TECHNICAL SPECIFICATION

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Hydrogen technologies — Methodology for determining the greenhouse gas emissions associated with the production, conditioning and transport of hydrogen to consumption gate

Technologies de l'hydrogène — Méthodologie pour déterminer les émissions de gaz à effet de serre associées à la production, au conditionnement et au transport de l'hydrogène jusqu'au point de consommation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies*, Subcommittee SC 1, *Hydrogen at scale and horizontal energy systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The Paris Agreement was adopted at the UN Climate Change conference (COP21) with the aims of: strengthening the global response to the threat of climate change, restricting global temperature rise to below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1,5 °C above pre-industrial levels. To meet these goals, greenhouse gas (GHG) emissions need to be reduced by about 45 % from 2010 levels by 2030, reaching net zero in 2050 (IPCC, 2018; UNFCCC, 2021).

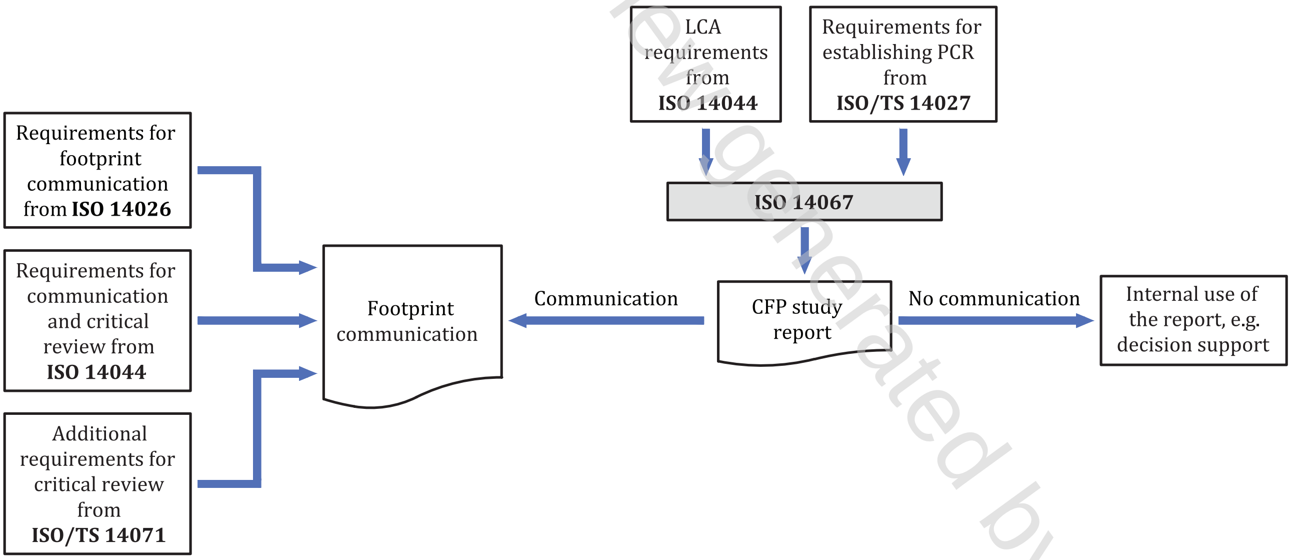
GHG initiatives on mitigation rely on the quantification, monitoring, reporting and verification of GHG emissions and/or removals. International Standards that support the transformation of scientific knowledge into tools can help in reaching the targets of the Paris Agreement to address climate change.

ISO 14040 and ISO 14044 define the principles, requirements and guidelines identified in existing International Standards on life cycle assessment (LCA). The ISO 14060 series provides clarity and consistency for quantifying, monitoring, reporting and validating or verifying GHG emissions and removals to support sustainable development through a low-carbon economy. It also benefits organizations, project proponents and stakeholders worldwide by providing clarity and consistency on quantifying, monitoring, reporting and validating or verifying GHG emissions and removals.

ISO 14067 is based on the principles, requirements and guidelines on LCA identified in ISO 14040 and ISO 14044 and aims to set specific requirements for the quantification of a carbon footprint (CFP) and a partial CFP.

ISO 14067 defines the principles, requirements and guidelines for the quantification of the carbon footprint of products. Its aim is to quantify GHG emissions associated with the lifecycle stages of a product, beginning with resource extraction and raw material sourcing and extending through the production, use and end-of-life stages of the product.

Figure 1 illustrates the relationship between ISO 14067 and other ISO documents on LCA.



PCR Product category rule

Figure 1 — Relationship between standards beyond the GHG management family of standards (source ISO 14067:2018)

Hydrogen can be produced from diverse sources including renewables, nuclear and fossil fuels using carbon capture, utilization and storage (CCUS) to reduce the emissions associated with its production. Hydrogen can be used to decarbonize numerous sectors including transport, industrial manufacturing and power generation.

A particular challenge is that identical hydrogen molecules can be produced and combined from sources that have different GHG intensities. Similarly, hydrogen-based fuels and derivatives will be indistinguishable and can be produced from hydrogen combined with a range of fossil and low-carbon inputs. Indeed, some of the products made from hydrogen (e.g. electricity) can themselves be used in the production of hydrogen. Accounting standards for different sources of hydrogen along the supply chain (see Figure 2) will be fundamental to creating a market for low-carbon hydrogen, and these standards need to be agreed upon internationally. Additionally, there is the possibility that consumption gates are not located in proximity to hydrogen production gates, requiring hydrogen transport. ISO 14083 gives guidelines for the quantification and reporting of GHG emissions arising from transport chain operations.

