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Tracking the carbon impact of space heating appliances from cradle to grave

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Abstract

To keep the global warming below 1.5°C, the European Union (EU) committed to carbon neutrality by 2050. The EU acknowledges that achieving this goal will require tracking the greenhouse gases (GHG) emissions of organisations, products and buildings, from cradle to grave. Carbon, and more generally environmental, impact of products and buildings is evaluated while performing life cycle assessments (LCAs). LCAs are not widespread so far in the EU. However, several signs show that LCAs will become the norm sooner or later. LCAs are governed by precise and strict rules that are described in standards which describe the LCA's process as well as how the environmental product declaration shall be performed and handled. In the French law, before any building construction, it is compulsory to perform LCAs. Construction projects shall demonstrate that GHG emissions from cradle to grave do not exceed defined thresholds. LCAs provide a much wider picture of the environmental impact of products or buildings and can serve for building up the best strategy for reducing the GHG emissions.

Keywords: space heating appliances, carbon footprint, climate change, carbon neutrality

1. Greenhouse gases emissions tracking

1.1. Worldwide commitment

In order to fight against climate change, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and has since been ratified by 195 Parties. The Kyoto Protocol was adopted in 1997 to implement the UNFCCC and entered into force in 2005.

In short, the Kyoto Protocol operationalizes the United Nations Framework Convention on Climate Change by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets.

Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept. Reporting is done by Parties by submitting annual emission inventories and national reports under the Protocol at regular intervals.

A compliance system ensures that Parties are meeting their commitments and support them to meet their commitments if they have problems doing so.

At the conference of the parties organized in 2015 in Paris (COP 21) 196 Parties signed a legally binding international treaty on climate change.

Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

To achieve this long-term temperature goal, countries aim to reach global peaking of GHG emissions as soon as possible to achieve a climate neutral world by mid-century.

The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.

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The Paris Agreement works on a 5-years cycle of increasingly ambitious climate action carried out by countries. By 2020, countries submit their plans for climate action known as nationally determined contributions (NDCs).

In their NDCs, countries communicate actions they will take to reduce their GHG emissions in order to reach the goals of the Paris Agreement. Countries also communicate in the NDCs actions they will take to build resilience to adapt to the impacts of rising temperatures [1].

In 2020, the European Union (EU) published its NDC where the EU set a binding target of a net domestic reduction of at least 55% GHG emissions by 2030 compared to 1990 [2]. The EU is pushing even further and targeting carbon emissions neutrality by 2050.

1.2. European Union actions

After the Kyoto protocol was signed, the EU put in place the first measures aiming at tracking and limiting the GHG emitted by the energy related activities, and several other very high GHG emitting sectors. However, the carbon neutrality cannot be achieved unless, the emissions in almost all the human activity sectors are tracked and limited. Therefore, the EU launched the Emission Trading System (ETS) that tracks the GHG emitted by the energy utilities and industries and other pieces of legislation addressing energy related products; buildings, transportation and many more.. The EU also set GHG reporting obligation (DIRECTIVE 2014/95/EU) for the largest organisations, both public and private and set the ambition of tracking both direct and indirect GHG emission.

This paper is focusing on the measures impacting products, and more specifically energy related products, such as heat pumps.

- Large organisations’ GHG emissions

Every company employing more than 500 persons must report on their direct and indirect GHG emissions as well as on information on the management’s approach to reduce them. The reporting periodicity is defined at the member state level. It is recommended to report according to the scope 1 and scope 2 as defined by the GHG protocol standards.

The GHG protocol is a partnership of businesses, non-governmental organisations (NGOS), governments, and other organisations convened by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). It first established in 2001 the most widely used international accounting tool for quantifying and measuring GHG emissions.

The GHG Protocol breaks GHG emissions down into three categories: scope 1 emissions are defined as those caused directly by an organization’s activities while scope 2 emissions count indirect emissions resulting from an organisation’s energy consumption. Scope 3 encompasses all other indirect emissions, caused along an organisation’s value chain, included the products that are purchased and placed on the market [3]. The three scopes concepts are illustrated on figure 1.

