October 2024

Hydrogen Certification 101

BREAKTHROUGH AGENDA

IPHE

Hydrogen TCP

Acknowledgements

The present Hydrogen Certification 101 paper was developed under the Breakthrough Agenda's Hydrogen Breakthrough priority action H.1 "Standards and certification" coordinated by IPHE and IEA H2 TCP with support from IRENA.

Disclaimer

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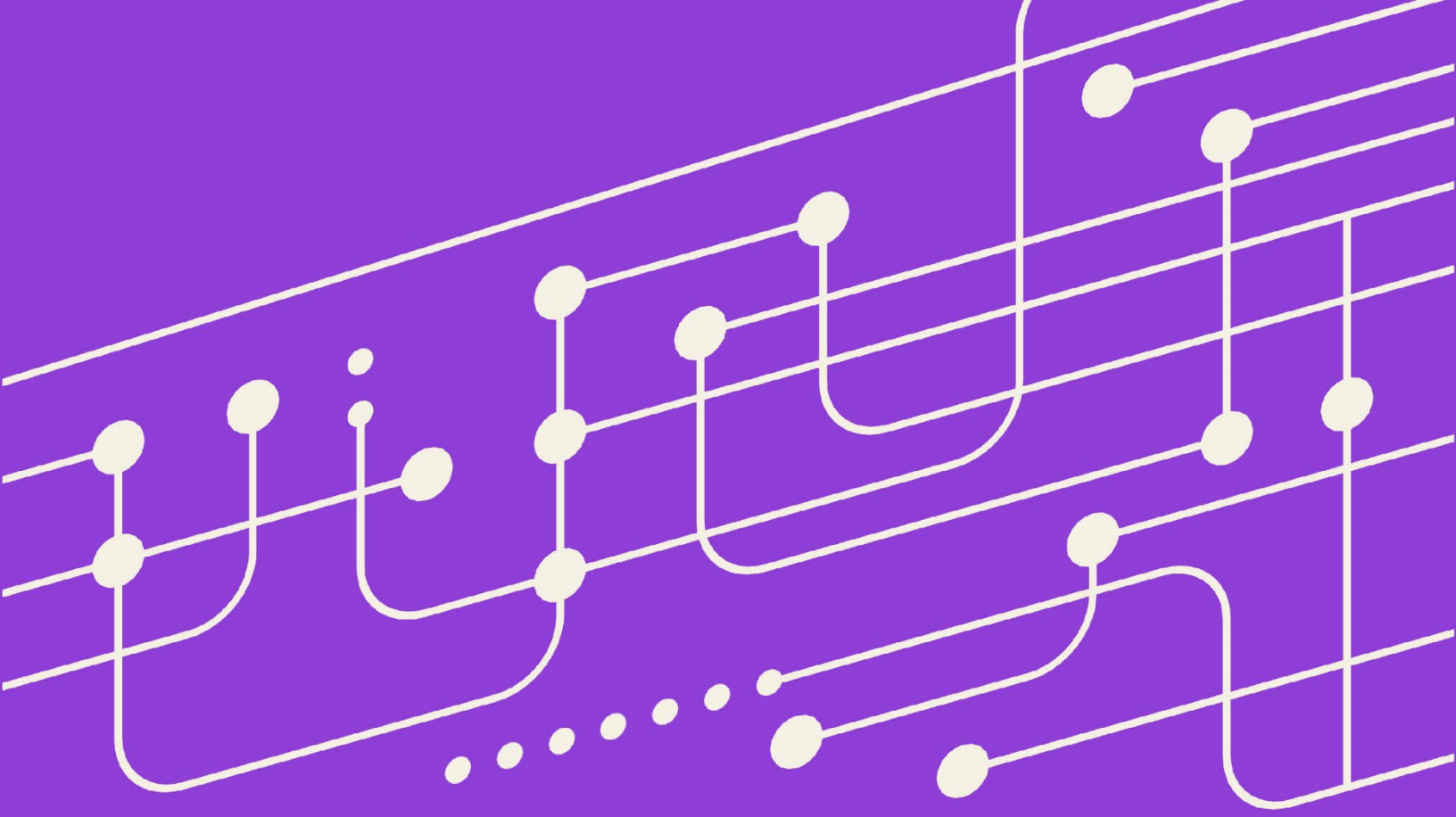

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01 — Purpose of this 101 paper[1]

This document aims to:

1. Provide clarity and precision on terminology and concepts used in hydrogen certification;
2. Describe the purposes and functionalities of hydrogen certification schemes;
3. Offer basic information on certification scheme design; and
4. Introduce the concepts of tradability, mutual recognition, and interoperability of certification schemes for hydrogen and derivatives.

This document does neither aim to explain what companies need to do to get certified nor how mutual recognition and interoperability can be achieved. For detailed certification requirements, companies need to consult the relevant documents brought forward by certification schemes in specific target markets. For steps towards mutual recognition and interoperability, the IPHE, the IEA H2 TCP, and other organisations are currently working on publications laying out detailed analysis and options.

