EUROPEAN FIRE SPRINKLER NETWORK

Sprinklers, Sprinkler Systems, Life Cycle Assessments and Environmental Product Declarations

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Table of Contents

Executive Summary

The construction industry is under increasing pressure to reduce its environmental impacts and contribute to national and international decarbonisation objectives. While operational energy efficiency has historically been the primary focus of sustainable building design, increasing attention is now being directed towards embodied carbon and other environmental impacts associated with construction materials and building systems.

Life Cycle Assessments (LCAs) and Environmental Product Declarations (EPDs) are internationally recognised tools that enable the quantification and communication of environmental impacts throughout the life cycle of construction products and buildings. LCAs provides a systematic methodology for assessing environmental performance, while EPDs provide standardised, independently verified environmental data that can be used for product selection and whole-building assessments.

These tools are increasingly being incorporated into planning requirements, procurement processes, sustainability certification schemes, corporate environmental reporting, and emerging whole-life carbon regulations. That is bringing pressure on suppliers to reduce the environmental impact of their products and systems. This also applies to suppliers of sprinkler components and systems.

A major flaw in the LCA methodologies is that they ignore the reductions in emissions from fires if sprinklers are fitted, instead seeing a sprinkler system as an additional environmental burden, rather than one that provides increased sustainability of the building and prevents major emissions from fire. There is then a risk that poor decisions will be made, excluding sprinklers to produce buildings that are less safe and likely to have a greater environmental impact. While the errors in these methodologies need to be challenged and are being challenged, the sprinkler industry can also take steps to make huge reductions in carbon emissions associated with sprinkler components and systems.

1. Background

EFSN members are increasingly being confronted by questions related to the environmental impact of sprinkler components and sprinkler systems. This paper has been written to gather our collective knowledge and act as a reference to assist members when faced with environmental questions.

Environmental considerations affect almost every activity, including fire protection systems and products. For construction this is addressed at the European Union level by the Energy Performance of Buildings Directive, EPBD[1], '*aiming to achieve a fully decarbonised building stock by 2050*'. Ahead of that, in 2004 the European Commission issued mandate M/350 to CEN, instructing it to develop standard methods to assess the

[1] https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/energy-performance-buildings-directive_en

integrated environmental performance of buildings and construction products. In response CEN set up Technical Committee 350[2] Sustainability of Construction Works, which '*provides a standardized approach for the delivery of environmental information on construction products, the assessment of the environmental, social and economic performance of new and existing construction works (buildings and civil engineering works), and more generally the sustainability performance of construction works*.' CEN TC/350 is expected to produce a report for the European Commission in October 2026, recommending how the different CEN TCs should report environmental product data. The lack of this guidance has held back work on harmonised standards, including the five existing sprinkler component standards.

Meanwhile at a national level, governments are implementing legislation to meet the EPBD. As far as we can tell this is not being done in the same way in each country but the direction of travel is clear – LCAs will be required on new buildings to assess their lifetime carbon emissions. Not only that, there are deadlines for new buildings to meet ever tightening targets. Today LCAs are required in France[3], The Netherlands[4] and the Nordic[5] countries but all EU countries are expected to follow. For example, Germany will mandate them from 2028[6] for large buildings and from 2030 for all buildings, in line with the timeline set out by the European Commission[7]. While the UK has not yet committed to mandate LCAs in all new buildings, they have been required for government projects since 2020[8].

2. Introduction

The built environment is responsible for a significant proportion of global greenhouse gas emissions, resource consumption, and waste generation. Environmental impacts occur throughout the life cycle of buildings, beginning with the extraction and processing of raw materials and continuing through manufacturing, transportation, construction, operation, maintenance, refurbishment, and end-of-life activities.

Historically, efforts to reduce environmental impacts focused primarily on operational energy use. However, improvements in building energy performance and the increasing

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[2] https://www.cencenelec.eu/areas-of-work/cen-sectors/construction/sustainability-safety-and-accessibility/

[3] https://www.ecologie.gouv.fr/politiques-publiques/reglementation-environnementale-re2020

[4] https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/milieuprestatie-gebouwen-mpg

[5] https://pub.norden.org/us2024-415/index.html

[6] https://www.bpie.eu/wp-content/uploads/2025/09/dgnb_short-study_building-life-cycle-assessments-costs-and-capacities.pdf

[7] https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/energy-performance-buildings-directive/global-warming-potential-buildings_en

[8] https://www.gov.uk/government/publications/the-government-workplace-design-guide/sustainability-and-net-zero-annex

use of renewable energy sources have highlighted the growing significance of embodied carbon and other life-cycle impacts associated with construction products and processes.

