Statement of Verification

BREG EN EPD No.: 0000522 Issue 01

This is to verify that the

Environmental Product Declaration

provided by:

Mitsubishi Electric Europe BV - UK & Ireland

BRE Global Verified EPD

is in accordance with the requirements of:

EN 15804:2012+A1:2013

and

BRE Global Scheme Document SD207

This declaration is for:

Installation of an EHPT20X-MHEDW FTC6 Packaged Cylinder and either a 5 kW PUZ[1]WM50VHA (-BS), a 6 kW PUZ-WM60VAA (-BS), a 8.5 kW PUZ-WM85VAA (-BS), a 11.2 kW PUZ-WM112VAA (-BS) or a 14 kW PUZ-HWM140VHA (-BS) Heat Pump unit

Company Address

Mitsubishi Electric Europe BV - UK & Ireland

ecodan MITSUBISHI ELECTRIC

Signed for BRE Global Ltd	Emma Baker Operator	14 August 2023 Date of this Issue
14 August 2023 Date of First Issue		13 July 2028 Expiry Date

BRE Global Verified EPD

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ECO PLATFORM EPD VERIFIED

Environmental Product Declaration

EPD Number: 0000522

General Information

EPD Programme Operator	Applicable Product Category Rules
BRE Global Watford, Herts WD25 9XX United Kingdom	BRE Environmental Profiles 2013 Product Category Rules for Type III environmental product declaration of construction products to EN 15804:2012+A1:2013
Commissioner of LCA study	**LCA consultant/Tool**
Mitsubishi Electric Europe BV - UK & Ireland	Flavie Lowres on behalf of BRE/LINA
Functional Unit	**Applicability/Coverage**
1 combined unit to produce either 5, 6, 8.5, 11.2 or 14 kW of heating and hot water, according to the appropriate usage scenario defined in the EN 14825 standard and during the 17-year reference lifetime of the product.	Product Average.
EPD Type	**Background database**
Cradle to Gate with options	ecoinvent

Demonstration of Verification
CEN standard EN 15804 serves as the core PCR [a]
Independent verification of the declaration and data according to EN ISO 14025:2010 ☐Internal ☒ External
(Where appropriate [b])Third party verifier: Roger Connick
a: Product category rules b: Optional for business-to-business communication; mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4)

Comparability
Environmental product declarations from different programmes may not be comparable if not compliant with EN 15804:2012+A1:2013. Comparability is further dependent on the specific product category rules, system boundaries and allocations, and background data sources. See Clause 5.3 of EN 15804:2012+A1:2013 for further guidance

Information modules covered

Product			Construction		Use stage							End-of-life					Benefits and loads beyond the system boundary
					Related to the building fabric					Related to the building							
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
Raw materials supply	Transport	Manufacturing	Transport to site	Construction – Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal		Reuse, Recovery and/or Recycling potential
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☐	☐	☑	☑		☐

Note: Ticks indicate the Information Modules declared.

Manufacturing site(s)

The unit is manufacturing at the following sites

5kW, 6kW, 8.5kW, 11.2kW units	14kW unit
Mitsubishi Air Conditioning Systems Europe Ltd Nettlehill Road Houstoun Industrial Estate Livingston EH54 5EQ	Mitsubishi Electric Corporation Shizuoka Works Chome-18-1 Oshika Suruga Ward Shizuoka 422-8021 Japan

Construction Product:

Product Description

This EPD refers to the installation of a EHPT20X-MHEDW FTC6 Packaged Cylinder and either a 5 kW PUZ-WM50VHA (-BS), a 6 kW PUZ-WM60VAA (-BS), a 8.5 kW PUZ-WM85VAA (-BS), a 11.2 kW PUZ-WM112VAA (-BS) or a 14 kW PUZ-HWM140VHA (-BS). The data has been calculated for a single combined unit of each product. The system is an air to water monobloc technology for heating and domestic hot water supply.

Product image

Technical Information for reference product of capacity of 5 kW, 6 kW, 8.5 kW, 11.2 kW and 14 kW

Property	5 kW PUZ-WM50VHA (-BS)[1]	6 kW PUZ-WM60VAA (-BS)[2]	8.5 kW PUZ-WM85VAA (-BS)[3]	11.2 kW PUZ-WM112VAA (-BS)[4]	14 kW PUZ-HWM140VHA (-BS)[5]
Heating (A-7/W35) capacity	5 kW	6 kW	8.5 kW	11.2 kW	14 kW
Heating (A-7/W35) COP	3	3.2	2.6	3	2.45
Heating capacity	5 kWh	6 kWh	8.5 kWh	11.2 kWh	14 kWh
Heating SCOP (MCS) 35dC	4.62	4.18	4.84	4.74	4.33
Heating SCOP (MCS) 55dC	3.24	3.57	3.48	3.34	3.26
Refrigerant	R32	R32	R32	R32	R32

[1] Ecodan PUZ-WM50VHA Monobloc Air Source Heat Pump Product Information Sheet - Document Library - Mitsubishi Electric
[2] https://library.mitsubishielectric.co.uk/pdf/book/Ecodan_PUZ-WM60VAA_Monobloc_Air_Source_Heat_Pump_Product_Information_Sheet?model_query=PUZ-WM60VAA-BS#page-1-2
[3] PUZ-WM85VAA TM65 Embodied Carbon Calculation - Document Library - Mitsubishi Electric
[4] https://library.mitsubishielectric.co.uk/pdf/book/Ecodan_PUZ-WM112VAA_Monobloc_Air_Source_Heat_Pump_Product_Information_Sheet#page-1-2
[5] https://library.mitsubishielectric.co.uk/pdf/book/PUZ-HWM140VHA_-BS#page-1-2

