LCA factors report

Grant Agreement N.	LIFE14 ENV/ES/000703	**Acronym**	LIFE FUTURE
Full Title	Sustainable Urban FUrniTURE: Tool design to perform environmental assessments in the green procurement framework		
Funding scheme	LIFE Environment and Resource Efficiency (2014)		
Start date of project	01/10/2015	**Duration of project**	30 months
Project coordinator	AIMPLAS		
Document Type	Working Document		
Document Title	D2.1. LCA factors report		
Authors	AIMPLAS		

Dissemination Level (mark with an ´X´ in the column to the far right)	CO	Confidential, only for partners of the Consortium (including the Commission´s Services)	X
	PU	Public	
	PP	Restricted to other programme participants (including the Commission Services)	
	RE	Restricted to a group specified by the Consortium (including the Commission Services)	

List of abbreviations

ADPE	Abiotic Depletion Potential - Elements
ADPF	Abiotic Depletion Potential - Fossil fuels
AP	Acidification Potential
D	Deliverable
ELCD	European reference Life Cycle Database
EP	Eutrophication Potential
EPD	Environmental product declaration
EU	European Union
GHG	Greenhouse gases
GPP	Green public procurement
GUF Tool	Green Urban Furniture Tool
GWP100	Global Warming Potential for time horizon 100 years
IPCC	Intergovernmental Panel on Climate Change

LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
LIFE FUTURE	Sustainable Urban FUrniTURE: Tool design to perform environmental assessments in the green procurement framework
ODP	Ozone Depletion Potential
PCR	Product category rules
WMO	World Meteorological Organization

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1. INTRODUCTION

The LIFE FUTURE project is aimed at promoting green public procurement (GPP) of urban furniture. The main objective is to overcome the difficulties encountered by procurers when including environmental clauses in call for tenders and assessing the offers received.

To this end, an online tool is being developed and will be further validated during the project: the Green Urban Furniture Tool (GUF Tool). This tool will support public authorities on the purchasing of environmentally friendly urban furniture, guiding users throughout the whole tender process, from the generation of environmental requirements to include in the call for public tenders to the comparative environmental assessment of the products offered by different suppliers. In a first step, the tool will provide GPP criteria allowing public authorities to include environmental clauses for urban furniture in their call for tenders and to select those tenders that better fulfil the criteria. Public authorities willing to invest extra effort in GPP will have the chance of using the tool through a second step to perform a simplified life cycle assessment (LCA) of the different tenders selected in the first step.

The implementation action B1 of the LIFE FUTURE project focuses on the development of a database to feed the GUF Tool with the environmental information necessary to establish environmental clauses and perform simplified environmental assessments of different urban furniture products. This information includes both GPP criteria and environmental profiles for urban furniture.

At present, the project consortium has already gathered (or calculated), evaluated and simplified all the information required for the database, including both the GPP criteria and environmental profiles for materials and/or processes related to the above urban furniture products. This deliverable provides the environmental profiles or LCA factors to be included in the database.

2. METHODOLOGY

The GUF Tool will cover sixteen different urban furniture products, which can be grouped into three product categories[1] as follows:

- Street furniture products: (i) Benches, seats and chairs; (ii) Bicycle parking; (iii) Canopies and kiosks; (iv) Bins and containers; (v) Hydrants; (vi) Advertising and information panels; (vii) Planters and pots; (viii) Tree pits, manholes and lids.
- Recreational and leisure products: (ix) Playgrounds; (x) Sports courts; (xi) Showers and footbaths; (xii) Fountains and hydrants.
- Traffic management products: (xiii) Traffic signs; (xiv) Guardrails, barriers and parapets; (xv) Milestones and bollards; (xvi) Speed reducers.

All these urban furniture products were identified and characterized according to the different materials, processes and technical specifications required. The main materials used for urban furniture include wood and wood-based materials, metals (steel, aluminium and iron), various types of plastics (polyethylene, polypropylene, and so forth), rubbers and some building materials (such as concrete).

Environmental profiles for the materials and/or processes related to urban furniture products were based on LCA studies; i.e., these are LCA-based factors which were obtained and/or calculated based on data from environmental product declarations (EPDs, provided by manufacturers), eco-profiles (provided by sectorial organisations), open LCA databases and scientific literature.

2.1. LCA FACTORS

The environmental profiles to be included in the database are made up of LCA factors which show the different environmental impacts for the various materials and/or processes related to urban furniture, expressed per amount of materials used. Once implemented in the database, these LCA factors together with other input data provided by the tool user will make up the core of the calculation for the simplified environmental assessment of urban furniture products.