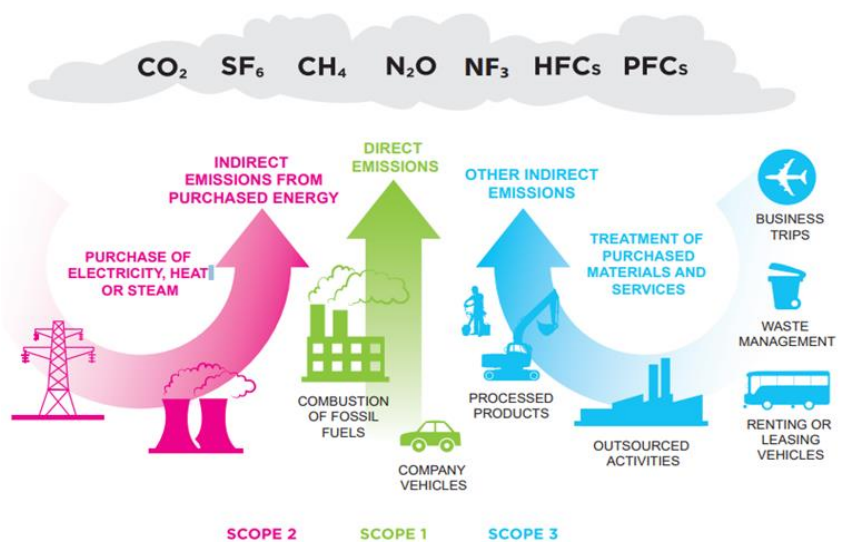


Fig. 1. Overview of the GHG Protocol scopes and emissions across the value chain [4]

As of today, reporting on emissions under scope 1 and 2 is mandatory while reporting under scope 3 is optional. However, in some member states, like France, reporting under scope 3, which requires accounting for the carbon footprint of products and goods, is recommended.

- Energy using products

The EU started to tackle the energy related products already back in 1994 when the energy label was introduced for several household appliances before being subsequently expanded in 2004.

The EU energy label has been a key driver for helping consumers choose products which are more energy efficient. At the same time, it also encourages manufacturers to drive innovation by using more energy efficient technologies.

The energy labelling directive was then followed, in 2009 by an eco-design directive. This directive is an effective tool for improving the environmental performance of products by setting minimum energy performance standards. This eliminates the least performing products from the market, significantly contributing to the EU's energy and climate targets.

The Ecodesign directive and Energy labelling regulation are both addressing energy efficiency, meaning the energy used by products during their life stage. Even though the GHG emissions from the usage phase of the energy using product often stand for a significant share of the overall GHG emissions, the GHG emissions from energy using products start when the raw material is extracted from the mines and stop when the products are either recycled, burned or land filled. To reach the 2050 zero emission target, the EU has to reduce the GHG emissions of products while taking in account their entire life cycle. An assessment limited to the usage phase is not enough.

A proposal for "Ecodesign for sustainable products regulation" is under development [5]. This regulation will replace the present Eco-design directive and is aiming at adding criteria addressing resource efficiency. In particular, the regulation proposes a mandatory carbon and environmental footprint declaration for the energy using products.

In parallel, the EU aims at switching its economy from a linear to a circular one. The actions taken in the framework of the circular economy action plan [6] will further speed up the GHG emissions' reductions and favor EU independency towards raw material.

- Buildings

In the EU, buildings represent 40% of the total energy consumption and 36 % of all GHG-emissions [7]. The GHG emission reduction target cannot be met without substantial reduction of the GHG emitted by buildings. The European Energy Performance of Building directive is the legislative instrument aiming at reducing the energy consumed by new buildings. As addressing new built buildings is not enough, the EU initiated, in 2020, the renovation wave which is targeting the existing buildings and is aiming at increasing the speed of renovation of the building stock. The renovation wave action plan includes a 2050 whole life-cycle performance roadmap to reduce GHG emissions from buildings [8].

Improving the energy efficiency of building is a good start as it helps reducing the GHG emissions over the life stage of the buildings. However, measuring the GHG emissions exclusively over the use phase of the building is misleading. As for the energy using products, reducing the energy use during the life stage would not be enough to reduce the GHG emissions so that carbon neutrality can be achieved by 2050. Indeed, a study on the Austrian building stock showed that the GHG "embodied" in building-related processes (e.g., material production, transport, refurbishment, or end-of-life) is four times higher than the GHG emitted during the use phase of the buildings [9].

In the recast of the Energy Performance of Building directive, a new requirement is added on a mandatory calculation of the life-cycle Global Warming Potential (GWP) of new buildings [7]. This new directive is to be published in 2023.

- General rules for life cycle assessment

Reporting on the GHG emitted over the use phase of products and buildings and directly or indirectly emitted by organisations is not enough to cut down GHG emissions so that the 2050 goal can be achieved. For that reason, carbon or environment footprint criteria are appearing in pieces of legislation related to reporting obligations for organisations, products and buildings.

The European Commission acknowledged that Life Cycle Assessments (LCA) provide the best framework for assessing the potential environmental impacts of products currently available. The need for consistent data and consensus LCA methodologies was underlined. Mid-2005. A joint project between DG Environment and the Commission's Directorate-General Joint Research Centre was initiated and the European Platform on Life Cycle Assessment was created.

2. Life Cycle Assessment

2.1. Definitions

The term “carbon footprint” has been widely established, including the public domain. However, this term is not clearly defined and moreover, several definitions can be found in the literature [8].

