

ENVIRONMENTAL PRODUCT DECLARATION (EPD) EcoCocon Straw Modules (Panels)

Product:	EcoCocon Straw Modules (Panels)
Manufacturer/Owner:	UAB/Ltd EcoCocon, Odminių 10 - 9, Vilnius, Lithuania
Declared unit:	1 m ² of exterior wall panel
Reference year:	2016 - 2017
Assessment made by:	VTT Technical Research Centre of Finland Ltd, Vuorimiehentie 3 , FI-02044 VTT, Finland
Project reference no:	VTT-CRM-158424-18
Assessment dated:	
Validity:	5 year period from assessment date



The declaration is calculated on the bases of standards ISO 14025 and EN 15804:2012 + A1:2014. EPD's of construction products may not be comparable if they do not comply with these standards.

Verification:

CEN standard EN 15804 serves as the core Product Category Rules. Verification should be performed where appropriate by third party verifier according to the EN ISO 14025. Verification is optional for business-to-business communication but mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4).

Disclaimer:

The owner of the declaration is liable for the underlying information and documentation. VTT is not liable in regards to manufacturer information, life cycle assessment data and other evidences.

EPD declaration, general information

1 Product / system description

1.1 General product description

EcoCocon Straw Modules (Panels) are produced by EcoCocon UAD in Lithuania. The loadbearing, exterior wall panels are insulated with straw and used for modular construction. The modules are Passivhaus and Cradle to Cradle certified. The panels have a load bearing wooden construction that is filled with compressed straw. No additives have been added to straw or wood.

1.2 Placing on the market and making available on the market

Since there are currently no harmonized European standards for straw insulation products at the time of issue of this EPD, CE marking is not required. A National Technical Assessment (NTA) (approval number NTJ-01-061:2013) based on EU conform testing is available for the EcoCocon modules. Conformity of production is regularly controlled by third party, Inspecta UAB.

1.3 Applications

The EcoCocon Straw Modules are used for small and medium sized buildings, for exterior, insulated and loadbearing wall segments. The walls are later covered on the inside with a clay plaster of gypsum based dry board and on the outside protected by a vapour permeable membrane and woodfibre board. The final facade can be plastered or a ventilated facade can be installed. In this EPD only the panels themselves are considered, without any other layers inside or outside.

1.4 Technical data

Fire resistance tests have been made on a clay plastered (interior) and wood fibre covered (exterior) wall segment 3x3 m. The achieved values were REI120 from the interior and REIef120 from exterior side.

Panels have at all times be protected from direct contact with water.

Table 1: Technical data of the declared straw panel according to NTJ-01-061:2013

Property	Value
Load-bearing capacity:	22-36 kN/m - see Technical Assessment for details
Class of reaction-to-fire performance:	B-s1,d0
Thermal resistance RD:	8.1 (m ² K)/W
Airborne sound insulation indicator RW (C; Ctr; C100-5000):	54 (-1;-3;0) dB

1.5 Delivery options

The panels come in five different types. All panels have a thickness of 40cm. The modules can individually be produced to demanded measures, depending on the project. See Planning Guide for details:

Table 2: Types and sizes of different panels

Designation	Minimum size in cm (W x H)	Maximum size in cm (W x H)
Standard panels	40 x 40	120 x 300
Braced panels	60 x 200	120 x 300
Column panel	40 x 40	55 x 300
Inclined panel (min 5° - max 45°)	20 x 40	120 x 300
Sill panel	120 x 40	300 x 120
Lintel panel	60 x 40	300 x 120

1.6 Declared unit

The declared unit is 1 square meter of EcoCocon Straw Panel.

1.7 Average formation

To be able to achieve an average value per m² for the different types of panel, two values have been taken into account: (a) Average % of panel types delivered during the last two years and (b) average use of materials in one type of panel

Table 3: Production of panel types during 2016-2017 in %

Panel type	% produced wall surface during 2016-2017
Standard panels	52,5 %
Braced panels	17 %
Column Panels	4 %
Inclined panels	13 %
Sill panels	6 %
Lintel panels	7,5 %
	100 %

A separate Excel table has been produced to calculate material use for each type of panel. See attachment. Below the resulting average of used materials per m² adjusted by distribution based on table 4.

