ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	Bosch Thermotechnik GmbH
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BSC-20240530-IBA1-EN
Issue date	10.01.2025
Valid to	09.01.2030

AW 7 OR-S

Bosch Thermotechnik GmbH

Institut Bauen und Umwelt e.V.

ECO PLATFORM EPD VERIFIED

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1. General Information

Bosch Thermotechnik GmbH

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-BSC-20240530-IBA1-EN

This declaration is based on the product category rules:

HVAC Appliances, 18.08.2023
(PCR checked and approved by the SVR)

Issue date

10.01.2025

Valid to

09.01.2030

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

AW 7 OR-S

Owner of the declaration

Bosch Thermotechnik GmbH
Sophienstraße 30-32
35576 Wetzlar
Germany

Declared product / declared unit

The declared unit is one outdoor heat pump unit AW 7 OR-S.

This outdoor heat pump unit (ODU) of the CS5800/CS6800i AW heat pump family is compatible with all indoor heat pump units (IDU) of the CS5800/CS6800i AW heat pump family: 12 M, 12 MB, 12 M SST and 12 E. There is only a distinction in the product family between the IDUs, the ODUs are identical. To account for a heat pump system, the environmental product declaration of the respective IDU and ODU must be aggregated.

Scope:

This EPD refers to one ODU AW 7 OR-S manufactured in Tranås, Sweden and Aveiro, Portugal at the production facility of Bosch Thermotechnik GmbH to be operated in Europe. The reference year of production is 2023. The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally

Dr.-Ing. Nikolay Minkov,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The product in scope is one ODU AW 7 OR-S, which is a part of the air-to-water heat pump family Compress 5800/6800i AW (CS5800i AW/CS6800i AW) which are encased assemblies designed as a unit, using a vapor compression cycle (refrigerant R290 (Propane)) driven by an electric compressor, to provide delivery of heat according to *EN 14511-1*. The heat pumps turn ambient heat into energy and can be used for both cooling and heating purposes via the building's heating circuit. The heat pump system always consists of an indoor unit (IDU) and outdoor unit (ODU) connected through a water-based circuit. The accessories needed for the installation are accounted for with the ODU.

The following trade numbers and product codes are to be covered with this EPD:
AW 7 OR-S *(8-738-213-466)*
Compress 5800i AW 7 OR-S *(8-738-215-136)*
AW 7 OR-S *(8-738-215-688)*
AW 7 OR-S *(8-738-215-703)*

The following accessories are considered in this EPD:
Cable CANbus *(8-738-206-184)*
INPA long *(8-738-214-740)*
Uponor wallDuctDWD *(7-747-204-777)*
ECOFLEX Anschlusspaket *(7-738-336-967)*
Connect-Key K 30 *(7-736-603-499)*

The following ODUs are identical except for the power output and related electrical consumption. The respective information and scenarios are described in sections 3.1 and 4:
AW 4 OR-S *(8-738-213-464)*
Compress 5800i AW 4 OR-S *(8-738-215-134)*
AW 4 OR-S *(8-738-215-686)*
AW 4 OR-S *(8-738-215-701)*

AW 5 OR-S *(8-738-213-465)*
Compress 5800i AW 5 OR-S *(8-738-215-135)*
AW 5 OR-S *(8-738-215-687)*
AW 5 OR-S *(8-738-215-702)*

For the placing on the market in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) the following legal provisions apply:
LVD 2014/35/EU
- EN 60335.1:2012+A1+A2+A111+A13+A14+A15
- EN 60335-2-40:2003+A1+A2+S11+A12+A13
- EN 62233:2008+AC:2008
EMC 2014/30/EU
- EN 55014-1:2017+A11
- EN 55014-2:1997+A1+A2
- EN 61000-3-2:2014
- EN 61000-3-3:2013
RoHS 2011/65/EU + (EU) 2015/863
- EN IEC 63000:2018
ErP 2009/125/EC + (EU) 813/2013
- EN 14825:2018
- EN 14511:2018
- EN 12102:2017
The design and operating characteristics of this product comply with the European and supplementary national requirements. The CE marking declares that the product complies with all the applicable EU legislation, which is stipulated by attaching this marking. The complete text of the Declaration of Conformity is available on the Internet: www.bosch-einfach-heizen.de

2.2 Application

The CS5800/CS6800i AW heat pumps belong to heating, ventilation, and air conditioning (HVAC) appliances. The main function is the supply of domestic hot water and regulating air temperature in both, heating and cooling mode with a specific seasonal coefficient of performance (SCOP) according to *DIN EN 14825*. Air-to-water heat pumps can provide many times more heat energy by consuming one kWh of electricity. The heat pumps can be implemented in new builds as well as renovation.