02 — Background

In the emerging global hydrogen economy, robust certification schemes for hydrogen and derivatives can play a key role to:

- **Support the implementation of government policies** as certification can facilitate the administration of policy measures such as targets and quotas;
- Create trust between market participants, in particular prospective importers and exporters, fostering global, **cross-border trade in hydrogen and derivatives** based on their environmental and social credentials;
- Create **transparency for consumers** and enable **consumer choice**;
- Allow consumers to **signal demand** for hydrogen based on its sustainability credentials;
- Enable producers to provide evidence of the **sustainability attributes of hydrogen** quantities, such as carbon footprint (CFP)—meaning greenhouse gases (GHG)—as well as the use of land and water and social impacts, in a reliable **and consistent manner**.

Certification allows an organisation to provide evidence that a unit of hydrogen or a derivative product has been produced, transported, and delivered to consumers with specific sustainability attributes. This commonly involves the issuance of electronic certificates, which may then be transferred either with or separately from the underlying physical hydrogen or a derivative product.

The need for and types of attributes evidenced by certification schemes, as well as design features of schemes are largely driven by government policies, in line with mandatory requirements (imposed by a regulatory obligation) as well as demands of the end-consumer or voluntary requirements.

Hydrogen certification schemes are currently largely national or regional, which may constitute a barrier to global, cross-border trade in hydrogen and derivatives that comply with specific requirements. Unless a certification scheme operates globally, mutual recognition of regional/national certification schemes is instrumental to overcoming this barrier, ensuring that an end-consumer in a given jurisdiction can trust in the veracity of the production and certification process in another jurisdiction. Mutual recognition of schemes requires first and foremost a political commitment and cooperation between governments championing the development of an international hydrogen economy. However, to advance towards mutual recognition of certification schemes, it is critical to use a common language on certification and the associated components and processes.

[1] The title “101” implies that this document offers basic, introductory information on the basics of certification of hydrogen and derivatives.

03 — What is certification?

Certification is defined as the process undertaken to evaluate and to confirm if a product complies with a given set of requirements. In the world of energy, the term certification refers to the issuance of a statement by an independent entity to confirm that a unit of a given energy carrier had a set of attributes upon its production and/or along the entire value chain.

This statement is often issued in the form of an electronic record, which may be transferred—with the product or separately—to be bought and sold on a market. Certification can involve multiple actors including regulators/authorities imposing relevant regulatory requirements, certification scheme owners, certification bodies, issuing bodies, and independent auditors (the roles of different actors are described in 04 – Purpose of hydrogen certification: disclosure, corporate reporting, and regulatory compliance).

Certification of hydrogen sustainability attributes can provide reliable information about the way hydrogen is produced and delivered to the consumption gate. These sustainability attributes may cover environmental aspects (GHG emissions of hydrogen production and transport; use of land and water; impact on air quality) as well as social aspects (such as rights of Indigenous peoples, labour rights, local value creation, increase in energy access, competence gains, as well as diversity, equity, and inclusion) of the relevant segment of the value chain covered by the certificate.

Certification, therefore, allows the end-consumer to make an informed choice about the hydrogen they procure, taking into account the impacts of its production. Certification can also be used as evidence of the supply and the consumption of the certified quantity of hydrogen. This, in turn, allows the producer and consumer to show and evidence their contribution to climate mitigation and/or the fulfilment of other sustainability goals such as mitigating resource depletion and improving air quality, land use, water consumption, and social aspects associated with the hydrogen value chain.

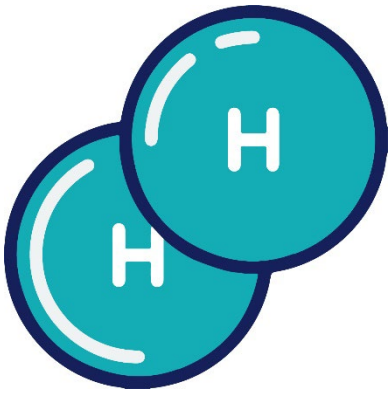
04 — Purpose of hydrogen certification: disclosure, corporate reporting, and regulatory compliance

Certification schemes can provide: (i) a means for **compliance** with a certain regulation or with criteria to access public funding (regulatory compliance), and/or (ii) a means for voluntary **reporting** by private companies to inform consumers (disclosure) and investors (corporate reporting).

Certification schemes designed for compliance refer to schemes whose purpose is to ensure legal compliance with requirements established by government authorities for product attributes or processes during production, conversion, storage, transport, and/or use of hydrogen. Among others, these government requirements can be associated with receiving financial support or benefiting from tax credits. For certification schemes with the purpose of compliance, it is the responsibility of government authorities to define the rules for the given certification scheme to meet the compliance requirements. A government may choose to develop and own schemes themselves or it may recognize schemes of independent organizations to carry out the certification.

Certification schemes designed for reporting refer to schemes whose purpose is to voluntarily disclose information to consumers, investors, or other interested parties regarding product attributes and/or processes during production, conversion, storage, transport, and/or use of hydrogen. Among others, these schemes can be associated with consumer or corporate reporting covering environmental, social, and governance (ESG) criteria or corporate social responsibility (CSR) reporting. For certification schemes with the purpose of voluntary reporting, it is the decision of non-governmental actors, including private sector associations, to define the criteria and attributes of the given certification scheme to meet the needs and expectations of consumers, investors, and other market participants.