The environmental profiles or factors provided herein for urban furniture are based on the LCA methodology (ISO, 2006a,b), since it is currently the most widely applied methodology to evaluate the environmental impacts associated with products throughout their entire life cycle (from the cradle to the gate). These methodology allows to assess diverse environmental impact categories, evaluating the level of impact for each category according to predefined methods for life cycle impact assessment (LCIA). The LCIA method used here was the current version of CML-IA (Guinée et al., 2002), which defines and evaluates a set of ten environmental impact categories. However, only seven of these impact categories have been initially selected for their inclusion in the GUF Tool:

- **Climate change – GWP100**. Climate change is related to emissions of greenhouse gases (GHG) to air. It can result in adverse effects upon ecosystem health, human health and material welfare. The model developed by the Intergovernmental Panel on Climate Change (IPCC) is used for impact assessment of climate change in the method CML-IA. LCA factors are expressed as Global Warming Potential for time horizon 100 years (GWP100), in kilograms of

[1] Note that urban furniture products consuming energy are outside the scope of the project and they will not be assessed using the GUF Tool.

carbon dioxide equivalent (kg CO_2 eq). The geographical scope of this indicator is at global scale.

- **Ozone layer depletion – ODP**. Stratospheric ozone depletion results in a larger fraction of UV radiation reaching the earth surface. It can have harmful effects upon human health, animal health, terrestrial and aquatic ecosystems, biochemical cycles and on materials. The model developed by the World Meteorological Organization (WMO) is used for impact assessment of ozone depletion in the method CML-IA. LCA factors are expressed as Ozone Depletion Potential (ODP), in kilograms of trichlorofluoromethane equivalent (kg CFC-11 eq). The geographical scope of this indicator is at global scale and the time span is infinity.

- **Acidification – AP**. Acidifying substances cause a wide range of impacts on soil, groundwater, surface water, organisms, ecosystems and materials (buildings). The adapted RAINS 10 model, which describes the fate and deposition of acidifying substances, is used for impact assessment of acidification in the method CML-IA. LCA factors are expressed as Acidification Potential (AP), expressed as kilograms of sulphur dioxide equivalent (kg SO_2 eq). The geographical scope of this indicator varies between local and continental scale, and the time span is infinity.

- **Eutrophication – EP**. Eutrophication (also known as nutrification) includes all impacts due to excessive levels of macro-nutrients in the environment caused by emissions of nutrients to air, water and soil. The stoichiometric procedure of Heijungs (1992) is used for impact assessment of eutrophication in the method CML-IA. LCA factors are expressed as Eutrophication Potential (EP), in kilograms of phosphate equivalent (kg PO_4^{3-} eq). The geographical scope of this indicator varies between local and continental scale, and the time span is infinity.

- **Photochemical oxidation – POCP**. Photo-oxidant formation is the formation of reactive substances (mainly ozone) that are injurious to human health and ecosystems and they also may damage crops. This environmental problem is also designated as “summer smog”, whereas “winter smog” is outside the scope of this impact category. The UNECE Trajectory model is used for impact assessment of photochemical oxidation in the method CML-IA. LCA factors are expressed as Photochemical Ozone Creation Potential (POCP), in kilograms of ethylene equivalent (kg C_2H_4 eq). The geographical scope of this indicator varies between local and continental scale, and the time span is five days.

- **Depletion of abiotic resources - elements – ADPE**. Depletion of abiotic resources is concerned with protection of human welfare, human health and ecosystem health. This impact category is related to extraction of minerals and the impact assessment in the method CML-IA is based on concentration reserves and rate of de-accumulation. LCA factors are expressed as Abiotic Depletion Potential - Elements (ADPE), in kilograms of antimony equivalent (kg Sb eq). The geographical scope of this indicator is at global scale.

- **Depletion of abiotic resources - fossil fuels – ADPF**. Depletion of abiotic resources is concerned with protection of human welfare, human health and ecosystem health. This impact category is related to extraction of fossil fuels and the impact assessment in the method CML-IA is based on concentration reserves and rate of de-accumulation. LCA factors are expressed as Abiotic Depletion Potential - Fossil fuels (ADPF), in megajoules (MJ). The geographical scope of this indicator is at global scale.

2.2. DATA SOURCES

The environmental profiles or LCA factors were obtained and/or calculated based on data from different industrial and scientific sources, namely:

- **Environmental product declarations (EPDs).** EPDs are ISO 14025 standardized reports that communicate transparent and comparable information about the life cycle environmental performance of products. They are based on data on composition and environmental characteristics of products collected from LCAs developed as specified by predefined product category rules (PCRs). PCRs are drawn up by industry in full consultation with stakeholders and competitors. The information is thus presented in a common format and in a neutral way that enables evaluations and comparisons by purchasers. The quality of the information can be verified by a third party and can be accredited to give additional credibility.

