TUV RHEINLAND Standard H2.21 Renewable and Low-Carbon Hydrogen Fuels

[Version 2.1 / March 2023]

1. Terms and definitions

Bidding Zone

As defined in the Regulation (EU) 2019/943 - "The largest geographical area within which market participants are able to exchange energy without capacity allocation".

CCF

Corporate Carbon Footprint - Amount of greenhouse gases emitted (represented as the mass of CO_2 equivalents) resulting from the operation of a company per time period (e.g. 1 year).

CCS

Carbon Capture and Storage - Method for the permanent capture and storage of CO_2 emissions in underground reservoirs excluding lift gas.

CCU

Carbon Capture and Utilization – separation and utilization of CO_2 in downstream processes to form other chemical compounds where CO_2 is fixed permanently.

CCUS

A newly applied abbreviation for both technologies CCU & CCS.

Certificate

A one-page confirmation of assessment from the Certification Body with time-limited validity of 12 month- stating that the specific criteria have been checked and complied with. Parameters and characteristics exceeding the criteria, set forth in this standard, can be individually highlighted in the certificate, or the associated Test Mark, respectively.

Certification Body

TÜV Rheinland, as well as acknowledged bodies by TÜV Rheinland, who are authorized to undertake assessments of the criteria listed in this standard H2.21 and issue Certificates (see chapter 8).

Comparator Value

Reference value from RED II for emissions from fuels of transportation (94 g CO_2-eq/MJ)

Cradle

The starting point in the Life Cycle of a product, usually the extraction of raw materials.

Downstream

Life Cycle section, subsequent to a reference point under consideration; here referring mostly to the part after the production facility (Gate).

Gate

Usually, the handover point at a manufacturer's plant exit in the Life Cycle or Supply Chain.

GHG Protocol

Greenhouse Gas Protocol - “A private transnational set of standards for greenhouse gas emissions accounting (carbon accounting) and related reporting for businesses and, increasingly, the public sector. The development of the GHG Protocol is coordinated by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD)" [Wikipedia].

Grave

The end point in the Life Cycle of a product, usually the final disposal or destruction, or the recycling point with a transition to a new Life Cycle.

GWP

Global Warming Potential - mass-based factor as the CO_2 equivalent of a specific greenhouse gas to describe the climate effect in direct comparison to the gas CO_2.

Hydrogen

H_2 and Hydrogen Derivatives

Hydrogen Derivatives

Downstream products generated from Hydrogen falling under this standard, such as ammonia, methane and methanol. Emissions include the PCFs of hydrogen and further input substances (such as nitrogen and carbon (mono/di) oxide), as well as the synthesis energy for Hydrogen Derivatives. Captured carbon emissions may be considered as neutral only if they are or have been fully accounted as emitted in the upstream process and have not received any credits or benefits from their capture.

Key Word

Terms written on a Test Mark in order to show the dominant approved criteria from the certification.

Life Cycle

Refers to specified products (here: Hydrogen) where their footprints are calculated between boundaries ranging from Cradle to a certain variable point X, such as gate or grave.

Low Carbon Hydrogen

Hydrogen produced without process and technology restrictions where the PCF must be equal or less than 30% of the fossil Comparator Value (94 g CO_2-eq/MJ).

PCF

Product Carbon Footprint - Amount of greenhouse gases emitted (represented as a mass of CO_2 equivalents) associated with the Life Cycle or life cycle stage of a product.

RED II[1]

Renewable Energy Directive (Version II), Standard (EU) 2018/2001 on the promotion of the use of energy from renewable sources, revised version of December 11, 2018. This includes supplementing Directives (EU) 2018/2001 of the European Parliament and of the Council (RED II, Article 28, Delegated Acts), as well as their Annex, and RED II amendments – as listed in section 6.

Renewable Energy of Non-Biologic Origin

Energy from renewable non-fossil and non-biological sources, namely wind, solar (solar thermal and solar photovoltaic), geothermal energy, hydropower, tide, wave and other ocean energy.

Renewable Hydrogen

Hydrogen produced by electrolysis of water or aqueous solutions (e.g., chlor-alkali electrolysis) with the use of electricity from renewable non-biological sources where the PCF must be equal or less than 30% of the Comparator Value (94 g CO_2-eq/MJ) as specified in RED II.