The ODU is intended to be used in closed heating systems for households. All other use is considered unsuitable. Any damage that is caused by such usage is excluded from liability. The ODU AW 7 OR-S is intended for connection to the respective IDUs 12 M, 12 M SST, 12 MB or 12 E of the CS5800i/CS6800i AW heat pump family.

2.3 Technical Data

The AW 7 OR-S has the following technical properties:

Technical properties

Name	Value	Unit
area of application	Supply of domestic hot water and regulating air temperature in both, heating and cooling mode	-
nominal capacity	7.09	kW
current voltage	1x230	V
Weight	143	kg
Overall dimension (WxDxH)	1100x540x800	mm
type of appliance in terms of working fluids (the first fluid identifies the heat source, the second the heat delivery fluid) - air to air - air to water - water to water - water to air	Air to water	-
number of appliances considered in the EPD	1	pce.
seasonal coefficient of performance (35°C)	4.58	-
seasonal coefficient of performance (55°C)	3.52	-
max. electrical power consumption	2.9	kW
flow temperature max. permissible	75	°C
working pressure permissible	3	bar
sound power level (max)	57.7	dBA
sound power level (nominal) (according to EN 13141-7)	42	dBA
energy efficiency class	A++	-
type of refrigerant	R290	-
refrigerant charge	0.95	kg

Product not harmonised in accordance with the CPR but in accordance with other provisions for harmonisation of the EU named under 2.1.

2.4 Delivery status

Each heat pump unit is delivered individually packaged with the following dimensions (WxDxH): 1100 mm x 540 mm x 800 mm

2.5 Base materials/Ancillary materials

Base materials

The main constituents of the product are indicated as mass percentages.

Name	Value	Unit
Aluminium	11	%
Steel	63	%
Copper	5	%
Brass	3	%
PE	1	%
EPP	3	%
PUR	4	%
PC	1	%
Other plastics	2	%
Electronics	6	%
Liquids	1	%

This product/article/at least one partial article contains substances listed in the candidate list (date: 19.06.2024) exceeding 0.1 percentage by mass: yes

The SVHC substance concentration is available per component only. A summary of the SVHC substances per appliance and respective CAS number is provided below.

SVHC AW 7 OR-S duty to declare:
4,4'-Isopropyliden *80-05-7*
Benzyl butyl phthalate *85-68-7*
C,C'-azodi(formamide) *123-77-3*
Cd *7440-43-9*
Chromium-trioxide *1333-82-0*
DEHP *117-81-7*
Diboron-trioxide *1303-86-2*
Dibutyl phthalate *84-74-2*
Fluoranthene *206-44-0*
Lead *7439-92-1*
Lead-monoxide *1317-36-8*
N-Methyl-2-pyrrolidone *872-50-4*
Phenanthrene *85-01-8*
Pyrene *129-00-0*
Anthracene *120-12-7*
benzo[ghi]perylene *191-24-2*

Uponor wallDuctDWD compliant
Cable CANbus compliant
INPA long compliant

Connect-Key K 30 duty to declare:
4,4'-Isopropyliden *80-05-7*
Cd *7440-43-9*
Diboron-trioxide *1303-86-2*
Lead *7439-92-1*
Lead-monoxide 1317-36-8
Lead-titanium-trioxide *12060-00-3*

2.6 Manufacture

The heat pump units are manufactured and assembled at the production plant in Tranås, Sweden and Aveiro, Portugal. Individual parts and materials are sourced from suppliers or manufactured within Bosch plants and assembled to heat pump units. The assembled heat pump units are then tested and packaged with an installation manual for shipment. The accessories are packed and delivered separately.