- **Eco-profiles**. Eco-profiles are standardised reports that communicate transparent information intended to be used as cradle-to-gate building blocks for LCA studies of defined applications or products. Cradle-to-gate means that the assessment only includes life cycle stages and processes from the extraction of raw materials to the delivery of the product at plant. PlasticsEurope provides Eco-profiles for plastics, which include Life cycle inventory (LCI) datasets and EPDs representing EU production averages for these materials. These Eco-profiles are prepared in accordance with ISO 14040 and 14044 requirements for the development of LCA studies (ISO, 2006a,b).

- **Other data sources**. They include LCA databases and scientific literature on LCI/LCA. It should be noted that only open LCA databases were used as data sources (e.g., ELCD or European reference Life Cycle Database), since the LCA factors are intended to be integrated into the GUF Tool and commercial LCA databases (such as Ecoinvent or GaBi) do not allow to use their datasets for free for this purpose. Moreover, open LCA software (openLCA) was used for the required inventories and impact assessments in order to tackle the development of LCA factors more effectively.

3. RESULTS

This section compiles the environmental profiles or LCA factors gathered and/or calculated that will be included in the database. These have been classified herein by material type as follows: (1) wood (including wood-based materials), (2) metals, (3) plastics, (4) rubbers, and (5) building materials.

3.1. WOOD

Wood includes wood-based materials, solid wood and surface treatments used for this materials. The LCA factors were based on data from EPDs provided by manufacturers.

3.1.1. Wood-based materials

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Fibreboard 18 mm (MDF), melamine coated	1 kg	-1.83E-01	9.81E-12	4.97E-03	8.98E-04	7.79E-04	1.94E-07	1.77E+01	WoodSolutions (2015a)
Fibreboard 25 mm (MDF), melamine coated	1 kg	-1.80E-01	9.48E-12	5.17E-03	9.24E-04	7.97E-04	1.92E-07	1.76E+01	
Fibreboard 18 mm (MDF), melamine coated, moisture resistant (MR)	1 kg	2.37E-01	1.50E-11	5.17E-03	1.14E-03	6.32E-04	5.05E-07	2.31E+01	
Fibreboard 25 mm (MDF), melamine coated, moisture resistant (MR)	1 kg	3.14E-01	1.54E-11	5.46E-03	1.20E-03	6.63E-04	5.33E-07	2.39E+01	
Plywood 9mm, C-bond interior (joinery)	1 kg	-6.52E-01	1.15E-11	5.74E-03	1.28E-03	1.28E-03	3.64E-07	1.09E+01	WoodSolutions (2015b)
Plywood 7 mm, A-bond exterior (bracing)	1 kg	-5.36E-01	1.35E-11	5.72E-03	1.17E-03	1.19E-03	5.10E-07	1.71E+01	

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Plywood 9 mm, A-bond exterior (structural)	1 kg	-5.37E-01	1.35E-11	5.72E-03	1.17E-03	1.19E-03	5.11E-07	1.71E+01	
Plywood 17mm, A-bond formply (formwork)	1 kg	-5.37E-01	1.35E-11	5.73E-03	1.16E-03	1.19E-03	5.11E-07	1.71E+01	
Plywood 15 mm, A-bond flooring (residential)	1 kg	-5.37E-01	1.35E-11	5.73E-03	1.16E-03	1.20E-03	5.12E-07	1.72E+01	
Plywood 25 mm, A-bond flooring (commercial)	1 kg	-5.37E-01	1.35E-11	5.73E-03	1.17E-03	1.19E-03	5.11E-07	1.71E+01	
Particleboard 16mm, melamine coated	1 kg	-4.66E-01	8.85E-12	3.35E-03	6.95E-04	6.06E-04	1.53E-07	1.46E+01	WoodSolutions (2015c)
Particleboard 18mm, melamine coated	1 kg	-4.87E-01	8.56E-12	3.34E-03	6.91E-04	6.00E-04	1.48E-07	1.42E+01	
Particleboard 16mm, melamine coated, moisture resistant (MR)	1 kg	-1.64E-01	1.45E-11	3.86E-03	9.92E-04	5.18E-04	4.67E-07	2.10E+01	
Particleboard 18mm, melamine coated, moisture resistant (MR)	1 kg	-1.13E-01	1.17E-11	3.05E-03	7.87E-04	4.12E-04	3.72E-07	1.69E+01	
Particleboard 19 mm, flooring, uncoated	1 kg	-4.19E-01	1.03E-11	2.83E-03	7.84E-04	3.67E-04	3.86E-07	1.48E+01	
Particleboard 22 mm, flooring, uncoated	1 kg	-4.12E-01	1.03E-11	2.85E-03	7.89E-04	3.70E-04	3.87E-07	1.48E+01	
Particleboard 25 mm, flooring, uncoated	1 kg	-4.07E-01	1.03E-11	2.88E-03	7.88E-04	3.73E-04	3.88E-07	1.49E+01	
Particleboard 25 mm, uncoated, based on UK consumption mix	1 kg	-9.63E-01	3.08E-11	1.64E-03	1.90E-04	2.34E-04	1.29E-07	8.63E+00	PE International & Wood for Good (2013a)

