Europump

The Voice of the European Pump Industry

Europump Life Cycle Assessment Guidelines for pump units and systems

A Europump document

09. 25. 2025

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Foreword

This document is prepared by a subcommittee of the Europump Technical Commission which consists of the following members:

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Table of Contents

1. Introduction

In recent years, environmental aspects and impacts have become increasingly important for most interested parties, such as customers and regulators. Life Cycle Assessment (LCA) is a standardized methodology for evaluating the environmental impacts of products throughout their life cycle.

The principles and framework of LCA are defined in the international standard **ISO 14040**, while **ISO 14044** outlines the specific requirements and guidelines for conducting an LCA.

LCAs can be applied for various purposes, including:

- Identifying opportunities to improve the environmental performance of products,
- Supporting internal decision-making within organizations,
- Facilitating external communication of environmental performance.

This guidance document is intended to support the practical application of LCAs in the pump industry. It can be used to structure and streamline LCA studies, whether for internal improvement or external reporting.

Communication of environmental aspects and impacts

The subject of environmental communication sees increased regulation to avoid greenwashing. The international standard **ISO 14020** describes principles and requirements for different types of environmental statements and in many cases serves as recognized best-practice on the matter.

Additionally, the following standards exist under the **ISO 14020** series of standards:

ISO 14021 on **self-declared environmental claims** made for products by manufacturers or suppliers. These claims do not require third-party verification but must be accurate, verifiable, and not misleading. LCA can be used to substantiate many such claims, although not mandatory in all circumstances.

ISO 14024 on **environmental labels known as ecolabels**. These are third-party certified labels based on predefined environmental criteria (usually different from LCA) established by independent certification bodies.

ISO 14025 on **Environmental Product Declarations (EPDs)** which are based on quantified LCA data. These declarations follow Product Category Rules (PCRs) and are independently verified to seek consistency and comparability across similar products.

ISO 14026 on **Footprint communications** provides further principles and requirements for communication of environmental footprint information based on LCA, such as carbon footprints in accordance with **ISO 14067** or water footprints in accordance with **ISO 14046**.

ISO/TS 14027 on **Development of Product Category Rules** offering principles, requirements and guidance for developing and maintaining Product Category Rules (PCRs) based on LCA.

ISO/TS 14029 on **Mutual recognition of EPDs and footprint communication programmes** specifying requirements for and guidance on Mutual Recognition Arrangements (MRAs) between program operators.

Sector specific Product Category Rules (PCRs)

Several standards already exist today as sector generic PCRs including:

- **EN IEC 63366:2025** (Replacing **EN 50693:2019**) on electrical and electronic products and systems.
- **EN 15804:2012+A2:2019/AC:2021** on construction products used in the European building sector.
- **ISO 21930:2017** on construction products used in building sectors outside Europe.

While these standards may be applicable for pump units and systems, they are generally broad in scope and for optimal use require either:

- Further development of more exact product category Rules (PCRs)/Product Specific Rules (PSRs), or
- The individual LCA practitioner to make their own assumptions and hypotheses.

In both cases, this guidance document can be used in support of consistent and transparent LCAs for pumps and pump units, thereby supporting robust and comparable LCA studies and declarations.

2. Normative references

EN ISO 14040:2006, *Environmental management – Life Cycle Assessment – Principles and framework*

EN ISO 14044:2006, *Environmental management – Life Cycle Assessment – Requirements and guidelines*

EN ISO 14020:2022, *Environmental statements and programmes for products – Pinciples and general requirements*

EN ISO 14021:2016, *Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)*

EN ISO 14025:2006, *Environmental labels and declarations – Type III environmental declarations - Principles and procedures*

EN 15804:2012+A2:2019/AC:2021, *Sustainability of construction works – Environmental products declarations – Core rules for the product category of construction products*

EN 50693:2019, *Product category rules for life cycle assessments of electronic and electrical products and systems*

IEC 63366:2025, *Product category rules for life cycle assessment of electrical and electronic products and systems*

ISO 21930:2017, *Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services*

EN 17038-1:2019, *Pumps – Methods of qualification and verification of the Energy Efficiency Index for rotodynamic pump units – Part 1: General requirements and procedures for testing and calculation of Energy Efficiency Index (EEI)*

ISO/TS 14027:2017, *Environmental labels and declarations – Development of product category rules*

A Europump Guide, February 15, 2025, *Use Phase GHG Emissions from Pump Units*

A Europump Guide, October 27, 2014, *Extended Product Approach for Pumps*

3. Scope

3.1. On product scope (definition and description)

This guide is intended for pump/s and pump units. It can also be used for extended products and pumping installations delivered as one pumping product/solution – e.g. Booster sets, pumping stations or packaged skid systems.