The Bosch Home Comfort production plants are certified according to:
- Certificate HC worldwide - *ISO 9001:2015* Quality Management System

2.7 Environment and health during manufacturing

The Bosch Home Comfort production plants are certified according to:
- Certificate HC worldwide - *ISO 14001:2015* Environmental Management System
- Certificate HC worldwide - *ISO 45001:2018* Occupational Health and Safety Management

2.8 Product processing/Installation

The product may only be installed, brought into operation, and maintained by trained personnel.
Directions and regulations below must be followed:
- Local provisions and regulations of the electricity supplier and corresponding special rules
- National building regulations
- ***EN 50160*** (voltage properties in power grids for public distribution)
- ***EN 12828*** (heating systems in buildings - Design and installation of water-based heating systems)
- ***EN 1717*** (Protection of potable water against pollution in potable water installations)
- ***EN 378*** (Refrigerating systems and heat pumps - Safety and environmental requirements)
- ***EN 60335-2-40*** (Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers)
- ***PED, 2014/68/EU*** (Pressure equipment directive)

Information on the rules of technology as well as on workers' safety and environmental production is provided in the installation manual. The product must only be installed according to the manufacturer's official system solutions.

In addition to the accessories delivered with the ODU, insulation material is needed to connect the ODU to the IDU.

2.9 Packaging

The packaging consists of wood pallets, cardboard, generic plastics (foil), paper, wood and minor metal parts. Bosch Home Comfort participates in country-specific recycling processes that ensure optimum recycling. All the packaging materials are environmentally compatible and can be recycled.

2.10 Condition of use

There is no change of use in the material composition over the service life of the product and/or regarding environmentally relevant material inherent properties over the service life of the product. Units are repaired/components are replaced if required. Rebuilds and repairs may only be performed by trained installers. Inspections and maintenance are necessary for ensuring safe and environmentally friendly operation.

2.11 Environment and health during use

The heat pump may only be installed, brought into operation, and maintained by authorised personnel. Information on the rules of technology as well as on workers' safety and environmental production is provided in the installation manual.

All instructions from the installation manual must be observed. Failure to comply with instructions may result in material damage and personal injury, including danger to life. Action requiring the product to be opened must only be taken by personnel with knowledge of the properties and risks associated with the refrigerant R290. Work on the refrigerant circuit and involving equipment with flammable refrigerants requires special training in addition to standard repair procedures for refrigerant equipment. The product contains the flammable refrigerant R290. If a leak occurs, the refrigerant may form a combustible gas due to mixing with air. There is a risk of fire and explosion. Electrical work may only be

performed by authorised electrical installers. Means to safely disconnect the unit from supply mains must be incorporated. The user must be instructed on the usage and operating conditions for the heating system at handover. Further safety information is provided in the installation manual.

2.12 Reference service life

The RSL is set to 20 years based on the PCR Guidance-Texts for Building-Related Products and Services from the range of *Environmental Product Declarations of Institute Construction and Environment e.V. (IBU) Part B: Requirements on the EPD for HVAC Appliances*. -

2.13 Extraordinary effects

Fire

The product contains the flammable refrigerant R290. If a leak occurs, the refrigerant may form a combustible gas due to mixing with air. There is a risk of fire and explosion.

Water

Damage to the heat pump due to water. Electrical connections and electronics can be damaged if they are exposed to water. The outer casing is a prerequisite for meeting the heat pump's IP rating. The heat pump must not be placed outdoors without its back panel, side panels, front plate, and roof. Mount side panels without delay after the electric connections are done. The heat pump may not be operated without the outer casing.

Mechanical destruction

Measures against following mechanical deconstruction are described in the installation manual.
Residue in the pipework can damage the system: Solids, metal/plastic filings, flux and thread tape residue and similar material can get stuck in pumps, valves and heat exchangers.
Material damage due to frost and UV radiation: In case of a power outage the water in the pipes may freeze. The insulation may become brittle due to UV radiation and crack after some time.
Damage due to risk of frost: If the condensate freezes and cannot be routed away from the heat pump, the evaporator may be damaged. The product contains the refrigerant R290. In the event of a leak, the refrigerant may end up in the ground via the condensate drain. Use a frost-free siphon if the condensate pipe is connected to an existing outlet pipe / rain drainage.

2.14 Re-use phase

Used appliances contain valuable materials that can be recycled. The various assemblies can be easily dismantled. Synthetic materials are marked accordingly. Assemblies can therefore be sorted by composition and passed on for recycling or disposal.

