

## IEooc\_Methods4\_Exercise 8: LCA with openLCA: Waste treatment, recycling, and allocation

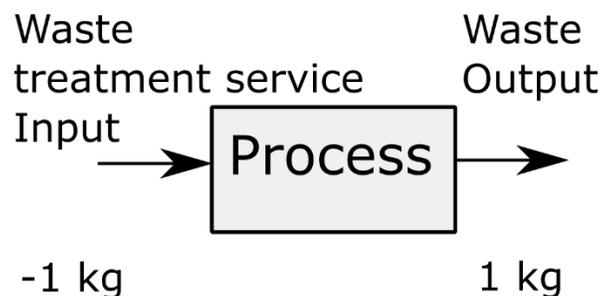
**Goal:** Learn how waste treatment, recycling, and allocation are handled in ecoinvent and openLCA.

**Note:** For this exercise an ecoinvent licence for openLCA is needed. If no license is at hand the exercise can be modified, using the freely available life cycle databases on the openLCA Nexus.

### 1) Waste treatment

To start with, remember that in most economic transaction, money and good flow in opposite directions. In LCA, we follow the physical goods from the producer via the markets to the consumer. A flow in that direction has a positive sign in the database and the product system model. For waste treatment, however, businesses who want to get rid of waste often have to pay for its treatment. For waste, money and good often flow in the same direction, which breaks the symmetry of the economic cycle, where money and goods always flow in opposite direction. To restore symmetry, waste treatment is commonly modelled as a service, the service of getting your waste treated. A service is an input and not an output of product, and when modelling waste treatment as service, it has to be moved from the output to the input side. When doing so, the sign of the waste flow has to change to keep the process mass balanced (Fig E6.1).

→ In ecoinvent, waste that is sent for treatment is modelled as input of a waste treatment service with negative sign (Fig. E6.1)



**Figure E6.1:** Two equivalent ways of representing waste treatment in LCA: left: as service input with negative sign to keep the process mass balanced, right: as output flow.

**Task:** Determine the carbon footprint of treating 1 kg of polystyrene waste with ecoinvent 3.2. Use the process from group 3821: “**market for waste polystyrene | waste polystyrene | cut-off, U – GLO**” to reflect a mix of treatment options. Use the ReCiPe Midpoint Hierarchist impact assessment method without long-term effects.

## 2) Recycling

In life cycle databases recycling can be modelled in two different ways: a) as unit process whose main output is a service of recycling waste or scrap, in which case the secondary material would be a by-product. Or b) as unit process whose main output is the secondary material, and waste or scrap is an input flow (Fig. E6.4). In ecoinvent the second option is chosen. That means that the recycling and recovery processes are not listed among the waste treatment processes (382) but among the group materials recovery (383) or with the respective material production sectors (groups 2xxx).

→ By default no benefits for substituting primary for secondary material are given by the cut-off version of ecoinvent. These have to be estimated by the practitioner, if meaningful.

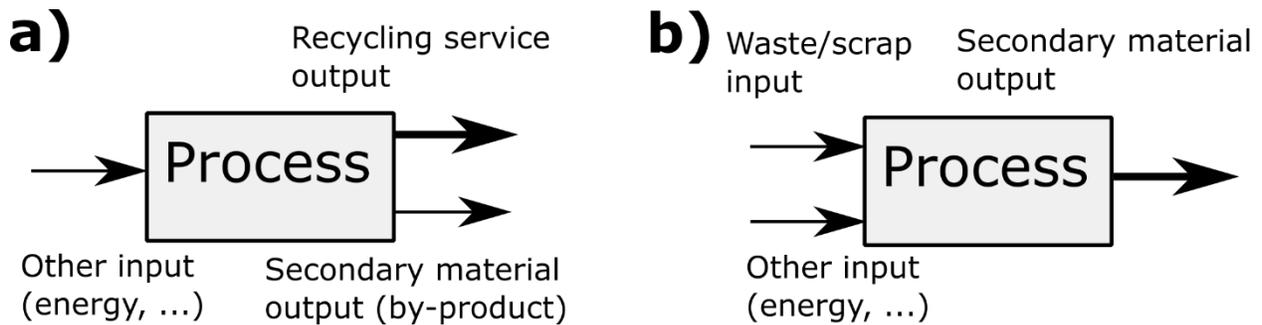


Figure E6.4: LCIA

**Task:** Determine the net carbon emissions savings of remelting 1 kg of steel scrap! Assume that secondary steel is a perfect substitute for primary steel. Use the processes “steel production, electric, low-alloyed | steel, low-alloyed | cut-off, U - RoW” for recycling and “steel production, converter, low-alloyed | steel, low-alloyed | cut-off, U - RoW” from the 2410 process group for primary steel production, and ignore that there is already some scrap input to the converter steel process (cf. Exercise 5).