RFNBO

Renewable fuels of non-biological origin - based on RED II Art. 2 §35: Liquid or gaseous fuels other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass.

Supply Chain

Consideration of the Life Cycle of a product from the commercial perspective of value creation.

Scope 1 Emissions

According to GHG Protocol - directly caused greenhouse gas emissions (e.g., from incineration plants, vehicle fleet operation, heating systems, etc.) generated at locations within a defined boundary.

Scope 2 Emissions

According to GHG Protocol - indirectly caused greenhouse gas emissions (e.g., through purchase and use of electricity, district heating/cooling or steam) produced outside the defined boundaries of the locations.

Scope 3 Emissions

According to GHG Protocol - indirect greenhouse gas emissions generated Upstream or Downstream to a defined site; contains 15 different categories.

[1] The current standard will follow the legislative development of RED II, and its criteria will be upgraded upon new releases (draft/final) published

Test Mark

A TÜV Rheinland label in digital graphic format, which is a separate part of the Certificate and is used to authenticate the Certificate and to publicly highlight the properties, features or characteristics of the individually certified Hydrogen product by Key Words.

Upstream

Life Cycle section preceding a particular reference point under consideration; here referring to subsections before X.

X

Variable point in the Life Cycle of Hydrogen between Cradle and Grave at which the Hydrogen is to be assessed and certified, to be defined by the customer.

2. Background

Hydrogen is considered an indispensable component for the achievement of the Paris climate targets by science, industry and politics. Hydrogen is a high-energy gas that emits no CO_2 during combustion and material use. It is thus fundamentally suited to be used as a climate-protecting alternative to fossil fuels. The European Green Deal and Germany's National Hydrogen Strategy, for example, take this into account and promote Hydrogen as a future energy carrier in the context of their broader climate policy. However, the production of Hydrogen is very energy intensive and conventionally based on fossil energy carriers. Therefore, only the sustainable production and application of Hydrogen has the potential to displace fossil-based energy carriers and consequently reduce greenhouse gases.

The decisive factor in the evaluation of the correct PCF and hence emission savings is to take into account all emissions, generated in the entire production process. In order to ensure comparability and resilience of the calculations, a standardized approach and a 3rd party verification is indispensable.

This TÜV Rheinland Standard H2.21 differentiates between two major Hydrogen classifications, also being in line with current efforts of political decision makers, namely:

1) **Renewable Hydrogen** addresses hydrogen produced by electrolysis of water or aqueous solutions (e.g., chlor-alkali electrolysis) with the use of electricity from renewable non-biological sources. The reduction target must be at least 70% of the Comparator Value (94 g CO_2-eq/MJ) as specified in RED II.
2) **Low Carbon Hydrogen** addresses all hydrogen production routes and therefore enables all technologies and processes to be subjected to certification. The reduction target must be at least 70% of the Comparator Value (94 g CO_2-eq/MJ).

3. Scope of application, system limits, remit

3.1. Scope

This standard defines requirements (criteria) for low-carbon Hydrogen in the variable point X, to be defined by the customer, within the Life Cycle section Cradle to X. The application of the standard is

ideally suited to those parties involved in the Hydrogen supply chain, e.g., manufacturers, producers, suppliers and logisticians, users, etc. (see Fig.1).