To support informed decision-making and provide a robust evidence base for sustainability strategies, the construction industry increasingly relies on LCAs and EPDs. These methodologies enable environmental impacts to be quantified, compared, and communicated using internationally recognised standards.

3. Life Cycle Assessments

3.1 Definition and Purpose

An LCA is a systematic method for evaluating the environmental impacts associated with a product, process, or service or asset throughout its entire life cycle. Rather than focusing on a single stage, an LCA considers every phase, from raw material extraction through manufacturing, transportation, use, and eventual disposal or recycling.

This "cradle-to-grave" perspective provides a comprehensive picture of where environmental impacts occur and identifies opportunities for improvement. Within the construction sector, LCAs may be applied to individual products, building elements, infrastructure assets, or entire buildings.

The methodology is governed by the international standards ISO 14040:2006[9] and ISO 14044:2006[10], which establish the principles, framework, requirements, and guidelines for conducting life cycle assessments.

The principal purpose of the LCA is to quantify environmental impacts and identify opportunities for improvement. By evaluating impacts across all life-cycle stages, LCAs support evidence-based decision-making and help avoid the transfer of environmental burdens from one stage of the life cycle to another.

3.2 Methodology

An LCA is conducted through four interconnected phases:

The first phase, Goal and Scope Definition, establishes the purpose of the assessment, the functional unit, system boundaries, assumptions, and intended application of the results.

The second phase, Life Cycle Inventory Analysis (LCI), involves the collection and quantification of material flows, energy consumption, transportation requirements, emissions, waste generation, and other relevant inputs and outputs.

[9] ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework

[10] ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines

The third phase, Life Cycle Impact Assessment (LCIA), translates inventory data into environmental impact indicators through recognised impact assessment methodologies.

The final phase, Interpretation, evaluates the results, identifies significant contributors to environmental impacts, and supports decision-making and reporting.

3.3 Environmental Impact Categories

Although carbon emissions frequently receive the greatest attention, LCAs assess a broader range of environmental indicators. Common impact categories include global warming potential, acidification potential, eutrophication potential, ozone depletion potential, photochemical ozone creation potential, resource depletion, water consumption, and waste generation.

Global Warming Potential, typically reported as kilograms of carbon dioxide equivalent, remains the most widely used indicator within the construction industry due to its direct relevance to climate change mitigation.

4. Whole-Building Life Cycle Assessments

4.1 Overview

Whole-Building Life Cycle Assessments extend the principles of LCAs to the assessment of entire buildings. Rather than evaluating individual products in isolation, they consider the cumulative environmental impacts associated with all materials, systems, and operational activities over the building's life.

Whole-building assessments are increasingly used to support sustainable design, planning applications, carbon reduction strategies, and compliance with emerging regulations and industry standards.

The European standard EN 15978:2026[11] provides the primary framework for undertaking building-level life cycle assessments. While it does not specify a reference study period, in general 50 years is applied and the focus is on carbon emissions. For a manufacturer it is important to check whether 50 years or a different period is applied in target markets.

4.2 Whole-Life Carbon

A key application of a building's LCA is the assessment of whole-life carbon. Whole-life carbon encompasses both embodied carbon and operational carbon emissions.

Embodied carbon includes emissions arising from the extraction of raw materials, product manufacturing, transportation, construction activities, maintenance, replacement, refurbishment, demolition, waste processing, and disposal.

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[11] EN 15978:2026 Sustainability of Construction Works – Assessment of Environmental Performance of Buildings – Requirements and guidance, CEN, 2026

Operational carbon includes emissions associated with energy consumption during building operation, including heating, cooling, ventilation, lighting, hot water generation, and building services.

The Royal Institution of Chartered Surveyors provides widely adopted guidance for assessing and reporting whole-life carbon impacts within the United Kingdom[12].

4.3 Life-Cycle Modules

Building LCAs generally follow the modular structure defined within EN 15978 and EN 15804[13]. The Product Stage (Modules A1–A3) covers raw material extraction, transportation, and manufacturing processes. These stages are often referred to as "cradle-to-gate" impacts. The Construction Process Stage (Modules A4–A5) includes transportation to site, installation activities, construction waste, and site operations. The Use Stage (Modules B1–B7) covers maintenance, repair, replacement, refurbishment, operational energy use, and operational water consumption throughout the building's service life. The End-of-Life Stage (Modules C1–C4) includes demolition, transport of waste materials, waste processing, and disposal. Module D accounts for potential environmental benefits associated with reuse, recycling, and energy recovery beyond the building's system boundary.