Property	5 kW PUZ-WM50VHA (-BS)[6]	6 kW PUZ-WM60VAA (-BS)[7]	8.5 kW PUZ-WM85VAA (-BS)[8]	11.2 kW PUZ-WM112VAA (-BS)[9]	14 kW PUZ-HWM140VHA (-BS)[10]
Refrigerant Charge	2 kg	2.2 kg	2.2 kg	3 kg	3.3 kg
Hot Water Cylinder Volume	200 L	200 L	200 L	200 L	200 L
Product Weight without packaging	165 kg/unit	192 kg/unit	192 kg/unit	213 kg/unit	226 kg/unit

Main Product Contents

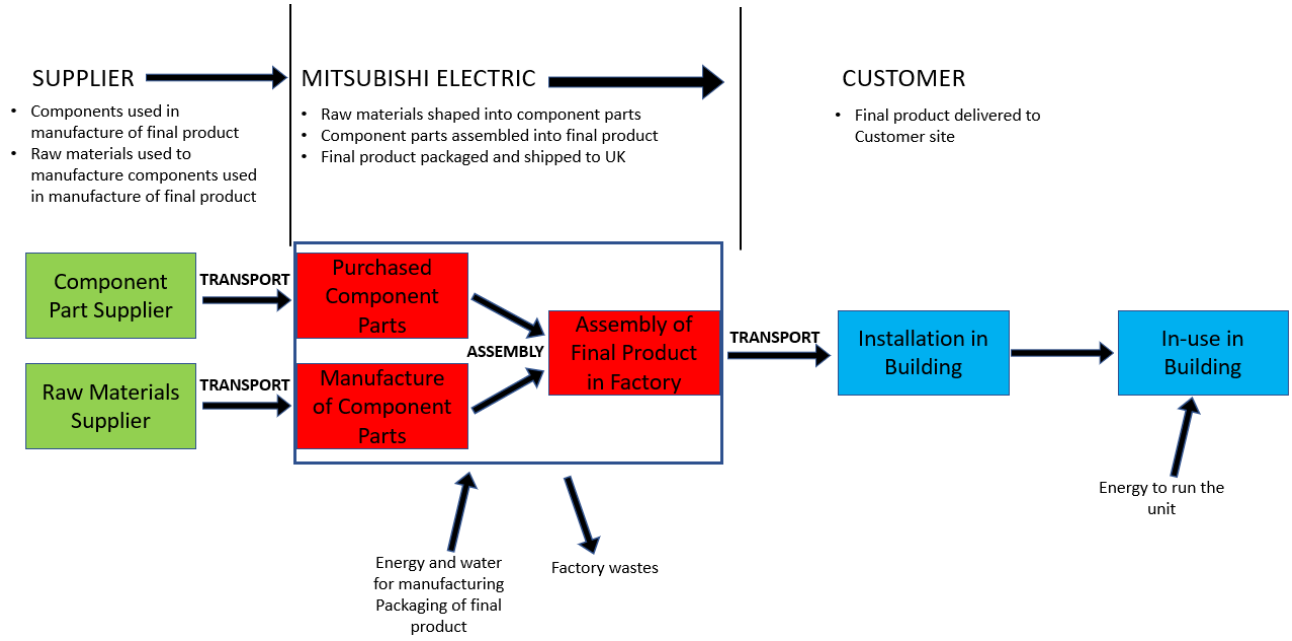
Material/Chemical Input	%
Steel	67-69% (80% for 14 kW)
Plastic and rubber	3-4% (9% for 14 kW)
Copper and brass	22-23% (10% for 14 kW)
Printed board	<1%
Magnet	<1%
Lubricating oil	<1%
Aluminium	<2%
Refrigerant	<1.5%

Manufacturing Process

An Air Source Heat Pump is made of components either directly manufactured and supplied by the manufacturer or components ready for assembly on site. The units are manufactured in Scotland (or Japan for the 14 kW unit) and distributed, installed and disposed of in UK and Ireland.

[6] Ecodan PUZ-WM50VHA Monobloc Air Source Heat Pump Product Information Sheet - Document Library - Mitsubishi Electric
[7] https://library.mitsubishielectric.co.uk/pdf/book/Ecodan_PUZ-WM60VAA_Monobloc_Air_Source_Heat_Pump_Product_Information_Sheet?model_query=PUZ-WM60VAA-BS#page-1-2
[8] PUZ-WM85VAA TM65 Embodied Carbon Calculation - Document Library - Mitsubishi Electric
[9] https://library.mitsubishielectric.co.uk/pdf/book/Ecodan_PUZ-WM112VAA_Monobloc_Air_Source_Heat_Pump_Product_Information_Sheet#page-1-2
[10] https://library.mitsubishielectric.co.uk/pdf/book/PUZ-HWM140VHA_-BS#page-1-2

Process flow diagram



Construction Installation

Products are manufactured in Livingston (or in Japan for the 14 kW unit) and distributed in the UK. The longest distance the unit can travel in the UK (1000 km) by lorry has been considered for this scenario.