05 — Key terms and concepts in hydrogen certification



Certification system refers to the entirety of the legal, institutional, procedural, and technical arrangements to certify a given product or process. It includes the legal and regulatory requirements set by the government and/or competent authority when the purpose of certification is compliance, or a voluntary agreement implemented by a contracted third party when the purpose of certification is reporting (**Figure 1**). The nature of the actor putting in place the requirements and supervising compliance depends on the purpose of the specific certification in question, i.e., whether certification serves for compliance or reporting. Within a certification system, one or multiple certification schemes can operate, either nationally or internationally.[2]

Certification scheme (or mechanism) refers to an instrument to confirm that a product or process meets the requirements set by a government, competent authority, or contracted third party (**Figure 1**). A scheme may cover additional attributes beyond those mandated by national legislation. Certification schemes consist of four key elements, which include a set of governance, assessment, and verification processes used to ensure that the considered product (e.g., hydrogen) meets a given set of requirements or criteria (see 06 – Key elements of a certification scheme).

Certification schemes may refer to voluntary technical standards, including standards defining their operational set-up and procedures as well as the methodologies for assessing the product attributes or processes they are designed to certify.

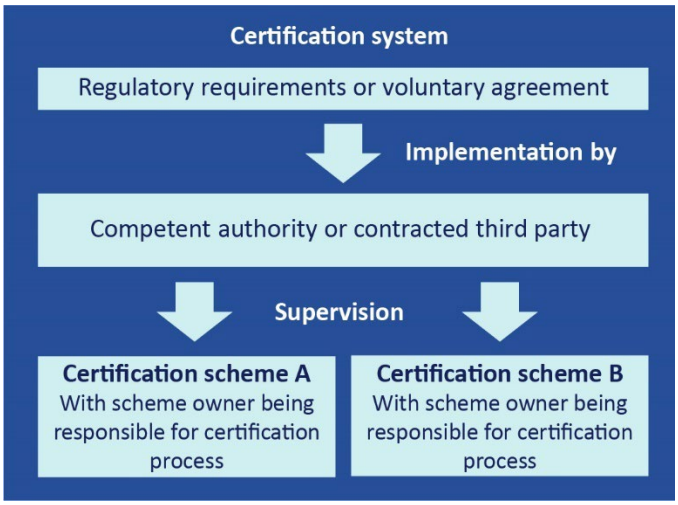


Figure 1: Certification system and certification scheme

Certificate – a document evidencing that a given product has certain attributes. In the energy sector, the term certification refers to the issuance of a statement by a certification body to confirm that a unit of a given energy product has a set of attributes upon its production and that certificate holders along the entire chain of custody provide accurate information about the attributes of the given energy product. This statement is often issued in the form of an electronic record, which may be transferred either separately from the physical product (with the book and claim chain of custody model) or with the physical product (with the mass balance chain of custody model).

[2] For example, under a certification system for compliance confirmation with the European Union regulation (EU renewable energy legislation, in force since 2009), multiple certification schemes operate on an international scale, also outside the EU.

- **Energy Attribute Certificates** provide information about the origin of the energy, its renewable source as well as related information including date and location of production. Examples include RECs (Renewable Energy Certificates), I-RECs (International Renewable Energy Certificates), and the European Union's (EU's) GO (Guarantee of Origin). These schemes initially focused on electricity as energy carrier. However, recently energy attribute certificates started to be developed for gases, including hydrogen. The term "energy attribute certificate" is often used in certification schemes that allow for the separation of product and certificate, using the book and claim chain of custody model. The scope, objectives, and related governance of such schemes are dependent on national or regional legislation. As such, there is no harmonized definition of a GO scheme. The certificates issued under such schemes are often but not exclusively used by market participants for disclosure to the end-users and corporate reporting purposes.

- **Sustainability certificates** are a distinct type of certificates, mostly used within the EU, and they can evidence the sustainability attributes of a given product and traceability of these attributes along the supply chain from production to consumption gate. The term 'sustainability certificate' is often used in certification schemes using a mass balance chain of custody model. Such certificates have been used for compliance purposes in some jurisdictions, for example, for biofuels in the EU.

- **A label signals** that certain defined requirements have been fulfilled. For example, a label may characterise a specific batch of hydrogen as "renewable" according to the respective requirements for that label.

Standard – the International Organization for Standardization (ISO) describes a standard as "a document, established by a consensus of subject matter experts and approved by a recognized body, that provides guidance on the design, use or performance of materials, products, processes, services, systems, or persons." Standard development organizations (see definition on page 14) produce voluntary technical standards, which can be used as reference across regulatory and voluntary frameworks internationally. A standard can be used by certification schemes to define their operational set-up and procedures as well as the methodologies for assessing the product attributes or processes they are designed to certify.

A voluntary technical standard is distinct from national laws and regulations. However, national or regional laws, regulations, and guidelines may refer to standards.

A **chain of custody model** within a scheme determines the process associated with the change of ownership and legal responsibility of a certificate and/or the underlying physical product for tracking and tracing of product attributes along the supply chain.[3] There are two types of chain of custody models commonly used in certification of energy products[4]:

1. The **mass balancing** model is designed to track and trace the total amount of certified products along the supply chain, while ensuring an appropriate allocation of this certified quantity to the products reaching the end-users. This requires that the product and the certificate have a reasonable physical link.[5] Mass balancing is commonly used in biofuels certification.