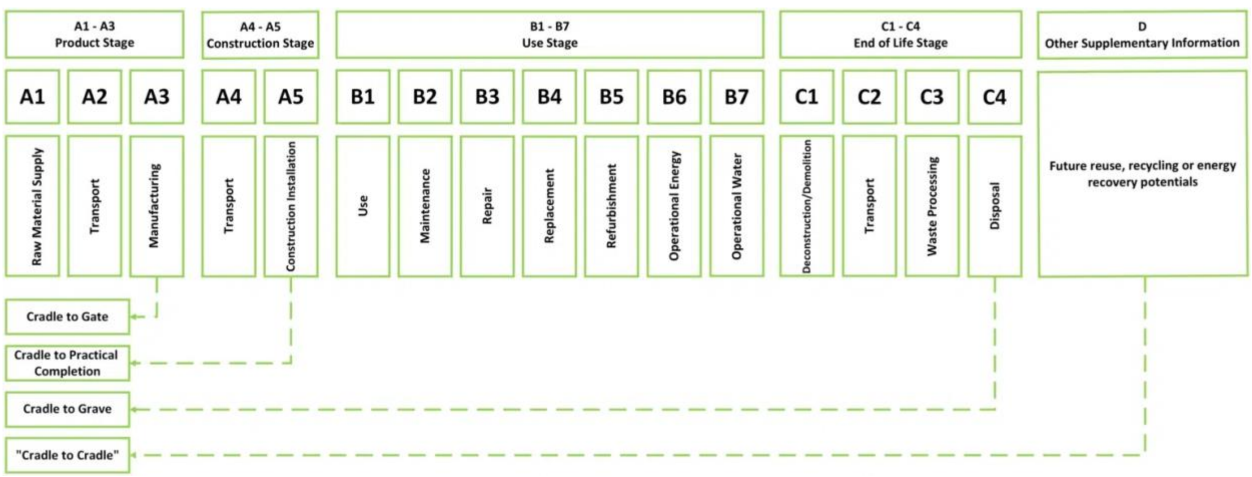

Figure 1: Modular structure of EN 15978

This modular framework enables consistent reporting and comparison between projects. Conducting an LCA also provides benefits that extend beyond environmental reporting. Manufacturers can identify opportunities to reduce material use, improve energy efficiency, lower emissions, and reduce production costs. Product designers gain insights

[12] Whole life carbon assessment for the built environment; Royal Institution of Chartered Surveyors; London, United Kingdom; 2024

[13] EN 15804:2012+A2:2019 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products

that support eco-design initiatives, while procurement teams can compare materials using objective environmental data. LCAs also help organisations prepare for increasing sustainability regulations and customer expectations by providing robust evidence to support environmental claims.

4.4 Building-Level Decision Making

Whole-building LCAs support decision-making throughout the design process. They can be used to compare structural systems, evaluate alternative materials, optimise building form, assess façade strategies, and identify opportunities for reducing embodied carbon.

Assessments undertaken during concept and developed design stages are generally the most effective because they allow significant design changes to be made before major decisions become fixed.

As embodied carbon targets become more stringent, whole-building LCAs are increasingly viewed as a core design tool rather than a compliance exercise. Today LCA methodologies ignore the benefits of sprinklers in reducing emissions from fire, instead treating a fire as an abnormal event and ignoring it. The EFSN would like to see whole-building LCAs take account of fire and of the reduction in emissions if sprinklers are installed. Nordic researchers and consultants have been working on this approach for some time,[14,15,16] finding a positive environmental case for sprinklers in some building occupancies. Recently they have shown how fire could be included to yield more realistic assessments[17].

5. Environmental Product Declarations

5.1 Definition

An Environmental Product Declaration is a standardised document that communicates the environmental performance of a product based upon a Life Cycle Assessment.