The guide is, however, not intended for:

- Complete pumping systems – e.g. a complete HVAC system in a building or a complete industrial system.
- Products or systems with other main-function(s) than pumping liquids but incorporating a pump or pump unit – e.g. a car incorporating a liquid pump or a complete car-wash system.
- Air compressors and other pumping solutions for pumping non-liquids.

Europump recommends that the scope of the product declared can include all the components of the pump unit/installations provided to the customer/end user – e.g.:

- Pump(s)
- Motor(s)
- Variable Speed Drive(s) (VSDs)
- Cables
- Packaging
- Piping and other auxiliaries

A detailed description of the product should be provided in the LCA report and any declaration based on the LCA.

If unknown to the pump manufacturer, a generic reference motor/VSD can be modelled provided it is transparently reported in the project/LCA report.

3.2. On system boundaries (Life cycle stages and modules)

Europump recommends making LCAs based on recognized system boundaries e.g. the *life cycle stages* according to **EN IEC 63366:2025** or as *modules* as defined by **EN 15804:2012+A2:2019**.

The boundaries of the LCA can be any of the following in accordance with Table 1.

- *Cradle to gate*
- *Cradle to gate with options*
- *Cradle to grave*

Note: For the case of EPDs often only *Cradle to grave* is allowed for products using electrical power.

Life cycle stage in EN IEC 63366	Manufacturing stage	Distribution stage	Installation stage	Use stage	De-installation stage[a]	End-of-life stage	NA[b]
Module in EN 15804	A1-A3	A4	A5	B1-B7	C1	C2-C4	D
Cradle to gate	Included	Not included	Not included	Not included	Not included	Not included	Not included
Cradle to gate with options	Included	*Optional*	*Optional*	*Optional*	*Optional*	*Optional*	*Optional*
Cradle to grave	Included	Included	Included	Included	Included	Included	Included

[a] De-installation stage could be separated from the end-of-life stage, otherwise the end-of-life stage of EN IEC 63366:2025

[b] In EN IEC 63366:2025 not only the processes of waste processing, but also potential benefits and avoided loads are accounted for in the corresponding life cycle stage. Assessed potential impacts and benefits should then be reported separately for each life cycle stage. For an EN 15804 compatible EPD, potential benefits and avoided loads should then be aggregated into module D instead.

Table 1 – Overview of lite cycle stages and modules (Adopted Table D.1 from EN IEC 63366:2025)

3.2.1. Exclusions from System Boundary

Adapted from IEC standard 63366:2025.

When not in conflict with other rules or standards applied for the LCA, Europump recommends that the following flows may be excluded from the analysis, due to the difficulty in allocating them to a particular reference flow:

- Lighting, heating, sanitary facilities and infrastructure cleaning.
- Employee transport, apart from transportation for product maintenance purpose.
- Manufacture and maintenance of the manufacturing facility and machines if they are not contributing to the reference flow.
- Construction and maintenance of the infrastructure if they are not proportional to the reference flow.
- Transport systems and infrastructures if they are not proportional to the reference flow.
- Administrative, management and R&D department flows. (testing facilities/energy consumption for testing)
- Marketing activity related to the product.

- Staff catering facilities.

4. On Declared/Functional Unit

To explain declared and functional unit there is a need to look at life cycle assessment goals.

Reasons for commissioning an LCA can include following reasons for a company:

- Establishing a baseline of overall environmental impact to identify environmental “hotspots”
- Identifying possible opportunities for improvement across the product lifecycle
- Comparing alternative manufacturing processes or supply chains to identify potential tradeoffs
- Determining the environmental preferability between alternative products choices
- Improving products through continuous improvement, often set with concrete reduction targets

The reasons above show that LCA´s can be performed to compare two or more systems. This is possible with functional unit or declared unit.