2.15 Disposal

This symbol means that the product must not be disposed of with other waste, and instead must be taken to the waste collection points for treatment, collection, recycling and disposal. The symbol is valid in countries where waste electrical and electronic equipment regulations apply, e.g., European '*Directive 2012/19/EU on waste electrical and electronic equipment* '. These regulations define the framework for the return and recycling of old electronic appliances that apply in each country. As electronic devices may contain hazardous substances, they need to be recycled responsibly in order to minimize any potential harm to the environment and human health. Furthermore, recycling of electronic scrap helps preserve natural resources. For additional information on the environmentally compatible disposal of old electrical and electronic appliances, please contact the relevant local authorities, your household waste disposal service or the retailer where you purchased the product. Evacuate refrigerant: This action may only be carried out by trained personnel with knowledge of the properties and risks associated with the refrigerant R290. Wear personal protective equipment and have a fire extinguisher on hand. Only use tools and equipment approved for refrigerant R290. Follow the safety instructions [6721836841] on how the refrigerant is to be evacuated from the product. Recycle the refrigerant according to applicable regulations.

2.16 Further information

More information is available here: www.weee.bosch-thermotechnology.com/

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is presented in the following table.

AW 7 OR-S

Name	Value	Unit
Declared unit	1	pce.
Mass reference	143	kg/pce
SCOP	4.58	
SEER	2.56	
E"heating"	1,281.10	kWh/a
E"cooling"	909.38	kWh/a

Scenarios:

AW 4 OR-S
SCOP: 4.58
SEER: 2.36
E "heating": 1,281.1
E"cooling": 770.34

AW 5 OR-S
SCOP: 4.57
SEER: 2.48
E "heating": 1,283.9
E"cooling": 887.9

Other declared units are allowed if the conversion is shown transparently.

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3.2 System boundary

Type of the EPD: cradle to grave.
The EPD includes cradle-to-grave and module D (A+B+C+D) and follows the modular structure according to EN15804 (option c) according to the PCR Part A.

Module A1-A3: Raw material supply (extraction, processing, and recycled content) for the components the heat pump units consist of. Transport from the raw material extraction to the supplier. Transport from the supplier to the Bosch plant. Manufacturing processes in the Bosch plant and considers energy use, required consumables, production waste and treatment as well as internal transport.

Module A4: Transport from the Bosch plant to the building sites of all target markets.
Module A5: Installation of the heat pump systems into the building. Manufacturing of installation material purchased by the installers, energy consumption and disposal of packaging are considered in this module.
Module B1: Propane release during the use phase.
Module B2: Covers the maintenance as described in the service manual of the heat pump systems.
Module B3: Covers the replacement of specific components with spare parts in case of errors.
Module B4: No foreseen replacement of major parts of the heat pump is required during the RSL. The heat pump unit can be repaired at component level in the event oferrors. Hence, no impacts arise from replacement.
Module B5: Refurbishment does not take place.
Module B6: Operational energy use.
Module B7: There is no operational water use.
Module C1: No environmental impacts arise from deconstruction or demolition.
Module C2: Transport to the treatment facility.
Module C3: Disassembly to separate large metal parts for material recycling.
Module C4: No environmental impacts arise from disposal.
Module D: Reuse, recovery, or recycling potential (D) – beyond system boundary.

For the environmental impact during manufacturing, the use of green electricity was calculated considering the residual electricity mix for the remaining electricity. The proportion of the electricity demand covered by green electricity in the total electricity demand is 100 %.

3.3 Estimates and assumptions

Concerning transport of materials, waste and heat pump units, information on supplier locations, treatment facilities as well as internal information on distribution channels and routes was used. However, few assumptions were made to fill gaps. To account for the transportation of the heat pump from the regional distribution centres to the building site, a 300 km road distribution scenario per heat pump unit was adopted as indicated in *PCR EPDItaly019*. Concerning spare parts replaced during the repair processes of the heat pump units (A3), as well as packaging waste, a 100 km road distribution scenario (200 km round trip) to the EoL treatment facility was applied. The installer is responsible for transportation to the treatment plant, and it is assumed that the waste is collected over a period of time before it is delivered to the treatment plant. The transport of the heat pump unit to the treatment facility was assumed to be 50 km (100 km round trip) and takes place directly.

In general, the thermal recovery of materials was assumed to take place in a MSWI facility with 15 % electrical and 35 % heat utilization. Following *PCR Part, A*, the R1 value for Ew > 0.6, hence, the impacts are reported in module C3.

As no special storage conditions are required, the storage of the heat pumps was neglected.