2. The **book and claim** model allows tracking and tracing of the electronic certificates containing the information of product attributes from their issuing to

[3] ISO/TS 24533:2012 defines tracing as a "function of retrieving information concerning goods, goods items, consignments, or equipment," while it defines tracking as a "function of maintaining status information of goods, goods items, consignments, or equipment." In other words, tracing relates to information on the origin of the product/certificate (where it comes from), while tracking relates to the destination of the product/certificate containing the relevant information (where/whom it is passed on to).

[4] While this document focuses on certification of fuels, certification is used across a wide range of products and commodities, including agriculture products. In food and agriculture industries, common chain of custody models include identity preservation (i.e., the certified product and its certificate cannot be separated along the value chain, and the product cannot be mixed with any other identical products, even if they have also been certified under the same certification scheme) and segregation model (similar to identity preservation, except that mixing of identical products, which have been certified under the same certification scheme, is allowed). The segregation model is commonly used in, but not limited to, certified organic or "fair-trade" products or materials.

[5] The definition of what constitutes an "reasonable physical link" often differs between jurisdictions.

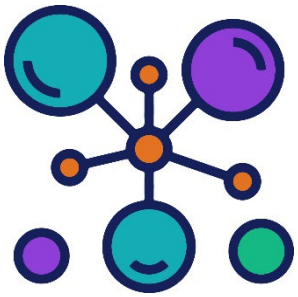
their cancellation (for disclosure). The model allows for completely separating the physical product from the certified product attributes, so that during any physical or commercial transactions after production, the certificate for the product attributes can be traded separately from the physical product. As a result, by purchasing a certificate, customers can claim the use of certified hydrogen without the need to physically transport that specific hydrogen.

In the case of certification schemes using the book and claim model, scheme users include producers of the given unit of energy, and the scheme is used to certify the production of a given unit of energy. In the case of certification schemes using a mass balancing model, scheme users include all stakeholders involved in the certificate and product transactions along the value chain (producers, traders, and suppliers), and the scheme is used to certify that scheme users along the chain of custody provide correct information about the product and its attributes.

Cancellation refers to the process of actively retiring a certificate by a scheme participant because the hydrogen was delivered for final consumption or has been used. Cancellation of certificates might also be initiated by certification bodies in the event of failure to comply with certification requirements. This cancellation process may be referred to as 'retirement' by some schemes.

Expiration is a particular case of cancellation and refers to an automatic process where a certificate no longer exists after a fixed period of time. In general, in the case of schemes for reporting using book and claim as their chain of custody model, certificates have an expiration date, after which they expire and no longer can be traded. In addition, under some certification schemes, entities involved in the value chain (e.g., producers, transport operators) themselves also need to be certified and, therefore, need regular recertification (usually annually).

06 — Key elements of a certification scheme



There are four key elements of certification schemes:

1. **Product attributes:** The characteristics of the product that the schemes are intended to certify, including the methodologies to measure these attributes.
2. **Operational set-up and procedures:** The institutional set-up and the processes of a certification scheme.
3. **Chain of custody:** The chain of custody model determines the approach that is applied to track and trace information on product attributes along the supply chain of a product and the related transactions.
4. **Information technology (IT):** An IT system is needed for a certification scheme to be operable. The system provides a practical means to participate in the scheme. It is the repository for any information on individual certificates throughout their life cycle, from issuance to transfer to cancellation. As such, the IT system serves as an interface for any party using the certification scheme and is essential to track compliance with the requirements of the certification scheme.

07 — Fundamental design principles for certification schemes

There are four fundamental design principles for certification schemes:

1. Robustness,
2. Transparency,
3. Impartiality, and
4. Accuracy.

Each of these design principles applies to the key elements of certification schemes (i.e., product attributes, operational set-up and procedures, chain of custody model, and information technology). Table 1 provides an overview of the practical consequences and benefits when applying the design principles to each of the key elements.

Table 1: Key elements and fundamental design principles of certification schemes

	Robustness	Transparency	Impartiality	Accuracy
Products attributes	Adequacy of definitions and methodologies to measure the product attributes a scheme is intended to certify Consistent application of accounting approaches, system boundaries, and methodologies Rationale for methodologies as well as rationale for and recording of any changes in methodologies	Disclosure of information on definitions and methodologies (including processes, procedures, assumptions, and limitations) of determining product attributes in a clear, factual, neutral, and comprehensible manner Information should be recorded, compiled, and analysed in a way that enables internal and external reviewers to arrive at the same results if provided with the underlying data sources	Unbiased definitions and methodologies	Measurements, estimates, or calculations of product attributes should neither be systemically over nor under the actual value Reduction of margin of error in quantifying product attributes as much as practicable
Operational set-up and procedures	Credible and trusted system of checks and balances within certification system Oversight by supervisory authority	Clear roles and responsibilities of different actors and bodies within a certification scheme	Certification body and/or auditors are independent third parties Declaration of any conflicts of interests by the bodies as part of the operational set-up	
Chain of custody model	Strong provisions to ensure trackability and traceability to avoid any kind of fraud, such as false declarations or double counting of certified products, certificates, and product attributes	Clear and publicly available requirements for tracking and tracing of certified products, certificates, and product attributes	Tracking and tracing of products and certificates without bias against any actors or types of transfers	Reliable tracking and tracing of certified products, certificates, and product attributes
IT system	Ensure the integrity of all users' accounts and of all data related to the accounts and certificate and product transactions Protection of repository from manipulation	Clear user rights and responsibilities Free and easy access of the wide public to generic data concerning the product, its certificates, the certification scheme status (number of certificates issued, transferred, cancelled, status of the tracking, etc.), annual reports, fraud attempts, etc.	Unbiased information repository, including non-discriminatory memory allocation within the database	Reliable tracking and tracing of certified products, certificates, and product attributes