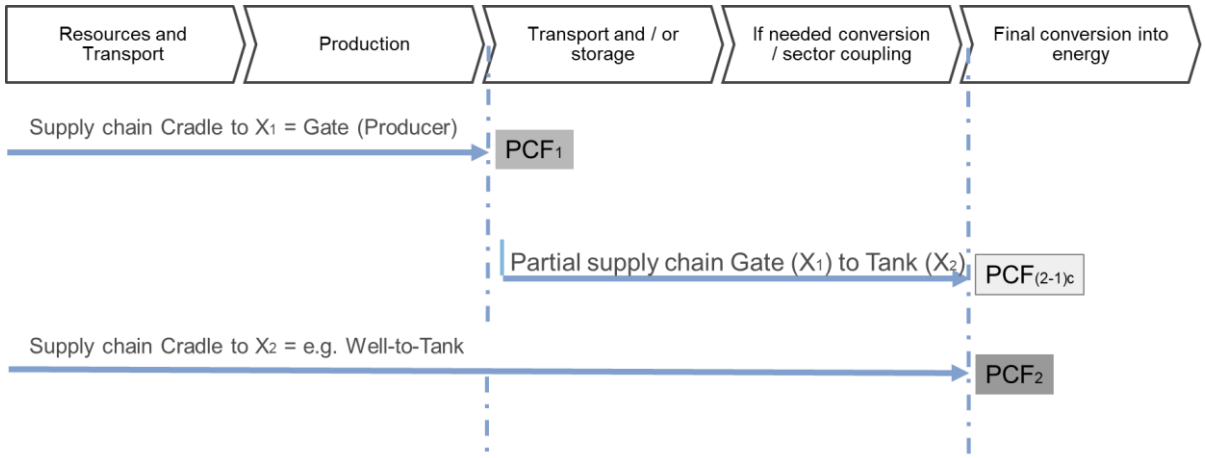

Figure 1: Typical supply chain for Hydrogen with variable exemplary Life Cycle points X1 (exit gate manufacturer) and X2 (user)

At point X, the PCF including all Upstream emissions (Cradle to X) must be calculated and verified, taking into account all Upstream emissions of raw, input and auxiliary materials (direct and indirect Upstream emissions). Emissions for the provision of process-specific plants and components (e.g., production plants, machines, vehicles, etc.) are not to be taken into account here. If no primary data of the Upstream chain is available, generic data shall be applied with a sufficiently conservative level of certainty. Data sources should be used that are highly trusted (e.g., publications from government environmental agencies or from scientific databases with good reputations).

In principle, X in the Supply Chain can also be chosen outside the customer's sphere of influence (e.g., Downstream in the case of transport of the Hydrogen after production by external logistics providers). If primary data cannot be obtained for the calculation, generic data shall be applied with a sufficiently conservative level of certainty.

If Upstream chain emissions have already been calculated and verified by an independent institution (e.g., PCF1 at point X1), it is sufficient to consider the CO_2 loads of the further partial supply chain (e.g. between X1 and X2), and then to determine PCF2 mathematically by summation.

In most applications, CO_2 is the only greenhouse gas relevant in PCF calculations. In addition, the following greenhouse gases shall be included in the calculation, if they occur and are emitted within the system limits:

- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorinated hydrocarbons (PFCs)
- Sulphur hexafluoride (SF6).

As a reference measure, all calculated greenhouse gases must be converted into mass-based CO_2 equivalents (CO_2-eq) with their currently valid GWP.

Identified errors, omissions or discrepancies in the calculation of the PCF must not exceed, in the aggregate of their effects on the overall result, the materiality threshold of 5% of the calculated PCF.

3.2. PCF calculation rules

The PCF of Hydrogen within its boundaries Cradle to X is either calculated according to ISO 14067, or alternatively as part of a life cycle analysis according to ISO 14040/44.

Except emissions for the provision of process-specific plants and components all direct and indirect emissions associated with production processes shall be taken into account. This includes the consideration of Category 1 and Category 2 emissions - as well as Upstream emissions caused by purchased goods needed for the process, such as water, fuels and electricity, (e.g., transmission, distribution, demineralisation, etc.).

4. Renewable Hydrogen

Renewable Hydrogen addresses Hydrogen produced by electrolysis of water or aqueous solutions (e.g., chlor-alkali electrolysis) with the use of electricity from renewable non-biological sources. The reduction target must be at least 70% of the Comparator Value (94 g CO_2-eq/MJ) as specified in RED II.

Consequently the maximum emission factor for Hydrogen to be considered "renewable" shall be 28.2 g CO_2-eq/MJ. With an energy density (LHV) of Hydrogen of 120 MJ/kg, this makes up for a maximum PCF value of 3.384 kg CO_2-eq/kg H_2.