3.1.2. Solid wood

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Beech timber planed, Beech (from Germany)	1 kg	-1.34E+00	2.30E-07	1.36E-03	2.12E-04	3.17E-03	5.55E-06	2.61E+01	Accsys Technologies PLC (2015)
Planed timber, Scots Pine (from Sweden)	1 kg	-1.37E+00	2.31E-07	1.82E-03	2.28E-04	3.65E-03	5.63E-06	2.65E+01	
Planed timber, Radiata Pine (from New Zealand)	1 kg	-8.49E-01	2.80E-07	2.20E-03	3.47E-04	7.22E-03	5.35E-06	3.00E+01	
Sawn timber planed, spruce and pine logs	1 kg	-1.54E+00	9.28E-13	5.17E-04	1.05E-04	1.69E-04	2.84E-08	6.56E-01	Fritz EGGER GmbH & Co. OG (2016a)
Sawn timber green, spruce and pine logs	1 kg	-1.05E+00	4.12E-13	1.59E-04	3.69E-05	7.72E-06	4.89E-09	3.26E-01	Fritz EGGER GmbH & Co. OG (2016b)
Kiln dried hardwood, based on UK consumption mix	1 kg	-1.26E+00	5.30E-11	1.62E-03	2.12E-04	8.52E-04	2.61E-08	3.62E+00	PE International & Wood for Good (2013b)
Kiln dried softwood based on the UK consumption mix	1 kg	-1.41E+00	6.17E-12	1.27E-03	2.19E-04	1.01E-04	1.62E-08	2.88E+00	PE International & Wood for Good (2013c)
Hardwood, rough-sawn, kiln-dried	1 kg	-1.08E+00	7.87E-13	3.34E-03	7.51E-04	3.01E-03	4.96E-08	4.68E+00	WoodSolutions (2015d)
Hardwood, dressed, kiln-dried	1 kg	-8.58E-01	1.54E-12	4.57E-03	9.92E-04	3.89E-03	6.56E-08	6.68E+00	
Green hardwood, rough-sawn	1 kg	-9.52E-01	5.30E-13	2.78E-03	6.34E-04	2.49E-03	2.86E-08	3.78E+00	
Green hardwood, dressed	1 kg	-7.63E-01	1.19E-12	3.83E-03	8.41E-04	3.22E-03	3.83E-08	5.48E+00	
American Southern Yellow pine treated with bio-based chemicals	1 kg	-1.26E+00	8.35E-08	8.33E-03	6.27E-04	-8.80E-05	3.00E-06	1.52E+01	Kebony AS (2016a)

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Scots Pine from Sweden treated with bio-based chemicals	1 kg	-1.05E+00	6.72E-08	4.02E-03	6.25E-04	8.13E-05	2.03E-06	9.84E+00	Kebony AS (2016b)
Glued laminated timber	1 kg	-1.27E+00	4.16E-08	1.55E-03	3.14E-04	2.91E-04	1.33E-06	4.29E-04	Studiengemeinschaft Holzleimbau e.V. (2013)
Cross laminated timber, based on UK consumption mix	1 kg	-1.01E+00	4.75E-11	2.17E-03	3.59E-04	1.90E-04	2.89E-07	8.18E+00	PE International & Wood for Good (2013d)
Cross laminated timber (X-Lam)	1 kg	-1.22E+00	6.66E-08	1.37E-03	2.70E-04	2.75E-04	1.25E-06	4.63E+00	Studiengemeinschaft Holzleimbau e.V. (2016)

3.1.3. Treatments

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Silicone exterior paint for wood (Natura A1)	1 kg	1.33E+00	9.51E-08	6.53E-03	1.82E-03	5.29E-04	2.30E-06	2.60E+01	Polisan (2015a)
Exterior paint for wood (Exelans Macro)	1 kg	2.14E+00	1.88E-07	9.93E-03	3.56E-03	1.00E-03	3.65E-06	3.90E+01	Polisan (2015b)
Protective anti-degradation water-repellent for wood	1 kg	6.84E-01	3.97E-08	2.29E-03	1.09E-03	9.02E-04	n/a	1.88E+01	Ecobeton (2012)
Adhesive mix for wood (UF+PVA+PF+PRF+MUF+PUR+EPI)	1 kg	1.62E+00	6.94E-11	3.60E-03	8.69E-04	9.31E-04	1.71E-06	3.36E+01	PE International & Wood for Good (2013e)

3.2. METALS

Metals include various types of steel and aluminium. The LCA factors were based on data from EPDs provided by manufacturers.

