Appendix 1. Data sources used and assumptions made for the life cycle inventory of PB and ULPB from cradle-to-grave.

|  |  |  |
| --- | --- | --- |
| Stage | Data Source | Environmental aspects |
| The product is supposed to be produced in Switzerland | Assumption | Swiss electricity mix is taken |
| Transport of the additives for co-extrusion to the foam precursor manufacturing plant (A1 module) | Assumption | Negligible (less than 0,004% of the total mass of the ULPB) |
| Transport of the glue component to the manufacturing plant (A2 module) | Assumption | Glue components (Urea Formaldehyde resin, hydrochloric acid, ammonium sulphate and ammonia) and paraffin are produced in Germany (Ludwigshafen area) and delivered at the plant in Zürich area (300 km by train and 40 km by truck) |
| Transport of the coextruded foam precursor to the manufacturing plant (A2 module) | Assumption | Foam precursors (co-extruded polymer, PMMA, PLA and EPS) are produced in Germany (Frankfurt area) and delivered at the plant in Zürich area (300 km by train and 90 km by truck) |
| Transport of the liquid CO2 to the manufacturing plant (A2 module) | Assumption | Negligible |
| Manufacturing of 1 m3 PB (A1 to A3 modules) | Ecoinvent v2.2 | Ecoinvent v2.2 process “Particleboard Indoor use” |
| Manufacturing of 1 m3 ULPB (A1 to A3 modules) | Ecoinvent v2.2, Laboratory data | Same production capacity as for PB production (600 000 m3/year) |
| Co-extrusion of polymers and additives (A3 module) | Assumption, Ecoinvent v2.2 | The co-extrusion of polymer is considered to be similar to the eco-invent v2.2 process “extrusion, plastic pipes” and happen at the polymer manufacturing place. |
| CO2 Batch impregnation (A3 module) | Assumption, Ecoinvent v2.2 | The CO2 liquid impregnation is assumed to be done in a classical chemical batch reactor and stored cool in a 100kW absorption chiller before it is dispersed as core layer on the first sheet of surface layer. The electrical consumption for the batch impregnation of the foam precursor with liquid CO2 in a reactor is unknown at the moment and not considered in the calculation. |
| ULPB Pressing (A3 module) | Assumption | The energy consumption is the same for pressing a ULPB or a PB (the cooling energy consumption for ULPB pressing is, in the worst case, equal to the difference of heat energy consumption between ULPB and PB pressing) |
| ULPB Pressing (A3 module) | Assumption | The total blowing agent emissions to the environment (CO2 or pentane) are attributed to the pressing stage |
| Transport from the plant to the furniture manufacturer (A4 module) | Assumption | Panels are transported to a furniture manufacturer on an average distance of 250 km with a truck and then transported from the furniture manufacturer to the user with truck on 100 km in average. |
| Transport from user to incineration plant (C2 module) | Assumption | Panels are transported from the user to the incineration plant with a municipal waste collection lorry on 20 km in average |
| The end-of-life scenario considered is the incineration in a Swiss municipal plant (most realistic scenario) | Assumption | See Text |
| Disposal of PB (C4 module) | Assumption, Ecoinvent v2.2 | Disposal of wood particle in the incineration plant has a similar impact to disposal of solid wood (no incineration process for wood particles are available for Swiss municipal incineration plant) |
| Disposal of UF resin (C4 module) | Assumption, Ecoinvent v2.2 | Disposal of UF resin has a similar impact as the disposal of polyurethane (PU) in Swiss municipal incineration plant with the exception that CO2 fossil emissions are adapted to the one produced by the total combustion of UF resin (Calculated from the formula: 2(H4N2C2O)+5(O2) -> 4(CO2)+4(H2O)+2(N2), 1 kg of UF are 13.88 mole and emit 27.77 mole of CO2 during combustion which correspond to 1.222 kg of CO2) |