The choice between the functional unit and the declared unit often depends on the data availability, the complexity of the studied product or service, and specific analysis goals. Some LCA projects may also use a combination of both approaches to leverage their respective advantages. Regardless of the chosen approach, clear and transparent documentation of the methodology used is essential to ensure credibility of the LCA results.

<u>Functional Unit (FU)</u>

If the aim is to identify a solution that has less environmental impacts, there might not be interest in the product directly, but in the reason for its existence, its function. For example, it is meaningless to compare an incandescent light bulb with an LED light bulb since these products have different life span and perform considerably differently. The functional unit expresses the function of the products, and, thereby, offers a way to equalize differences in performance, for instance “lighting a standard room of 15 square meters with 1000 lumen for 1 hour”.

A Functional Unit (FU) is a quantified description of *the service* provided by the system.

Functional Unit = Function + Quantity of service provided + Time or typical Life Span

Function = This function must describe the service provided to the user

Quantity of service = The level of performance or requirement achieved by the function(s). This level must be quantified and can be determined by reference to the standards applicable to the product.

Time = Reference lifetime

Example of FU that can be used for LCA:

Produce 1 kW of hydraulic power (P_{hyd}) at best efficiency point (BEP) of the pump(s)/pump units/pumping installations over the specified Reference Service Life.

Declared Unit (DU)

A declared unit can be easier to define for intermediate products and allows the integration of specific product information that may not be easily expressed in standard functional unit terms.

A Declared Unit (DU) is the quantity of a product intended to be used as a reference unit.

Declared Unit = Function + Quantity of product + Lifetime

Function = pump(s)/pump unit/pumping installations can have a lot of different functions, so it is important that the intended application/function is described.

Quantity of product = main performance and the intended product/equipment

Lifetime = reference service life of x years

Example: For a double service heat pump

DU = Produce domestic hot water and heating using a 5 kW heat pump with a reference lifetime of 17 years (power to be adjusted according to the product in range). Reference unit: kW

Example of DU that can be used for LCA:

[Function/s] using one piece (pcs.) of product (pump(s)/pump unit/pumping installations) over the specified Reference Service Life.

More information about functional and declared unit can be found in the Cetim report which is available for Europump members.

5. On calculating operational use stage in use stage

For pumps, pump units and pump installations, the electricity consumption in the use stage often constitutes the majority of combined impacts across all life cycle stages in an LCA. For this reason, the applied use-stage scenario is essential for the total impact result of the pumping product under study.

Due to the diversity of pump applications, as well as geographical differences (e.g. climate and temperature) influencing some applications such as HVAC, it is generally problematic to establish standardized default use-stage scenarios without introducing bias in a potential comparison of two different pumping products.

For example pumping solution 'A' would be favored under one particular use-stage scenario by having the lowest environmental impact compared to solution 'B', while if compared under another set of use-conditions the result could be opposite.
Uncritically comparing, or even selecting, pumping-products without accounting for the real and specific use-case scenario (e.g. on project- or building-level) would in many cases be misleading and could lead to the sub-optimal choices if striving to minimize total environmental impacts in practice.

This LCA guide presents two calculation methodologies suitable for rotodynamic pumps driven by electric motors or power drive systems in section 5.1 and 5.2.
Please note that other calculation methodologies and assumptions would be required to calculate the energy consumption of other types pumps (e.g. pumps driven by turbines or pumps operating under other principles such as peristaltic pumps).

To ensure transparency, Europump recommends explicitly stating the use stage scenario assumptions and calculation parameters described in 5.6 when presenting calculated use phase results.

