ffLCA Case Study: Solid Recovered Fuel for Energy Sector in Declining Coal Region
Part I: Environmental Burden of Solid Recovered Fuel Production

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Introduction

Coal is still dominant energy source in many regions. In EU there are 31 regions of 11 countries which are still strongly dependent on coal mining and utilisation, while only 10 countries are coal-free, which is relative in terms of continental electricity grid. Coal is responsible for 20% of total electricity production on the continent, and an intensive transition towards its elimination is expected [1]. In the continental and regional perspective, renewable energy sources and nuclear sources are expected to replace coal in the following period. However, fuel from waste materials is one of possible ways of transition as well.

Waste management through energy utilisation brings benefits in reducing the waste fraction and avoiding landfilling of energy rich materials, which cannot or only hardly be recycled/reused. The solid recovered fuel (SRF) can be considered partly renewable as it contains, apart from plastics, spent paper, cardboard, wood, and textiles. SRF is a high-quality municipal- and industry-derived fuel, often certified, with declared moisture content, heating value, granulometry, and other parameters evaluated in laboratory. Its heating value usually ranges from 22 to 26 MJ·kg^{-1} while moisture is below 30%$_{wt.}$., but, usually, it is much lower. According to the EN 15443, SRF with net calorific value ≥25 is classified as class 1 SRF [2].

The production of SRF requires advanced technology production line, providing various treatment steps, such as sorting of unsuitable particles, dewatering, shredding, grinding, sieving, homogenisation, etc. Sometimes, pelletisation may be applied as well, in order to increase the energy density and avoid operation obstruction [3]. The application of SRF in energetics is possible in many viable ways, such as combustion and co-combustion in cement kilns, fluidised bed combustion units, gasification in fixed, or fluidised bed, and pyrolysis. Moreover, it is possible to include such material in the alternative production of hydrocarbon substances[4]. The production of SRF for energy sector can grow rapidly. In this study, the life cycle analysis is applied on the commercial production of SRF in the Moravian-Silesian region (MSK – Moravskoslezský kraj), Czech Republic. The application of the specific SRF into the energy mix of post-coal MSK region is included in the Part II.

Materials and Methods

SRF preparation

The SRF fuel is produced by OZO Ostrava a.s., the greatest waste collecting and utilising company in the MSK region. The composition of this SRF slightly varies throughout the season and with specific demands of customers. The considered average lower heating value is equal to 19.1 MJ·kg^{-1}. The range of individual fractions within SRF and the actual fraction used for the purposes of this study are summarised in Table 1.

Table 1. SRF composition.

		Plastics	Paper (+cardboard)	Wood (furniture)	Textile	Inert (non-ferrous)
Usual range	[%$_{wt.}$]	35–70	20–40	0–35	0–30	0–10
In this study	[%$_{wt.}$]	35	15	35	10	5

The energy demand was calculated from real equipment and their consumption. Primary and secondary shredder, magnetic separator for ferrous materials, vibrating feeder, air sorter for fine particles, PVC optical separator, conveyor system for inter-operational transport, filtration equipment, and ball sorter. The heating of individual segments is also included in the energy consumption scheme.

LCA analysis

The environmental burden is identified through Product Environmental Footprint – PEF 3.0 method, using the OpenLCA software with inventory dataset databases of EF 3.0, ELCD and Ecoinvent 3.8 with total of 29 environmental categories. The boundaries of the LCA analysis include separation of waste material in the sorting area, transportation of this material within 100 – 200 km distance (EURO truck), treatment of the waste material and its transformation into certified SRF. Functional unit is 1 ton of SRF.

Results and discussion

The overall power demand of the SRF production was equal to 0.04–0.06 MWh·t^{-1}. The determined Environmental Footprint of the specific SRF production is equal to 0.05 EF3.0 per ton, while overall annual amount of 515 Mt of produced SRF is considered. From the achieved results it is evident, that the most significant impact can be expect in the category “Climate change”, also named “Carbon footprint”, forming approximately 78% of the overall environmental impact.

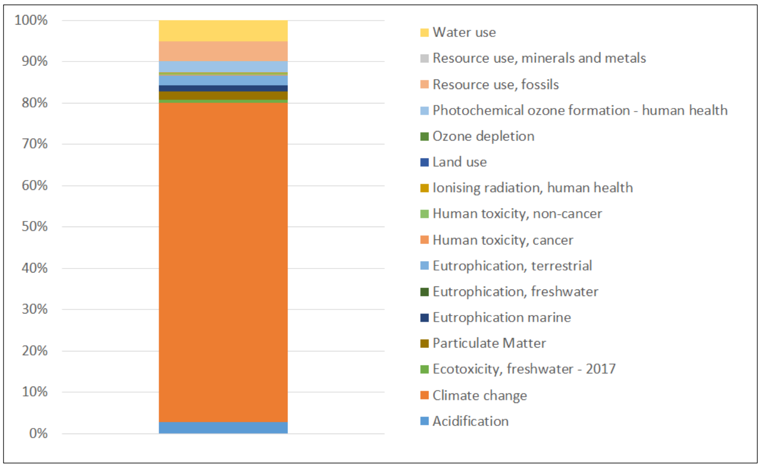

Figure 1. Impact of individual categories on the environment.

The item most responsible for the climate change is the plastic material (77.2%), followed by wood (13.5%), bituminous coal (3.1%), transportation (to the production line and the end-user) (2.1%) and synthetic gas (1.6%).

Conclusion

In this study the LCA analysis was applied to the production of SRF from the municipal/industrial waste of Moravian-Silesian region. PEF 3.0 characterisation method was applied for determination of the Environmental Footprint. OpenLCA software with inventory dataset databases of EF 3.0, ELCD and Ecoinvent 3.8 was utilised. The results showed that climate change is the most affected category by the SRF production. The share of clime change impact was 78% out of which, the production of plastic materials is the most significant impact in this category (77.2%).

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