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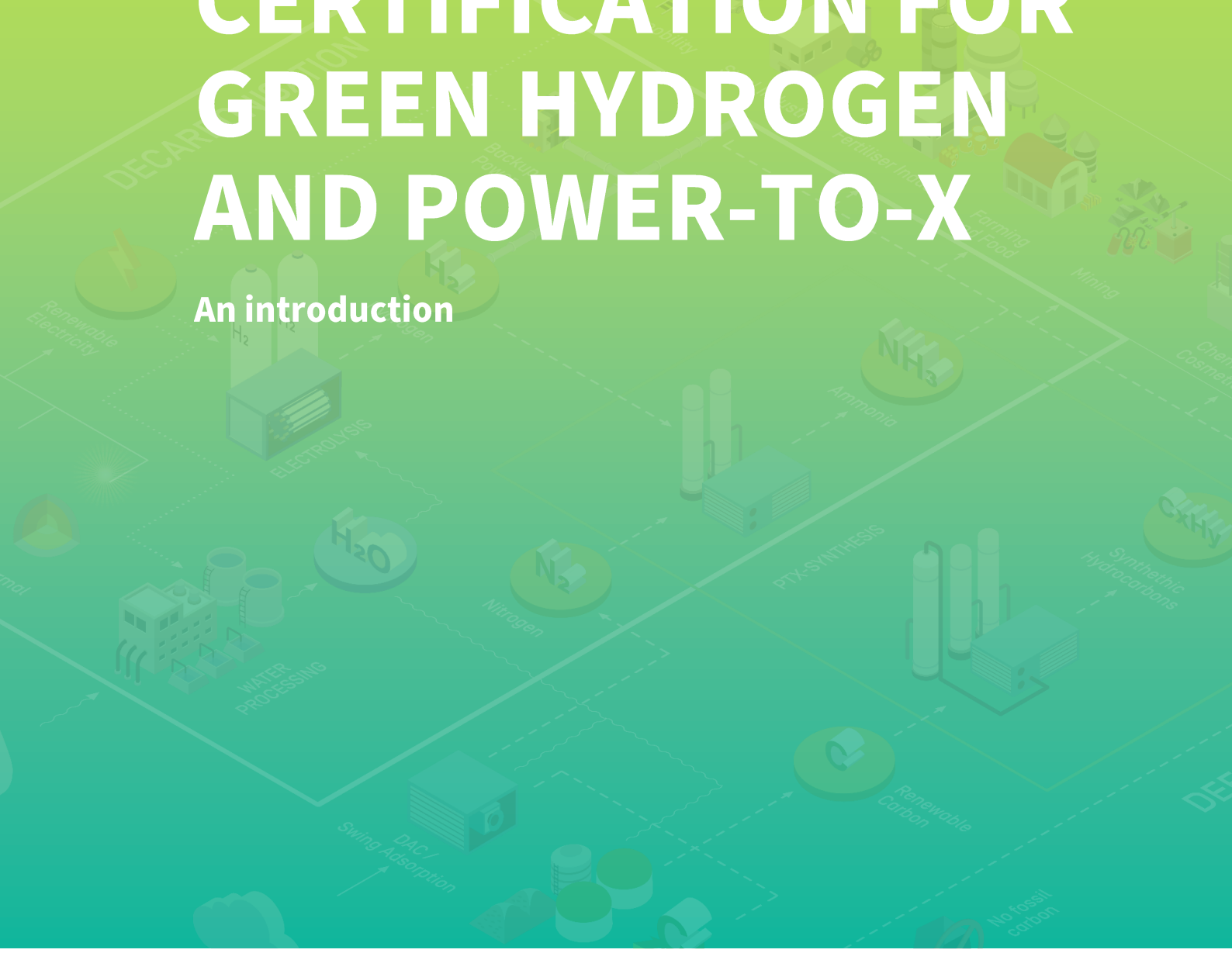
CERTIFICATION FOR GREEN HYDROGEN AND POWER-TO-X

An introduction



IMPRINT

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by:
Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) GmbH

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Bonn and Eschborn, Germany

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The International PtX Hub is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK). Financed by the International Climate Initiative (Internationale Klimaschutzinitiative, IKI), the International PtX Hub is a contribution to the German National Hydrogen Strategy of 2020 and represents one of the four pillars of the BMUV's PtX action programme initiated in 2019.