08 — Main actors

The following stakeholders use a certification scheme.

Governments and legislators set rules and requirements for the operation and use of certification schemes that serve compliance purposes, such as the achievement of regulatory targets and quotas. Particularly for certification schemes aimed at compliance, governments and legislators also have the responsibility to ensure consumer protection and to put in place safeguards against double counting and fraud. They are the only authority with power of inquiry, i.e., they are the only authority of control/inspection and the imposition of fines or other penalties.

Producers use certification schemes to have their products certified for mandatory or voluntary compliance purposes.

Traders/suppliers/end-consumers can use certificates to (i) voluntarily disclose information to consumers, investors, or other interested parties that product attributes and/or processes during production, conversion, storage, transport, and/or use of hydrogen fulfill certain requirements or (ii) comply with mandatory requirements, such as quotas and targets. An example of the latter case is fuel suppliers and industry buying hydrogen with a carbon footprint below a specific threshold and fulfilling the conditions for electricity sourcing to comply with requirements under the Renewable Energy Directive of the EU.

The following parties are directly involved in the operation of the certification scheme.

Certification scheme owners (also referred to as certification scheme holders) are responsible for designing and operating certification schemes. Scheme owners may be public or private entities. In compliance schemes, governments can play a key role, as supervision of scheme owners by government authorities is important to ensure their credibility.

Certification bodies (CB)/conformity assessment bodies (CAB) are independent third parties that carry out conformity assessment activities with the purpose to validate or verify both the conformity of a given product or facility with a voluntary technical standard, where it is referred to as a requirement (in case of a CAB) or with the requirements of the certification scheme, determining the attributes according to a methodology (in case of a CB). A certification body can be governmental or non-governmental—i.e., with or without regulatory authority. A certification body may also assume the role of an issuing body and issue certificates.

Certification bodies can employ auditors (and laboratories where necessary) who conduct in-depth assessments. These assessments can use a variety of methods. Certification bodies play a key role in independent monitoring by conducting third-party assessments to provide independent confirmation that scheme participants are in line with certification scheme requirements. Certification schemes define the qualifications required from certification bodies and auditors.

In order to be able to work on behalf of a certification scheme, a certification body and its auditors must be recognized by the scheme owner and approved to certify on behalf of the certification scheme (based on specifications and requirements defined by the scheme). A prominent example are the requirements for certification bodies to be accredited according to certain ISO standards, like ISO 17065 (Conformity assessment—Requirements for bodies certifying products, processes and services).

Once all requirements defined by the scheme are fulfilled—including, for example, any accreditation requirements—the certification scheme owner can recognize the certification body, if different, to certify products in accordance with the scheme on its behalf. As soon as a certification body is recognized by the certification scheme owner, it can conduct audits according to the specifications in the scheme. The

interactions between scheme owners, certification bodies, and accreditation bodies are shown schematically in **Figure 2**.

Issuing bodies ensure, taking into account the validation or verification processes established by the certification bodies, that the information evidenced by the certificate is correct and complies with the requirements of the scheme. Where the judgement of the issuing body is positive, it issues the related certificates. The issuing body may be a separate body, or the certification body may additionally take that role.

Accreditation bodies assess and regularly monitor the technical competence, reliability, independence, and integrity of certification bodies in the public interest. National accreditation bodies act as a regulatory authority, when empowered by the respective state to do so.

The worldwide system of accreditation is based on cooperation of accreditation associations and accreditation bodies. By applying common international standards on conformity assessment, accredited certification bodies are comparable and can enhance mutual trust in accreditation equivalence (see also Section 8).

In this context, the International Accreditation Forum (IAF) plays an important role as a worldwide association of accreditation bodies, as its primary function is to develop a single worldwide approach of conformity assessment, which reduces risk for businesses and their customers by assuring them that accredited certificates and validation and verification statements are reliable.

Scheme participants are persons or organisations that implement or operate under the requirements and procedures of a certification scheme without being involved in the development, revision, or approval of the scheme.