3.4 Cut-off criteria

Module A1-A3: Material and energy flows were assessed that at least account for 1 % of the use of renewable or non-renewable primary energy or mass, whereby the total sum of the flows not considered per module does not exceed 5 %. The expenses for the provision of the infrastructure (machinery, buildings, etc.) of the entire new system were not considered. This is based on the assumption that the impacts for the construction and maintenance of the infrastructure, as described above, do not exceed 1 % of the total impacts described above. The provision of heat was not considered as it does not contribute directly to the manufacturing process of the product. On the contrary, the electricity required to operate the infrastructure of the manufacturing process was considered. In the case of the plant production waste, the waste associated with the heat pumps mainly consists of packaging waste and small metal parts that may arise during manufacturing. Hence, a cut-off criterion of 5 % was applied to ensure the feasibility of the calculations.
Module C1: Due to the minor electricity consumption (less than 5 %) in C1 compared to all other C modules, the activities related to module C1 were cut off. Hence, noprocesses are allocated to module C1.

3.5 Background data

The LCA model was developed with the *LCA for Experts* software with the support of the *ecoinvent 3.9.1* database used for the background datasets.

3.6 Data quality

Product-specific data was collected for all life cycle phases and processes within Bosch HC's sphere of influence. The foreground data has a high level of differentiation (detailed bills of materials, direct measuring, waste and energy reports, technical datasheets, service manuals and expert knowledge) and therefore corresponds to the level of very good quality according to the definition in *EN 15804 Annex E*.

Generic data was used for:
- 'Upstream' processes: The extraction and pre-processing of raw materials prior to arriving to the Bosch plant.
- 'Downstream' processes: Considering additional technical data according to *EN 15804*, chapter 7.3, of the specific EPD covering all stages of the life cycle (from cradle to grave), the impacts (and benefits) of waste treatment through incineration, recycling and substituted processes were calculated using generic data supplemented by product-specific information on calorific values and/or type of treatment.

The background data (*ecoinvent v.3.9.1*) corresponds to the level of good quality according to the definition in *EN 15804 Annex E*, as the best available background datasets were chosen according to the location of e.g., the supplier or energy consumption. The technology used for processing the materials used was considered as well.

3.7 Period under review

The LCA study was developed between June 2023 and March 2024, with data referring to the first half of the year 2023.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Europe

3.9 Allocation

There are no co-products generated during the heat pump unit production. Concerning allocations in the foreground system to allocate plant-related activities such as energy consumption, internal transport, and waste production as well as related loads and benefits product- and plant-specific allocation keys are used. The allocation key is used in A1-A3 and module D only.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account. The LCA model was developed based on the

support of the *ecoinvent 3.9.1* database used for the background datasets.

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The total mass of biogenic carbon-containing materials of the heat pump unit is less than 5 % of the total mass of the product. The total mass of biogenic carbon-containing materials in the accompanying packaging is presented in the following table.

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO2.

Information on describing the biogenic carbon content at factory gate

Name	Value	Unit
Biogenic carbon content in product	-	kg C
Biogenic carbon content in accompanying packaging	7.97	kg C

The disposal of the packaging material on the construction site is declared in A5.

Transport from the gate to the site (A4)

Following information on shipping from the Bosch plants to the regional distribution centres (RDCs) is reported: Location of the RDCs, distances between the place of dispatch and the RDCs, type of transportation, number of units shipped to the RDCs (+weight of the products and packaging). The target market-weighted average tkm per heat pump unit were calculated according to the respective weight of the heat pump unit including packaging. In line with the Science Based Targets initiative (SBTi) reporting, a capacity utilization of 70 % was considered. As no special storage conditions are required, the storage of the heat pumps was neglected.

Assembly (A5)

Name	Value	Unit
Insulation material	2.5	kg
Electricity consumption	0.5832	MJ

Disposal of the packaging materials takes place in module A5. As the EoL treatment differs from country to country, the EoL treatment was calculated as average European scenario across all target countries. Average European recycling shares and substitution factors from the EF3.0 method were applied (European Commission, 2022).

Use or application of the installed product (B1) see section 2.12 "Use"

PCR Part B states that only in the case of hermetically sealed HVAC, no releases shall be considered during use phase, otherwise an entire refill of refrigerant gas must be considered. However, a minimal annual release (emitted to the air) is accounted for in the EPD, as specific measured values were available. Due to this low leakage rate, no refrigerant needs to be refilled during the RSL.

Maintenance (B2)

Maintenance includes manual unscrewing of insulation material and cleaning of the drip tray with water and a mild detergent.