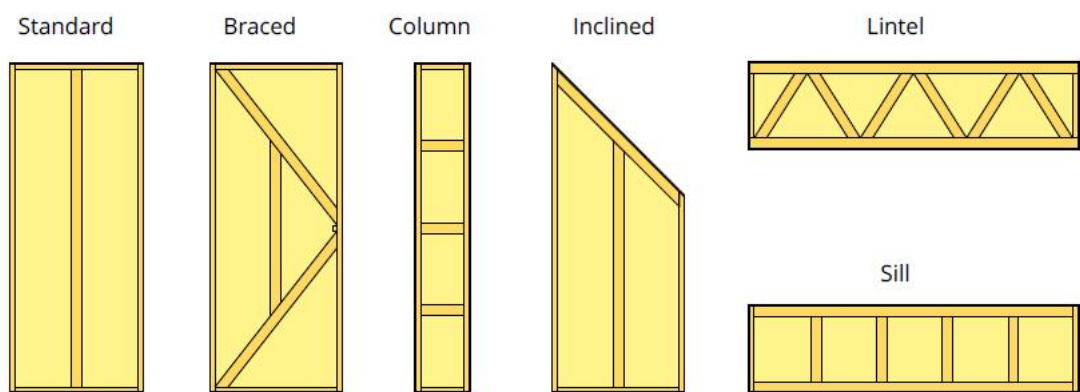


Figure 1. Wall panel types.

Table 4: Average use of materials per m2 of panel

Materials used	Volume, %	Weight, %	Weight, kg/m ²	Waste %	Weight (including wastes), kg/m ²
Wood	9.6 %	27.18 %	17.26	10 %	19.0
Plywood	1.6 %	6.52 %	4.35	10 %	4.79
Wood fibreboard	0.2 %	0.38 %	0.23	5 %	0.24
Straw	88.6 %	64.77 %	40.62	5 %	42.65
Screws	-	1.16 %	0.74	-	0.74
Total	100 %	100 %	63.2		66.19

2 Lifecycle description

2.1 Used materials

Material properties used for calculations based on values presented Table 5.

Table 5: Used materials

Designation	Value	Unit
Wood C24	350	kg/m ³
Wheat and Rye straw nominal density	110	kg/m ³
Straw nominal/max. humidity	15/20	%
Plywood (used)	640-700 (670)	kg/m ³
Wood fibre board	270	kg/m ³
Screws	Carbon steel, martensitic stainless steel, nickel coated	

2.2.1 WOOD

The wood is FSC certified C24 quality. The wood is purchased from SIA Baltic Wood Trading with production ready dimensions 95 x 45mm and 45 x 45mm. We estimate the transport distances to be 196 km from local seller. In production the wood is only cut to correct length. We estimate that there is about 10 % waste. The leftovers are used for heating during winter.

As SIA Baltic Wood Trading has no EPD's published, environmental impacts caused from the use of wood, based on the Stora Enso Classic sawn production and EPD. It covers 90% of Stora Enso sawn timber production in Europe, among the others also some Baltic countries is included. It is assumed that this EPD (EPD Classic Sawn) represents also situation for Lithuania.

2.2.2 STRAW

Straw is purchased in the form of round bales from local producers and stored in a non-heated warehouse during the rest of the year. The round bales are wrapped on the round side with a thin Polypropylene lacing holding the straw together.

The straw is checked for moisture content during harvest, storing and production, and must not exceed 20% rel. moisture content. Nominal value is approx. 15%.

The straw is moved between storage and production onsite with a forklift. The remaining machinery for the production of the panels is electrical. In wall production straw waste is 5 %, this is based on the estimation. The leftovers are used for heating during winter. The polypropylene lacing of the round bales is returned for recycling.

It was assumed that there were no location-dependent differences in the cultivation and harvest of cereals within EU. As round bales are closer to large bales, we would estimate the PEI for pressing straw bales would be in worst case scenario 59,1 kWh/t or for an ideal scenario 39,5 kWh/t. This assumption based on the literature (Krick 2008). And thus the assessment considers to use average PEI 50 kWh/t.

Other processes that are directly connected with food production is not been taken into account. Straw is used as a waste product.

The calorific value of the straw (15% moisture) at end of life through incinerating is 14.4 MJ/kg or 4032 kWh/t (Source: Teagasc).