3.2.1. Steel

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Stainless steel, secondary production route (scrap)	1 kg	3.79E+00	1.83E-08	2.49E-02	1.35E-03	1.45E-03	1.84E-05	4.30E+01	Outokumpu Stainless Ltd (2015)
Galvanized steel, grade S 250 GD + z 140	1 kg	2.65E+00	4.40E-08	6.10E-03	5.50E-04	1.10E-03	2.30E-07	4.00E-02	Europrofil AB (2014)
Galvanized steel, grade S 350 GD + z 275	1 kg	2.64E+00	4.30E-08	5.95E-03	5.45E-04	1.10E-03	2.30E-07	4.00E-02	
Galvanized steel, grade S 250 GD + az 185	1 kg	2.70E+00	4.05E-08	6.30E-03	5.35E-04	1.10E-03	2.30E-07	4.00E-02	
Galvanized steel, grade S 250 GD + z 275, polyester coated (min 2*25 µm)	1 kg	2.73E+00	4.80E-08	6.40E-03	5.90E-04	1.10E-03	2.30E-07	4.00E-02	
Galvanized steel sheet, as fixings, connectors, joist webs, hangers	1 kg	2.25E+00	3.71E-11	8.04E-03	6.96E-04	1.12E-03	1.43E-04	2.56E+01	PE International & Wood for Good (2013f)
Hot rolled steel	1 kg	2.52E+00	5.88E-11	9.60E-03	1.03E-03	1.54E-03	1.59E-07	2.80E+01	BlueScope Steel Ltd (2015)
Hot rolled steel plates	1 kg	2.55E+00	9.11E-09	5.60E-03	7.93E-07	5.27E-03	5.43E-07	2.65E+01	Norwegian Steel Association (2014)

3.2.2. Aluminium

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Primary aluminium ingot	1 kg	8.94E+00	4.35E-10	6.11E-02	2.60E-03	3.11E-03	4.94E-06	8.83E+01	The Aluminum Association (2014a)
Secondary aluminium ingot (100% scrap)	1 kg	6.73E-01	8.49E-11	2.08E-03	1.48E-04	1.52E-04	5.15E-07	1.02E+01	The Aluminum Association (2014b)
Aluminium sheet	1 kg	9.40E+00	2.80E-07	4.90E-02	2.70E-03	2.90E-03	5.10E-06	1.00E+02	German Aluminium Association GDA (2013a)
Aluminium sheet, coil coated	1 kg	1.10E+01	3.00E-07	5.40E-02	3.00E-03	3.30E-03	5.60E-06	1.20E+02	German Aluminium Association GDA (2013b)
Cold rolled aluminium	1 kg	5.33E+00	4.47E-10	3.07E-02	1.46E-03	1.82E-03	2.98E-06	6.13E+01	The Aluminum Association (2014c)
Hot rolled aluminium	1 kg	3.93E+00	2.52E-10	2.34E-02	1.09E-03	1.32E-03	2.26E-06	4.36E+01	The Aluminum Association (2014d)
Extruded aluminium	1 kg	6.57E+00	4.14E-10	4.01E-02	1.90E-03	2.21E-03	3.97E-06	7.13E+01	The Aluminum Association (2014e)
Cold-formed aluminium sheet	1 kg	1.10E+01	3.00E-07	5.70E-02	3.10E-03	3.40E-03	5.90E-06	1.30E+02	German Aluminium Association GDA (2013c)
Aluminium composite panels	1 kg	3.70E+01	8.10E-07	1.70E-01	1.00E-02	1.20E-02	2.10E-05	5.50E+02	German Aluminium Association GDA (2013d)

3.3. PLASTICS

Plastics include various types of plastic materials both virgin and recycled. The LCA factors were based on data from the Eco-profiles developed by PlasticsEurope for plastics.