Berlin, May 2023

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WHY IS CERTIFICATION NEEDED?

Global demand for hydrogen and its derivates is expected to rise in the upcoming years. This demand is triggered both by regulatory incentives and by voluntary ambitions of private companies for more climate friendly production processes. Regulatory-driven compliance markets such as the European Union (EU) include the mandated use of Renewable Fuels of Non-Biological Origin (RFNBOs) in the mobility and industry sectors, contracts for difference for hydrogen and the Carbon Border Adjustment Mechanism (CBAM) to be implemented in the EU. Large industrial producers are aiming to decarbonise and/or defossilise their supply chains, and hydrogen and its derivatives can play a crucial role here.

However, liquid global markets need a common language to assess, describe and categorise the characteristics of traded products. Standardised processes are crucial to track and verify product properties that cannot be measured on the physical products alone. This holds true also for the emerging global market of hydrogen and PtX products. The distinction between green, greenhouse gas (GHG)-neutral hydrogen and low-carbon or blue hydrogen is not evident in the respective products themselves. A separate documentation is necessary to assess the specific GHG-intensity of the traded hydrogen products. This information is key for enabling transparent accounting of the traded products on GHG audits of consumers and/or countries. As the current debate on hydrogen and derivatives clearly shows,[1] the GHG-intensity is not the only parameter relevant for measuring the characteristics of hydrogen and derivatives. Other sustainability criteria, such as the water and land-use footprint or the socio-economic impact of hydrogen(-derived) products in producing countries are likely to be applied to differentiate between premium and non-premium products. Such criteria can only be made "visible", i.e. assignable to a traded product, in a reliable way by means of commonly approved certification processes. In a nutshell, certification is needed as it helps to tackle the following aspects:

- Prove the properties of a product in terms of GHG intensity as well as other sustainability criteria (e.g. environmental and/or socio-economic impact)
- Ensure reliable accounting of traded hydrogen volumes for specific consumers and/or countries and their production pathway
- Avoid double counting[2]

Appropriate certification schemes can help achieve these goals. It is essential to implement harmonised certification schemes for supply chain accounting of traded hydrogen and derivates and for creating global markets for these products. Consistently, this is also explicitly required to some extent on a mandatory basis by the regulation of importing countries to make such imports eligible under national or regional support schemes.[3] For the time being, there are different approaches and initiatives for certification of hydrogen and derivatives under discussion and preparation. However, no single certification standard has yet been established on a global scale. Table 1 and Table 2 give an overview of certification initiatives for hydrogen and derivatives by both governmental and private bodies.

[1] Oeko-Institut Working Paper: Sustainability dimensions of imported hydrogen (2021), available at: https://www.oeko.de/fileadmin/oekodoc/WP-imported-hydrogen.pdf
[2] Double counting means that the attributes of interest of one unit of produced hydrogen or PtX is claimed more than once in the relevant accounting scheme, e.g. by two different end consumers.
[3] International PtX Hub (2023): EU Requirements for Renewable Hydrogen and its Derivatives; online available at: https://ptx-hub.org/eu-requirements-for-green-hydrogen-and-its-derivatives/ (last access: 8 May 2023)

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HOW DOES CERTIFICATION WORK?

In the following sections, we will explore certification from a general perspective, how it works, i.e., which elements are involved and interrelate with each other.

For a clear understanding, the distinction between standards and certification should first be understood: "standards" simply describe a standardised way of doing things, while the term "certification" refers to providing a proof of compliance with such standards. The required elements for certification which are to be defined and implemented are illustrated in Figure 1; their specific functions are discussed in more detail below.

Parameters and relevant data

Parameters and relevant data have to be agreed upon in order to clarify which aspects of the certified product and the related product life cycle are considered relevant at all to be assessed and documented.