Name	Value	Unit
Maintenance cycle	1	Number/RSL
Water consumption	0.005	m³/a
Mild detergent for cleaning	0.01	kg/a

Maintenance is assumed to take place annually and requires the cleaning of the drip tray using a brush and a cloth with a mild detergent instead of using a water hose.

Repair (B3)

Units are repaired/components are replaced in extraordinary cases if required. This module includes all input materials, components, energies, packaging, and transport required for replacing components of the heat pump units and the EoL treatment of the replaced components.

Name	Value	Unit
Electricity consumption in case of replacements	0.002	MJ
Repair cycle	Only in case of errors	

The RSL is set to 20 years based on the PCR Guidance-Texts for Building-Related Products and Services from the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU) *Part B: Requirements on the EPD for HVAC Appliances.*

Reference service life

Name	Value	Unit
An assumed quality of work, when installed in accordance with the manufacturer's instructions	-	-
Reference service life	20	years

Operational energy use (B6) and Operational water use (B7)

The chassis of the 4 OR-S, 5 OR-S and 7 OR-S are identical.

Name	Value	Unit
Electricity consumption - 7 OR-S	43.81	kWh
Electricity consumption - 4 OR-S	41.029	kWh
Electricity consumption - 5 OR-S	43.436	kWh

The heat pump system always consists of IDU and ODU. To avoid double counting, the operational energy use is accounted in relation with the ODU.

End of life (C1-C4)

C2 covers the transport of the heat pump units, accessories, and installation material to the treatment facility. The transportation distance to the treatment facility was assumed to be 50 km (100 km round trip).

Module C3 covers the EoL of the device, installation material and accessories. Large parts of the ODU and IDU are disassembled to separate larger metal parts for material recycling. The remaining parts of the heat pump units and accessories are shredded and incinerated in a MSWI plant with energy recovery. The steel parts are automatically separated directly after the shredding (assuming a yield quota of 90 % for steel separation) and fed into a recycling process. A collection rate of 100 % without any losses due to the shredding of the material is assumed. Regarding the installation material, insulation material (elastomer) is assumed to be incinerated in a MSWI plant. Impacts and credits related to recycling activities are reported in module D. There are no activities taking place associated with reuse or with disposal.

Name	Value	Unit
Reuse	0.95	kg
Recycling	99.2	kg
Energy recovery	83.1	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information

This module covers all burdens from recycling processes and net credits from energy or material substitution related to net flows. The burdens and credits arise from the recycling of materials, substitution or thermal recovery related to the production plant waste, packaging of the heat pump systems and accessories, repair activities and the EoL of the heat pump systems and installation material.
In general, the thermal recovery of materials was assumed to take place in a MSWI facility with 15 % electrical and 35 % heat utilization. The exported energy substitutes fuels from fossil sources, whereby it is assumed that the thermal energy is generated from natural gas and the substituted electricity corresponds to the German electricity mix from the year 2016. The energy generated is assumed to replace impacts from the following datasets of the *ecoinvent database v.3.9.1*: Europe without Switzerland: market for heat, district or industrial, natural gas and SE: market for electricity, high voltage.
The recycled materials are assumed to substitute functional equivalent primary materials. Considered share of secondary material (according to *ecoinvent 3.9.1* system model *EN15804*, inventory indicator *ISO21930* use of secondary material) and material substitution. As substitution factors, average European substitution factors from the EF3.0 method were applied (European Commission, 2022).

Name	Value	Unit

5. LCA: Results

The LCA results are presented below.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 pcs AW 7 OR-S