5.1. Calculations based on average power

When knowing the average power for a given flow-time/load profile, the electricity consumption E_1 of a rotodynamic pump can be calculated using the following formula:

$$E_1[kWh] = P_{1,AVG}[kW] \cdot RH\left[{}^{h}/_{year}\right] \cdot Lifetime[year]$$

Where,

- $P_{1,AVG}[kW]$ = Average power input
- $RH\left[{}^{h}/_{year}\right]$ = running hours per year [see 5.3. Running hours]
- Lifetime = years [see 5.4. Lifetime]

Flow-time/Load profiles can be stated in the following format:

Flow Q in % of $Q_{100\%}$	Head H in % of H100%	Time in % of total operating hours	Power (P_1) at part load point
Q_1	H_1	L_1	$P_{1,PL1}$
Q_2	H_2	L_2	$P_{1,PL2}$
…	…	…	…
Q_N	H_N	L_N	$P_{1,PLN}$

Example of flow-time/load profile using typical values for variable flow/HVAC products (**EN 17038-2:2019 / EN 16297-1:2012**):

Flow Q in % of $Q_{100\%}$	Head H in % of H100%	Time in % of total operating hours	Power (P_1) at part load point
100	100	6	$P_{1,PL1}$

75	87,5	15	$P_{1,PL2}$
50	75	35	$P_{1,PL3}$
25	62,5	44	$P_{1,PL4}$

The average power consumption $P_{1,AVG}$ can be established from the following relationship when the flow-time/load profile and power at part load point is known:

$$P_{1,AVG}[kW] = L_1[-] \cdot P_{1,PL1}[kW] + L_2[-] \cdot P_{1,PL2}[kW] + \ldots + L_N[-] \cdot P_{1,PLN}[kW]$$

Where,

- $P_{1,AVG}[kW]$ = calculated average power input of the motor or Power Drive System (PDS)
- L_N = time in % of total operating hours (in decimal numbers – e.g. 15% = 0,15)

Further information on determination of average power and typical flow/time or Load profiles for some rotodynamic pump-types can be found in the following EN standards:

- **EN 17038-1:2019** – General requirements for rotodynamic pump units
- **EN 17038-2:2019** – Single pump units
- **prEN 17038-3:2024** – Booster sets
- **EN 17038-4:2023** – Submersible multistage pumps
- **EN 16297-1:2012** – General requirements for glandless circulators
- **EN 16297-2:2012** – Standalone glandless circulators
- **EN 16297-3:2012** – Glandless circulators integrated in products

5.2. Calculations based on Nominal Power and Control Factors

In alignment with the principles of the ***Europump GHG emissions guide*** a conservative but simple estimate of the electricity consumption E_1 of a pump unit can be calculated using the following formula:

$$E_1[kWh] = P_{1,nominal}[kW] \cdot CF[-] \cdot RH\left[{}^{h}/_{year}\right] \cdot Lifetime[year]$$

Where,

- $P_{1,nominal}[kW]$ = nominal power input of the motor or Power Drive System (PDS)
- $CF[-]$ = control factor (dimensionless) subject to the following relationship with the average power input $P_{1,AVG}$:
$$P_{1,AVG}[kW] = P_{1,nominal}[kW] \cdot CF[-]$$
- $RH\left[{}^{h}/_{year}\right]$ = running hours per year [see 5.4. Running hours]
- Lifetime = years [see 5.5. Lifetime]

The following Control Factors (CF) can be used as general reference values:

- CF = 0,90 for pump units/systems without VSD

- CF = 0,57 for pump units/systems with VSD

Further information about the calculation methodology and Control Factors (CF) is available in the ***Europump GHG emissions guide:*** ***USE PHASE GHG EMISSIONS FROM PUMP UNITS***

5.3. On Running Hours (RH)

The number of running hours is a key parameter in Life Cycle Assessments (LCAs), as energy consumption is directly proportional to the duration of operation.

To ensure meaningful results, it is important to use realistic and representative running hour estimates based on actual or expected usage patterns of the product, application and region.

For pump units/installation where running conditions are unknown a value of e.g. 250, 3625 or 5000 hours per year can be used as recommended in accordance with Europump GHG emissions Guide.

5.4. On Lifetimes

Several parameters influence the actual operational lifetime of a pump, and understanding these is essential for accurate modelling:

- **Operating Conditions**: Harsh environments (e.g., high temperatures, corrosive fluids, or abrasive particles) can accelerate wear and reduce lifetime.
- **Maintenance Practices**: Regular and preventive maintenance can significantly extend the service life by reducing the risk of premature failure.
- **Design Quality and Materials**: Robust engineering, high-quality components, and corrosion-resistant materials contribute to longer lifespans.
- **Installation and Commissioning**: Proper installation and alignment help avoid mechanical stress and early failures.
- **Application Fit**: Selecting a pump that is well-suited and sized to the specific application ensures efficient operation and minimizes unnecessary strain.