Conventions & definitions

In order to ensure that the provided data actually refers to the same aspects and is therefore comparable, terms have to be consistently defined. Also, system boundaries, methodological approaches for the calculation of parameters and other such aspects have to be clarified by common conventions.

Governance & verification

Clear governance structures assign responsibilities for the maintenance of the overall framework and requirements. This also ensures that all participants of the certifications scheme adhere to the same common rules, and that these rules are properly maintained with evolving experience and scope. Common rules for verification ensure that the provided values and data are actually accurate and reliable, and that fraud is avoided in an appropriate manner.

Qualification criteria

From the perspective of importing parties, qualification criteria may be defined in order to be able to assess whether imported products qualify to expected characteristics and thresholds. For producing and exporting parties, it is important to know at an early stage which qualification criteria are to be met in order to adapt the technical production appropriately and to plan their export strategies.

Tracking

Appropriate schemes for the tracking of the certified products and the information of the related characteristics from the point of production to the point of consumption have to be agreed upon and have to be established and maintained.

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Required elements for certification schemes which are to be defined and implanted custody

Figure 1. Source: Based on Oeko Institute (2023)

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To establish and facilitate such certification systems, different actors have to play an active role:

- **Governance institutions:** Include governmental, but also private regulatory bodies in order to define the overall framework and requirements. This also encompasses core criteria and basic definitions and requirements.
- **Non-governmental scheme providers:** Can have a subsidiary role for the definition of more detailed specifications on conventions and definitions and details on verification. This also includes the role of e.g. the International Organization for Standardization (ISO) or the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) for the definition of underlying standards.
- **Voluntary schemes:** In EU regulation, a specific role is assigned to so-called voluntary schemes which have to be generally approved by the European Commission and then are recognized as providing a proof of the EU sustainability requirements defined by the European Renewable Directive II.
- **Technical system providers** Include e.g. providers of tracking systems or databases.
- **Auditors:** Verify the relevant information for individual product volumes or for assets/technical infrastructure.
- **System users (e.g., hydrogen producers):** Are the parties which initiate the whole certification process, and they seek to receive a certificate. This encompasses market participants like sellers and buyers, but also intermediate traders. Furthermore, information associated with the certificate can partly be made assessable to, for example, governments but also end-consumers and broad public in general.

TRACKING APPROACHES

One central element of certification is the tracking of information of the relevant product characteristics. The term tracking refers to the method of how certain attributes of a product are followed throughout the supply chain of a product. This is comparably easy for products that are "segregated" (see first part in Figure 2) throughout a supply chain from products that do not have these certain attributes (i.e., are not certified), is more sophisticated and complex for products which are mixed thoughout the supply chain that do and do not have certain attributes. The most relevant approaches for tracking (i.e., chain of custory options) for hydrogen and its derivatives are mass balance and certificate-based book & claim. The following sections will give further insights in these approaches.

Mass balance approach

The mass balance approach (second part in Figure 2) aims at ensuring a continuous traceability of a given quantity of a product all the way throughout the supply chain. The tracking of attributes follows the tracking of the physical product. In principle, mass balance does allow for physical mixing of certified and non-certified products. In the EU, this approach is common for gas grids (e.g., biogas). It is also required by the recent EU Delegated Act on renewable hydrogen and RFNBOs.[4]

Book & claim

Certificate systems have electronic registries, where information on the production characteristics of a given volume of a traded product is documented by (tradable) certificates. For example, in the EU this approach is mandatory

[4] International PtX Hub (2023): EU Requirements for Renewable Hydrogen and its Derivatives; online available at: https://ptx-hub.org/eu-requirements-for-green-hydrogen-and-its-derivatives/ (last access: 8 May 2023)

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for the accounting of renewable electricity for the purpose of disclosure towards end-consumers. This has been defined by the revised Renewable Energy Directive (RED II) with certificates being referred to as guarantees of origin (GOs). Producers of renewable electricity can request the issuing of one GO for each MWh of produced electricity by the responsible registry provider on their individual registry account. Such a GO contains information ("attributes") on characteristics of the production plant and on the specific production volume, e.g. energy input, date of production, and type and amount of public support. The GOs can be traded by market participants and be transferred between the respective registry accounts until an owner of the GOs wants to finally account for the given attributes, e.g. in order to disclose the delivery of renewable electricity to an end-consumer. In principle, this approach also has been legally introduced by the RED II for other energy types besides electricity, including hydrogen, while this is not being applied in practice for the time being. So GOs are one example for a book & claim (see third part of Figure 2) chain of custody approach.