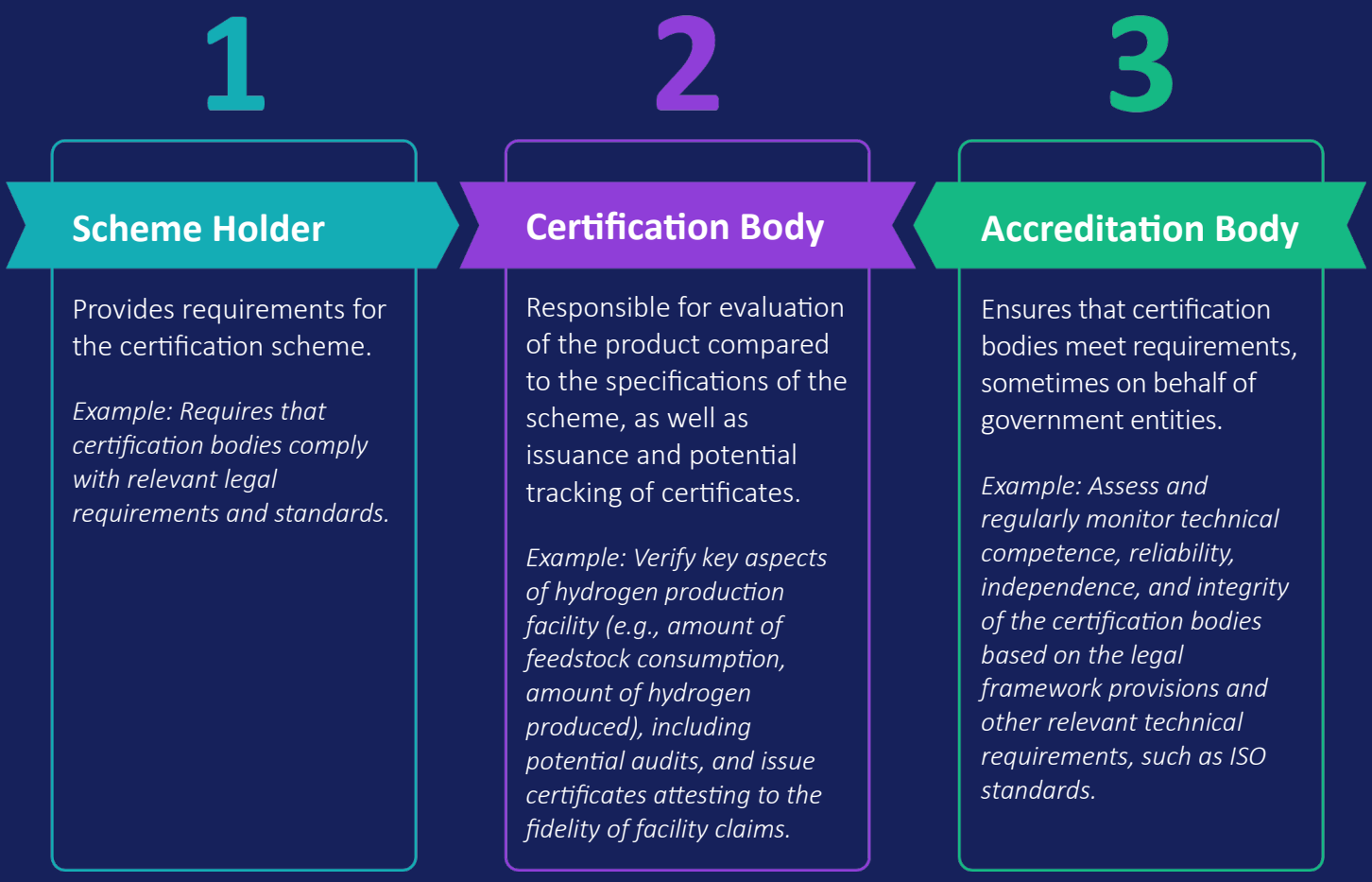


Figure 2: Schematic representation of interactions between scheme owners, certification bodies and accreditation bodies

Certification scheme registry is an IT tool that allows storing all the information related to the operations of the certificates issued under a given scheme digitally, as well as tracking and tracing product movements along the chain of custody as required.

The flow of information between certification scheme participants is shown schematically in **Figure 3**.

Supervisory authorities of certification schemes are responsible for continuous monitoring of certification schemes with regards to the requirements imposed on them and to make the certification bodies accountable for non-compliance. Supervision represents a fundamental principle of certification. The primary goal of supervision is to ensure credibility of and to create trust in the respective certification scheme(s) as well as the certification system as a whole.