In the proposal for a regulation on Ecodesign for sustainable products [5], the carbon footprint is defined as “the sum of greenhouse gas (GHG) emissions and GHG removals in a product system, expressed as CO₂ equivalents and based on a life cycle assessment using the single impact category of climate change”.

The “environmental footprint” is defined as “a quantification of a product’s environmental impacts, whether in relation to a single environmental impact category or an aggregated set of impact categories based on the Product Environmental Footprint method”.

Looking at the above-mentioned definitions, it seems that the “carbon footprint” is limited to the GHG emissions, whereas “the environmental footprint” has a wider scope and includes other types of impact than GHG emissions. In any case, both the carbon and environmental footprints are quantified by performing a life cycle assessment (LCA).

2.2. LCA methodologies

Two LCA methodologies are described in the literature: the bottom-up, based on process analysis and the top-down, based on environmental input-output (EIO) analysis [10]. The top-down method is an economic quantitative method to study the interdependence between various parts of the economic system, which runs in the whole industry cycle. The method aims at estimating all purchases and activities in a supply chain leading up to final manufacture in an industry. The carbon or environmental footprints are then calculated based on these transactions within the supply chain.

Process analysis is a bottom-up method, which has been developed to understand the environmental impacts of individual products from cradle to grave. The bottom-up approach describes the environmental footprint calculation of individual materials, products or processes. Setting the boundary conditions is key while performing a LCA using the process analysis method. Omrany et al [11] made an extensive review of existing LCA in buildings and showed that there is no common way of defining boundary conditions. However, comparing carbon or environmental footprint of similar materials, products or services is only possible if the boundary conditions are identical. For that reason, it is essential to describe common ways and method for performing LCA.

2.3. LCA international standards, process-based method

The development of the international standards for life cycle assessments by the International Standardisation Committee (ISO), ISO 14040 series was an important step to consolidate procedures and methods of LCA. Their contribution to the general acceptance of LCA by all stakeholders and by the international community was crucial.

ISO 14040 describes the four phases of an LCA: goal and scope definition, life cycle inventory analysis (LCI), life cycle impact assessment (LCIA) and life cycle interpretation. The scope definition includes, among others, the boundary conditions. ISO 14041, ISO 14042, ISO 14043 ISO 14044 provide details and guidelines on the four phases.

ISO 14040 series contains overarching standards that are addressing a very wide audience. In order to establish the carbon or environmental footprint of materials, products, services... the ISO 14040 series is complemented by more specific standards addressing specifically material, buildings, products...

2.3.1. Environmental product declaration (EPD)

EPDs are Type III environmental declarations, according to ISO 14025 (2006) and are often a good source of environmental data for a life cycle analysis.

ISO 14025 standard establishes the principles and specifies the procedures for developing Type III environmental declaration programs and Type III environmental declarations. It specifically establishes the use of the ISO 14040 series of standards in the development of Type III environmental declaration programs and Type III environmental declarations.

Type III environmental declarations present quantified environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function. Such declarations

- are provided by one or more organisations,
- are based on independently verified life cycle assessment (LCA) data, life cycle inventory analysis (LCI) data or information modules in accordance with the ISO 14040 series of standards and, where relevant, additional environmental information,
- are developed using predetermined parameters, and
- are subject to the administration of a program operator, such as a company or a group of companies, industrial sector or trade association, public authorities or agencies, or an independent scientific body or other organisation.

Type III declaration process is illustrated in figure 2.

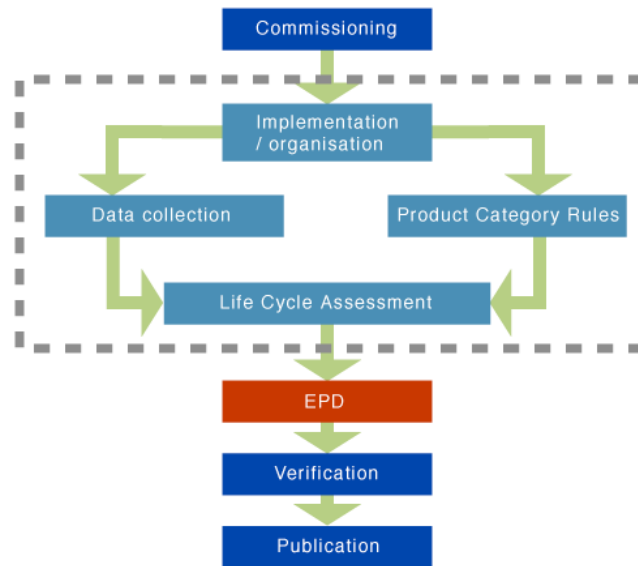


Fig. 2. Type III declaration process (Source: <https://www.greenspec.co.uk>)

In the development of Type III environmental declarations, all relevant environmental aspects of the product throughout its life cycle shall be taken into consideration and become part of the declaration. If the aspects considered to be relevant do not cover all stages of the life cycle then this shall be stated and justified. The data shall be generated using the principles, framework, methodologies and practices established by the ISO 14040 series of standards (i.e. ISO 14040 and ISO 14044).