Certificate systems can facilitate so-called book & claim systems, where there is a full de-coupling of:

- the physical trade of a commodity like electricity (including feed-in, trade, transport and consumption of electricity),
- and the accounting of the respective production attributes (like the primary energy source) to a specific consumption of the same volume of electricity.

Book & claim systems allow for creating a financial link between the producer of a product with specific characteristics with a consumer of that product type, even when the physical supply chain makes the physical sourcing difficult. They also can be applied if no physical option exists at all for delivering the commodity from the point of production to the point of consumption. However, the requirement that the technical option for a physical delivery has to be in place can be defined as convention by respective criteria. The functionality of a certificate-based book & claim system is shown in Figure 2 (third part).

Due to increased level of complexity and abstraction, the application of such certificate-based book & claim systems even more strongly require a consistent definition of overall accounting schemes to avoid inconsistencies and double counting. It is worth mentioning that mass balance and certificates like GOs can also be combined for a mandatory bundled use (no unbundled use of GO like in a book & claim approach).

Overview of the functionality of different tracking approaches in order to prove the chain of custody

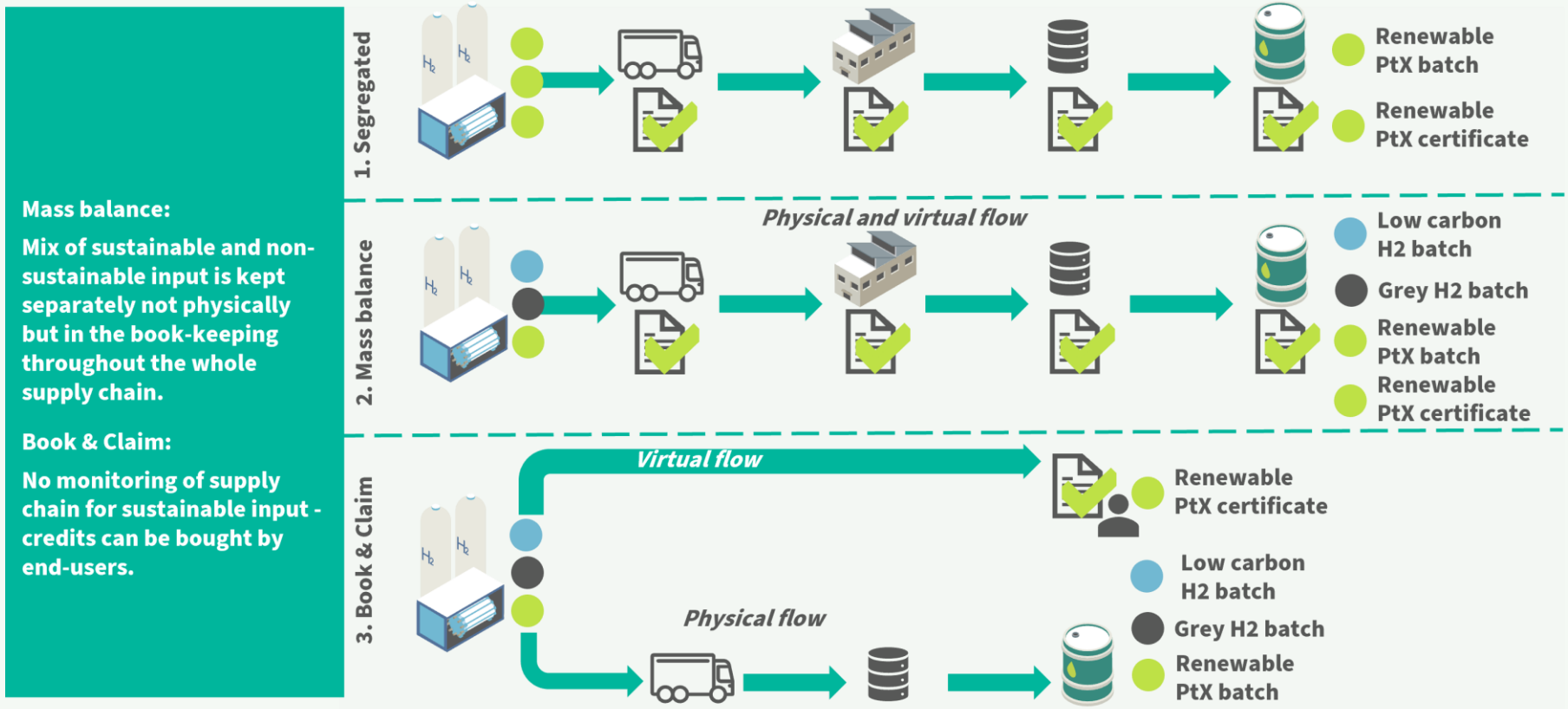

Figure 2. Source: Own illustration

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VERIFICATION

Data availability

