Modeling of a glass mineral wool process in view of Life Cycle Analysis

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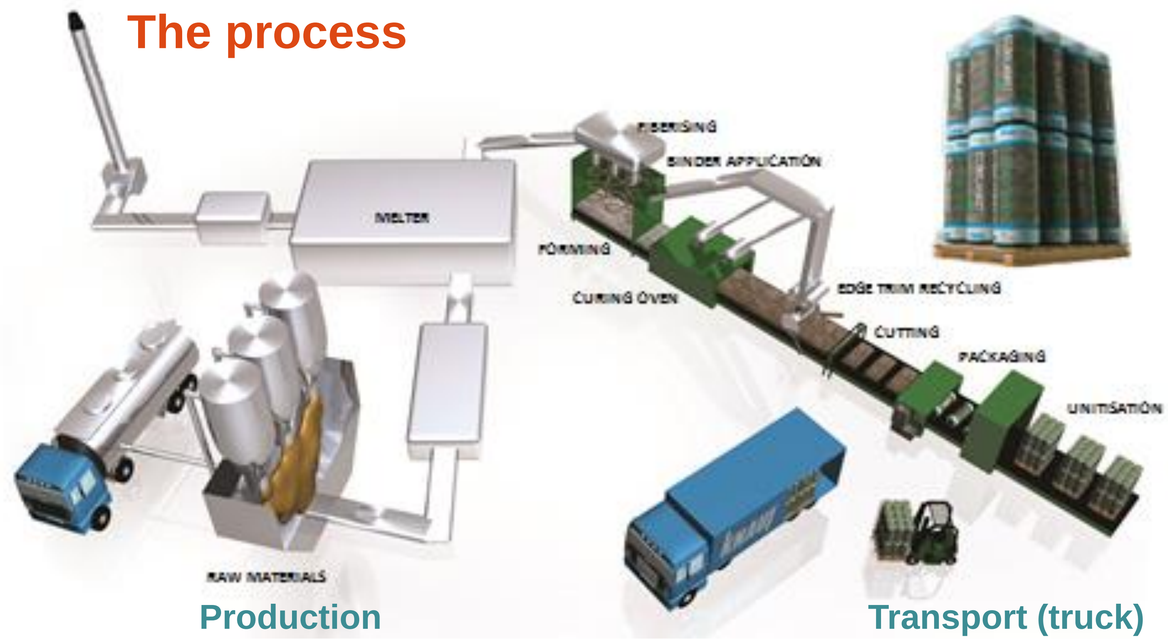
Introduction

Building sector: Environmental Product Declarations (EPD) → Life Cycle Assessment (LCA)

Knauf Insulation (glass wool producer): LCA → Several glass wool factories in Europe → Various products and the same product can be produced in several factories → **Generic** GaBi model [1] → EPD and Eco-design

The process



8 plants in Europe

- Raw materials: recycled glass (cullet), sand, limestone, soda ash, recycled off-cuts, borax and sodium carbonate → weighed, mixed → furnace (1350°C - oxy-combustion + electricity).
- Forming: melted mass fiberized + binder (ECOSE, based on plants starch) → mattress (+ facing).
- Curing oven: natural gas oven at 250°C to cure the binder.
- Cutting, compressing, packing

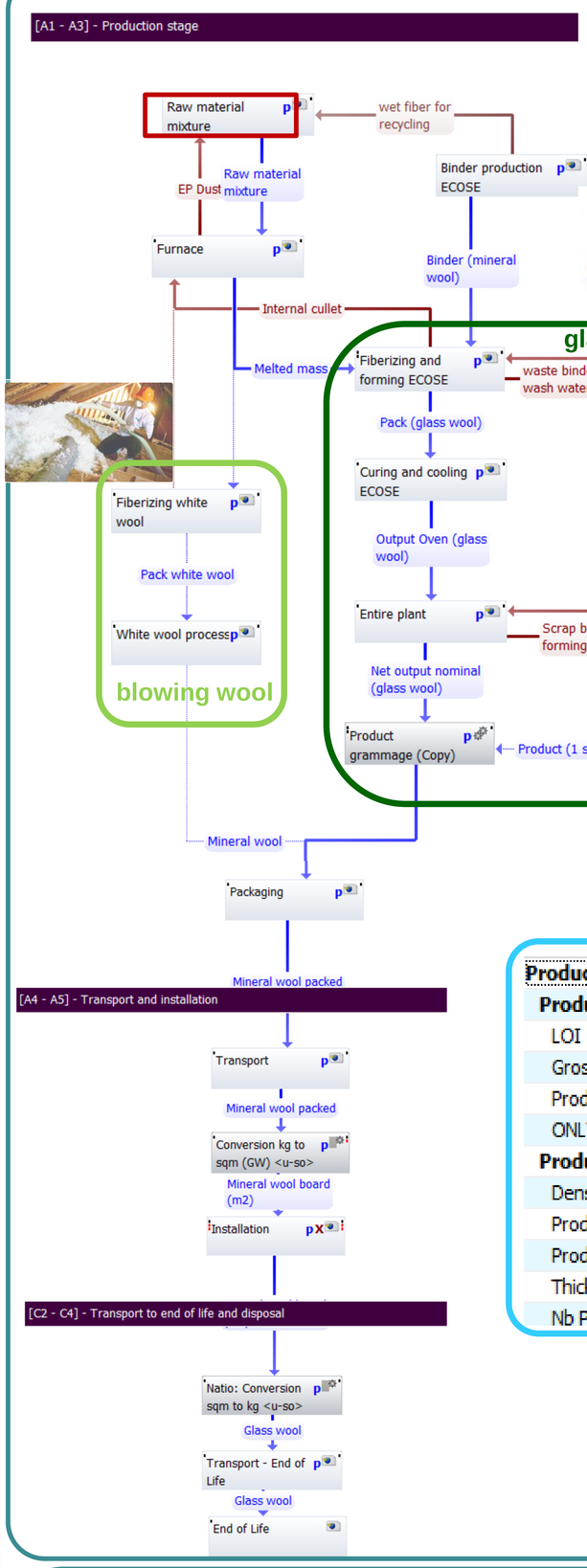
Environmental benefits from insulation not included