2.2.3 PLYWOOD

The plywood is cut to dimensions from large boards on site. All tools are electrical. The Plywood is purchased from Trukme Latvia Finieris and transport is estimated to be up to 87 km from local seller. In wall production plywood waste is 10 %, this is based on the estimation. The leftovers are used for heating during winter.

Environmental impacts, caused from the use of plywood, based on the MetsäWood EPD: which including material sourcing, raw material transportation, raw material use and production operations (EPD MetsäWood Spruce Plywood).

2.2.4 WOODFIBREBOARD

Wood fibre board is cut to size on site. Used tools are electrical. As very small amounts are used, the wood-fibre boards are taken from other deliveries to building sites. The transport is in that case negligible. We estimate that there is about 5 % waste. The leftovers are used for heating during winter.

Environmental impacts, caused from the use of wood fibre board, based on STEICO SE production (EPD for Wood fibre insulation materials).

2.2.5 SCREWS

The screws are delivered ready for use to the production site. The screws are delivered by Ottensten (194 km) in Lithuania but produced by Eurotec. However, the transportation distance is taking into account from manufacturing site Eurotec (Belgium, Venlo) and the distance to the Lithuania, wall manufacturing site (Kybartu) is 1484 km. Material for screws is a hot-dip galvanized steel. There is no waste.

2.3 Panel production

The production facility is 100% electrical. Heating is supported by waste burning ovens in winter.

Table 6: Use of energy in production per year (for 3000 m² panels produced).

Energy type	Value per year	Value per wall-m ²
Electricity for machinery, lighting and IT (kWh)	9200	3.054
Fuel for forklift (diesel) (litre)	50	0.017
Fuel for forlift (natural gas) (litre)	80	0.027
Biomass oven for heating	Only waste materials from production is burned	

2.4 Packaging and Transport

Storage of raw materials, production of EcoCocon panels and their storage before delivery is limited to a local production site. No water is used at all for production. Some water is used for sanitary means for the workers. Finished panels are stored until delivery in a non-heated warehouse. The transport of panels to and from the onsite storage is provided with a forklift.

The panels are not separately packed - during loading on a transporter wooden sticks are used to put the panels on. Approx. 0.4 m³ of wood is used for 140 m² of panels in one lorry. That is approx. 1.3 kg low quality wood per m² of panel. This wood is also used for storage of panels on building site and probably used for heating after end of use.

The panels are loaded with a forklift in covered trucks and delivered from production directly to the building site. As the building sites can be anywhere in Europe, the transport CO₂ emissions can vary a great deal. We have developed a calculation tool for transport emissions that takes into consideration type of transport, loading capacity of lorry and distance to building site. See attached excel calculation tool. **However this assessment uses 100 km distance for the building site as the assumption.**

3 Life Cycle Assessment

3.1 Assessed Life cycle phases and parameters

Environmental product declaration covers life cycle assessment for EcoCocon Straw Panel according to the life cycle phases presented in Table 7 and impacts in Table 8.

Table 7. Life cycle phases covered in this assessment (EN 15804 + A1).

Phase		Description	
Product Phase	A1	Provision of raw materials	X
	A2	Transport of raw materials	X
	A3	Production	X
Construction Phase	A4	Transport to the construction site	X
	A5	Installation	X
Use phase	B1-B7	*no relevant material and energy flows	X
End of Life Phase	C1	Dismantling	X
	C2	Transport for waste treatment	X
	C3	Waste management	X
	C4	Waste disposal	X
Information module	D		X

Note: X = included in life cycle assessment; MND = module not declared as related to the specific building properties.

The impact assessment phase of LCA is aiming at evaluating the significance of potential environmental impacts using the LCI results. LCA result considers parameters, which are describing environmental impacts, resource use, different waste categories and other environmental information like components for re-use, and recycling.

Table 8. Life cycle phases covered in this assessment (EN 15804 + A1).