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[14] Brand som faktor i livscykelanalys - Hur påverkar risken för brand byggnaders klimatpåverkan?, Mossberg A., Wetterqvist C., Holmstedt L., Brandforsk, 2023

[15] Climate impact of building fires – Benefits with sprinkler systems; Nauckhoff H., Fire Sprinkler International 2025

[16] Assessing environmental impacts of active fire protection and egress systems using environmental product declarations: A review, Dormohamadi M., Kanafani K., Birgisdottir H., Dragsted A., Hoxha E., Cleaner Environmental Systems Systems 17 (2025) 100280, Elsevier, 2025

[17] A methodology for the integration of fire risk in building life cycle analysis, Mossberg A., Wetterqvist C., Holmstedt L., McNamee M., Fire Safety Journal 160 (2026) 104601, Elsevier, 2026

EPDs are governed by ISO 14025[18] and, for construction products within Europe and the United Kingdom, are generally prepared in accordance with EN 15804.

EPDs are intended to provide transparent, objective, and comparable environmental information, enabling informed product selection and supporting building-level environmental assessments.

5.2 Product Category Rules

EPDs are developed in accordance with Product Category Rules (PCRs), which define the methodology, assumptions, functional units, system boundaries, impact categories, and reporting requirements applicable to a particular product group.

PCRs ensure consistency between products within the same category and provide the basis for meaningful comparisons. Careful definition of PCRs helps to provide useful information at reasonable cost. One example is to use weight for sprinklers, so that EPDs generate values per kg for a specific manufacturer.

Without a sound PCR for sprinkler components, there is a risk of non-comparable EPDs being produced for similar products if different assessment approaches are applied.

5.3 Verification

A defining characteristic of an EPD is independent third-party verification. Before publication, the underlying LCA and declaration are reviewed by qualified verifiers to confirm compliance with applicable standards and programme requirements.

This verification process enhances confidence in the reliability and credibility of reported environmental data.

5.4 Types of EPD

EPDs may be either industry-wide or product-specific. Industry-wide EPDs represent average environmental performance across multiple manufacturers or products and are often used when specific data is unavailable. In The Netherlands the government provides industry figures but as yet none for sprinkler components[19].

Product-specific EPDs represent the performance of an individual product manufactured at a particular facility and generally provide a more accurate representation of environmental impacts. Specifiers are increasingly seeking product-specific EPDs and EFSN members are providing them.

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[18] ISO 14025:2026 Environmental statements and programmes for products – Environmental Product declarations (EPDs), ISO, 2026

[19] https://milieudatabase.nl/nl/

6. Relationship Between Building LCAs and EPDs

LCAs and EPDs are complementary tools.

LCA is the analytical methodology used to calculate environmental impacts. EPDs are the mechanism through which those impacts are communicated in a standardised and verified format.

Within building assessments, EPDs provide much of the environmental data required to quantify embodied impacts. Designers and sustainability consultants use EPD data within building LCA software platforms to model environmental performance and calculate whole-life carbon impacts.

The increasing availability of high-quality EPDs has significantly improved the accuracy and reliability of building-level environmental assessments.

7. Industry Applications

LCAs and EPDs are now widely used throughout the construction sector. Designers use them to evaluate alternative design options and identify opportunities to reduce environmental impacts. Contractors and developers use them to demonstrate compliance with project sustainability objectives and client requirements. Manufacturers use them to communicate environmental performance and identify opportunities for process improvement.

These tools are also increasingly incorporated into sustainability assessment frameworks such as BREEAM[20], LEED[21] and other building certification systems.

Furthermore, local authorities and national governments are progressively introducing requirements for embodied carbon reporting and whole-life carbon assessment, increasing the importance of robust LCA methodologies and verified environmental data.

8. Emerging Standards and Future Direction

The construction sector is moving towards greater transparency, standardisation, and accountability in environmental reporting. Several initiatives are expected to accelerate adoption of LCAs and EPDs, including embodied carbon regulations, digital product passports, BIM-integrated environmental assessment tools, and the development of national carbon benchmarks.

In the United Kingdom, the UK Net Zero Carbon Buildings Standard is expected further to strengthen requirements for measuring and reporting whole-life carbon impacts. At the same time, increasing investor expectations and Environmental, Social and Governance

[20] Building Research Establishment Environmental Assessment Method, BRE, Watford, UK

[21] Leadership in Energy and Environmental Design, US Green Building Council, Washington, D.C., USA

reporting requirements are driving demand for more comprehensive environmental data throughout construction supply chains.

These developments are likely to establish whole-building LCAs and product-specific EPDs as standard practice across much of the construction industry before government mandates take effect.