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	kg CO_2 eq	1.31E+03	5.5E+01	2.45E+01	0	0	3.46E-01	0	0	1.62E+04	0	0	3.66E+00	5.2E+01	0	-3.04E+02
GWP-fossil	kg CO_2 eq	1.3E+03	5.5E+01	2.44E+01	0	0	3.78E-01	0	0	1.6E+04	0	0	3.66E+00	5.2E+01	0	-3.04E+02
GWP-biogenic	kg CO_2 eq	1.75E+01	1.84E-02	3.62E-02	0	0	1.74E-03	0	0	9.84E+01	0	0	1.29E-03	2.48E-02	0	1.71E-04
GWP-luluc	kg CO_2 eq	3.06E+00	2.79E-02	1.51E-02	0	0	7.34E-04	0	0	3.94E+01	0	0	1.76E-03	1.58E-02	0	-9.23E-02
ODP	kg CFC11 eq	5.06E-05	1.12E-06	5.34E-07	0	0	1.52E-08	0	0	3E-04	0	0	7.76E-08	1.78E-07	0	-6.69E-06
AP	mol H^+ eq	1.69E+01	3.6E-01	1.03E-01	0	0	3.97E-03	0	0	9.02E+01	0	0	1.16E-02	6.46E-02	0	-1.93E+00
EP-freshwater	kg P eq	1.3E+00	3.48E-03	3.66E-03	0	0	4.53E-04	0	0	1.49E+01	0	0	2.5E-04	6.68E-03	0	-1.43E-01
EP-marine	kg N eq	1.94E+00	1.05E-01	1.52E-02	0	0	5.57E-04	0	0	1.47E+01	0	0	4.01E-03	2.1E-02	0	-2.99E-01
EP-terrestrial	mol N eq	2.05E+01	1.13E+00	1.45E-01	0	0	5.92E-03	0	0	1.32E+02	0	0	4.22E-02	1.94E-01	0	-3.06E+00
POCP	kg NMVOC eq	6.85E+00	3.84E-01	6.6E-02	3.98E-02	0	1.78E-03	0	0	4.25E+01	0	0	1.74E-02	5.26E-02	0	-1.18E+00
ADPE	kg Sb eq	2.15E-01	1.56E-04	1.17E-04	0	0	1.1E-04	0	0	1.88E-01	0	0	1.14E-05	7.07E-05	0	-4.38E-04
ADPF	MJ	2.08E+04	7.53E+02	2.99E+02	0	0	5.49E+00	0	0	3.94E+05	0	0	5.11E+01	1.4E+02	0	-4.36E+03
WDP	m^3 world eq deprived	6.47E+02	4.33E+00	5.88E+00	0	0	1.8E-01	0	0	1.21E+04	0	0	3.09E-01	6.25E+00	0	-3.56E+01

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

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 pcs AW 7 OR-S

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	MJ	4.25E+03	1.08E+01	1.42E+01	0	0	7.18E-01	0	0	7.79E+04	0	0	7.86E-01	1.31E+01	0	-2.52E+02
PERM	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PERT	MJ	4.25E+03	1.08E+01	1.42E+01	0	0	7.18E-01	0	0	7.79E+04	0	0	7.86E-01	1.31E+01	0	-2.52E+02
PENRE	MJ	2.09E+04	7.53E+02	2.99E+02	0	0	5.52E+00	0	0	3.94E+05	0	0	5.11E+01	1.4E+02	0	-4.36E+03
PENRM	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PENRT	MJ	2.09E+04	7.53E+02	2.99E+02	0	0	5.52E+00	0	0	3.94E+05	0	0	5.11E+01	1.4E+02	0	-4.36E+03
SM	kg	4.21E+01	0	0	0	0	5.92E-04	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FW	m^3	1.51E+01	1.01E-01	1.37E-01	0	0	4.2E-03	0	0	2.82E+02	0	0	7.2E-03	1.46E-01	0	-8.3E-01

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 = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2:
1 pcs AW 7 OR-S

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NHWD	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWD	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRU	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	0	0	0	0	0	0	0	9.5E-01	0	0
MER	kg	6.17E+00	0	7.43E+00	0	0	9.52E-03	0	0	0	0	0	0	9.92E+01	0	0
EEE	MJ	8.47E+00	0	7.29E+00	0	0	8.9E-03	0	0	0	0	0	0	8.31E+01	0	0
EET	MJ	5.7E+01	0	1.03E+02	0	0	9.09E-02	0	0	0	0	0	0	7.81E+02	0	0

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional:
1 pcs AW 7 OR-S

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	9.36E-05	3.2E-06	1.08E-06	0	0	2.39E-08	0	0	3.04E-04	0	0	2.3E-07	5.45E-07	0	-1.35E-05
IR	kBq U235 eq	1.17E+02	9.23E-01	1.06E+00	0	0	3.71E-02	0	0	9.97E+03	0	0	6.77E-02	1.03E+00	0	-2.21E +01
ETP-fw	CTUe	1.44E+05	7.44E+02	3.66E+02	0	0	4.51E+01	0	0	3.08E+05	0	0	5.12E+01	4.45E+02	0	-6.36E +03
HTP-c	CTUh	7.15E-06	2.61E-08	1.86E-08	0	0	1.55E-09	0	0	8.8E-06	0	0	1.71E-09	1.77E-08	0	6.67E-07
HTP-nc	CTUh	1.81E-04	6.05E-07	2.68E-07	0	0	3.6E-08	0	0	3.32E-04	0	0	4.31E-08	7.3E-07	0	-5.7E-06
SQP	SQP	1.73E+04	4E+02	5.05E+01	0	0	2.14E+00	0	0	7.18E+04	0	0	3.01E+01	4.44E+01	0	-7.61E +02