The organisations acting as program operator are elaborating product category rules (PCR) which are defined as a set of specific rules, requirements and guidelines for developing Type III environmental declarations. PCRs set the rules, among other, for the environmental aspect and the life cycle stages to be considered, for the data quality requirements and the boundary conditions.

An EPD is a particular type of LCA, conducted using a defined set of Product Category Rules (PCR). Many PCR can be used for construction products (CPA, 2012) but only EPD following the same PCR can be compared.

EPDS are stored in dedicated database such as the INIES database or “the international EPD system” database.

2.3.2. Product standards

The European Committee for Standardisation (CEN) was mandated in 2004 for the development of horizontal standardised methods for the assessment of the integrated environmental performance of buildings. CEN TC350 works on the two standards dedicated to the evaluation of the environmental impacts of buildings: the EN 15978 (2011) and the EN 15804 (2012), for the building and material/product levels, respectively.

- Building level (EN 15978)

EN 15978 provides calculation rules for the assessment of the environmental performance of new and existing buildings based on a life cycle approach. It is intended to support the decision-making process and documentation of the assessment of the environmental performance of a building.

- Product level (EN 15804)

At the product level, EN 15804 standard defines the product category rules to develop Environmental Product Declarations (EPD) of construction products. The product category referred to in this standard includes all construction products and construction services for buildings and other construction works.

2.4. EU recommendations for LCA

The European Platform on Life Cycle Assessment (LCA) was created in 2008. This platform is aiming at proposing common methods to quantify the environmental impacts of products (goods or services) and organisations.

The European Commission proposed the Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF) methods as a common way of measuring environmental performance.

The overarching purpose of PEF and OEF information is to enable to reduce the environmental impacts of goods, services and organisations taking into account supply chain activities (from extraction of raw materials, through production and use to final waste management). This purpose is achieved through the provision of detailed requirements for modelling the environmental impacts of the flows of material/energy and the emissions and waste streams associated with a product or an organisation throughout the life cycle.

The EU in COMMISSION RECOMMENDATION (EU) 2021/2279 sets the rules for establishing product environmental footprint. The document describes general procedure to conduct a LCA and the rules for establishing the Product Environmental Footprint Category Rules (PEFCR). The general procedure follows the same steps as these describes in ISO 14040 while the rules to establish the PEFCR are based on the minimum recommendation of ISO 14025. The recommendation also provides guidance to elaborate Product Specific Rules (PSR) which are vertical rules addressing specific products. While PEFCR describe horizontal rules to be followed by products belonging to the same category, the PSR are addressing sub-categories.

The term PEFCR is used instead of PCR in order to avoid confusion between ISO 14025 and EU recommendations.

The recommendation 2021/2279 goes into the very details of each phase of the LCA and PEFCR.

3. LCA in the French building code

3.1. French building code RE2020

The first building code was introduced in France in 1974. The building code aims at ensuring a minimum energy performance of new buildings. Since the first edition of the EU Energy Performance of Buildings Directive in 2002, the French building code serves as the national implementing regulation of the EU directive.

The building code is associated to a calculation tool that calculates the yearly energy consumption of a building based on its structural characteristics (shape, insulation, walls, windows...), equipment (heating, ventilation systems...) and location. Prior to each new building construction, the building project shall demonstrate compliancy with the building code requirements.

Until 2022, the building code requirements were mainly addressing the energy consumption, the building envelop performance and the amount of renewable energy used.

On 1st of January 2022, the new French building code, RE2020 entered into force. The RE2020 includes the calculation of the LCA of the buildings, including equipment. from cradle to grave.

3.2. Buildings' LCA

3.2.1. General methodology

The whole process for the LCA follows the approach as recommended by the EU in COMMISSION RECOMMENDATION (EU) 2021/2279.

The buildings' LCA is conducted according to ISO 14040 and ISO 14044 and follows the four steps of the LCA as defined in ISO 14040: definition of scope and goal, life cycle inventory, life cycle impact assessment, interpretation and declaration. The buildings' LCA is performed according to NF EN 15978 and comes as the sum of the LCA of the construction material, including heating, ventilation and air conditioning (HVAC) equipment, the impact from the energy used during the life phase and the impact of the construction services.

The LCA of construction materials and HVAC equipment are conducted according to ISO 14025, NF EN 15804 and NF EN 15804/CN (national complement to the standard for construction products) and are delivered as EPD.