Additional calculations were made to develop LCA factors for recycled plastics. LCIs were in this case developed using data from scientific literature regarding the environmental loads from the different recycling process steps (Hestin et al., 2015), including waste collection, pre-treatment and sorting, transportation to recyclers and reprocessing operations in recycling plants. In addition, LCIs for auxiliary materials, energy, transport operations and other inputs used for the assessments were taken from the ELCD database. Two different approaches were assumed for the modelling of recycled plastics:

- Cut-off approach. Under this approach all virgin material production burdens are assigned to the first use of the material, and the burdens assigned to the recycled plastics system begin with recovery of the post-consumer material. Hence, all of the burdens for plastics recovery, including collection and transport, separation and sorting and reprocessing, are assigned to the recycled material.
- Open-loop approach. Under this approach the burdens for virgin material production, recovery and recycling, and ultimate disposal of recycled material are shared among all the sequential useful lives of the material. Therefore, the share of virgin material burdens allocated to any individual use of the plastic material depends upon assumptions about the total number of useful lives of the material. For the purposes of obtaining cradle-to-gate factors for recycled plastics, an assumption of two useful lives of the plastic material was done in this study (i.e., once in a virgin product, once in a recycled product, and then disposed). Hence, the burdens for virgin material production, post-consumer recovery and reprocessing are divided between the virgin and recycled uses of the material.

3.3.1. Virgin plastics

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
High impact polystyrene granulate (HIPS)	1 kg	2.43E+00	1.72E-08	5.65E-03	5.10E-04	9.00E-04	1.04E-06	7.85E+01	PlasticsEurope (2012)
Polyvinylchloride resin, emulsion polymerisation (E-PVC)	1 kg	2.56E+00	2.40E-06	6.93E-03	1.25E-03	5.40E-04	1.40E-05	5.42E+01	PlasticsEurope (2015a)

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Polyvinylchloride resin, suspension polymerisation (S-PVC)	1 kg	1.99E+00	2.20E-06	5.05E-03	9.40E-04	5.60E-04	1.29E-05	4.72E+01	
Polypropylene granulate (PP)	1 kg	1.63E+00	5.50E-07	4.32E-03	1.18E-03	3.70E-04	1.40E-07	7.02E+01	PlasticsEurope (2014a)
Low-density polyethylene granulate (LDPE)	1 kg	1.87E+00	8.20E-07	4.36E-03	1.25E-03	1.33E-03	5.20E-08	7.28E+01	PlasticsEurope (2014b)
High-density polyethylene granulate (HDPE)	1 kg	1.80E+00	6.40E-07	4.28E-03	1.20E-03	6.30E-04	4.40E-08	7.20E+01	
Acrylonitrile-butadiene-styrene granulate (ABS)	1 kg	3.10E+00	2.60E-10	7.69E-03	1.03E-03	1.09E-03	1.48E-06	8.14E+01	PlasticsEurope (2015b)
Polymethyl methacrylate (PMMA) beads	1 kg	3.75E+00	4.20E-07	1.74E-02	2.16E-03	9.40E-04	2.30E-06	9.70E+01	PlasticsEurope (2015c)
Polymethyl methacrylate (PMMA) cast sheet	1 kg	4.77E+00	4.60E-07	2.63E-02	2.99E-03	1.48E-03	7.00E-06	1.19E+02	
Polymethyl methacrylate (PMMA) extruded sheet	1 kg	4.38E+00	4.10E-07	1.83E-02	3.04E-03	9.60E-04	2.30E-06	1.06E+02	
Polycarbonate granulate (PC)	1 kg	4.13E+00	1.99E-07	7.47E-03	9.20E-04	1.61E-03	7.26E-06	8.90E+01	PlasticsEurope (2011a)
Polyamide 6 granulate (PA 6)	1 kg	6.70E+00	1.20E-07	1.20E-02	4.20E-03	6.00E-04	1.70E-08	1.16E+02	PlasticsEurope (2011b)
Polyamide 66 granulate (PA 66)	1 kg	6.44E+00	8.30E-08	1.29E-02	3.70E-03	1.00E-03	3.20E-06	1.27E+02	PlasticsEurope (2011c)

3.3.2. Recycled plastics

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Recycled plastics, cut-off	1 kg	3.98E-01	2.38E-08	1.65E-03	1.23E-04	9.32E-05	3.52E-08	4.60E+00	Own calculations primarily based on Hestin et al. (2015)
Recycled HIPS, open-loop	1 kg	1.41E+00	2.05E-08	3.65E-03	3.16E-04	4.97E-04	5.38E-07	4.15E+01	
Recycled PVC, open-loop	1 kg	1,34E+00	1,16E-06	3,82E-03	6,09E-04	3,22E-04	6,74E-06	2,77E+01	
Recycled PP, open-loop	1 kg	1.01E+00	2.87E-07	2.99E-03	6.51E-04	2.32E-04	8.76E-08	3.74E+01	
Recycled LDPE, open-loop	1 kg	1.13E+00	4.22E-07	3.01E-03	6.86E-04	7.12E-04	4.36E-08	3.87E+01	
Recycled HDPE, open-loop	1 kg	1.10E+00	3.32E-07	2.97E-03	6.61E-04	3.62E-04	3.96E-08	3.83E+01	
Recycled ABS, open-loop	1 kg	1.75E+00	1.20E-08	4.67E-03	5.76E-04	5.92E-04	7.58E-07	4.30E+01	
Recycled PMMA, open-loop	1 kg	2.07E+00	2.22E-07	9.53E-03	1.14E-03	5.17E-04	1.17E-06	5.08E+01	
Recycled PC, open-loop	1 kg	2.26E+00	1.11E-07	4.56E-03	5.21E-04	8.52E-04	3.65E-06	4.68E+01	
Recycled PA 6, open-loop	1 kg	3.55E+00	7.19E-08	6.83E-03	2.16E-03	3.47E-04	2.61E-08	6.03E+01	
Recycled PA 66, open-loop	1 kg	3.42E+00	5.34E-08	7.28E-03	1.91E-03	5.47E-04	1.62E-06	6.58E+01	