Under this category Renewable Hydrogen, the following sub-categories are eligible:

4.1. Green Hydrogen

Under this sub-category, Hydrogen is produced by the electrolysis of water or aqueous solutions (e.g., chlor-alkali electrolysis) with the use of electricity from renewable non-biological sources only. In order to ensure the purchase of electricity exclusively from these sources, the criteria listed below must be met for the purchase of the entire electricity amount. All electrical appliances involved in the direct process (e.g., electrolyser, desalination, synthesis units, separation unit, CO_2 capture, etc.) and peripheral devices (e.g., purification, compression, cooling, storage, etc.) must be considered. All emissions related to fossil energy used in above appliances will be accounted accordingly. Derivatives based on Green Hydrogen and still not exceeding the PCF value calculated with 70 % reduction to the Comparator Value of 94 g CO_2-eq/MJ and their energy density can be considered under this sub-category.

If one of the following criteria is met, zero greenhouse gas emissions shall be attributed to the electricity. Otherwise, indirect emissions associated to the generation of renewable electricity must be fully accounted.

a. Renewable electricity of non-biological origin delivered either by direct line or stipulated by Power Purchase Agreement (PPA).
b. Procuring electricity from a grid without specified power plants is allowed only when this electricity is backed by certification and cancellation of green power certificate (such as Guarantees of Origin in the EU, or I-RECs outside the EU). For power plants in the EU, GoO have to be procured; Power plants outside the EU under I-REC or equivalent schemes should be in the same country.
c. The Hydrogen and the renewable electricity shall be produced within the same crediting period (max 12 months).

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key words:

- Renewable Hydrogen
- Green Hydrogen.

4.2. RFNBO (RED II)

With Regulation (EU) 2018/2001 on the promotion of the use of energy from renewable sources ("RED II"), the European Union has committed itself to steadily increasing the share of renewable energies in final energy consumption.

Thereby, several quotas have been proposed in the RED II directive, for example, the share of renewable energies in the final energy consumption in the transport sector and in the overall gross final energy consumption. Binding targets for the year 2030 in the member states shall be at least 14 % (Art. 25 §1) and 32 % (Art. 3 §1) respectively. Under the new RED II developments, shares of RFNBOs in the transport sector of at least 2.6 % in 2028 and at least 5.7 % in 2030 are proposed. In addition, the fuel supplier shall ensure that the greenhouse gas intensity reduction of at least 16 % by 2030 is achieved with renewable fuels and renewable electricity supplied to the transport sector. Whereas in the industrial sector, at least 50 % of Hydrogen used shall be RFNBO by 2030, increasing to 70 % by 2035. Furthermore, the overall share of renewable sources in gross final energy consumption in the EU will be increased from the mentioned 32 % to at least 45 % in 2030.

Various drafts are available in the form of Delegated Acts or Amendments, supplementing RE D II by specifying rules and methodologies in the context of the production of RFNBO and Recycled Carbon Fuels. In this standard, the RED II, Article 28, Delegated Acts of 10.02.2023 are applied. Main additional requirements mentioned therein address temporal and geographical correlation between electricity production unit and fuel production unit. Criteria on additionality and allowed subsidies are also defined.

For Renewable Hydrogen to be sub-categorized as RFNBO, the PCF shall be calculated in line with the methodology outlined in RED II, Article 28, Delegated Act, Annex 1, which establishes a methodology for assessing GHG emissions savings from RFNBOs- allowing the application of a zero-emission factor only for renewable electricity which follows the additional criteria outlined in this section.

In line with RED II, including all its amendments and Delegated Acts, the target for greenhouse gas savings from the use of renewable fuels shall be at least 70 %, compared to the Comparator Value of 94 g CO_2-eq/MJ. The energy content for hydrogen is to be set at 120 MJ/kg.

For the additional certification of conformity with RFNBO,the criteria[2] mentioned below must be met:

a. Renewable Hydrogen produced by the electrolysis of water or aqueous solutions (e.g., chlor-alkali electrolysis) with the use of renewable electricity from non-biological sources.
b. Criteria for additionality: For fuel production facilities that come into operation after 01.01.2028, the commissioning date of the renewable electricity plant shall not be more than 36 months prior to the start of fuel production. Furthermore, financial support for the RE plant is not allowed (after repowering). Support for land and for grid connection or support that does not constitute net support (i.e., if repaid) is allowed.
   For fuel production facilities that come into operation before 01.01.2028, no additionality criteria are applied to the renewable energy plant until 31.12.2038. Similarly facilities located in a bidding zone where the emission intensity of electricity is lower than 18 gCO2eq/MJ do not have to demonstrate additionality.
c. Criteria for temporal correlation: The RFNBO and the renewable electricity shall be produced within the same calendar month, until 31.12.2029, and from 01.01.2030, the fuel shall be produced during the same one-hour period as the renewable electricity produced.
d. Criteria for geographical correlation: Renewable electricity and electrolysis facilities must be located in the same electricity Bidding Zone, as defined in Regulation (EU) 2019/943. If electricity grid congestion between the facilities may be precluded, the installations may also be located in neighbouring electricity Bidding Zones. In countries outside of Europe an equivalent concept shall apply.

[2] Please note that especially the mentioned dates and the temporal correlation criteria may change. Hence re-certifications will consider the latest regulatory developments.

If the above-mentioned criteria are met, or exceptions as defined in the RED II, Article 28, Delegated Acts apply (e.g., downward re-dispatch, renewable grid, etc.), the electricity shall be attributed zero greenhouse gas emissions. Otherwise, indirect emissions associated to the generation of renewable electricity must be fully accounted.

For Hydrogen Derivatives based on Renewable Hydrogen and captured carbon emissions, the same criteria shall apply. As outlined in the current version of RED II, Article 28, Delegated Act, Annex 1 apply. Consequently, only the following sources of CO_2 qualify:

- CO_2 from an activity listed under Annex I of Directive 2003/87/EC (EU ETS); Within the EU, corresponding CO_2 has been taken into account Upstream in an effective carbon pricing.
- CO_2 from Direct Air Capture
- CO_2 from biofuels
- CO_2 from geological source.

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key words:

- Renewable Hydrogen
- RFNBO (RED II)
- Green Hydrogen.

5. Low-Carbon Hydrogen

Low Carbon Hydrogen addresses all Hydrogen production routes and therefore enables all technologies and processes to be subjected tocertification. The reduction target must be at least 70% of the Comparator Value of 94 g CO2-eq/MJ.

The official definition of low carbon gases as outlined in the EU Hydrogen and decarbonized Gas package (EU-HDG) is pending. However the latest available proposal for the Directive on common rules for the internal markets in renewable and natural gases and in hydrogen suggests that “greenhouse gas emission savings from the use of low carbon fuels shall be at least 70% relative to a fossil fuel Comparator Value with a threshold of 94 gCO2eq/MJ”.

Consequently, the maximum emission factor for a gas to be considered “low carbon“ shall be 28.2 g CO_2-eq/MJ. With an energy density (LHV) of hydrogen of 120 MJ/kg, this makes up for a maximum PCF value of 3.384 kg CO_2-eq/ kg H_2.

The maximum PCF value for Hydrogen Derivatives shall be calculated similarly with the mentioned emission factor and average energy density of Hydrogen Derivatives defined under RED II or equivalent references. Low Carbon Hydrogen may be produced by the following technologies and approaches, but not limited to those:

5.1. CCS

CO_2 gas produced during the manufacture of Hydrogen is permanently stored via CCS measures and can thus no longer be emitted into the atmosphere. At least 30 percent by mass (threshold) of the CO_2

gas arisen must be stored. The net amount of CCS referred to the total amount of CO_2 off-gases of the relevant process determines the share of Blue Hydrogen. The compressed CO_2 must be geologically monitored in order to detect possible leaks.

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key words:

- Low Carbon Hydrogen
- Blue Hydrogen (CCS).

5.2. CCU

In case CO_2 off-gases from Hydrogen production are captured and processed, Hydrogen can qualify as being Blue if these CO_2 off-gases are either chemically or minerally fixed for at least 25 years. At least 30 mass percent (threshold) of the total CO_2 gas arisen must be permanently utilized and hence, fixed. The whole life cycle of the CO_2 off-gases and its permanent fixation need to be proven transparently. The share of Blue Hydrogen is determined by the net amount of CCU referred to the total amount of CO_2 off-gases of the relevant process.

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key words:

- Low Carbon Hydrogen
- Blue Hydrogen (CCU).