The energy used during the use phase includes the energy needed for lighting, ventilation, space heating and domestic hot water production. In tertiary buildings and multifamily houses, energy needed for the lift and for lighting the car parks are also accounted for.

The impact of the building on the climate change is defined as the global warming potential (GWP) expressed in kg CO₂ eq/m².

The life-time of the building is assumed to be 50 years. A life-time is also defined for each piece of equipment. As an example, the life-time of heat pumps is 17 years. The GWP is calculated over the 50 years and the calculation takes into account the replacement of equipment. Primary energy factor for electricity is equal to 2.3 and it is considered constant for the entire life time of the building. The CO₂ content of the energy carriers are also considered constant over the 50 years.

3.2.2. Boundary conditions for the EPD

LCAs are performed from cradle to grave (according to NF EN 15804). The EPD shall be established while considering the following stages of the building life:

- Production: (modules A1-A3 according to NF EN 15804) extraction of raw material, transportation to the manufacturing site, manufacturing. Management of residues including packaging not leaving the factory gates are including in this stage
- Construction: (modules A4-A5 according to NF EN 15804) transportation from the production gate to the manufacturing site, construction or installation of the material or product, management of waste and packaging
- Usage: (modules B1-B7 according to NF EN 15804) use stage including maintenance, repair and replacement, energy and water used
- End of life: (modules C1-C4 according to NF EN 15804) deconstruction, transportation of the discarded products, waste processing
- Benefits and loads beyond the product system boundaries: (modules D according to NF EN 15804) environmental benefits or loads resulting from reusable products, recyclable materials and/or useful energy carriers leaving a product system.

The details of all the modules are describes in NF EN 15804.

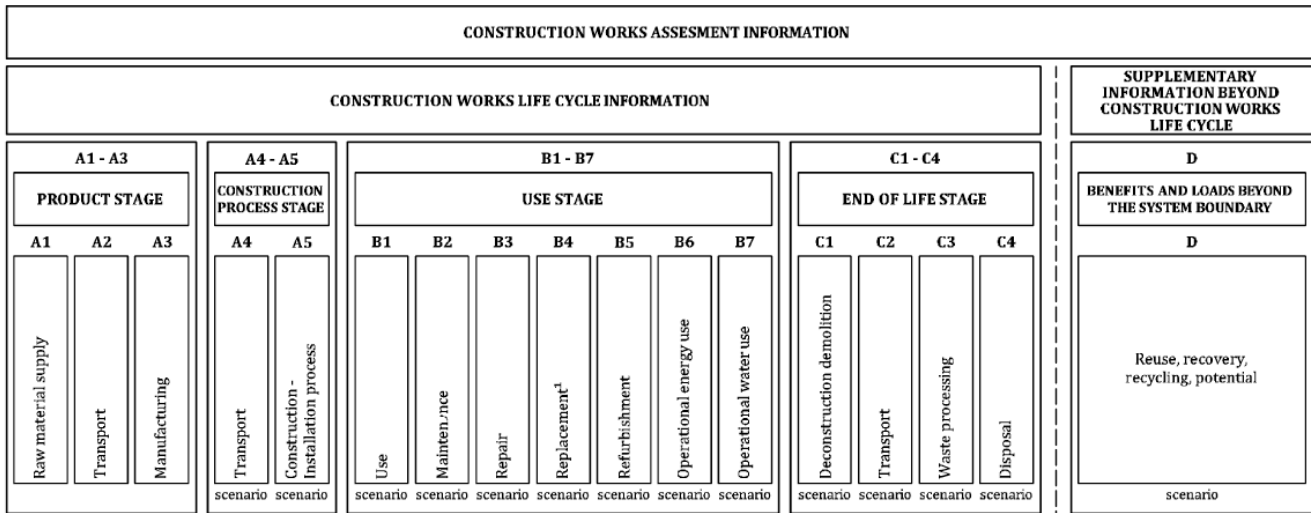


Fig. 3. Stages that shall be observed for a cradle to grave LCA (Source: NF EN 15804)

The EPD might be established for equipment providing one or several functions or for material and services.

The EPD shall be established for clearly defined and measurable functional (equipment) or declared (material and services) units to allow for the comparison of equipment, material and services.

3.2.3. Environmental impacts covered in the EPD

The EPD shall provide, at least:

- The global warming potential indicator

This indicator accounts for the GHG emitted over the entire life cycle of the product. It is expressed in CO₂ equivalent.

6 energy indicators: basically the renewable and non-renewable energy used during the use phase of an equipment.

- 12 indicators related to circular economy.
- 11 indicators related to biodiversity which include air, water and sea pollution.

3.2.4. EPD types

- General rules

The environmental product data shall be made available through EPD. However, in cases where no EPD is available, default values might be used.

The EPD are managed by the organization called INIES and made available on INIES database publicly and freely accessible on the internet.