Availability of data is crucial for certifying relevant attributes. Therefore, when any party is considering to participate in a market where it has to provide specific data, it should be ensured that the relevant data is either available or respective data management systems can be set up e.g. on a national level. For this purpose, different approaches could be considered, as is illustrated in the following Figure 3 for the example of information on the electricity supply mix and its related GHG emissions. In any case, a basic pre-requisite for the provision of data is a consistent definition of data and parameters (see Figure 1), while this does not *per se* exclude the application of different approaches when this is sufficiently specified.

Example for the alternative application of different optional data sources according to the given circumstances and data availability for the case of information on the electricity supply mix and related GHG emissions

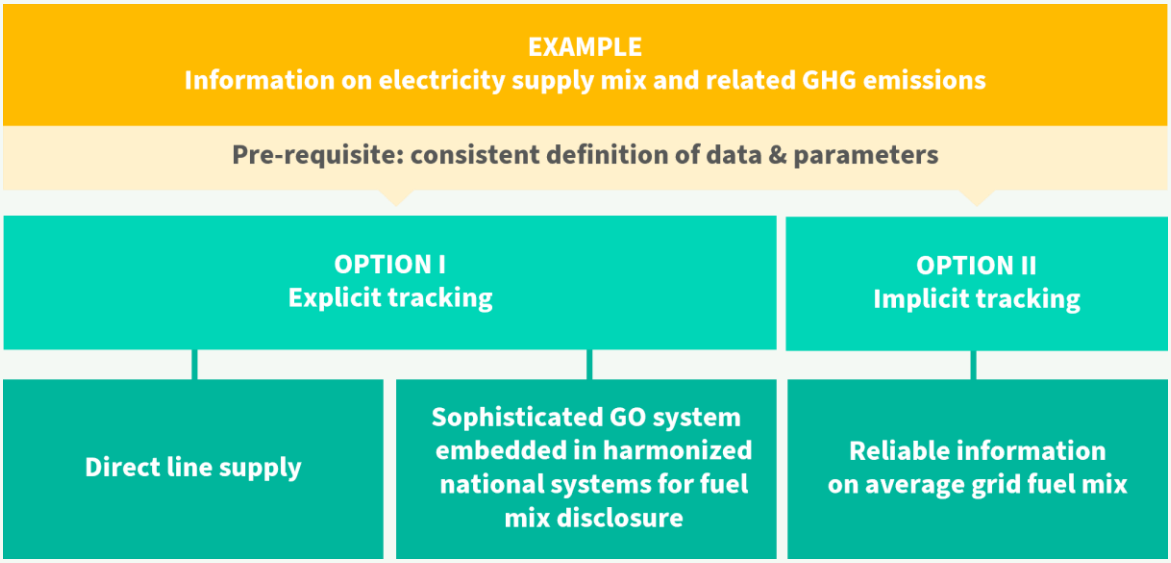

Figure 3. Source: Own illustration

Generally, in line with the International Social and Environmental Accreditation and Labelling Alliance (ISEAL) provisions, the requirements with respect to data are the following:

- **Relevance:** data collected are good measures of the issue and are applied at the appropriate scale;
- **Integrity:** data are protected from deliberate bias or manipulation for political or personal reasons;
- **Consistency:** data are collected consistently in the required formats, definitions and methodologies are consistent;
- **Resolution:** data have sufficient detail to measure what is intended;
- **Coverage:** data are complete (i.e. no missing data attributes or elements);
- **Timelines:** data are representative of current conditions, up-to-date and available when needed;
- **Availability:** data are accessible, so they can be validated and used for other purposes.