The installation of the combined PUZ-WM50VHA, PUZ-WM60VAA, PUZ-WM85VAA, PUZ-WM112VAA or HWM140VHA heat pump and EHPT20X-MHEDW Tank requires the installation of a anti vibration fixing foot (recycled tyre).
The packaging of the units are disposed of during the installation of the combined units. Packaging includes (recycling rates from Defra: UK_stats_on_waste_dataset_July_2021_accessible_rev_v4.xlsx (live.com)):

- corrugated cardboard: 65.6% recycled
- polystyrene: 47.2% recycled
- plain wood: 44.1% recycled
- paper: 65.6% recycled
- plastic: 47.2% recycled

Use Information

B1: It was assumed that 3 g of refrigerant was leaked per year but that it was not replaced as it is a closed loop system.
B2: maintenance is carried out on a yearly basis and consist of a visual inspection of the unit.
B3: If the unit is installed and maintained yearly in accordance with the manufacturer's requirements, the unit should not require repair throughout its reference lifetime.
B4: the unit has a reference lifetime of 17 years and therefore no replacement is required providing the unit has been installed and maintained in accordance with the manufacturer's requirement.
B5: the unit has a reference lifetime of 17 years and therefore no refurbishment is required providing the unit has been installed and maintained in accordance with the manufacturer's requirement.
B6: the energy required to operate the unit was considered.
B7: the unit is sealed. the water runs through the system to be heated and then fed back into the system. there is therefore no water input into the unit.

End of Life

C3: 65% of the refrigerant was reused at the end of the unit's life
C4: No information was provided, so a conservative estimate was made. It was assumed the following: 70% of metal and 50% of the plastics are recycled.

Life Cycle Assessment Calculation Rules

Functional unit description

1 combined unit to produce either 5, 6, 8.5, 11.2 or 14 kW of heating and hot water, according to the appropriate usage scenario defined in the EN 14825 standard and during the 17-year reference lifetime of the product.

System boundary

In accordance with the modular approach as defined in EN15804:2012+A1:2013, this cradle-to-gate with options EPD includes the processes covered in the manufacturing site and product stage A1 to A3, use stage B1-B7 and disposal stage C3 and C4.

Data sources, quality and allocation

Specific primary data derived from the manufacturing of PUZ-WM50VHA, PUZ-WM60VAA, PUZ-WM85VAA, PUZ-WM112VAA or HWM140VHA heat pump and EHPT20X-MHEDW tank process in Livingston, UK factory (and in Japan for the 14 kW unit) have been modelled using Simapro v9.1 LCA software and the BRE LINA database v2.0.73 and data collected during the period of .1st April 2021 to 31st March 2022. In accordance with the requirements of EN15804, the most current available data has been used. The manufacturer-specific data for one unit of each. Secondary data has been obtained for all other upstream and downstream processes that are beyond the control of the manufacturer (i.e. raw material production) from the ecoinvent 3.2 database. All ecoinvent datasets are complete within the context used and conform to the system boundary and the criteria for the exclusion of inputs and outputs, according to the requirements specified in EN15804. The quantities of materials have been calculated based on the components used in the unit. The amount of water, energy and waste was allocated to each product based on the total number of units manufactured.

Specific UK datasets have been selected from the ecoinvent LCI for this LCA (Japan dataset for energy were used for the 14 kW unit). The quality level of geographical and technical representativeness is therefore good. The quality level of time representativeness is good as the background LCI datasets are based on ecoinvent v3.2 which was compiled in 2015. Therefore, there is approximately 5-6 years between the ecoinvent LCI reference year and the time period for which the LCA was undertaken.

Cut-off criteria

The impact of the storage tank has been included. Transport distances to site were calculated as the distance from the supplier of the component to the UK (or in Japan for the 14 kW unit).

LCA Results for reference unit of capacity of PUZ-WM50VHA

(MND = module not declared; MND = module not declared; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP	ODP	AP	EP	POCP	ADPE	ADPF
			kg CO_2 equiv.	kg CFC 11 equiv.	kg SO_2 equiv.	kg $(PO_4)^{3-}$ equiv.	kg C_2H_4 equiv.	kg Sb equiv.	MJ, net calorific value.
Product stage	Raw material supply	A1	1.18E+03	1.91E-02	1.85E+01	1.06E+01	1.35E+00	1.15E-01	1.42E+04
	Transport	A2	1.09E+01	1.85E-06	1.71E-01	2.05E-02	1.30E-02	1.13E-05	1.59E+02
	Manufacturing	A3	-1.25E+01	4.35E-06	2.37E-01	6.70E-02	3.44E-02	1.31E-04	8.54E+02
	Total (of product stage)	A1-3	1.18E+03	1.91E-02	1.89E+01	1.07E+01	1.40E+00	1.15E-01	1.52E+04
Construction process stage	Transport	A4	2.76E+01	5.08E-06	9.23E-02	2.43E-02	1.61E-02	7.27E-05	4.17E+02
	Construction	A5	1.69E+01	1.25E-06	5.56E-02	6.80E-02	1.42E-02	4.02E-04	3.33E+02
Use stage	Use	B1	3.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	4.01E+04	2.60E-03	2.17E+02	4.99E+01	1.24E+01	4.84E-02	6.17E+05
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	5.56E+00	2.93E-07	5.23E-03	4.78E-02	1.39E-03	3.65E-06	1.72E+01