- Default values

Default values are established for construction material and equipment by the French authorities (ministry). They are penalizing compared to specific data from EPD.

Default values are also established for services that are not covered by any program and thus cannot benefit from any EPD. These services are: waste treatment, transportation..., energies (electricity, wood, district heating...), refrigerants...

- FDES

FDES (Fiche de Données Environnementales et Sanitaires) are the EPD for construction material. INIES is the operator for the FDES and defines the program rules.

There are two main categories of FDES: collective and individual FDES. The collective FDES are established by several companies and concern a given material type (eg: clay roof tiles) while individual FDES is established for a given material reference of a given manufacturer.

The FDESs are valid for 5 years.

- Product Environmental Profile (PEP)

The operator for the equipment's EPD is an organization called PEP Ecopassport which is dedicated to electric, electronic and HVAC-R products. The EPD managed by PEP Ecopassport are called PEP (product environmental profile).

PEP Ecopassport is managing the electric, electronic and HVAC-R product category rules as well as specific product rules.

Just as FDES, there are two main categories of PEP: collective and individual PEP. The collective PEP are established by several companies and concern a given material type (eg: combination air to water heat pumps using R410A) while individual PEP is established for a given material reference of a given manufacturer.

The PEPs are valid for 5 years.

3.3. Minimum RE2020 criteria

RE2020 set minimum requirements related to the global warming potential (GWP). Two thresholds are defined, one addressing the construction phase: construction work, material and equipment, one addressing the energy used during the usage phase.

In order to be compliant, the calculated GWP of the construction phase and the calculated GWP of the energy used during the usage phase shall be lower than the thresholds.

- GWP of the material and equipment

The GWP is calculated as the sum of the GWP calculated in modules A, C and D for all the construction service and material, equipment that constitute the building

- GWP of the energy used during the usage phase

The GWP is calculated as the sum of the GWP calculated in modules B for all the material, equipment and services that constitute the building

3.4. Example of results of LCA performed on a single-family house

The LCA is performed on a 100m² single family house located in the West part of France. Table 1 shows the GWP values for both construction and use phase achieved if both the space heating and domestic hot water demand are covered by either an air to water heat pump or a wall-hung condensing gas boiler providing both space heating and domestic hot water. The heat pump considered in the example has a seasonal energy performance equal to 3 while the gas boiler has an efficiency of 94%.

Table 1. GWP calculated and GWP thresholds in kg CO₂ eq/m² when an air to water heat pump is installed

Phase	Construction phase	Use phase
	Air to water combination heat pump / wall hung gas boiler	Air to water combination heat pump / wall hung gas boiler
LCA GWP values kg CO ₂ eq /m ²	630 / 528	52 / 419
RE2020 thresholds kg CO ₂ eq /m ²	640	140

One can observe that the GWP impact of the construction phase is higher for the air to water heat pump than for the wall-hung gas boiler. However, the gas boiler is not compliant as the GWP on the use phase is higher than the authorized threshold.

4. Opportunities of the LCA calculations

So far, the EPBD mainly focuses on the yearly energy use in buildings. However, setting up a building construction strategy on the basis of the energy consumption might be completely different from the one that might be adopted while considering the GHG emissions during the life-time of the building or the total GHG emissions from cradle to grave.

Let's consider the example above (100m² single family home in the West part of France). Let's consider an existing similar house, located in the West part of France as well, built in the 60s and equipped with a 20-years-old non condensing gas boiler which achieves 75% efficiency. The primary energy used for space heating and domestic hot water for the new built house and the existing one over 50 years (for the existing building, the web tool [13] has been used) are shown in figure 4. Figure 5 shows the GHG emissions, calculated for 50 years corresponding to the energy used for space heating and domestic hot water production while considering the data listed in table 2.