Usually, the projected service life for a pump/pump unit ranges between 10 to 20 years.

In line with the Europump guide *Use Phase GHG Emissions from Pump Units* default value, a Reference Service Life (RSL) is recommended by default to be defined as 10 years (unless the actual lifetime of the product is less).

NOTE: The Reference Service Life (RSL) is a theoretical period used for calculation purposes and cannot be directly compared to the minimum, average or actual lifetimes of the products.

5.5. On electricity (grid mix) for use phase calculations

The energy source composition used to generate electricity—commonly referred to as the grid mix—is a key factor in Life Cycle Assessments (LCAs) of energy-using products such as pump units. This is because the environmental impacts of electricity consumption vary significantly depending on the generation method.

Electricity from fossil fuels like coal or natural gas typically results in a high Global Warming Potential (GWP) due to associated greenhouse gas emissions. In contrast, electricity from renewable sources such as wind, solar, or hydro has a substantially lower GWP.

As global energy systems shift toward decarbonization, the reference year of the grid mix used in an LCA becomes increasingly important. Even within a few years, changes in the energy mix can significantly affect the calculated environmental impacts.

To ensure relevance and accuracy, Europump recommends carefully selecting a grid mix dataset that is representative of both the geographical location and the time-period (reference year) of the scenario being assessed.

5.6. Ensuring transparency

Europump recommends explicitly stating the following information about the assumed scenario when communicating the results of LCAs:

- Nominal power input $P_{1,nominal}$ and Control Factor (CF) or average power input $P_{1,AVG}$ and Flow-time/Load profile.
- Number of Running Hours (RH) [see 5.3.]
- The Lifetime / Reference Service Life (RSL) [see 5.4.]
- Full name of electricity mix dataset and the name of the database [see 5.5.]

The following (or similar) statement on-use phase calculations can also be included:

The environmental impacts from the use phase in this declaration is based on a generic use phase scenario and should hence not be used for pump unit/system selection. The use stage results should therefore also not be compared with results from other product LCA's, in a context where other scenarios can be relevant.

6. On transport scenarios

It is recommended that transport-related data – such as distance and modes of transport – is considered and reflected in the project and LCA report, with appropriate context and documentation.

If no specific data or default scenarios are available, the following by default data may be applied (for every transport situation):

- International transport: Used for transport cross oceans or multiple regions.
    - 19,000 km by boat plus 1,000 km by lorry,
- Intracontinental transport: Used for transport within the same continent but across countries.
    - 3,500 km by lorry,
- Local/domestic transport: Used for transport for last-mile delivery, distribution to/from warehouses, or within a single country.
    - 1,000 km by lorry.

By default, an articulated lorry >27 t is used with a loading rate of 85%. If the loading rate is not specified in the Life Cycle Impact (LCI) dataset, it is recommended to declare the rate in the project/LCA report.

Take special means of transport or unladen return journeys into consideration.

7. On installation scenarios

For installation a default transportation distance of 100 km roundtrip for 1 person may be used, specifying the Life Cycle Impact dataset used.
The transportation means (e.g. Utility vehicle) is recommended to be specified.

The installation of larger pump units may involve cranes and other equipment; this is considered part of the construction project of the building or the pumping station and hence outside the system boundary and can be excluded from the pump LCA.

8. On maintenance scenarios

It is common for pumps to be regularly inspected and maintained. For maintenance, a default transportation distance of 100 km roundtrip for 1 person may be used specifying the Life Cycle Impact dataset used.

Europump recommends that:

- The transportation means (e.g. utility vehicle) to be specified
- The operating, servicing and maintenance conditions include
    - Maintenance operation frequency where applicable
    - The parts, products and consumables used to maintain/service the reference product

If other distance data is used for transport this is recommended to be described and justified in the LCA report.

9. On recycling rates for end-of-life scenarios

Europump recommends that the applied recycling rates are justifiable and assumptions regarding the collection, sorting and recycling rated to be explicitly described and reviewed for plausibility in the LCA/project report.

If there is no specific data available, the default values for recycling rates from EN 50693 – table G-4, can be used.