GWP = Global Warming Potential;
ODP = Ozone Depletion Potential;
AP = Acidification Potential for Soil and Water;
EP = Eutrophication Potential;
POCP = Formation potential of tropospheric Ozone;
ADPE = Abiotic Depletion Potential – Elements;
ADPF = Abiotic Depletion Potential – Fossil Fuels;

LCA Results (continued) for reference unit of capacity of PUZ-WM50VHA

Parameters describing resource use, primary energy								
			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	1.97E+03	1.30E-01	1.97E+03	1.53E+04	2.54E+02	1.55E+04
	Transport	A2	3.36E+00	5.25E-06	3.36E+00	1.61E+02	0.00E+00	1.61E+02
	Manufacturing	A3	8.85E+02	1.21E-03	8.85E+02	1.03E+03	0.00E+00	1.03E+03
	Total (of product stage)	A1-3	2.86E+03	1.31E-01	2.86E+03	1.65E+04	2.54E+02	1.67E+04
Construction process stage	Transport	A4	5.53E+00	2.06E-05	5.53E+00	4.14E+02	0.00E+00	4.14E+02
	Construction	A5	9.94E+00	1.23E-04	9.94E+00	3.41E+02	0.00E+00	3.41E+02
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	5.34E+04	9.63E-02	5.34E+04	8.22E+05	0.00E+00	8.22E+05
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.61E+00	1.46E-06	1.61E+00	1.81E+01	0.00E+00	1.81E+01

PERE = Use of renewable primary energy excluding renewable primary energy 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 resource

LCA Results (continued) for reference unit of capacity of PUZ-WM50VHA

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	5.46E-03	0.00E+00	0.00E+00	2.07E+01
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	3.73E-02
	Manufacturing	A3	0.00E+00	0.00E+00	0.00E+00	3.91E-01
	Total (of product stage)	A1-3	5.46E-03	0.00E+00	0.00E+00	2.11E+01
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	9.03E-02
	Construction	A5	0.00E+00	0.00E+00	0.00E+00	2.12E-01
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	1.64E+02
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	1.98E-02

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued) for reference unit of capacity of PUZ-WM50VHA

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	3.40E+02	1.00E+02	3.64E-02
	Transport	A2	6.68E-02	2.47E+00	1.08E-03
	Manufacturing	A3	3.90E-01	2.24E+00	4.47E-03
	Total (of product stage)	A1-3	3.40E+02	1.05E+02	4.20E-02
Construction process stage	Transport	A4	1.75E-01	1.94E+01	2.87E-03
	Construction	A5	1.25E-01	1.56E+01	1.35E-03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	9.39E+01	1.00E+03	4.53E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	MND	MND	MND
	Transport	C2	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.05E+00	5.71E+01	1.16E-04

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued) for reference unit of capacity of PUZ-WM50VHA

Other environmental information describing output flows – at end of life						
			CRU	MFR	MER	EE
			kg	kg	kg	MJ per energy carrier
Product stage	Raw material supply	A1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Manufacturing	A3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
	Total (of product stage)	A1-3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	1.44E+01	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	1.40E+00	1.17E+02	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	0.00E+00

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

LCA Results for reference unit of capacity of PUZ-WM60VAA

(MND = module not declared; MND = module not declared; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP	ODP	AP	EP	POCP	ADPE	ADPF
			kg CO_2 equiv.	kg CFC 11 equiv.	kg SO_2 equiv.	kg $(PO_4)^{3-}$ equiv.	kg C_2H_4 equiv.	kg Sb equiv.	MJ, net calorific value.
Product stage	Raw material supply	A1	1.35E+03	2.02E-02	2.07E+01	1.18E+01	1.52E+00	1.26E-01	1.64E+04
	Transport	A2	1.18E+01	2.01E-06	1.81E-01	2.19E-02	1.39E-02	1.27E-05	1.72E+02
	Manufacturing	A3	-1.97E+01	4.54E-06	2.45E-01	7.07E-02	3.73E-02	1.44E-04	8.84E+02
	Total (of product stage)	A1-3	1.34E+03	2.02E-02	2.11E+01	1.19E+01	1.57E+00	1.26E-01	1.75E+04
Construction process stage	Transport	A4	3.21E+01	5.91E-06	1.07E-01	2.83E-02	1.87E-02	8.45E-05	4.85E+02
	Construction	A5	1.76E+01	1.25E-06	5.59E-02	7.51E-02	1.43E-02	4.02E-04	3.33E+02
Use stage	Use	B1	3.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	4.27E+04	2.76E-03	2.31E+02	5.31E+01	1.32E+01	5.15E-02	6.57E+05
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	5.74E+00	3.19E-07	5.69E-03	4.84E-02	1.47E-03	3.90E-06	1.89E+01

GWP = Global Warming Potential;
ODP = Ozone Depletion Potential;
AP = Acidification Potential for Soil and Water;
EP = Eutrophication Potential;
POCP = Formation potential of tropospheric Ozone;
ADPE = Abiotic Depletion Potential – Elements;
ADPF = Abiotic Depletion Potential – Fossil Fuels;