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Self-verification vs. third party certification

A sound verification mechanism is crucial for the buyer side for ensuring that the purchased product accords to the expected characteristics. For this purpose, technical measures, independent audits and self-verification can be applied depending on the needs and level of ambitions. Key aspects of both approaches are shown in the following Figure 4.

Example for the alternative application of different optional data sources according to the given circumstances and data availability for the case of information on the electricity supply mix and related GHG emissions

Self-Verification	Third-Party Verification
Pre-requisites: • Low incentives for fraud • Low complexity and clear definitions in order to avoid unintended false declarations • Optional safeguard measures, e.g. option for ex-post verification on a random basis → Low effort, only basic level of reliability, accuracy and fraud-resistance	• Third party has to be independent and competent • Mandatory for established European energy certification systems, e.g. for operational GO system for electricity • Initial and recurring audit of plants • Meter readings automated or third-party verified → Higher level of reliability, accuracy and fraud-resistance

Figure 4. Source: Own illustration

NON-EU ACTORS ACCESSING HYDROGEN & PTX CERTIFICATION

As outlined above, there is a high expected interest from within the EU to import hydrogen and its derivatives. In order to participate in such export options, the application of certification schemes in (potential) exporting countries is crucial. Shortfalls in fulfilling the certification requirements may limit export options, irrespective of the technical potential to produce and export hydrogen and PtX. Therefore, countries and stakeholders which are interested in increasingly producing and exporting hydrogen products should assess and identify options to tap the EU or also other markets.

Notably, it is important to assess whether there is the necessary technical infrastructure for a physical trade of product. Besides that, it should be clarified how different trading opportunities can be remained (by fulfilling the requirements of different markets and certification schemes). Figure 5 gives a high-level checklist for getting involved in this process.

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High-level checklist for Non-EU Actors accessing hydrogen and PtX certification for EU (and global) markets