Environmental impact	<ul style="list-style-type: none"> • depletion of abiotic resources (fossil) (ADP fossils), • depletion of abiotic resources (elements) (ADP elements), • acidification of soil and water (AP), • ozone depletion (ODP), • global warming (GWP), • eutrophication (EP), • photochemical ozone creation (POCP).
Resource use	<ul style="list-style-type: none"> • Use of renewable primary energy excluding renewable primary energy resources used as raw materials (PERE), • Use of renewable primary energy resources used as raw materials (PERM),

	<ul style="list-style-type: none"> · Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT), · Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials (PENRE), · Use of non-renewable primary energy resources used as raw materials (PENRM), · Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT), · Use of secondary material (SM), · Use of renewable secondary fuels (RSF), · Use of non-renewable secondary fuels (NRSF), · Net use of fresh water (FW).
Waste categories	<ul style="list-style-type: none"> · Hazardous waste, (HWD), · non-hazardous and (NHWD), · radioactive waste disposed (RWD).
Other parameters	<ul style="list-style-type: none"> · Components for re-use (CRU), · Materials for recycling (MFR), · Materials for energy recovery (MER), · Exported electricity (EEE), · Exported heat (EEH).

3.2 Lifecycle information for the Life Cycle Assessment

3.2.1 PRODUCTION PHASE

Provision of raw materials (A1)

The raw materials needed for food production such as seeds, fertilisers and pesticides are not considered for the straw used in the product. The generic data used [Krick 2008] includes baling, PP lacing and transport to production site. The reclamation of the agricultural area remains unconsidered, a possible later renaturation is outside the considered system. For other used materials, such as wood, plywood, wood-fibre board and screws generic data set from EPD's has been used.

Transport of raw materials (A2)

The straw bales are transported from the field to the production site by tractor and then with a lorry. Transport from producer of other materials (wood, plywood, screws) to production site are included. Other transports in the upstream chains of separate producers are included in the generic data used for these materials.

Wall Panel Production (A3)

Based on the data from EcoCocon wall panel production year 2016 - 2017.

3.2.2 TRANSPORT AND INSTALLATION PHASE

Transport of wall panels (A4)

Panel lifting time for transport is supplied by manufacture and diesel consumption is estimated according to the forklift type machinery use per hour.

The EcoCocon panels are transported to the customer by the manufacturer usually with large trailer. The transport to building site is calculated for the assumed building site distance 100 km. However, the user of this EPD should understand that building sites could be located in very different distances than used here.

It is assumed that no material losses occur during transport.

Installation (A5)

The panels are unloaded with a Manitou forklift or crane. Panels can easily be moved by hand on the ground floor to their exact installation point. We calculate 5 hours for unloading of one truck (140 m²) and installation. That is 0.036 h/m² in average.

3.2.2 USE PHASE (B1 - B7)

During the use phase (stages B1 Use, B2 Maintenance and B3 Repair), there are no material and energy flows that are relevant for this product group assessment. The stage B4 replacement is synonymous with the product life. There are no material and energy flows when removing the product. Stages B5 conversion / renewal, B6 energy use and B7 water use are not applicable at insulation level.

The reference service life is determined by the service life catalogue of EcoCocon for at least 50 years.

3.2.3 END OF LIFE (C1 - C4)

Reuse or recycling does not take place under the current economic and technical conditions. As there are no harmful substances in the EcoCocon panels, landfill or incineration for co-generation of heat and electricity or the use in biogas plants is possible, depending on availability and legislation in the respective countries.

De-construction (C1)

The EcoCocon panels are screwed together and will need to be removed with force. After cables, windows and other materials are removed, we expect the wall being demolished with force, including inside and outside layers.

Transport for waste treatment (C2)

At the end of the use phase and deconstruction, the product, production wastes and wooden sticks, used in transportation transported by truck to the utilization plant. The mean transport distance was assumed to be 150 km.

Waste management (C3)

The most likely scenario for EcoCocon panels at the end of use is the thermal utilisation in a waste incineration plant. C3 takes into account waste preparing for the incineration and combustion.

Waste disposal (C4)

The sorting of residue (metals, burnt clay) and landfilling of the ashes after thermal utilisation is assumed to be extremely low and not accounted.

3.2.4 REUSE, RECOVERY AND RECYCLING POTENTIAL (D)

The product is sent for thermal utilization at the end of its useful life and declared as, otherwise used, electricity substitution credit in the information module D. It is assumed that 75 % efficiency of waste to incineration would be achieved.

The credit will occur also from the material loss in module A5 and the polypropylene lacing (from straw bales) and screws removed and recycled.

4 Dangerous substances and emissions in indoor air and environment

4.1 Declaration of substances of very high concern

The considered raw construction bales have no hazardous substance properties listed in the table and are not classified.