| Disposal of PLA (C4 module) | Assumption, Ecoinvent v2.2, Natureworks 2014 | Disposal of PLA has a similar impact as the disposal of wood in Swiss municipal incineration plant with the exception that CO2 biogenic emissions are adapted to the one produced by the combustion of PLA (data from Literature (Natureworks 2014): 2.020 kgCO2biogen/kg PLA) |
| Disposal of PMMA (C4 module) | Assumption, Ecoinvent v2.2 | Disposal of PMMA has a similar impact as the disposal of polyethylene (PE) in Swiss municipal incineration plant with the exception that CO2 fossil emissions are adapted to the one produced by the combustion of PMMA (calculated from the formula: C5O2H8+6CO2 -> 5CO2+4H2O, incineration of 1 mole PMMA (100g) give 5 mole CO2 (220g)) |
| Disposal of Paraffin (module C4) | Assumption, Ecoinvent v2.2 | Disposal of paraffin has a similar impact as the disposal of PE in Swiss municipal incineration plant. |
| Disposal of additives (module C4) | Assumption | Negligible |
| Energy recovery from PB (module D) | Assumption, Ecoinvent v2.2 | Calculation on the energy recovery benefit from wood are based on the information of the Ecoinvent process “disposal, wood untreated, 20% water, to municipal incineration” |
| Energy recovery from UF resin (module D) | Assumption, Ecoinvent v2.2 | Calculation on the energy recovery benefit from UF resin are assumed to be similar to those of PU (Ecoinvent process “disposal, polyurethane, 0.2% water, to municipal incineration”) |
| Energy recovery from paraffin (module D) | Assumption, Ecoinvent v2.2 | Calculation on the energy recovery benefit from paraffin are assumed to be similar to those of PE (Ecoinvent process “disposal, polyethylene, 0.4% water, to municipal incineration”) |
| Energy recovery from PLA (module D) | Assumption, Ecoinvent v2.2, IFEU 2006 | Calculation on the energy recovery benefit from PLA are based on the efficiency of municipal Swiss incineration plant for the Ecoinvent process “plastics mixture” and the low heating value of PLA (IFEU 2006) |
| Energy recovery from PMMA (module D) | Assumption, Ecoinvent v2.2, Walters 2000 | Calculation on the energy recovery from benefit PMMA are based on the efficiency of municipal Swiss incineration plant for the Ecoinvent process “plastics mixture” and the low heating value of PMMA (Walters 2000) |
| Energy recovery from panel disposal (module D) | Assumption, Ecoinvent v2.2 | Calculated amount of energy recovery (in MJ) with specific efficiencies for thermal and electrical production were considered as avoided consumption of electricity mix Switzerland and avoided light fuel oil for heat, burned in boiler 100kW. |

Appendix 2: Results of the LCIA of 1 m3 ULPB with PLA/PMMA core for the 7 environmental indicators as well as for UseTox and the Swiss method Ecological Scarcity 2006 (GWP = Global Warming Potential, GWP\* = GWP without biogenic carbon; IPCC 2007 100 years; ODP = Ozone Depletion Potential steady state; AP = Acidification Potential average European; EP = Eutrophication Potential generic; POCP = Photochemical Ozone Creation Potential high NOx; ADPE = Abiotic Depletion Potential Elements; ADPF = Abiotic Depletion Potential Fossil; CTUe = Comparative Toxic Unit ecotoxicity; UBP = “Umweltbelastungspunkte” or eco-points)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **EN15804 modules** | **A1** | **A2** | **A3** | **A4** | **C2** | **C4** | **D** |
| GWP (kg CO2-eq.) | -163 | 8 | 63 | 15 | 8 | 456 | -112 |
| GWP\* (kg CO2-eq.) | 214 | 8 | 63 | 15 | 8 | 79 | -112 |
| ODP (kg CFC11- eq.) | 1.55E-05 | 9.28E-07 | 4.83E-06 | 2.37E-06 | 1.24E-06 | 5.47E-07 | -1.62E-05 |
| AP (kg SO2- eq.) | 1.00 | 0.04 | 0.30 | 0.08 | 0.04 | 0.10 | -0.29 |
| EP (kg PO–3 - eq.) | 0.30 | 0.01 | 0.15 | 0.02 | 0.01 | 0.04 | -0.08 |
| POCP (kg Ethen- eq.) | 5.70E-02 | 1.43E-03 | 1.29E-02 | 2.38E-03 | 1.42E-03 | 1.27E-03 | -1.40E-02 |
| ADPE (kg Sb- eq.) | 1.96 | 0.05 | 0.45 | 0.11 | 0.05 | 0.04 | -0.73 |
| ADPF (MJ) | 4009 | 110 | 817 | 233 | 118 | 70 | -1571 |
| USETox (CTUe) | 124 | 6 | 48 | 9 | 1 | 27 | -20 |
| Ecological Scarcity (UBP) | 2.17E+05 | 8.83E+03 | 7.53E+04 | 1.62E+04 | 9.20E+03 | 2.59E+05 | -1.02E+05 |