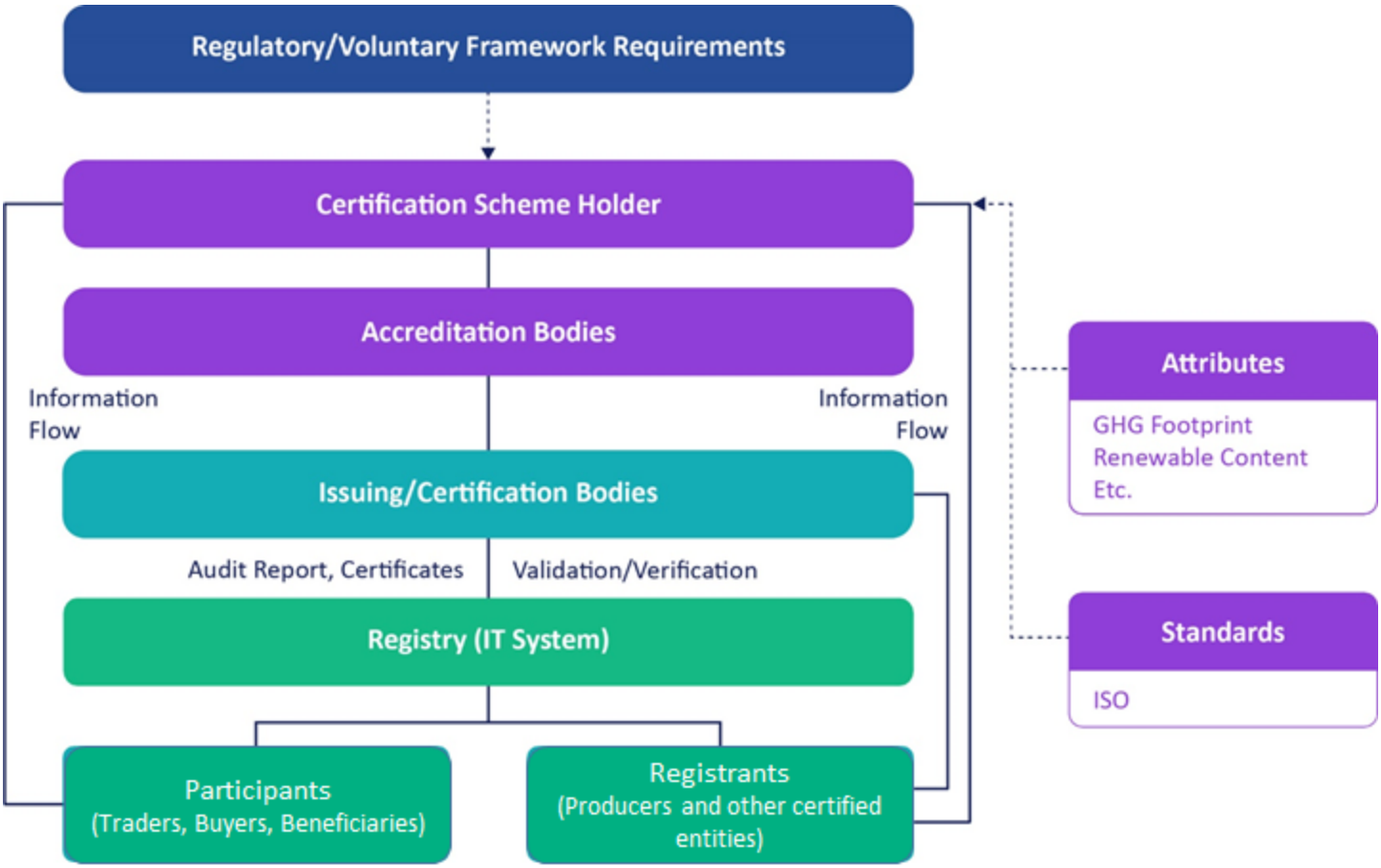


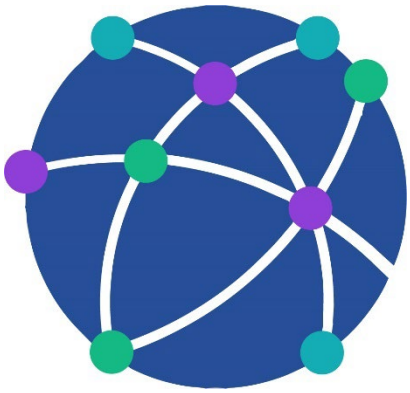
Figure 3: Schematic representation of a certification process – user information flow (solid lines indicate information or document flows between stakeholders, dotted lines indicate external documents that may inform a given scheme)

Standards Development Organizations (SDOs), such as national standardization bodies and the International Organization for Standardization (ISO), are organizations focused on developing, publishing, and disseminating voluntary technical standards to meet the needs of an industry or field.

In hydrogen specifically, ISO/TC 197 "Hydrogen Technologies" leads international standardization in the field of systems and devices for the production, storage, transport, measurement, and use of hydrogen. ISO/TC 197/Sub-committee 1 "Hydrogen at scale and horizontal energy systems" focuses in particular on standardization of large-scale hydrogen energy systems and applications, including aspects of testing, certification, sustainability and placement, and coordination with other relevant standardization bodies[6] and stakeholders.

[6] Examples of relevant SDOs active at the regional level include the European Committee for Standardization (CEN)—an association that brings together the National Standardization Bodies of 34 European countries—and the European Committee for Electrotechnical Standardization (CENELEC), which prepares voluntary standards in the electrotechnical field to help facilitate trade between countries, create new markets, cut compliance costs, and support the development of a single European market.

09 — Tradability, interoperability, and mutual recognition of certification schemes



Currently, a number of countries and regions, including some of the European Union Member States, Japan, and Korea, seek to secure imports of hydrogen and derivatives that meet specified product attributes. A number of other countries are focusing primarily on production of certified hydrogen for export or for domestic use.

Producers of hydrogen that meets specified product attributes may need to have their products certified for each purpose or country/region individually according to the respective requirements. Incompatibility of requirements between different markets and different jurisdictions may lead to non-recognition of certification schemes, additional administrative burdens, and barrier for the development of international value chains of certified hydrogen and derivatives.