The hazardous substances declarations from producers made during the Cradle to Cradle certification are the basis for this declaration:

Table 9: Declaration of hazardous substance properties.

Hazardous substance property according to EC regulation 1272/2008 (CLP regulation) Chemical name (CAS number)	CAS- Number
Carcinogenic Cat. 1A or 1B (H350)	not applicable
Genetic modification cat. 1A or 1B (H340): not applicable	not applicable
Reproductive hazard Cat. 1A or 1B (H360F)	not applicable
PBT (persistent)	not applicable
vPvB (highly persistent and strongly bio accumulating) (REACH)	not applicable
Substances of very high concern due to other properties (SVHV):	not applicable

Environmental performance

The EPD of Straw wall Panel includes the information about potential environmental impacts, use of resources, waste categories and other information like materials for re-use, -recycling, -energy production.

The declared environmental performance unit is 1 m²- of average straw wall without inner and outer covering materials. The construction and maintenance of factory building and related infrastructure have been excluded from the assessment.

Product phase (A1-A4) and construction phase (A4-A5)

Table 10. Parameters describing environmental impacts (Product stage and construction stage).

Parameter	Units in equiv.	A1	A2	A3	A1 -A3	A4	A5	A4 - A5
ADPE	kg Sb	3.78E-03	0	5.20E-03	8.99E-03	0	0	0
ADPF	MJ	99.2	3.25	37.6	140	3.82	1.31	5.1
AP	kg SO ₂	0.351	5.95E-04	8.94E-03	0.361	6.99E-04	1.86E-03	2.56E-03
ODP	kg CFC 11	4.13E-05	0	2.53E-07	4.15E-05	0	0	0
GWP*	kg CO ₂	-91.2	0.216	2.26	-88.7	2.53E-01	0.620	0.874
EP	kg(PO ₄) ³⁻	0.0964	1.56E-04	1.95E-03	0.099	1.83E-04	4.86E-04	6.69E-04
POCP	kg C2H4	0.0293	3.33E-05	3.83E-04	0.0297	3.91E-05	1.85E-04	2.25E-04

Notes: ADPE = Depletion of abiotic resources-elements, ADPF = Depletion of abiotic resources-fossil fuels, AP = Acidification for soil and water, ODP = Ozone Depletion, GWP = Global Warming, EP = Eutrophication, POCP = Photochemical ozone creation.

* Wood materials storing CO₂ during the growth: wood 1.59 kg/kg, Plywood 1.69 kg/kg, straw 1.34 kg/kg and wood fibreboard 1.4 kg/kg. In total stored CO₂ is-97.6 kg

Table 11. Parameters describing resource use.

Parameter	Unit	A1	A2	A3	A1 -A3	A4	A5	A4 - A5
PERE	MJ	117	0	4.40	122	0	0	0
PERM	MJ	1033	0	0	448	0	0	0
PERT	MJ	537	0	4.40	541	0	0	0
PENRE	MJ	95	3.25	40.5	139	3.82	6.48	10.3
PENRM	MJ	12.7	0	1.48	14.2	0	0	0
PENRT	MJ	108	3.25	42.0	153	3.82	6.48	10.3
SM	kg	0	0	0	0	0	0	0
RSF	MJ	0	0	3.20E-05	3.20E-05	0	0	0
NRSF	MJ	0	0	5.33E-04	5.33E-04	0	0	0
FW	m3	6.04	0	8.55	14.6	0	0	0

Notes: PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PENRT = Total use of non-renewable primary energy resources, SM = Use of secondary material, RSF = Use of renewable secondary fuels, NRSF = Use of non-renewable secondary fuels, FW = Net use of fresh water.

Table 12. Other environmental information describing waste categories.

Parameter	Unit	A1	A2	A3	A1 -A3	A4	A5	A4 - A5
HWD	kg	9.13E-02	0	0	9.13E-02	0	0	0
NHWD	kg	4.41E-02	0	0	4.41E-02	0	0	0
RWD	kg	7.34E-03	0	0	7.34E-03	0	0	0

Notes: HWD = Hazardous waste disposed, NHWD = Non-hazardous waste disposed, RWD = Radioactive waste disposed

Table 13. Other environmental information describing output flows.

