LCA of the Pork Value Chain in Germany – Case Study of a German Slaughterhouse

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Abstract

The production of pork is a global environmental challenge, especially given its status as the most widely consumed meat (Benton et al., 2023; Statista, 2023). The research project SPECK aims to conduct a comprehensive life cycle assessment of pork production in Germany, the fourth-largest pork producer in the world (FAO, 2023). This case study specifically focuses on the environmental impacts of producing pork halves at a slaughterhouse. The results for the impact categories of Global Warming Potential, Acidification, and Eutrophication are consistent with existing literature (Dorca-Preda et al., 2021; González-Garcia et al., 2015; Reckmann et al., 2013). Notably, slaughterhouse waste significantly impacts all categories. Furthermore, the production and use of heat and power also contribute significantly to Global Warming Potential and Acidification.

Keywords: Slaughterhouse, Pig, Agriculture, Waste, Meat

Introduction

The production of meat presents a significant global environmental challenge (Benton T. et al., 2021). Pork meat needs to be addressed specifically because it is the most widely consumed meat globally (Statista, 2023). To comprehensively assess the environmental impact, closely examining the complete value chain, including factory farming, slaughter, processing, and distribution, is essential. The SPECK research project aims to address this aspect by conducting a life cycle assessment of various value chain stages in pork production in Germany, which is ranked as the fourth-largest pork producer (FAO, 2023).

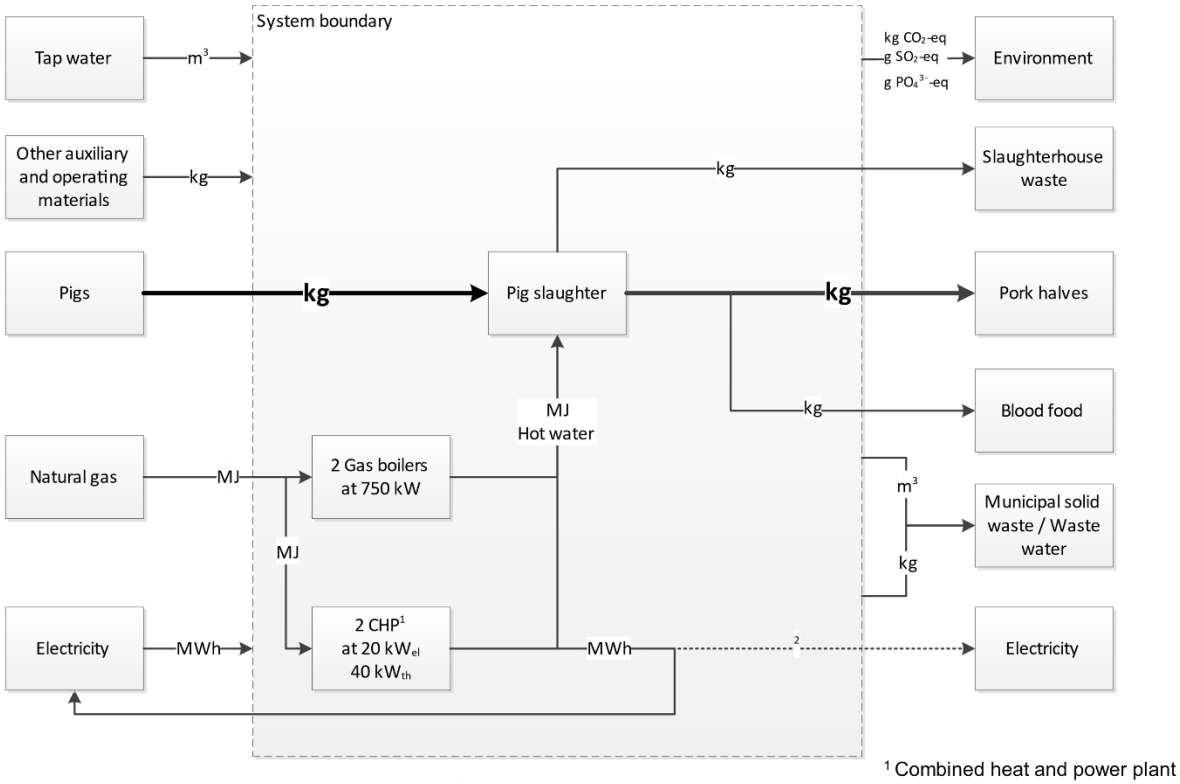
The presented case study focuses on the production of pork halves at a slaughterhouse and aims to determine the underlying environmental impacts. The slaughterhouse primarily processes organic animals, primarily pigs, but also bovine and sheep. Considering the mixed input of different animal species, the study specifically analyzes the environmental impacts associated with pork production, accounting for 75% of the overall operation.