3.4. RUBBERS

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Resilient floor covering, GRANITO 2mm	1 kg	2.90E+00	4.60E-07	1.31E-02	1.25E-03	1.73E-03	5.30E-05	5.61E+01	Artigo (2015)
Smooth rubber floor covering, ERFMI 2mm	1 kg	3.03E+00	5.15E-07	1.15E-02	1.09E-03	2.36E-03	5.15E-05	5.45E+01	ERFMI (2013)
Recycled rubber, Sport Mat flooring, DINOFLEX 8 mm	1 kg	1.97E+00	3.01E-07	8.80E-03	2.50E-03	4.62E-04	6.31E-03	4.52E+01	Dinoflex (2015)
Rubber, SBR crumb, ECORE (6.6mm	1 kg	1.52E+00	6.59E-09	8.36E-03	1.04E-03	3.93E-04	2.13E-07	2.44E+01	Ecore (2016)
Playground tile, rubber, SBR, MATSINC 63.5mm	1 kg	3.04E+00	2.67E-07	1.31E-02	3.82E-03	7.04E-04	1.19E-05	5.65E+01	Mats Inc (2015)

3.5. BUILDING MATERIALS

Building materials include concrete, cement, gypsum, bricks and tiles. The LCA factors were based on data from EPDs provided by manufacturers.

3.5.1. Concrete

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Precast concrete wall elements	1 kg	1.89E-01	1.07E-08	6.53E-04	7.50E-05	3.78E-05	2.26E+01	1.54E+00	UPB AS (2016a)
Precast concrete insulated wall elements	1 kg	2.14E-01	1.27E-08	8.73E-04	9.17E-05	4.93E-05	2.93E+01	1.91E+00	UPB AS (2016b)
Precast concrete columns	1 kg	2.36E-01	1.35E-08	8.42E-04	9.34E-05	4.60E-05	2.78E-07	1.96E+00	UPB AS (2016c)
Precast concrete beams	1 kg	2.41E-01	1.38E-08	8.77E-04	9.56E-05	4.76E-05	2.81E-07	2.02E+00	UPB AS (2016d)
Hollow core slabs	1 kg	2.47E-01	1.17E-08	7.50E-04	1.09E-04	6.89E-05	6.00E-07	1.73E+00	UPB AS (2016e)
Hanson Thermalite autoclaved aerated concrete block	1 kg	2.80E-01	1.44E-07	6.12E-04	8.34E-05	7.85E-05	4.91E-10	2.54E+00	Hanson UK (2015)
Precast concrete kerbs	1 kg	2.25E-05	1.54E-08	6.34E-04	1.58E-04	3.68E-05	1.92E-07	1.89E+00	Aggregate Industries (2016)
Lightweight concrete block, Leca Universalblokk 20 cm,	1 kg	5.57E-02	1.52E-09	1.72E-04	1.69E-05	6.62E-05	8.52E-08	3.66E-01	Saint-Gobain Byggevarer AS (2014a)
Lightweight concrete block, Leca Finblokk 15 cm	1 kg	9.90E-02	1.89E-09	2.28E-04	2.45E-05	1.33E-04	1.06E-07	5.67E-01	Saint-Gobain Byggevarer AS (2014b)
Lightweight concrete block, Leca Basicblokk 15 cm	1 kg	6.29E-02	1.60E-09	1.97E-04	1.90E-05	7.33E-05	9.29E-08	4.06E-01	Saint-Gobain Byggevarer AS (2014c)

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Lightweight concrete block, Leca Lettveggsblokk 88 mm	1 kg	5.62E-02	1.50E-09	1.52E-04	1.65E-05	7.33E-05	9.38E-08	3.70E-01	Saint-Gobain Byggevarer AS (2014d)

