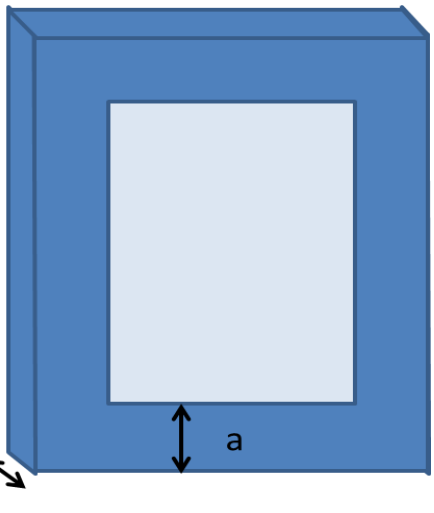
Evaluation of one element using GRANTA EduPack.

This tutorial depicts the use of GRANTA EduPack as a tool to evaluate the environmental impact of the fabrication of one element. The case of study is a window located in a residential building. The students should be able to calculate the CO_2 footprint and energy consumption of the fabrication of the window, and an assessment of the usage of recycled materials.

1. Case of study.



Modern windows are usually glazed or covered in some other transparent or translucent material set in a frame. We will evaluate the CO_2 print and the energy consumption of this building element. The size of the window is 1.23 m x 1.48 m. In this example, we take into account only the glass (double glazing type) and the frame, excluding other parts of the element (handles, hinges, PVB coatings, Argon filling, etc.).

Glass. The glass is made of glass ceramic – MCR with the following characteristics:

Total glass thickness	Dimensions	Space between glazing	Weight per m^2	Filling type
4+4 mm	1.18 m x 0.72 m	16 mm	20.1 kg	Ar

Frame. Frames are usually made of Aluminum, plastic, wood and wood-metal. However, depending on the design and final use, many different materials can be utilized. In this case, we compare the most common materials: Aluminum and PVC.

Material	Dimensions	Mass
Aluminum 6063 T1	a = 7 cm b = 1.5 cm	14.5 kg
PVC: semi-rigid, moulding and extrusion	a = 7 cm b = 2 cm	9.3 kg

a) Calculate the CO_2 print and energy consumption of both cases.

b) Evaluate the impact of recycling these materials.

2. List of materials.

The data input in Granta is a list of materials, mass, recycled content, and fabrication process of each part of the element. With the information provided in the case study, the students should prepare the following list. In this first step, the students are required to not take into account the recycled fraction.

Material	Mass (kg)	Process	Recycled fraction

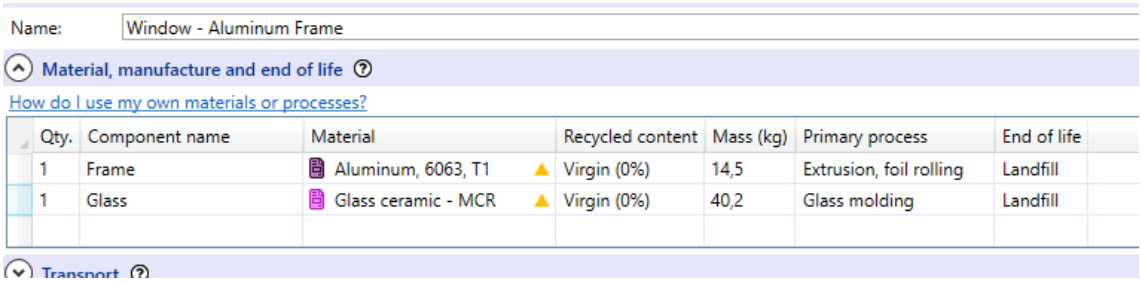
Glass ceramic – MCR	40.2	Glass molding	0
Aluminum 6063 T1	14.5	Extrusion	0
PVC: semi-rigid, moulding and extrusion	9.3	Extrusion	0

3. Case studies.

In the follwoing three cases, we show the input data to the Granta EcoAudit interface and the summary of the output report.

1. Aluminum frame.

Input. We select the two main materials: aluminum and glass. These two materials are commonly used for these applications, as it can be seen in the technical data of GRANTA.