9. Relevance to the Sprinkler Industry

Not only is there a regulatory and market demand for EPDs but there is pressure to reduce the carbon footprint of sprinkler systems. As other construction products and systems reduce their carbon footprints, those of sprinkler systems become proportionally more significant, gathering more attention. The risk is that designers will not include sprinklers but find some other way to meet fire safety regulations, which do not aim to prevent massive environmental emissions from fires. NFPA and insurance data find that sprinkler systems reduce fire deaths and property losses by 80%[22, 23]. They do even better when it comes to environmental emissions, with a report from FM finding a reduction of 97%[24]. Unfortunately, BREEAM, LEED and other methodologies do not take account of the reductions in emissions from a fire if a sprinkler system is present. A fire is regarded as an abnormal event and therefore is ignored. This can lead to a suboptimal design, without sprinklers, that over the building lifetime is likely to lead to greater emissions than a design with sprinklers.

Even if the benefits of sprinklers are one day recognised by LCA methodologies, EFSN members are likely to see pressure to reduce the emissions associated with their products and systems. The focus today is on carbon emissions but it could be extended to other criteria, probably beginning with water use. Since a major part of the carbon emissions associated with sprinklers is embodied in steel and bronze components, there is pressure to use recycled or green steel, for which much less carbon is emitted in its production. The steel industry reports that to recycle scrap steel requires up to 74% less carbon (and energy) than to produce virgin steel[25]. Recycling takes place in electric-arc furnaces and if the electrical energy is from renewable sources the carbon emissions are near zero. Virgin steel can also be produced with very low carbon emissions by using hydrogen (hopefully produced by electrolysis of seawater using renewable energy) instead of coke to remove

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[22] U.S. Experience with Sprinklers, McGee, T., NFPA, Quincy, MA, USA, 2024

[23] https://www.thefpa.co.uk/advice-and-guidance/advice-and-guidance-articles/how-do-fire-sprinklers-work-

[24] Environmental Impact of Automatic Fire Sprinklers; Wieczorek, C., Ditch, B., Bill, R., FM Global Research Division, Norwood, MA, USA, 2010

[25] https://www.recyclemetals.org/newsandarticles/green-steel-why-scrap-metal-is-key-to-cutting-co.html

the oxygen in the iron ore[26]. Some EFSN members have commented that green steel pipe is now the norm in their country, even though it is more expensive.

Another important contributor to the emissions associated with sprinkler systems is the energy consumed in the weekly pump tests. We can therefore expect increasing pressure to power the pump using zero-emission energy. This could be biodiesel, hydrogen or some other inorganic (non-carbon) fuel, or electricity from renewable sources.

The sprinkler industry is responding. At Fire Sprinkler International 2026[27] many presentations were of innovations to reduce the environmental impact of sprinkler systems. Great ideas showed how to reduce carbon emissions and water consumption. Pump cooling water from the weekly test can be recycled and with monitoring systems providing better data, it may be possible to justify less frequent testing, saving energy.

While most of a sprinkler system can readily be recycled, the components have not been designed with re-use in mind (module D of EN 15978). Sprinkler threads are deformed during tightening to make a good seal while pipes are generally too corroded for re-use. Yet some manufacturers now offer sprinklers that are not connected using threads and with great improvements in corrosion protection it is possible that pipes may become reusable. Water storage tanks are a good example of what can be achieved. They represent one of the largest steel masses in a stored-water system but bolted panel tanks are designed to be disassembled and reused, they are compact to transport, and can be manufactured from recycled steel.

10. Conclusion

LCAs and EPDs have become essential tools for measuring, managing, and reducing the environmental impacts of construction products and buildings. LCAs provide a scientifically robust methodology for evaluating impacts across all stages of the life cycle, while EPDs provide transparent and independently verified environmental information that supports product selection and building-level assessment.

The integration of EPD data within whole-building LCAs enables project teams to quantify embodied and operational impacts, identify carbon reduction opportunities, and support compliance with emerging regulations and industry standards. As the construction industry continues its transition towards net-zero carbon and more sustainable forms of development, the importance of these tools will continue to grow.

EFSN manufacturer members are increasingly supplying EPDs and some installers report they routinely use recycled steel pipe. The sprinkler industry will not only have to supply data but find ways to reduce the environmental impact of components and systems. It is

[26] https://www.metals-hub.com/en/blog/green-steel-explained/

[27] Fire Sprinkler International 2026, 22-23 April, Paris Marriott Rive Gauche Hotel & Conference Center

rising to the challenge, as manufacturers and installers innovate to achieve huge reductions in carbon emissions and water consumption.