A mutually recognized international framework that is robust, avoids miscounting or double counting of environmental impacts is needed. Such a framework will provide a mutually agreed approach to “guaranties" or “certificates” of origin, and cover greenhouse gas inputs used for hydrogen production, conditioning, conversion and transport.

This document aims at increasing the methodologies that should be applied, in line with ISO 14067, to the specific case of the hydrogen value chain, covering different production processes and other parts of the value chain, such as conditioning hydrogen in different physical states, conversion of hydrogen into different hydrogen carriers and the subsequent transport up to the consumption gate.

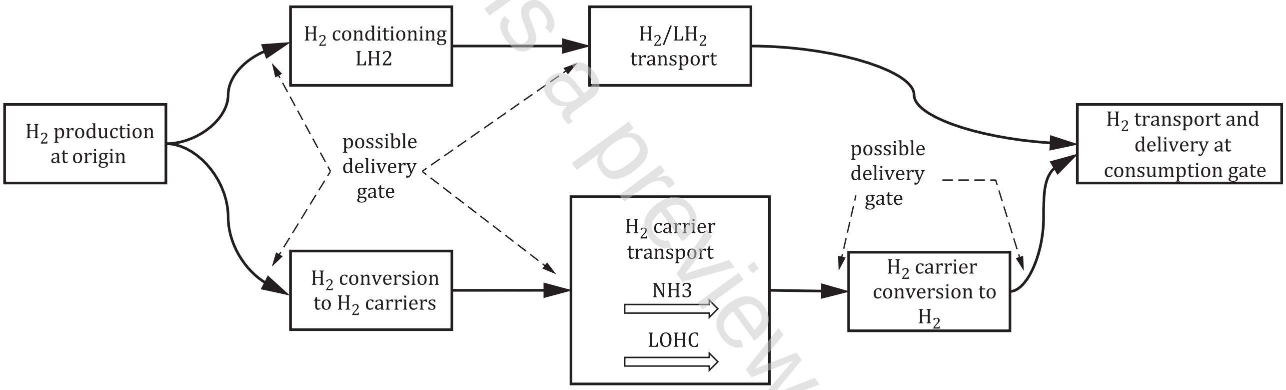


Figure 2 — Examples of hydrogen supply chain

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1 Scope

ISO 14044 requires the goal and scope of an LCA to be clearly defined and be consistent with the intended application. Due to the iterative nature of LCA, it is possible that the LCA scope needs to be refined during the study.

This document specifies methodologies that can be applied to determine the carbon footprint of a product (CFP) or partial CFP of a hydrogen product in line with ISO 14067. The goals and scopes of the methodologies correspond to either approach a) or b), given below, that ISO 14040:2006, A.2 gives as two possible approaches to LCA.

a) An approach that assigns elementary flows and potential environmental impacts to a specific product system, typically as an account of the history of the product.

b) An approach that studies the environmental consequences of possible (future) changes between alternative product systems.

Approaches a) and b) have become known as attributional and consequential, respectively, with complementary information accessible in the ILCD handbook.[1]

There are numerous pathways to produce hydrogen from various primary energy sources. This document describes the requirements and evaluation methods applied to several hydrogen production pathways of interest: electrolysis, steam methane reforming (with carbon capture and storage), co-production and coal gasification (with carbon capture and storage), auto-thermal reforming (with carbon capture and storage), hydrogen as a co-product in industrial applications and hydrogen from biomass waste as feedstock.

This document also considers the GHG emissions due to the conditioning or conversion of hydrogen into different physical forms and chemical carriers:

— hydrogen liquefaction;

— production, transport and cracking of ammonia as a hydrogen carrier;

— hydrogenation, transport and dehydrogenation of liquid organic hydrogen carriers (LOHCs).

This document considers the GHG emissions due to hydrogen and/or hydrogen carriers' transport up to the consumption gate.

It is possible that future revisions of this document will consider additional hydrogen production, conditioning, conversion and transport methods.

This document applies to and includes every delivery along the supply chain up to the final delivery to the consumption gate (see Figure 2 in the Introduction).

This document also provides additional information related to evaluation principles, system boundaries and expected reported metrics in the form of Annexes A to K, that are accessible via the online ISO portal (https://standards. iso. org/iso/ts/19870/ed-1/en).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14040:2006, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

ISO 14067:2018, *Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification*

ISO 14083:2023, *Greenhouse gases — Quantification and reporting of greenhouse gas emissions arising from transport chain operations*

ISO/TS 14071, *Environmental management — Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Quantification of the Carbon Footprint of a Product

3.1.1
allocation
partitioning the *input* (3.2.8) or *output* (3.2.10) flows of a process or a *product system* (3.2.3) between the product system under study and one or more other product systems

[SOURCE: ISO 14040:2006 and ISO 14040:2006/AMD 1:2020]

3.1.2
carbon footprint of a product
CFP
sum of *greenhouse gas emissions* (3.1.12) and *greenhouse gas removals* (3.1.4) in a *product system* (3.2.3), expressed as *CO_2 equivalent* (3.1.10) and based on a *life cycle assessment* (3.4.5) using the single impact category of climate change

Note 1 to entry: A CFP can be disaggregated into a set of figures identifying specific *GHG emissions* (3.1.12) and *removals* (3.1.4). A CFP can also be disaggregated into the stages of the *life cycle* (3.4.4).

Note 2 to entry: The results of the *quantification of CFP* (3.1.8) are documented in the CFP study report expressed in mass of *CO_2e* (3.1.11) per *functional unit* (3.2.14).

[SOURCE: ISO 14067:2018, 3.1.1.1]