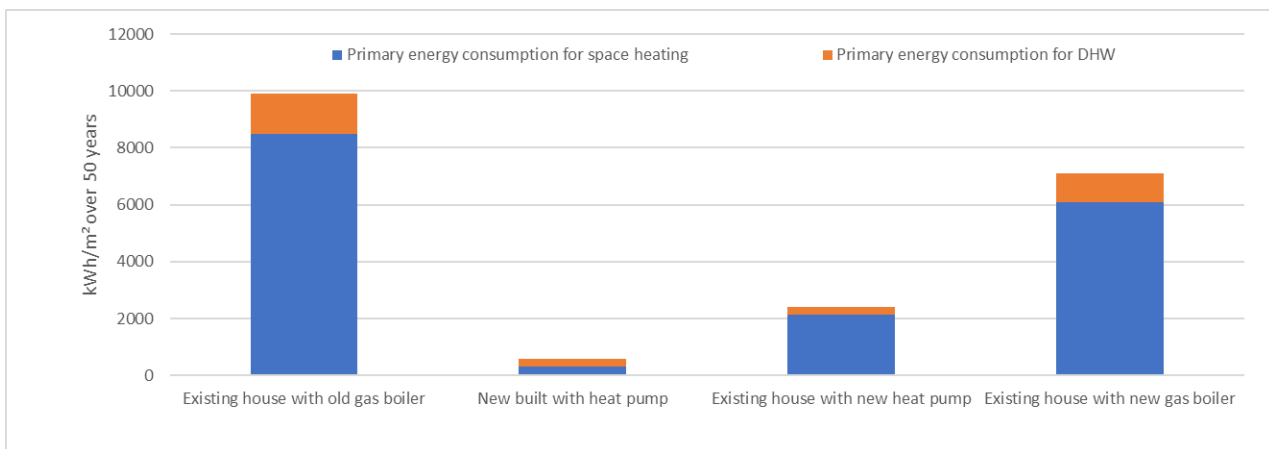


Fig. 4. Primary energy used for space heating and domestic hot water production over 50 years in kWh/m²

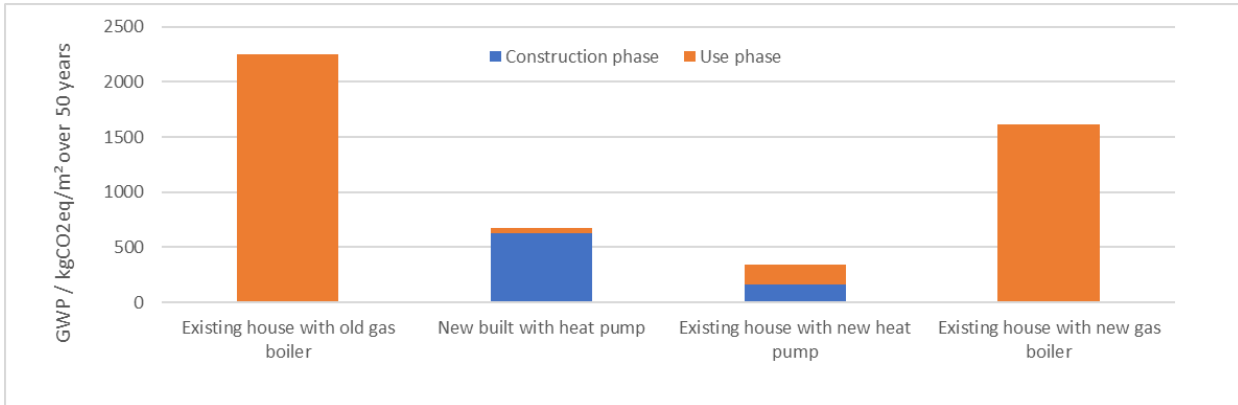


Fig. 5. GWP for construction and use phases for new built and existing house

In figure 5, the GHG impact of the heat pump and new gas boiler installation and two replacements are considered, while it is assumed that the existing boiler will last for 50 years.

Table 2. Assumptions [12]

	GWP kg CO ₂ eq / kWh	Primary energy factor
Electricity for heating	0,079	2.3
Electricity for domestic hot water	0.065	2.3
Natural gas	0,227	1
GHG emission kg CO ₂ eq		
GWP for the construction of a 12kW air to water combination heat pump (PEP UNICLIMA [14])	5358	
GWP for the construction of a 23kW wall-hung condensing boiler (PEP UNICLIMA [15])	228	
Seasonal Performance factor of heat pump	3	
Energy efficiency of the new gas boiler	94%	
Energy efficiency of the old gas boiler	75%	

Figure 6 shows the emissions savings achieved while considering the following scenario:

- Scenario a: only the GHG emitted during the use phase of the house are considered
- Scenario b: GHG emitted by both the use and construction phase of the house are considered

