Manufacturers' data vs. literature data - a comparison of LCI and LCA results for wood-burning residential heating systems

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Introduction

Life Cycle Assessment (LCA) can help to improve the sustainability of products. The quality of LCA results depends on the quality of life cycle inventory (LCI) data. However, in LCA practice secondary LCI data sources are often used where primary data would be appropriate, but are not available.

Objective

Using the example of wood burning residential heating systems, this study compares the effects of using either furnace manufacturers' (= primary) data, or ecoinvent (= secondary) data in foreground modeling. **Three approaches** are compared:

1. **Secondary data only**: Unmodified ecoinvent data are used for foreground data, both for combustion emissions and equipment bills of materials.

2. **Hybrid primary/secondary data**: Selected combustion emissions (CO, NOx and particulate matter (PM)) and complete bills of materials are sourced from heating equipment manufacturers; other combustion emissions are retained from the ecoinvent database.

3. **Primary data only**: Only bills of materials and emission data from manufacturers are used in foreground modeling, but no ecoinvent data.

Methods

The assessment was done for a **log wood stove** (8 kW_{th} nominal power) and a **wood pellet boiler** (20 kW_{th} nominal power). Primary data were collected from two manufacturers, one for the stove and one for the boiler. Manufacturers' primary data were checked for completeness and plausibility. The bills of materials for production of the stove and boiler (Tables 1 and 2) vary in depth of detail, but both account for at least 95% of the total weight. For secondary data and upstream processes, the ecoinvent database versions 3.4, as integrated in the software GaBi version 8.7, were used [3], [4].

Tab.1. Main materials for log wood stove – primary data vs secondary data

Log wood stove		
Material	Manufacturer information	Ecoinvent data
Soapstone	*132 kg*	-
Steel	*63 kg*	*104 kg*
Cast iron	*40 kg*	-
Mineral wool	*6 kg*	*2 kg*
Fireclay	*6 kg*	-
Concrete	-	*0.059 m³*
Glass fiber	*2 kg*	-
Glass ceramic	*1 kg*	-
Aluminium	*1 kg*	-
Misc. polymer materials (different)	*1 kg*	-
Electronic	*1 kg*	-

Tab.2. Main materials for pellet boiler – primary data vs secondary data

Pellet boiler		
Material	Manufacturer information	Ecoinvent data
Steel	*335 kg*	*500 kg*
Cast iron	-	*12k g*
Mineral wool	-	*5 kg*
Fireclay	*7 kg*	-
Concrete	-	*6 m³*
Ceramic panel	-	*90 kg*
Aluminium	-	*0.2 kg*
Copper	-	*6 kg*
Polyethylene granules	-	*1 kg*
electric motor	*24 kg*	-
Electronic	*10 kg*	-

Results

Table 1 and 2 give an overview of the **LCI data** for the materials included in the production of the log wood stove and the pellet boiler. More than 10 different materials are listed by the manufacturer for the log wood stove, but fewer for the pellet boiler. Emissions of CO, NOx and PM were measured during the operation phase. Ecoinvent emission data are much more detailed, with 38 different pollutants in its datasets for both stove and boiler.

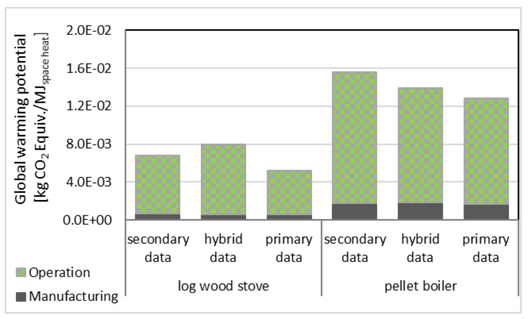

Fig. 1. LCA results climate change GWP 100: stove and boiler – comparison of the three approaches

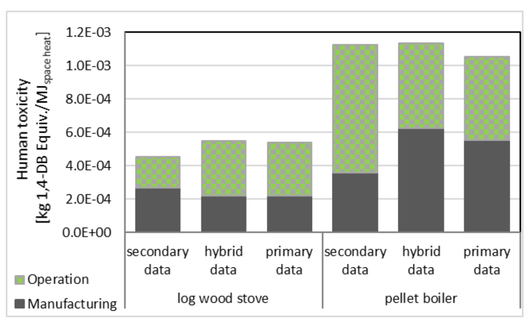

Fig. 2. LCA results human toxicity HTP: stove and boiler – comparison of the three approaches

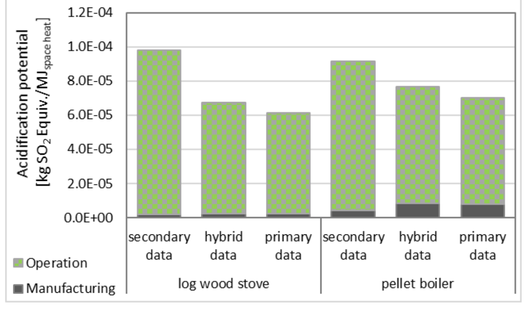

Fig. 3. LCA results acidification potential AP: stove and boiler – comparison of the three approaches

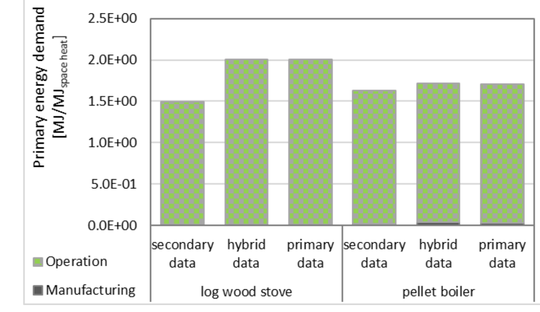

Fig. 4. LCA results primary energy demand PED: stove and boiler – comparison of the three approaches

Figures 1 to 4 show the **LCA results** of all three approaches using secondary, hybrid or primary data, including both the materials manufacturing and operation phases. For the log stove there is a noticeable relative difference in the global warming potential between all three approaches (Fig. 1), but human toxicity potential (HTP), acidification potential and primary energy demand (PED) are comparable for the second and the third approach. In case of the pellet boiler the three approaches are quite similar for HTP and PED.

Conclusion

The study demonstrates that detailed bills of materials from manufacturers can change LCA results relative to secondary data in some cases, e.g. the HTP for manufacturing where we see the influence of metals used. But for GWP, PED or HTP there is no large difference between secondary and primary data despite a difference in materials used. As to emissions, secondary data may cover more pollutants, and they can be substantially different from measured data. The primary data used are only from one manufacturer, and a lack of representativeness may limit the applicability of the study's findings.

List of references

[1] EN ISO 14040 Environmental management – Life cycle assessment- Principles and framework (EN ISO14040:2006), Deutsche und englische Fassung. Brüssel: CEN, 2006.
[2] EN ISO 14044 Environmental management – Life cycle assessment-Requirements and guidelines (EN ISO14044:2006). Deutsche und englische Fassung. Brüssel: CEN, 2006.
[3] Ecoinvent Centre, „Ecoinvent Database v3.4.", Swiss Centre for Life Cycle Inventories, St. Gallen, Switzerland, 2017.
[4] Thinkstep AG, "GaBi Software System and Database for Life Cycle Engineering", LBP-GaBi, University of Stuttgart, Leinfelden-Echterdingen, Germany, 2018.
[5] E. Pali, „Ökobilanz-Studie von zwei ausgewählten Bioenergiesystemen", master thesis, IMC University of Applied Sciences, Krems, Austria, 2018.

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