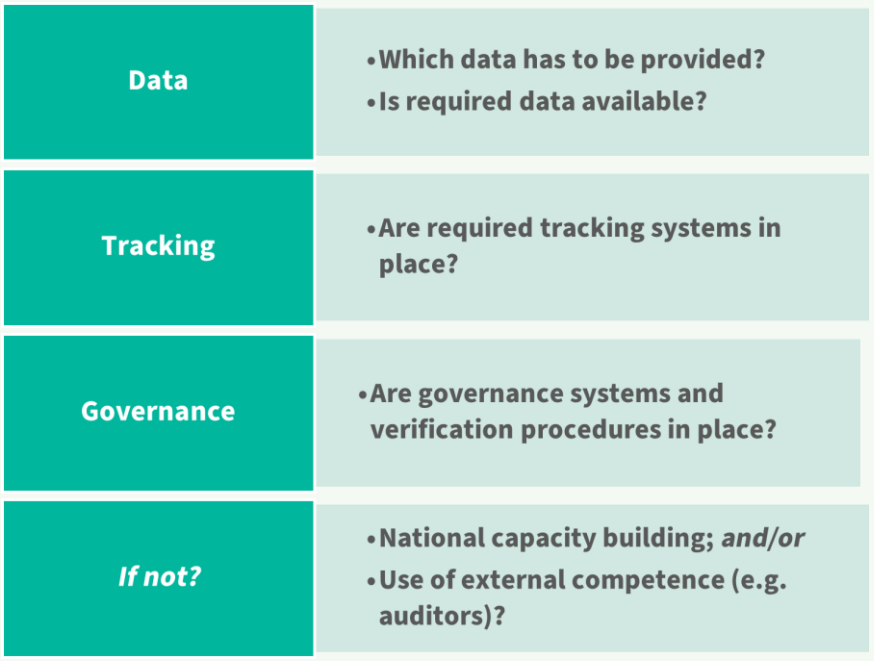

Figure 5. Source: Own illustration

There are different relevant initiatives for standardisation and certification which can be considered as references for an initial assessment of certification needs. With a view to an export to European markets, the most tangible framework is provided by the quota obligations which are imposed by the EU Directives and, more specifically, the EU Delegated Act on Article 27 of the RED II. This Delegated Act clarifies under which general conditions fuels – including hydrogen - can be claimed as renewable fuels of non-biological origin (RFNBOs) and therefore serve as an option to fulfill regulatory quota obligations in the transport sector and potentially beyond (for more information on the applicable criteria see International PtX Hub (2023)[5]). The RED II furthermore imposes that it is mandatory to apply the mass-balance approach in order to prove the chain of custody of RFNBOs for becoming eligible under the respective quota obligation. Consequently, it is obligatory that not only renewable attributes are claimed within a book & claim system, but that a respective volume of RFNBOs is physically transported from the place of production to the obliged party in the EU.

Further details on how these regulatory requirements exactly have to be proven and certified are in the responsibility of so-called "voluntary schemes", which have to be recognised by the European Commission. For this purpose, organisations which are interested to act as certification scheme have to apply to the European Commission, outlining their respective governance concept in order to provide a reliable certification scheme. At the time of writing of this briefing paper, no voluntary scheme has been approved yet by the

[5] International PtX Hub (2023): EU Requirements for Renewable Hydrogen and its Derivatives; online available at: https://ptx-hub.org/eu-requirements-for-green-hydrogen-and-its-derivatives/ (last access: 8 May 2023)

European Commission with respect to RFNBOs.[6] However, such organisations will be relevant contact points for interested market parties after their approval. With respect to specific rules and the handling of the country-specific situation in individual production countries, it can be expected that there will be a learning curve on a case-to-case basis.

With a view to international standards for the certification of hydrogen, the International Standardisation Organisation ISO and particularly the European organisation European Committe for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC) are also addressing this issue. The CEN-CENELEC standard 16325 is about to describe rules and procedures for establishing and operating a GO-like certification scheme for renewable gases including hydrogen. However, it is worth noting that the market relevance of such certificates in Europe will be probably limited, as the major market incentives by the European legislation are linked to an application of the mass balance tracking approach.

Other initiatives on certification include activities of the Ammonia Energy Association (as a global certification system for GHG emissions of ammonia), the IPHE activities on defining a methodology for GHG accounting, the Green Hydrogen Standard (of the Green Hydrogen Organisation) or the Zero Carbon Certification Scheme.

Table 1 and Table 2 provide overviews of different approaches for hydrogen certification, covered markets and related criteria and requirements. This can be used by market parties in potential exporting non-EU countries to start assessing their market options and the related requirements for certification of hydrogen and PtX (based on IRENA & RMI (2023)[7], World Energy Council & dena (2022)[8], Öko-Institut (2022)[9]). However, it should be pointed out that these tables do not claim completeness, and that the content is subject to considerable volatility with time.

[6] There are currently two organisations which have handed in their applications for a Voluntary Scheme for RFNBO at the European Commission: CertifHy (https://www.certifhy.eu/) and ISCC (International Sustainability & Carbon Certification, https://www.iscc-system.org/). Other schemes like RSB, REDcert or Green Hydrogen Organisation have announced interest for application.