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Disclaimer 1 – for the indicator “Potential Human exposure efficiency relative to U235”. This impact category deals mainly with the eventual impact of low-dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure or radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators “abiotic depletion potential for non-fossil resources”, “abiotic depletion potential for fossil resources”, “water (user) deprivation potential, deprivation-weighted water consumption”, “potential comparative toxic unit for ecosystems”, “potential comparative toxic unit for humans – cancerogenic”, “Potential comparative toxic unit for humans - not cancerogenic”, “potential soil quality index”. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

6. LCA: Interpretation

The operational energy use related to the European grid mix in B6 dominates the **core impact indicators** with >80 %. Only in the case of resource use, minerals and metals does B6 account for 47 % of the impacts, followed by A1-A3 with 53 %. The impacts in A1-A3 mainly result from the supply of metals (copper, brass) as well as electronic components and printed circuit boards. Manufacturing has no relevant effect on the results.

For the **resource use indicators**, B6 accounts for 95 % to 96 % of the impacts. The highest proportion of secondary material is used in A1-A3 due to the use of metals, particularly steel. For the secondary material use indicator, however, the proportion of secondary material is based on background datasets (*v.3.9.1 system model EN15804*) and is not covered by primary sources. However, the values from the ecoinvent background database represent a market average. As the materials for the heat pump unit are sourced from various suppliers from different countries across the globe, it seems reasonable to rely on these market averages. The indicators RSF and NRSF are not declared.

In terms of **waste categories and output flows**, C3 indicates the highest proportion of reusable components, material for recycling, material for energy recovery and exported energy with 83 % to 100 %. The refrigerant is assumed to be collected and reused, the amount of material for recycling is mainly related to steel and aluminium parts such as cover and structural parts of the ODU. The plastic from the accessories contributes largely to the exported energy.

The drivers for the **optional indicators** is B6, although this module only accounts for more than 80 % in case of the impact indicators ionizing radiation, human health with 99 % and land use with 81 %. Regarding the other optional indicators, the impacts from A1-3 and B6 together add up to over 80 %. For those indicators, the impacts in A1-A3 mainly result from the supply of metals such as aluminium, copper and brass as well as electronic components. Sawn wood used in the packaging dominates the impact indicator land use.

In general, the highest contribution of the LCI and LCIA indicators results from either B6 or A1-A3. The calculation of B6 is based on technical data, A1-A3 impacts are mainly related to the bill of material. In accordance with the requirements from *PCR Part A*, the *ecoinvent database* serves as a valid background database, the uncertainty related to the BOMs is rather low as the accuracy is high. All other modules have a low relevance regarding the considered impact categories.

7. Requisite evidence

The technical documentation related to the heat pump unit is available here: www.bosch-homecomfort.com The product family contains the refrigerant R290. According to *ISO 817*, propane is classified as class A (lower toxicity) and 3 (higher flammability). The operational energy use and the refrigerant are accounted for in the EPD of the ODU.
The operation of the heat pump unit does not generate waste gas.

8. References

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EN 61000-3-2:2014 Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase) (IEC 61000-3-2:2014)

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Publisher

Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

+49 (0)30 3087748- 0
info@ibu-epd.com
www.ibu-epd.com

Programme holder

Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

+49 (0)30 3087748- 0
info@ibu-epd.com
www.ibu-epd.com

Author of the Life Cycle Assessment

Bosch Thermotechnik GmbH
Sophienstraße 30-32
35576 Wetzlar
Germany

+49 152 28037119
Pia.Szichta@de.Bosch.com
https://www.bosch-homecomfortgroup.com/de/startseite.html

Owner of the Declaration

Bosch Thermotechnik GmbH
Sophienstraße 30-32
35576 Wetzlar
Germany

+49 152 28037119
Pia.Szichta@de.Bosch.com
https://www.bosch-homecomfortgroup.com/de/startseite.html