Parameter	Unit	A1	A2	A3	A1 -A3	A4	A5	A4 - A5
CRU	kg	0	0	7.42E-02	7.42E-02	0	0	0
MFR	kg	5.12E-02	0	4.20	4.25	0	0	0
MER	kg	2.59E-02	0	1.04E-03	2.69E-02	0	0	0
EEE	MJ	2.90E-02	0	0	2.90E-02	0	0	0
EET	MJ	0	0	0	0	0	0	0

Notes: CRU = Components for re-use, MFR = Materials for recycling, MER = Materials for energy recovery, EEE = Exported energy, electricity, EEH = Exported energy, heat

Use phase (B1-B7) and End of Life phase (C1-C4) and phase D

Table 14. Parameters describing environmental impacts.

Parameter	Units in equiv.	B1-B7	C1	C2	C3	C4	C1-C4	D
ADPE	kg Sb	0	3.43E-08	0	4.24E-06		4.27E-06	-3.64E-01
ADPF	MJ	0	6.18	5.98	16.4		28.51	-2503
AP	kg SO ₂	0	7.29E-04	1.09E-03	0.0697		7.16E-02	-1.59
ODP	kg CFC 11	0	8.06E-08	0	2.83E-07		3.64E-07	-4.58E-04
GWP	kg CO ₂	0	7.58E-02	0.397	98.6		99.09	-151
EP	kg(PO ₄) ³⁻	0	1.14E-04	2.87E-04	0.0375		0.038	-0.417
POCP	kg C ₂ H ₄	0	1.87E-05	6.12E-05	5.02E-03		5.10E-03	-0.115

Notes: ADPE = Depletion of abiotic resources-elements. ADPF = Depletion of abiotic resources-fossil fuels. AP = Acidification for soil and water. ODP = Ozone Depletion. GWP = Global Warming. EP = Eutrophication. POCP = Photochemical ozone creation.

Table 15. Parameters describing resource use.

Parameter	Units	B1-B7	C1	C2	C3	C4	C1-C4	D
PERE	MJ	0	2.34E-02	0	6.28		6.30	-308
PERM	MJ	0	0	0	-1032		-1032	0.00
PERT	MJ	0	2.34E-02	0	-1026		-1.03E+03	-308
PENRE	MJ	0	6.18	5.98	38.1		50.2	-2790
PENRM	MJ	0	0.00	0.00	-0.271		-0.27	-20.1
PENRT	MJ	0	6.18	5.98	37.8		49.9	-2810
SM	kg	0	0	0	0		0	0
RSF	MJ	0	0	0	0		0	0
NRSF	MJ	0	0	0	0		0	0
FW	m3	0	4.72E-04	0	0.0409		4.14E-02	-599

Notes: PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials. PERM = Use of renewable primary energy resources used as raw materials. PERT = Total use of renewable primary energy resources. PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials. PENRM = Use of non-renewable primary energy resources used as raw materials. PENRT = Total use of non-renewable primary energy resources. SM = Use of secondary material. RSF = Use of renewable secondary fuels. NRSF = Use of non-renewable secondary fuels. FW = Net use of fresh water.

Table 16. Other environmental information describing waste categories

Parameter	Units	B1-B7	C1	C2	C3	C4	C1-C4	D
HWD	kg	0	0	0	3.80E-05		3.80E-05	1.69E-02
NHWD	kg	0	0	0	1.48		1.48	2.71E-02
RWD	kg	0	0	0	3.26E-04		3.26E-04	3.30E-04

Notes: HWD = Hazardous waste disposed. NHWD = Non-hazardous waste disposed. RWD = Radioactive waste disposed

Table 17. Other environmental information describing output flows.

Parameter	Units	B1-B7	C1	C2	C3	C4	C1-C4	D
CRU	kg	0	0	0	0	0	0	0
MFR	kg	0	0	0	0.82	0	0.819	-0.819
MER	kg	0	0	0	68.0	0	68.0	-68.0
EEE	MJ	0	0	0	0	0	0	760
EET	MJ	0	0	0	0	0	0	0

Notes: CRU = Components for re-use. MFR = Materials for recycling. MER = Materials for energy recovery. EEE = Exported energy, electricity. EET = Exported energy, heat

References

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- ISO 14040:2006 Environmental management - Life Cycle Assessment.
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- ISO 14025:2010 Environmental labels and declarations - Type III environmental declarations - Principles and procedures
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