5$ and $1.09 \cdot 10^5$, respectively.
The graph of the Climate change indicators for heat and electricity production is shown in Figure. 2.

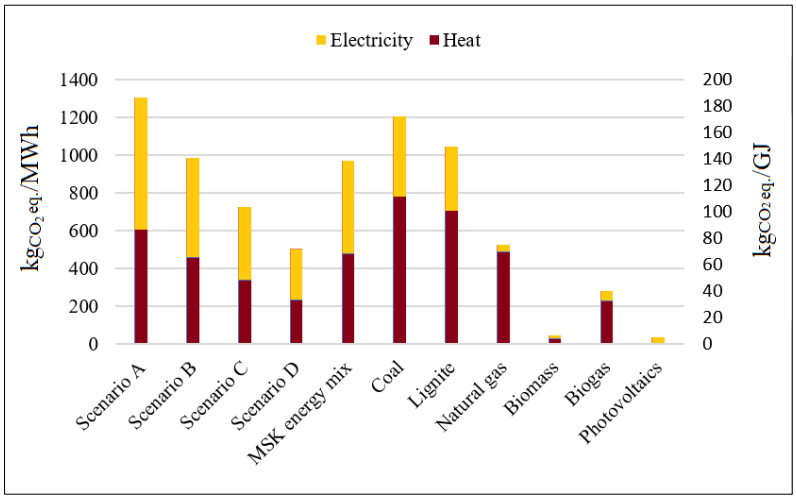

Figure 2. The Climate change indicator connected to electricity and heat production in MSK region.

From Figure 2 it is obvious, that from the climate change indicator perspective, only Scenario A appears to be worse than the original MSK energy mix, while scenario B is similar, and scenarios C and D significantly better.

Conclusion

In this study, the LCA analysis was applied on replacement of fossil resources by solid recovered fuel utilisation within the energy mix of the Moravian-Silesian region, Czech Republic. The presented results show the possible footprint of such replacement, considered in four different WtE approaches within the boundaries of the region.

The most positive scenario, with respect to the Climate change indicator, is the full application as a primary fuel in the combined heat and power production facility with a maximum of 30 and 90% of electricity and heat production. Then, the climate change reduction could be expected to reach 35.7%, while in the case of the Carbon footprint indicator, it could be up to 40.5% for the same scenario.

References

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