Fragmented compliance markets with different certification systems would effectively preclude the development of a global hydrogen market.

To better understand how certification supports or inhibits trade, it is useful to distinguish the three concepts of tradability, interoperability, and mutual recognition:

1. **Tradability** represents the extent to which hydrogen that meets specified product attributes can be traded without impediments caused by the differences in the legal and technical requirements of certification schemes. Tradability is regarded as a spectrum, moving from a multitude of independent certification schemes with little to no tradability to a common (global) certification system with complete tradability of certified products, with a number of options along that path. In this specific context, tradability has two dimensions: interoperability and mutual recognition (**Figure 4**).

2. **Interoperability** represents the technical dimension of tradability. It refers to the ability of schemes to exchange information and to (mutually or singularly) use the information that has been exchanged to enable them to operate effectively together.

3. **Mutual recognition** represents the intergovernmental and legal dimension of tradability. It refers to the legal framework leading to the acceptance of the equivalency of certification schemes or parts of certification schemes, such as information related to product attributes, their operational set-up, and the modalities of tracking and tracing of products by the relevant competent authorities and/or government agencies.

The differences within the key elements between individual certification systems generally touch on both aspects of tradability. For example, while the IT system is regarded as pertaining to interoperability, there are aspects that fall within mutual recognition, e.g., protection against manipulation, prevention of double-counting, data protection, registry ownership. Complementarily, while many aspects of operational set-up and procedures are related to mutual recognition, there are operational questions that can be addressed on a technical level (e.g., through ISO standards such as the data transfer protocol) and, therefore, fall within the dimension of interoperability (**Figure 4**).

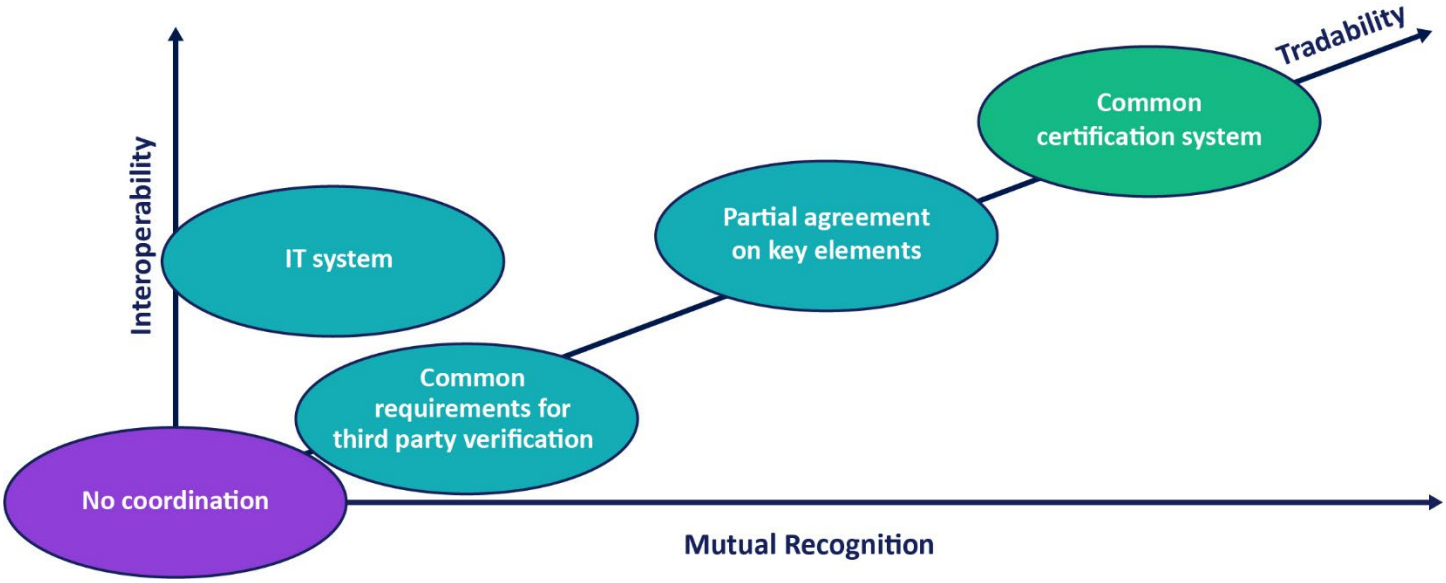


Figure 4: Tradability, interoperability, and mutual recognition

**Note: Location of options along the tradability spectrum is illustrative and depends on design details within each option*

010 — Acronyms and Abbreviations

CAB	Conformity assessment body
CB	Certification body
CFP	Carbon Footprint
CSR	Corporate Social Responsibility
ESG	Environmental, Social and Governance
EU	European Union
GHG	Greenhouse Gas
GO	Guarantee of Origin
H2	Hydrogen
IAF	International Accreditation Forum
IEA	International Energy Agency
IEA H2 TCP	International Energy Agency Hydrogen Technology Collaboration Program
I-REC	International Renewable Energy Certificate
IPHE	International Partnership for Hydrogen and Fuel Cells
IRENA	International Renewable Energy Agency
ISO	International Organization for Standardization
SDO	Standards Development Organisation