Production → **Transport (truck)** → **Installation** → **(Use (50 years))** → **End of Life (landfill)**

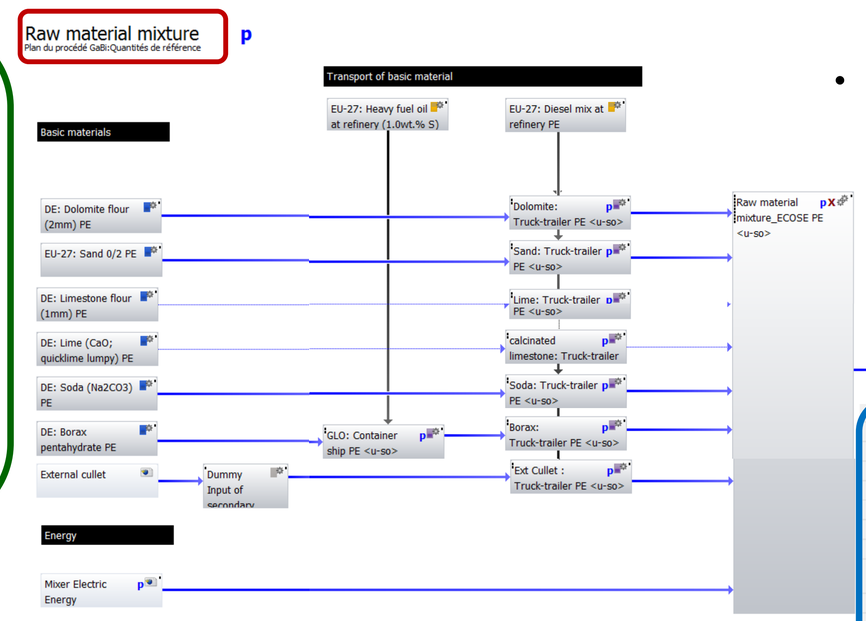
LCA

ISO 14040 [2], 14044 [3] and ILCD handbook [4] = guides. Compliant with EN 15804 [5] (→ EPD).
Allocation procedures: economic. Functional unit: expressed in m^3 of a specific glass mineral wool product (thermal conductivity and application)

Model



- GaBi 6: plans of different levels. Plan contains other plans/processes. Flows connect plans/processes. Parameters → scenarios.
- The general operation principle is the same for all the plants
  → **generic factory plan**: include all alternatives (raw materials, energy sources, recycling loops, wastes and co-products) in subplan. Parameters: specify amount/transport distances/origin for each raw materials, emissions, energy consumption, wastes, product,…
  → changing parameters: adaptation of the model to each production plantt.



- Example: **raw material mixture plan**:
  - All raw materials
  - Amount fixed by **plant parameters**
  - Amount need for product calculated by GaBi with plant and product parameters