3.5.2. Cement

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Cement, Cem III	1 kg	4.17E-01	4.40E-08	1.16E-03	2.75E-04	1.23E-04	1.03E-07	3.09E+00	ICEA (2014)
Calcium aluminate cement	1 kg	1.13E+00	1.29E-07	5.80E-03	1.06E-03	2.40E-04	1.91E-07	1.23E+01	Çimsa Çimento San. Ve Tic. A.Ş. (2015a)
White Portland cement	1 kg	1.07E+00	2.02E-05	1.00E-03	6.29E-04	4.31E-05	1.30E-07	3.07E+00	Çimsa Çimento San. Ve Tic. A.Ş. (2015b)
Portland cement, CEM I 52.5 N	1 kg	8.80E-01	4.11E-11	2.07E-01	3.12E-04	1.83E-04	1.41E-06	4.18E+00	Nesher Israel Cement Enterprises Ltd (2014)

3.5.3. Gypsum

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Gyproc WallBoard 12.5mm	1 kg	2.51E-01	7.43E-09	7.31E-04	9.34E-05	8.02E-05	4.31E-08	3.83E+00	BPB United Kingdom Ltd (2013)
Gypsum-based plaster	1 kg	1.51E-01	1.27E-08	1.44E-04	3.21E-05	5.69E-04	9.09E-08	2.88E+00	Alçıbay (2016)

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Gyproc Finish plaster	1 kg	8.80E-02	3.90E-09	2.10E-04	2.00E-05	2.30E-05	1.70E-08	1.20E+00	Gypsum Industries Ltd (2014)
Glasroc 15mm	1 kg	2.21E-01	1.70E-08	5.97E-04	4.57E-05	6.49E-05	2.36E-08	3.24E+00	BPB United Kingdom Ltd(2014)

3.5.4. Bricks

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Generic bricks	1 kg	1.58E-01	n/a	1.35E-03	5.00E-05	7.50E-05	n/a	2.84E+00	The Brick Development (2013)
Hollow bricks	1 kg	2.83E-01	8.08E-10	7.02E-04	8.50E-05	5.10E-05	3.40E-08	2.60E+00	Heluz (2015)
Proof wall and ceiling bricks	1 kg	1.89E-01	1.24E-12	2.55E-04	3.04E-05	2.69E-05	1.38E-08	1.95E+00	Ziegel (2014)

3.5.5. Tiles

Material/Process	Functional unit	GWP (kg CO_2 eq)	ODP (kg CFC11 eq)	AP (kg SO_2 eq)	EP (kg PO_4^{3-} eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ)	Data source
Floor tiles	1 kg	4.40E-01	2.81E-08	1.45E-03	4.61E-04	7.49E-05	3.57E-07	6.79E+00	Seranit (2015a)
Wall tiles	1 kg	7.02E-01	4.30E-08	1.93E-03	5.38E-04	1.16E-04	3.33E-07	9.82E+00	Seranit (2015b)
Ceiling tiles	1 kg	6.36E-01	5.64E-08	6.36E-04	4.55E-04	4.73E-03	1.05E-06	1.15E+01	Rockwool Rockfon Norway (2015)
Porcelain Tiles	1 kg	7.13E-01	4.18E-08	2.59E-03	9.24E-04	1.24E-04	0.00E+00	1.09E+01	Seranit (2015c)

4. DISCUSSION AND CONCLUSIONS

The action B1 is aimed at developing a database with environmental data to feed the GUF Tool. The environmental data have already been collected and/or calculated, including environmental profiles for materials/processes related to urban furniture products including wood and wood-based materials, metals, plastics, rubbers, and building materials. These are LCA-based factors (incl. global warming, acidification, ozone depletion, etc.), which were obtained and/or calculated based on data from EPDs, eco-profiles, open LCA databases, literature, etc. These data were treated to be consistent with the needs of the target users, but further simplification is still required to achieve a high usability of the GUF Tool.

Simplification measures were proposed (in action B2), and these must be based on the results from the LCA studies conducted (in action B1) during the next months based on field data provided by urban furniture manufacturers. These simplifications measures include:

- Reduction of the number of environmental indicators: seven environmental indicators (or impact categories) have been collected but these could be reduced to only those more relevant and understandable by tool users; e.g., climate change, depletion of fossil resources, and other demonstrated to be especially relevant, or integrating them into single indicators.
- Reduction of the number of materials/processes: these are being aggregated into a manageable number for the user; e.g., 3-4 categories for the most used wood-based materials plus another category covering the rest of wood-based materials.
- Inclusion of only those processes/stages with significant environmental impact.
- Some measures to simplify the data entry by tool users are also being investigated (in Action B2), like the use of different formats to import data directly provided by manufacturers/suppliers; e.g., spreadsheets, BIM format, etc.

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