5.3. Pyrolysis

Hydrogen which is produced via the thermal cracking of hydrocarbons (e.g., methane pyrolysis) is considered as being Turquoise. It must be ensured that the elemental carbon (sometimes also called black carbon) formed in parallel with the Hydrogen is not re-converted into CO_2 for at least 25 years. All Cradle-to-X emissions from the process must be taken into account, including those from the heat source. Both fossil (e.g., natural gas) and renewable (e.g., bio-methane) sources are permitted for the origin of the hydrocarbon.

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key words:

- Low Carbon Hydrogen
- Turquoise Hydrogen.

5.4. Nuclear power

Hydrogen which is produced by the electrolysis of water or aqueous solutions (e.g., chlor-alkali electrolysis) with the use of electricity from nuclear sources. Even though the EU Taxonomy classifies nuclear power as being renewable and to be accounted with zero emissions, it is not considered as a renewable source of electricity under RED II.

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key words:

- Low Carbon Hydrogen

- Pink Hydrogen.

5.5. Compensation

When all emissions caused by the production of Hydrogen are compensated, it shall be considered Carbon-Neutral Hydrogen. This involves offsetting through purchasing and retiring registered CO_2 reduction certificates (carbon credits) from internationally recognized climate protection programs (e.g., GoldStandard, CDM or Verra/VCS), and/or emission rights from established trading systems (e.g., EU ETS).

Presuming a positive verification statement can be made against the criteria set forth in this sub-category, the Hydrogen can be classified with the following key word:

- Carbon Neutral Hydrogen.

6. Methods and standards

The following methods and standards in their currently valid versions are applied:

- EN ISO 14064-1
- EN ISO 14064-2
- EN ISO 14064-3
- EN ISO 14067
- EN ISO 14040
- EN ISO 14044
- GHG Protocol, A Corporate Accounting and Reporting Standard
- GHG Protocol, Corporate Value Chain (Scope 3) Accounting and Reporting Standard
- RED II, Standard (EU) 2018/2001 on the promotion of the use of energy from renewable sources, revised version of December 11, 2018.
- European Commission Delegated Regulation of 10.2.2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin
- European Commission Delegated Regulation of 10.2.2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels
- Annex to the European Commission Delegated Regulation supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels
- Directive 2009/28/EC, 2003/87/EC the European Parliament and of the Council and regulations of AVR 2018 / 2067, 2020/2084, MRR 2018/2066, 2020/2085
- Act for the Expansion of Renewable Energies (Renewable Energies Act - EEG 2021)
- TÜV RHEINLAND QMA H2.21 v1.1.

7. Verification and Certification Process

The verification and process have to follow TÜV Rheinland's QMA H2.21 v1.1 and are divided into the following major steps:

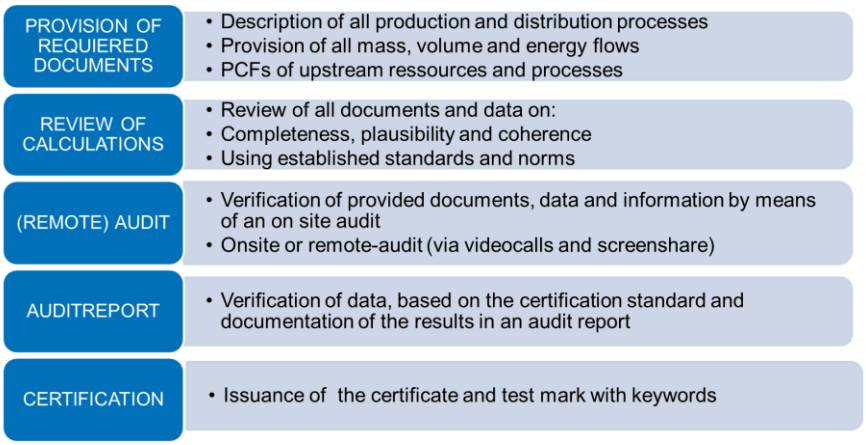

Figure 2: Major steps for certification process

The issued Certificate relies solely on the criteria defined by TÜV Rheinland and set forth in this standard. It does not grant compliance with valid legislation, directives or legislation.