Product PE <u-so>

quantities

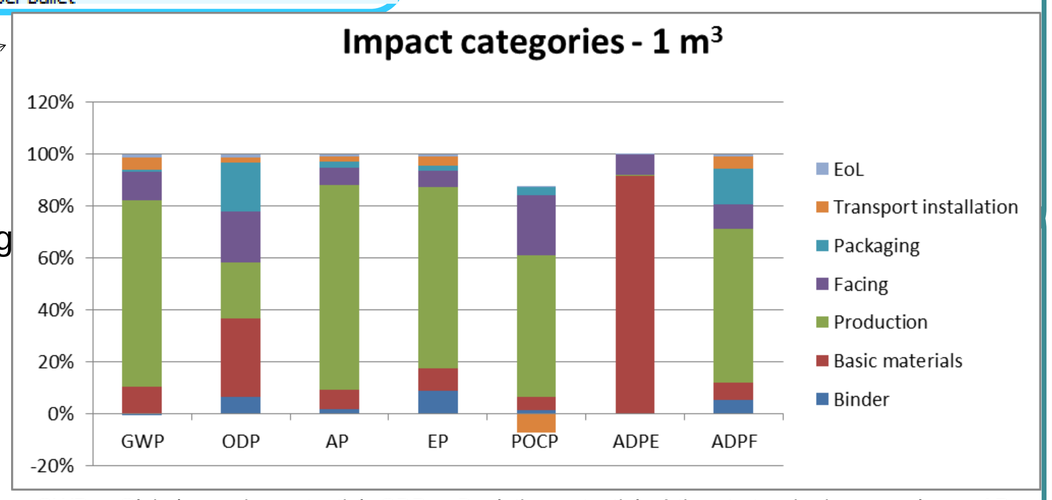
Plant 1			
Raw material mixture			
IN			
Borate	Glass Wool: plant Borate		[kg] Borate consumption (raw material)
Dolomite	Glass Wool: plant Dolomite		[kg] Dolomite consumption (raw material)
Limestone	Glass Wool: plant Limestone		[kg] Limestone consumption (raw material)
Calcinated limestone	Glass Wool: plant Calcinated_lime		[kg] Calcinated limestone consumption (raw material)
Sand	Glass Wool: plant Sand		[kg] Sand consumption (raw material)
Soda	Glass Wool: plant Soda		[kg] Soda consumption (raw material)
External cullet	Glass Wool: plant Ext_cullet		[kg] external cullet consumption (raw material)
Electricity consumption at raw material m	Glass Wool: plant Elec_raw_mat		[MJ] Electricity consumption for raw material
Out			
Raw material mixture	Glass Wool: plant Raw_material_mi		[kg] Raw materila mixture
Other			
Transport distance borate by SHIP	Glass Wool: plant Di_borate_ship	4,6E003	[km] Transport distance by ship for borate (raw material)
Transport distance Borate by TRUCK	Glass Wool: plant Di_Borate_truck	300	[km] Transport distance by truck for borate (raw material)
Transport distance Dolomite	Glass Wool: plant Di_Dolomite	500	[km] Transport distance for dolomite (raw material)

Product parameters				
Product				
LOI	1. Plant weighting	LOI	7,25	% of binder
Gros calorific value	1. Plant weighting	GCV	1,35	[MJ/kg] gross calorific value
Product type	Sous-ensemble	Product type	Glass wool	All the processes related to white wool in the plant
ONLY RELEVANT for white wool product	Sous-ensemble	White wool applic	Loft	
Product dimension				
Density nominal	1. Plant weighting	density_nominal	24,8	[Kg/m3] of finished product to calculate grammage
Product length	1. Plant weighting	Product_length	1,25	m
Product width	1. Plant weighting	Product_width	0,6	m
Thickness	1. Plant weighting	Thickness	80	mm of finished product to calculate grammage
Nb Piece pallet	1. Plant weighting	Nb_PC_per_palle	120	pc per pallet

- Generic plan reproduced: weighting plan (factories combination)
- Model adapted to different products (**glass wool** or **blowing wool**), different types (panel/roll, etc.), dimensions, etc.
  → **product parameters**

Results

- Example: **1 m^3 of product** (density: 24.8 kg/m^3 - CML 2011)
- **EPD** (fast: only parameters changing)
- **Eco design**:
  - Detailed LCA
  - changing parameters → scenarios
  - Different plants (comparison)
  - Several impact categories (avoid impact transfer)



GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non fossil resources; ADPF = Abiotic depletion potential for fossil resources

Conclusions and perspectives

A generic LCA model (GaBi 6)
- **every glass mineral wool product**
- **any manufacturing plant, or combination**

This model
- **structured data collection**
- **flexible → EPD and Eco-Design.**

Bibliographie: 1. LBP, University of Stuttgart, and PE INTERNATIONAL, GaBi 6, 2012. p. GaBi 6: Documentation of GaBi6-Datasets for life cycle engineering. **2.** ISO 14040 : Management environnemental - Analyse du cycle de vie - Principes et cadre, ISO, Editor 2006./ **3**. ISO 14044 : Management environnemental - Analyse du cycle de vie - Exigences et lignes directrices, ISO, Editor 2006. **4**. Guinee, J., Handbook on life cycle assessment - Operational guide to the ISO standards. International Journal of Life Cycle Assessment, 2001. 6(5): p. 255-255. **5**. EN 15804. p. EN 15804:2012-04: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products.