LCA Results (continued) for reference unit of capacity of PUZ-WM60VAA

Parameters describing resource use, primary energy								
			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	2.34E+03	1.40E-01	2.34E+03	1.76E+04	2.52E+02	1.79E+04
	Transport	A2	3.61E+00	5.77E-06	3.61E+00	1.74E+02	0.00E+00	1.74E+02
	Manufacturing	A3	1.00E+03	1.29E-03	1.00E+03	1.07E+03	0.00E+00	1.07E+03
	Total (of product stage)	A1-3	3.34E+03	1.41E-01	3.34E+03	1.88E+04	2.52E+02	1.91E+04
Construction process stage	Transport	A4	6.44E+00	2.40E-05	6.44E+00	4.82E+02	0.00E+00	4.82E+02
	Construction	A5	9.97E+00	1.23E-04	9.97E+00	3.42E+02	0.00E+00	3.42E+02
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	5.68E+04	1.03E-01	5.68E+04	8.75E+05	0.00E+00	8.75E+05
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.73E+00	1.56E-06	1.73E+00	1.98E+01	0.00E+00	1.98E+01

PERE = Use of renewable primary energy excluding renewable primary energy 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 resource

LCA Results (continued) for reference unit of capacity of PUZ-WM60VAA

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	5.20E-03	0.00E+00	0.00E+00	2.33E+01
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	4.04E-02
	Manufacturing	A3	0.00E+00	0.00E+00	0.00E+00	4.77E-01
	Total (of product stage)	A1-3	5.20E-03	0.00E+00	0.00E+00	2.38E+01
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	1.05E-01
	Construction	A5	0.00E+00	0.00E+00	0.00E+00	2.13E-01
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	1.75E+02
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	2.17E-02

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued) for reference unit of capacity of PUZ-WM60VAA

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	4.26E+02	1.22E+02	4.16E-02
	Transport	A2	7.24E-02	2.82E+00	1.18E-03
	Manufacturing	A3	4.28E-01	2.42E+00	4.60E-03
	Total (of product stage)	A1-3	4.27E+02	1.27E+02	4.74E-02
Construction process stage	Transport	A4	2.03E-01	2.26E+01	3.34E-03
	Construction	A5	1.25E-01	1.76E+01	1.36E-03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	9.99E+01	1.06E+03	4.82E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND
	Transport	C2	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.12E+00	6.47E+01	1.27E-04

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued) for reference unit of capacity of PUZ-WM60VAA

Other environmental information describing output flows – at end of life						
			CRU	MFR	MER	EE
			kg	kg	kg	MJ per energy carrier
Product stage	Raw material supply	A1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Manufacturing	A3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
	Total (of product stage)	A1-3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	1.65E+01	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	1.48E+00	1.34E+02	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	0.00E+00

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

LCA Results for reference unit of capacity of PUZ-WM85VAA

(MND = module not declared; MND = module not declared; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP	ODP	AP	EP	POCP	ADPE	ADPF
			kg CO_2 equiv.	kg CFC 11 equiv.	kg SO_2 equiv.	kg $(PO_4)^{3-}$ equiv.	kg C_2H_4 equiv.	kg Sb equiv.	MJ, net calorific value.
Product stage	Raw material supply	A1	1.41E+03	2.02E-02	2.12E+01	1.21E+01	1.61E+00	1.33E-01	1.73E+04
	Transport	A2	1.22E+01	2.07E-06	1.88E-01	2.27E-02	1.44E-02	1.29E-05	1.77E+02
	Manufacturing	A3	-1.94E+01	4.58E-06	2.45E-01	7.07E-02	3.73E-02	1.44E-04	8.89E+02
	Total (of product stage)	A1-3	1.40E+03	2.02E-02	2.16E+01	1.22E+01	1.66E+00	1.33E-01	1.84E+04
Construction process stage	Transport	A4	3.21E+01	5.91E-06	1.07E-01	2.83E-02	1.87E-02	8.45E-05	4.85E+02
	Construction	A5	1.76E+01	1.25E-06	5.59E-02	7.51E-02	1.43E-02	4.02E-04	3.33E+02
Use stage	Use	B1	3.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	5.83E+04	3.78E-03	3.16E+02	7.25E+01	1.80E+01	7.04E-02	8.98E+05
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	7.56E+00	3.28E-07	6.05E-03	5.98E-02	1.84E-03	3.98E-06	1.96E+01

GWP = Global Warming Potential;
ODP = Ozone Depletion Potential;
AP = Acidification Potential for Soil and Water;
EP = Eutrophication Potential;
POCP = Formation potential of tropospheric Ozone;
ADPE = Abiotic Depletion Potential – Elements;
ADPF = Abiotic Depletion Potential – Fossil Fuels;

LCA Results (continued) for reference unit of capacity of PUZ-WM85VAA

Parameters describing resource use, primary energy								
			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	2.43E+03	1.47E-01	2.43E+03	1.86E+04	2.52E+02	1.89E+04
	Transport	A2	3.73E+00	5.91E-06	3.73E+00	1.79E+02	0.00E+00	1.79E+02
	Manufacturing	A3	1.00E+03	1.29E-03	1.00E+03	1.07E+03	0.00E+00	1.07E+03
	Total (of product stage)	A1-3	3.43E+03	1.48E-01	3.43E+03	1.98E+04	2.52E+02	2.01E+04
Construction process stage	Transport	A4	6.44E+00	2.40E-05	6.44E+00	4.82E+02	0.00E+00	4.82E+02
	Construction	A5	9.97E+00	1.23E-04	9.97E+00	3.42E+02	0.00E+00	3.42E+02
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	7.76E+04	1.40E-01	7.76E+04	1.20E+06	0.00E+00	1.20E+06
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.79E+00	1.72E-06	1.79E+00	2.06E+01	0.00E+00	2.06E+01