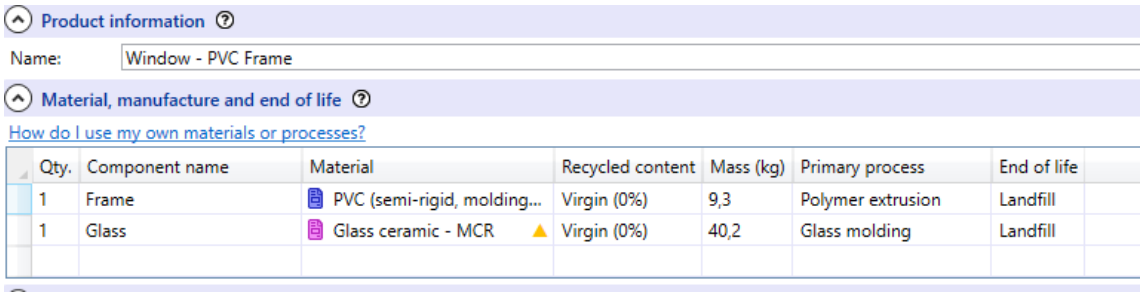


Output. The following table is a summary of the whole report where it appears the energy and CO_2 footprint in MJ and kg for the different phases: materials, manufacture and disposal. The selected End of Life is landfill, and therefore the contribution is positive due to waste collection.

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	4504,417	85,6	299,222	83,2
Manufacture	747,682	14,2	59,561	16,6
Transport	0,000	0,0	0,000	0,0
Use	0,000	0,0	0,000	0,0
Disposal	10,940	0,2	0,766	0,2
Total (for first life)	**5263,039**	**100**	**359,549**	**100**
End of life potential	0,000		0,000	

2. PVC frame.

Input. This second case is analogous to case 1. Now we replace Aluminum by PVC.

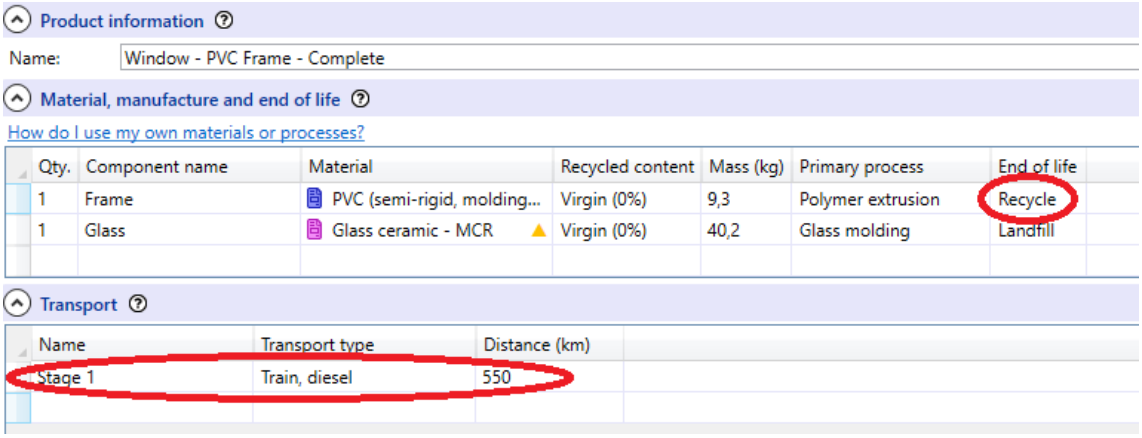


Output. As it was mentioned before, this is a collection of the most important data given by EcoAudit.

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	2207,351	74,3	120,159	66,5
Manufacture	752,621	25,3	59,930	33,2
Transport	0,000	0,0	0,000	0,0
Use	0,000	0,0	0,000	0,0
Disposal	9,900	0,3	0,693	0,4
Total (for first life)	**2969,872**	**100**	**180,782**	**100**
End of life potential	0,000		0,000	

3. PVC frame. With transport and recycling.

Input. We will consider two more options: the end of life and the transport. The plastic will be recycled, and the window will be transported by train 550 kms.



Output. There are two main differences with case 2: a new phase appears (Transport) and there is a potential end of life with a negative contribution. This is the value of the potential energy and carbon footprint recovery.

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	2207,351	73,7	120,159	65,8
Manufacture	752,621	25,1	59,930	32,8
Transport	20,963	0,7	1,497	0,8
Use	0,000	0,0	0,000	0,0
Disposal	14,550	0,5	1,019	0,6
Total (for first life)	**2995,485**	**100**	**182,605**	**100**
End of life potential	-344,133		-14,253	

4. **Questionnaire.** As an example, we present four different questions that could appear in the questionnaire for the students.

a) According to the data extracted from cases 1 and 2.
    a. Which is the option with the largest environmental impact?
    b. Which material contributes the most to the carbon footprint?
b) According to the data extracted from case 3.
    a. Which phase contributes the most to the energy consumption?
    b. Can recycling compensate the carbon emissions of the transport?

References:

Daniel Kellerberger et al. Life Cycle Inventories of Building Products. Ecoinvent report No. 7 (2007).

Michael F. Ashby. Materials and the Environment, 3rd edition (2021).