Materials and Methods

Considering ecological evaluation techniques, the life cycle assessment approach is commonly used to identify and quantify the environmental impacts of

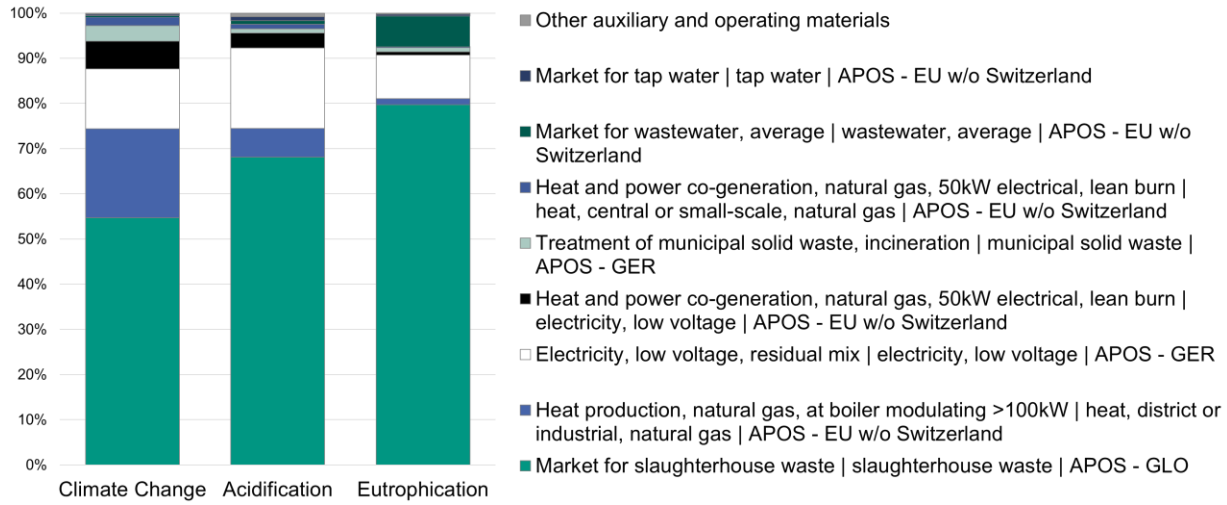
production processes. Regarding the acceptance and tangibility of LCA, the use case is evaluated by this method.
The goal of the study is to determine the most influential impact factors by identifying and visualizing the ecological influences of the process. Therefore, the system boundaries, as displayed in Fig. 1, were identified. These include all the processes that take place inside the slaughterhouse and contribute to the functional unit of 1 kg carcass weight (see Fig. 1: pork halves). This functional unit is chosen consistently with the literature (Dorca-Preda et al., 2021; González-Garcia et al., 2015; Reckmann et al., 2013).
Regarding the inventory, the study applies to the reference flow pork as an output. Besides this product flow, there are several auxiliary flows like intermediate flows and elementary flows considered. Those are energy flows like electricity, raw materials and supplies like natural gas and workwear as inputs, and emissions and waste flows as outputs. The blood food flow is treated with physical allocation, representing approximately 0.3% of the mass fraction of the products. The processes inside the slaughterhouse are the slaughter process and the heat and power generation. Following the inventory, it's obvious that the key aspects of the life cycle assessment of the

Figure 1: System Boundaries of the Slaughterhouse



[1] Combined heat and power plant
[2] The electricity produced by the CHP plant fed into the grid is negligible according to the operator of the slaughterhouse, hence, it is outside the system boundaries.

Figure 2: Results of the LCA with relative representation of the influences



internal processes should be focused on the electric and thermal energy provision. The basis for the life cycle inventory and impact assessment builds on the data of the database ecoinvent in version 3.9.1 calculated with the open-source software OpenLCA.

For the impact assessment in alignment with the obligatory steps, three impact categories are selected according to literature findings (Dorca-Preda et al., 2021; González-Garcia et al., 2015; Reckmann et al., 2013). These categories are climate change, acidification, and eutrophication with their associated category indicators, namely global warming potential, eutrophication potential, and acidification potential, based on the characterization model of the CML-IA baseline method.

Results

The results are 0.313 kg CO_2-equivalent for climate change, 0.51 g SO_2-equivalent for acidification, and 0.68 g PO_4^{3-}-equivalent for eutrophication. Krieter et al. (2013) calculated a global warming potential of 0.21 kg CO_2-equivalent, acidification of 0.3 g SO_2-equivalent and eutrophication of 1.9 g PO_4^{3-}-equivalent, while Dorca-Preda et al. (2021) state the global warming potential with 0.2 kg CO_2-equivalent, the acidification with 0.3 g SO_2-equivalent and the eutrophication with 0.0 g PO_4^{3-}-equivalent in their study from 2016. The results of the presented study can be fitted into an understandable range of these results.

The contributions of the individual processes shown in Figure 2 display an enormous impact on the specific waste flow of slaughterhouse waste. For GWP and acidification, energy production and supplies generate a considerable impact. Focusing on eutrophication wastewater treatment has a recognizable influence.

Conclusion

Compared to similar studies, the results of the impact categories in this case study could be located in a justifiable range. The impact of slaughterhouse waste is significant. Hence, the underlying data must be examined when interpreting the results. Furthermore, energy use is a great influence

caused by the energy intensity of the necessary process steps.

Acknowledgments

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