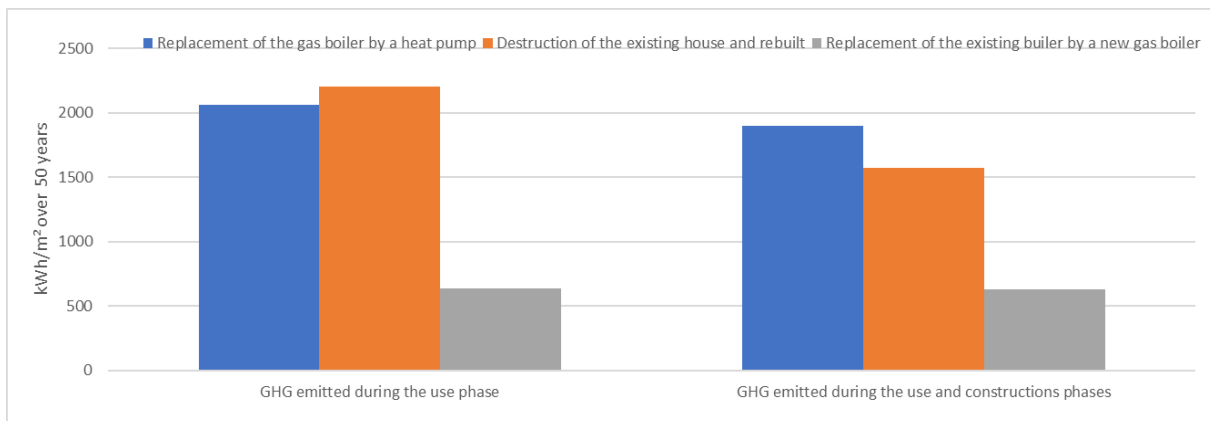


Fig. 6. Energy savings achieved while considering scenario a and b

Would only the use phase be considered, the conclusion would be that in order to achieve the highest GHG saving the old house should be torn down and replaced by a new one.

However, would both the use and the construction phases be considered, the best option would be to replace the existing gas boiler by a heat pump.

The conclusion here is only valid for France. Indeed, the conclusion could be very much different in countries where the CO₂ content of electricity is higher than the one in France. Figure 7 illustrates where the breaking point is.

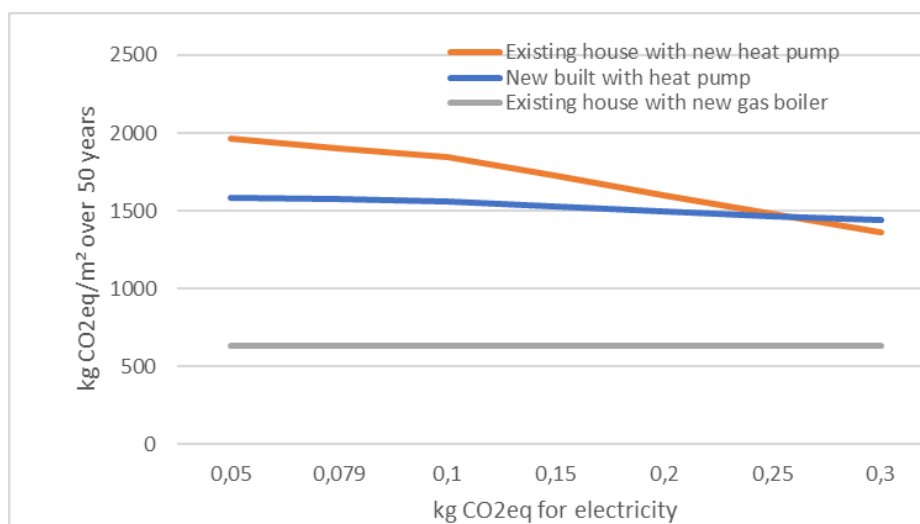


Fig. 7. CO₂ savings achieved depending on the CO₂ content of electricity

In countries where carbon intensity of electricity is lower or equal to the emission factor of gas, 0.25kg CO₂eq/kWh, it is worthwhile tearing down the existing building and rebuild a new one. Indeed, the GWP of the use phase become much more impacting than this of the construction phase.

This calculation illustrates the potential behind the life cycle assessment. Moreover, the calculation done here is only considering the GHG emissions impact. While accounting for more than one environmental impact, it would be possible to be sharper on the best strategy to adapt in order to protect our environment and preserve the natural resources.

5. Conclusion

In order to meet the COP 21 target and to achieve carbon neutrality by 2050, it is not enough to track the GHG directly and indirectly emitted by organizations and the GHG emitted during the use phase of the energy related product and buildings. Tracking the GHG emitted over the entire life cycle of products and buildings, from cradle to grave, has become a necessity. The tracking is done through the LCA that leads to environmental impact declarations for product, material and services. EPDs allow for a fair comparison of equivalent products and help choosing the less harming products in order to reduce the impact on the climate change.

In the EU, signs show that EPDs will become the norm soon or later for material and products, and in particular for heat pumps.

In France, since January 2022, EPDs are needed for construction material and HVAC equipment where installed in new buildings. In their national building code, RE2020, the French authorities go even beyond the GHG emissions as a full LCA is to be performed prior to every building construction. The LCAs include many impacts and not only the GWP impact. Even so, for the time being, minimum requirements are only addressing the GWP.

LCAs provides much more information than the GHG impact of a product, material or service. Other environmental impacts are assessed that give a much broader overview of how harmful a product, material or service can be for the environment. Indeed, Life cycle assessment allows for establishing construction strategy based on more extensive environmental criteria. In France, because the CO₂ content of electricity is low, it is better to replace existing boilers by heat pumps than to tear down the building and build up new ones.

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