PERE = Use of renewable primary energy excluding renewable primary energy 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 resource

LCA Results (continued) for reference unit of capacity of PUZ-WM85VAA

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	5.20E-03	0.00E+00	0.00E+00	2.48E+01
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	4.16E-02
	Manufacturing	A3	0.00E+00	0.00E+00	0.00E+00	4.80E-01
	Total (of product stage)	A1-3	5.20E-03	0.00E+00	0.00E+00	2.53E+01
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	1.05E-01
	Construction	A5	0.00E+00	0.00E+00	0.00E+00	2.13E-01
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	2.39E+02
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	2.26E-02

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued) for reference unit of capacity of PUZ-WM85VAA

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	4.30E+02	1.26E+02	4.42E-02
	Transport	A2	7.46E-02	2.85E+00	1.21E-03
	Manufacturing	A3	4.29E-01	2.42E+00	4.61E-03
	Total (of product stage)	A1-3	4.31E+02	1.31E+02	5.00E-02
Construction process stage	Transport	A4	2.03E-01	2.26E+01	3.34E-03
	Construction	A5	1.25E-01	1.76E+01	1.36E-03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	1.37E+02	1.45E+03	6.59E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND
	Transport	C2	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.12E+00	6.69E+01	1.34E-04

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued) for reference unit of capacity of PUZ-WM85VAA

Other environmental information describing output flows – at end of life						
			CRU	MFR	MER	EE
			kg	kg	kg	MJ per energy carrier
Product stage	Raw material supply	A1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Manufacturing	A3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
	Total (of product stage)	A1-3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	1.65E+01	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	1.48E+00	1.33E+02	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	0.00E+00

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

LCA Results for reference unit of capacity of PUZ-WM112VAA

(MND = module not declared; MND = module not declared; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP	ODP	AP	EP	POCP	ADPE	ADPF
			kg CO_2 equiv.	kg CFC 11 equiv.	kg SO_2 equiv.	kg $(PO_4)^{3-}$ equiv.	kg C_2H_4 equiv.	kg Sb equiv.	MJ, net calorific value.
Product stage	Raw material supply	A1	1.51E+03	2.67E-02	2.26E+01	1.29E+01	1.65E+00	1.36E-01	1.79E+04
	Transport	A2	1.35E+01	2.29E-06	2.11E-01	2.53E-02	1.61E-02	1.39E-05	1.96E+02
	Manufacturing	A3	-1.97E+01	4.54E-06	2.45E-01	7.07E-02	3.73E-02	1.44E-04	8.84E+02
	Total (of product stage)	A1-3	1.50E+03	2.67E-02	2.31E+01	1.30E+01	1.70E+00	1.36E-01	1.90E+04
Construction process stage	Transport	A4	3.56E+01	6.56E-06	1.19E-01	3.14E-02	2.08E-02	9.38E-05	5.38E+02
	Construction	A5	1.76E+01	1.25E-06	5.59E-02	7.51E-02	1.43E-02	4.02E-04	3.33E+02
Use stage	Use	B1	3.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	6.90E+04	4.47E-03	3.74E+02	8.59E+01	2.13E+01	8.34E-02	1.06E+06
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	7.13E+00	3.94E-07	6.86E-03	5.40E-02	1.76E-03	5.07E-06	2.27E+01

GWP = Global Warming Potential;
ODP = Ozone Depletion Potential;
AP = Acidification Potential for Soil and Water;
EP = Eutrophication Potential;
POCP = Formation potential of tropospheric Ozone;
ADPE = Abiotic Depletion Potential – Elements;
ADPF = Abiotic Depletion Potential – Fossil Fuels;

LCA Results (continued) for reference unit of capacity of PUZ-WM112VAA

Parameters describing resource use, primary energy								
			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	2.54E+03	1.63E-01	2.54E+03	1.93E+04	2.66E+02	1.95E+04
	Transport	A2	4.16E+00	6.50E-06	4.16E+00	1.99E+02	0.00E+00	1.99E+02
	Manufacturing	A3	1.00E+03	1.29E-03	1.00E+03	1.07E+03	0.00E+00	1.07E+03
	Total (of product stage)	A1-3	3.54E+03	1.64E-01	3.54E+03	2.06E+04	2.66E+02	2.08E+04
Construction process stage	Transport	A4	7.14E+00	2.66E-05	7.14E+00	5.34E+02	0.00E+00	5.34E+02
	Construction	A5	9.97E+00	1.23E-04	9.97E+00	3.42E+02	0.00E+00	3.42E+02
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	9.19E+04	1.66E-01	9.19E+04	1.42E+06	0.00E+00	1.42E+06
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	2.22E+00	1.93E-06	2.22E+00	2.38E+01	0.00E+00	2.38E+01

PERE = Use of renewable primary energy excluding renewable primary energy 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 resource