Part II Methods

Methods part 4 (Life cycle assessment)

<http://www.teaching.industrialecology.uni-freiburg.de/>

3) Allocation

The different allocation mechanisms were presented and explained in the lecture. Here, a simple model for the two major partitioning allocations *economic* and *physical* shall be created and evaluated. For this exercise consider a process with electricity as its main output and heat as a by-product (1.5 kWh heat per kWh electricity). CO<sub>2</sub> emissions (1.0 kg CO<sub>2</sub> per kWh electricity) and coal input (0.27 kg lignite per kWh electricity) are the only other flows. The total revenues are 0.2 EUR for electricity and 0.1 EUR for heat.

**Task: 1)** Create a process description in openLCA as shown in Fig. E6.7 below, using the information supplied in the text. **2)** Determine the carbon footprint of the electricity generated for both physical and economic allocation, *both by hand and with openLCA* (The carbon footprint of 1 kg of lignite group 051: “lignite | market for lignite” is 0.01955 kg CO<sub>2</sub>/eq per kg (pre-calculated)). **3)** Interpret your results! Use the ReCiPe Midpoint Hierarchist impact assessment method without long-term effects.

**Hint:** To enter prices the currency “Euro” must be created by adding it to the currency group in the main menu (bottom left in Fig. E6.7).

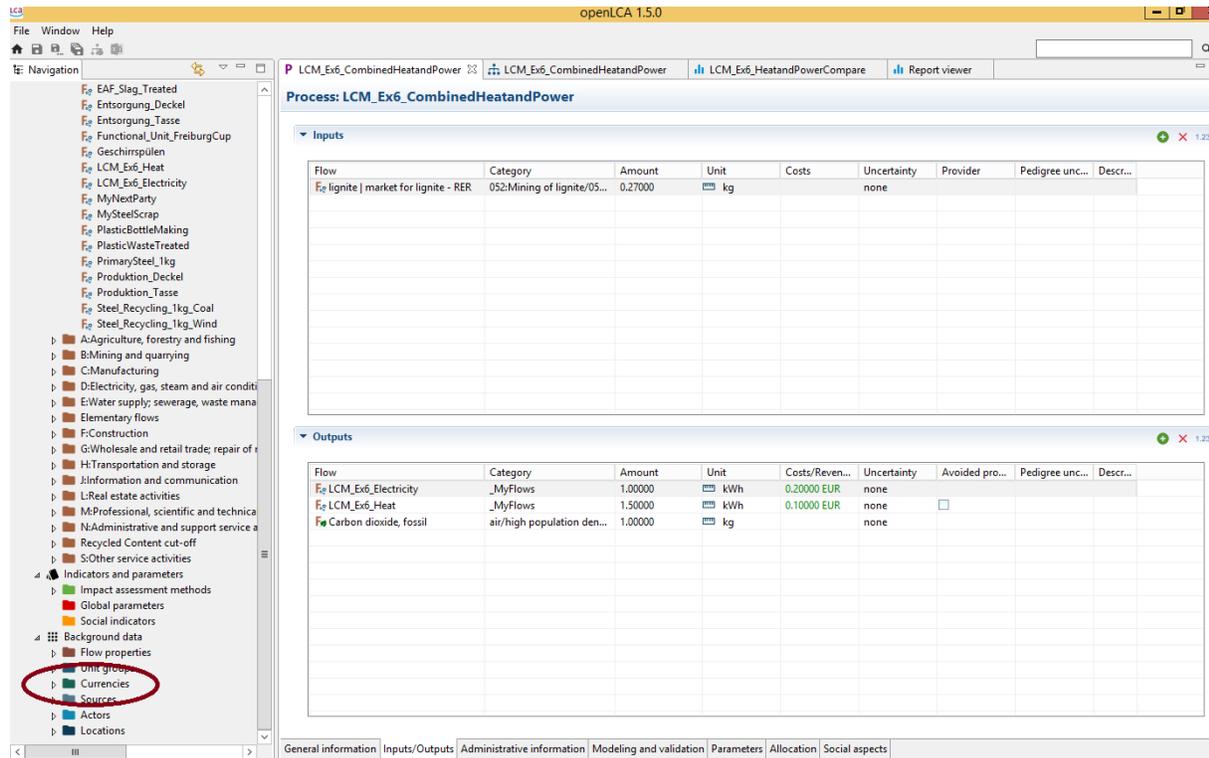


Figure E6.7: Input-output panel of the exemplary multi-output process.

More tutorials for openLCA:

<https://www.youtube.com/channel/UCGiahq1YZWK4pRXDVXuli6w>