8. Certification Body

TÜV Rheinland makes the testing of the criteria listed in this standard H2.21 available to other Certification Bodies, provided that they can present a valid accreditation according to EN ISO 14065:2020, EN ISO/IEC 17029:2019 or successor version, which includes at least the following scopes in their respective valid version:

- EN ISO 14064-1
- EN ISO 14064-2
- EN ISO 14064-3
- EN ISO 14067.

Certification Bodies assessing conformity according to this TÜV Rheinland H2.21 standard must, beforehand, send to Certification Body and H2.21 owner, TÜV Rheinland Energy GmbH, proof and evidence for demonstration of compliance with the aforementioned requirements, and seek for written approval as Certification Body by TÜV Rheinland.

TÜV Rheinland accepts no liability for tests, assessments, certifications and statements of any kind made by third parties and external Certification Bodies that refer to this standard H2.21.

9. Applicability of the standard

The present standard H2.21 in its version 2.0 of February 2023 is valid from 01.03.2023. Initial certifications as well as re-certifications assigned on or after this date must follow the criteria set forth in this version 2.0. Certificates issued based on the older versions remain valid until their date of expiration.

Annex I: Different Hydrogen forms and their requirements

Keyword/ Parameter	Green Hydrogen	RFNBO (RED II)	Low-carbon Hydrogen	Blue Hydrogen (CCS/CCU)	Turquoise Hydrogen	Pink Hydrogen	Carbon-neutral Hydrogen
Technology	Electrolysis with renewable electricity	Electrolysis with renewable electricity	All applicable	Reforming where CO_2 is captured and stored underground **(CCS)**, or captured and utilized **(CCU)**.	Hydrocarbon pyrolysis	Electrolysis with nuclear electricity	All applicable
Energy source	Renewables of non-biological origin	Renewables of non-biological origin	All applicable	Fossil fuel	All applicable	Nuclear	All applicable
Renewable electricity connection	Direct line/ grid connection via PPA, GoO or equivalent (e.g. I-REC)	Direct line / grid connection via PPA	NA	NA	NA	Direct line / grid connection via PPA	NA
Additionality	NA	RE plant comes into operation not earlier than 36months before Hydrogen production plant (unless Grid EF < 18 gCO2eq/MJ or H_2 production starts before 01.01.2028)	NA	NA	NA	NA	NA
Geographic correlation	GoO or same country	RE and H_2 production in the same Bidding Zone, or neighboring Bidding Zones with same electricity price, or offshore adjacent Bidding Zone	NA	NA	NA	NA	NA
Temporal correlation	The Hydrogen and the renewable electricity shall be produced within the same 12 months	RFNBO is produced during the same one-month period as the renewable electricity (within same hourly after 01.01.2030)	NA	NA	NA	NA	NA

Subsidies/ Grants	No constraint	Only support for land and for grid connection or support that does not constitute net support is allowed if plant starts operation after 01.01.2028	NA	NA	NA	NA	NA
PCF (kg CO_2-eq per kg fuel)*	PCF < 3.384 kg CO_2-eq/kg H_2.	PCF < 3.384 kg CO_2-eq/kg H_2.	PCF < 3.384 kg CO_2-eq/kg H_2.	PCF < 3.384 kg CO_2-eq/kg H_2.	PCF < 3.384 kg CO_2-eq/kg H_2.	PCF < 3.384 kg CO_2-eq/kg H_2.	PCF ≤ 0 g CO_2-eq/kg H_2
PCF compensation mechanism	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Not Allowed	Allowed

***The PCF for Hydrogen Derivatives shall be calculated with mentioned Comparator Value and average energy density of Hydrogen Derivatives defined under RED II or equivalent references.

Annex II: Document Information

Updates are conducted according to Industry feedback and regulatory development. For increased transparency the following table tracks these changes:

Version	Date	Description
H2.21 v1	July, 2021	Standard for Carbon Neutral Hydrogen
H2.21 v2	February, 2023	New Version: Standard for Renewable and Low Carbon Hydrogen Fuels considering regulatory developments in EU
H2.21v2 (post-editorial change)	March, 2023	Update: Precise reference of the European Commission Delegated Regulation of 10.2.2023
H2.21v2.1	April, 2023	Update: exclusion of RCF for increased consistency