[7] IRENA & RMI (2023): Creating a global hydrogen market: Certification to enable trade; online available at: https://www.irena.org/Publications/2023/Jan/Creating-a-global-hydrogen-market-Certification-to-enable-trade (last access: 7 May 2023)

[8] World Energy Council & dena (2022): Global Harmonisation of Hydrogen Certification; online available at: https://www.weltenergierat.de/wp-content/uploads/2022/01/dena_WEC_Harmonisation-of-Hydrogen-Certification_digital_final.pdf (last access: 7 May 2023)

[9] Oeko-Institut (2022): online available at: https://www.oeko.de/fileadmin/oekodoc/Comparing-sustainability-of-RES-and-methane-based-hydrogen.pdf (last access: 7 May 2023)

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Overview of different regulatory mechanisms relevant for hydrogen certification, covered markets and related criteria

REGULATORY MECHANISMS				GHG emissions	Electricity supply	Water	Biodiversity & land-use	Other
COUNTRY/REGION	REGULATORY MECHANISM	STATUS	EMISSION THRESHOLD [gCO_2equ/MJ]	QUALIFICATION CRITERIA				
EUROPEAN UNION	Renewable Energy Directive II (RED II) European Commission	Active New Delegated Acts on Renewable Hydrogen adopted in Feb 2023	28.2	●	●			
	EU Taxonomy European Commission	Active	28.2	●		●	●	
UNITED KINGDOM	Low Carbon Hydrogen Standard Department for Business, Energy & Industrial Strategy (BEIS)	Active Version 2 published in April 2023	20	●	●		●*	●
	Renewable Transport Fuel Obligation (RTFO) UK Department for Transport	Active	32.9	●	●			
SOUTH KOREA	Renewable Portfolio Standards (RPS) KOR Ministry of Trade, Industry and Economy (MOTIE)	In discussion A draft for the extension of the RPS scheme on hydrogen supply is aimed to be released in 2023			●			
UNITED STATES	Clean Hydrogen Production Standard (CHPS) US Department of Energy (DoE)	Proposed (in draft) Not yet finalized, currently undergoing a review process	37.04	●				
	Low Carbon Fuel Standard (LCFS) California Air Resources Board	Active Only valid in US Federal State of California	No threshold Certificate issued based on reduction from annual target	●	●		●**	

* Only in case of hydrogen production pathway: biomass/waste conversion to hydrogen (with/without CCS).
** Mechanism only indirectly addresses land use changes through its assessment scope & criteria.

Table 1. Source: Own illustration based on IRENA & RMI (2023), World Energy Council (2022), Oeko Institute (2022)

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Overview of different certification schemes for hydrogen certification, covered markets and related criteria and requirements

CERTIFICATION SCHEMES			GHG emissions	Electricity supply	Water	Biodiversity & land-use	Other	
COUNTRY/REGION | TITLE & ORGANISATION	LABEL	EMISSION THRESHOLD [gCO_2equ/MJ]	QUALIFICATION CRITERIA					CHAIN OF CUSTODY MODEL
AUSTRALIA Smart Energy Council Zero Carbon Certification Scheme	Renewable H_2	No threshold	●	●				Unclear
CHINA China Hydrogen Alliance Standard and Assessment for Low-carbon Hydrogen, Clean Hydrogen, and Renewable Hydrogen Energy	Renewable H_2	40.8	●	●				Not specified
	Clean H_2	40.8	●	●				Not specified
	Low-carbon H_2	121	●					Not specified
EUROPEAN UNION CertifHy Green and Low-Carbon Hydrogen Certification	Green H_2	36.4	●	●				Book & Claim
	Low-carbon H_2	36.4	●	●				Book & Claim
International Sustainability and Carbon Certification (ISCC) ISCC PLUS	Green H_2	28.2	●	●				Mass balance
TÜV Süd CMS 70	Green H2 +	24	●	●				Book & Claim
	Green H2	28.2	●	●				Mass balance
GERMANY *H2Global Foundation** *H2Global tailored funding windows*	-	*28.2*	●	●	●	●	●	*Mass balance*
JAPAN Aichi Prefecture Low-Carbon Hydrogen Certification	Low-carbon H_2	No threshold	●	●				Book & Claim
INTERNATIONAL Green Hydrogen Organisation Green Hydrogen Standard	Green H_2	8.3	●	●	●	●	●	Not specified
*International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)** *Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen*	-	*No threshold*						-

* No certification systems, but other relevant mechanisms such as market instruments (based on tracking of product characteristics) and GHG accounting methodologies.

Table 2. Source: Own illustration based on IRENA & RMI (2023), World Energy Council (2022), Oeko Institute (2022)

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