LCA Results (continued) for reference unit of capacity of PUZ-WM112VAA

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	5.72E-03	0.00E+00	0.00E+00	2.54E+01
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	4.62E-02
	Manufacturing	A3	0.00E+00	0.00E+00	0.00E+00	4.77E-01
	Total (of product stage)	A1-3	5.72E-03	0.00E+00	0.00E+00	2.59E+01
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	1.17E-01
	Construction	A5	0.00E+00	0.00E+00	0.00E+00	2.13E-01
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	2.83E+02
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	2.60E-02

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued) for reference unit of capacity of PUZ-WM112VAA

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	4.61E+02	1.33E+02	4.54E-02
	Transport	A2	8.27E-02	3.06E+00	1.34E-03
	Manufacturing	A3	4.28E-01	2.42E+00	4.60E-03
	Total (of product stage)	A1-3	4.62E+02	1.38E+02	5.13E-02
Construction process stage	Transport	A4	2.25E-01	2.51E+01	3.71E-03
	Construction	A5	1.25E-01	1.76E+01	1.36E-03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	1.62E+02	1.72E+03	7.81E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND
	Transport	C2	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.48E+00	7.11E+01	1.52E-04

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued) for reference unit of capacity of PUZ-WM112VAA

Other environmental information describing output flows – at end of life						
			CRU	MFR	MER	EE
			kg	kg	kg	MJ per energy carrier
Product stage	Raw material supply	A1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Manufacturing	A3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
	Total (of product stage)	A1-3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	1.65E+01	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	1.96E+00	1.47E+02	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	0.00E+00

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

LCA Results for reference unit of capacity of HWM140VHA

(MND = module not declared; MND = module not declared; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP	ODP	AP	EP	POCP	ADPE	ADPF
			kg CO_2 equiv.	kg CFC 11 equiv.	kg SO_2 equiv.	kg $(PO_4)^{3-}$ equiv.	kg C_2H_4 equiv.	kg Sb equiv.	MJ, net calorific value.
Product stage	Raw material supply	A1	1.68E+03	3.08E-02	2.83E+01	1.66E+01	1.98E+00	1.65E-01	2.01E+04
	Transport	A2	4.87E+01	8.30E-06	7.15E-01	8.75E-02	5.58E-02	5.63E-05	7.09E+02
	Manufacturing	A3	-3.21E+00	5.09E-06	2.71E-01	5.97E-02	3.99E-02	9.84E-05	9.05E+02
	Total (of product stage)	A1-3	1.73E+03	3.08E-02	2.93E+01	1.67E+01	2.08E+00	1.65E-01	2.17E+04
Construction process stage	Transport	A4	7.96E+01	1.38E-05	9.80E-01	1.28E-01	8.19E-02	1.17E-04	1.17E+03
	Construction	A5	7.78E+01	1.43E-06	6.37E-02	2.36E-01	2.63E-02	4.04E-04	3.46E+02
Use stage	Use	B1	3.44E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	9.63E+04	6.23E-03	5.22E+02	1.20E+02	2.97E+01	1.16E-01	1.48E+06
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	7.62E+00	6.04E-07	1.14E-02	1.84E-01	2.43E-03	6.37E-06	3.92E+01

GWP = Global Warming Potential;
ODP = Ozone Depletion Potential;
AP = Acidification Potential for Soil and Water;
EP = Eutrophication Potential;
POCP = Formation potential of tropospheric Ozone;
ADPE = Abiotic Depletion Potential – Elements;
ADPF = Abiotic Depletion Potential – Fossil Fuels;

LCA Results (continued) for reference unit of capacity of HWM140VHA

Parameters describing resource use, primary energy								
			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	2.82E+03	1.89E-01	2.82E+03	2.15E+04	4.13E+02	2.19E+04
	Transport	A2	1.46E+01	2.44E-05	1.46E+01	7.17E+02	0.00E+00	7.17E+02
	Manufacturing	A3	8.28E+02	1.12E-03	8.28E+02	9.29E+02	0.00E+00	9.29E+02
	Total (of product stage)	A1-3	3.66E+03	1.90E-01	3.66E+03	2.31E+04	4.13E+02	2.35E+04
Construction process stage	Transport	A4	2.22E+01	4.40E-05	2.22E+01	1.18E+03	0.00E+00	1.18E+03
	Construction	A5	1.16E+01	1.27E-04	1.16E+01	3.59E+02	0.00E+00	3.59E+02
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	1.28E+05	2.31E-01	1.28E+05	1.97E+06	0.00E+00	1.97E+06
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	MND	MND	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	2.87E+00	2.81E-06	2.87E+00	4.03E+01	0.00E+00	4.03E+01

PERE = Use of renewable primary energy excluding renewable primary energy 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 resource

LCA Results (continued) for reference unit of capacity of HWM140VHA

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	9.10E-03	0.00E+00	0.00E+00	2.95E+01
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	1.66E-01
	Manufacturing	A3	0.00E+00	0.00E+00	0.00E+00	4.02E-01
	Total (of product stage)	A1-3	9.10E-03	0.00E+00	0.00E+00	3.01E+01
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	2.69E-01
	Construction	A5	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	3.95E+02
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	4.47E-02

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued) for reference unit of capacity of HWM140VHA

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	4.72E+02	1.38E+02	5.13E-02
	Transport	A2	2.99E-01	1.28E+01	4.85E-03
	Manufacturing	A3	4.08E-01	2.17E+00	2.08E-03
	Total (of product stage)	A1-3	4.73E+02	1.53E+02	5.82E-02
Construction process stage	Transport	A4	4.92E-01	2.83E+01	8.01E-03
	Construction	A5	1.51E-01	6.05E+01	1.51E-03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	2.25E+02	2.40E+03	1.09E+01
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction , demolition	C1	MND	MND	MND
	Transport	C2	MND	MND	MND
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.71E+00	1.59E+02	2.60E-04

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued) for reference unit of capacity of HWM140VHA

Other environmental information describing output flows – at end of life						
			CRU	MFR	MER	EE
			kg	kg	kg	MJ per energy carrier
Product stage	Raw material supply	A1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	A2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Manufacturing	A3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
	Total (of product stage)	A1-3	0.00E+00	8.97E+00	0.00E+00	0.00E+00
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	1.35E+01	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	MND	MND	MND	MND
	Transport	C2	MND	MND	MND	MND
	Waste processing	C3	2.26E+00	3.33E+02	0.00E+00	0.00E+00
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	0.00E+00

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

Scenarios and additional technical information

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
A4 – Transport to the building site	Products are manufactured in Livingston and distributed in the UK. The longest distance the unit can travel in the UK (1000 km) by lorry has been considered for this scenario. For the 14 kW HWM140VHA unit, the unit was assumed to be transported from Japan to the UK		
	Lorry	Litre of fuel type per distance or vehicle type	0.227
	Distance for all units manufactured in Livingston	Km	1,000
	Distance for the 14 kW HWM140VHA – lorry	Km	1,000
	Distance for the 14 kW HWM140VHA – sea	Km	15,000
	Capacity utilisation (incl. empty returns) – lorry	%	50
	Capacity utilisation (incl. empty returns) – sea	%	65
	Fuel transoceanic freight ship	g/tkm	2.5
A5 – Installation in the building	For the purpose of this study, it was assumed that no unit were damaged on installation. The installation of the combined heat pumps and tank requires the installation of an anti vibration fixing foot (recycled tyre). The packaging of the unit is disposed of during installation. Packaging includes (recycling rates from Defra UK_stats_on_waste_dataset_July_2021_accessible_rev_v4.xlsx (live.com)):		
	Corrugated cardboard	Recycled	65.6%
	Polystyrene	Recycled	47.2%
	Plain wood	Recycled	44.2%
	Paper	Recycled	65.6%
	Plastic	Recycled	47.2%
B1 – Use	This unit is hermetically sealed. It was estimated that 3 g of refrigerant leaked per year throughout its reference lifetime - providing the unit has been installed and maintained in accordance with the manufacturer's guidance.	unit	quantity
	Emission to air	g per year	3
B2 – Maintenance	The unit is maintained once a year repair throughout its reference lifetime. This maintenance requires a check of electrical circuits and the removal of any obstructions. No parts are removed or replaced during this maintenance - providing the unit has been installed and maintained in accordance with the manufacturer's guidance.	N/A	0

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
B3 – Repair	The unit should not require repair throughout its reference lifetime - providing the unit has been installed and maintained in accordance with the manufacturer's guidance.	N/A	0
B4 – Replacement	The unit has a reference lifetime of 17 years. No replacements are required - providing the unit has been installed and maintained in accordance with the manufacturer's guidance.	N/A	0
B5 – Refurbishment	The unit has a reference lifetime of 17 years. No refurbishment is required - providing the unit has been installed and maintained in accordance with the manufacturer's guidance.	N/A	0
B6 – Operational energy use	Total energy consumption of the HP per functional unit over 17 years	unit	Value
	PUZ-WM50VHA	kWh	66,725
	PUZ-WM60VAA	kWh	71,009
	PUZ-WM85VAA	kWh	97,019
	PUZ-WM112VAA	kWh	114,920
	HWM140VHA	kWh	160,225
B7 – Operational water use	The unit is sealed. Water runs through the system to be heated and is then fed back into the system. There is therefore no water consumed by the unit throughout its reference lifetime.	Litres	0
Reference service life	Mitsubishi confirms that, providing the unit is installed and maintained in accordance with the appropriate procedure, the unit will have a service life of 17 years – as per guidelines in PEP Product Specific Rules 0013 'Thermodynamic Generators with Electric Compression' (link).	Years	17
C3 – Waste processing	65% of the refrigerant has been reused	%	65
C4 - End of life, Disposal	Conservative figures were used for the disposal of the various components	unit	value
	% recycled metal	%	70
	% recycled plastic	%	50
	% landfill of other components	%	100
	% refrigerant recovered	%	65

References

BSI. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. BS EN 15804:2012+A1:2013. London, BSI, 2013.

BSI. Environmental labels and declarations – Type III Environmental declarations – Principles and procedures. BS EN ISO 14025:2010 (exactly identical to ISO 14025:2006). London, BSI, 2010.

BSI. Environmental management – Life cycle assessment – Principles and framework. BS EN ISO 14040:2006. London, BSI, 2006.

BSI. Environmental management – Life cycle assessment – requirements and guidelines. BS EN ISO 14044:2006. London, BSI, 2006.