IRENA coalition FOR ACTION

DECARBONISING END-USE SECTORS:

GREEN HYDROGEN CERTIFICATION

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About the Coalition

The IRENA Coalition for Action brings together leading renewable energy players from around the world with the common goal of advancing the uptake of renewable energy. The Coalition facilitates global dialogues between public and private sectors to develop actions to increase the share of renewables in the global energy mix and accelerate the energy transition.

About this paper

This technical brief has been developed jointly by members of the Coalition's Working Group on decarbonising end-use sectors. This brief by the Coalition for Action highlights the benefits and challenges of green hydrogen certification to support the development of green hydrogen in order to reach decarbonisation by 2050. It provides examples of green hydrogen certification schemes implemented and planned to date, as well as includes key recommendations for the successful implementation of green hydrogen certificate systems.

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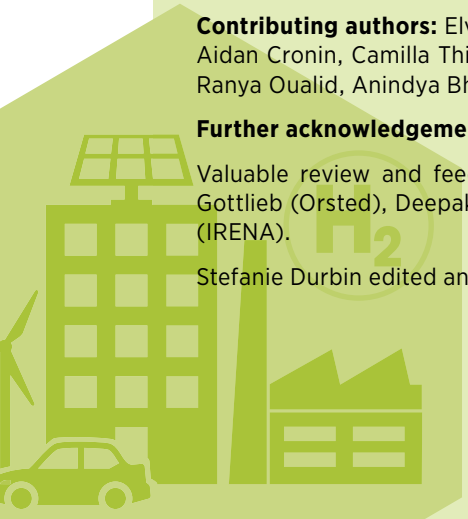
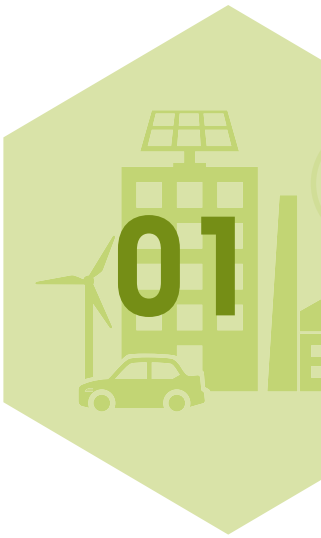


CONTENTS

FIGURES, TABLES AND BOXES

ABBREVIATIONS

CCS	Carbon capture and storage
EU	European Union
GHG	Greenhouse gas
GO	Guarantee of Origin
GW	Gigawatt
I-RECS	International Renewable Energy Certificate
MWh	Megawatt hour
RECs	Renewable Energy Certificates
RED II	Renewable Energy Directive
RFNBO	Renewable fuel of non-biological origin
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute



INTRODUCTION

As countries seek to become climate neutral, green hydrogen (hydrogen produced from renewable energy) and synthetic fuels derived from green hydrogen will have a key role to play in the energy transition, particularly in hard-to-abate sectors. More specifically, green hydrogen can play a major role in replacing fossil fuels in non-energy processes and products, such as steel, fertilisers and plastics production. According to IRENA's 1.5°C Scenario, described in the World Energy Transition Outlook (IRENA, 2021), green hydrogen and its derivatives will account for 12% of final energy use by 2050, and together with electricity, will represent 63% of final energy consumption. Achieving decarbonisation globally will require 5 000 gigawatts (GW) of hydrogen electrolyser capacity to be installed by 2050, compared to only 0.3 GW of installed capacity in 2020 (IRENA, 2021).

Today, 98% of the hydrogen produced globally comes from fossil fuels. The massive deployment and uptake of green hydrogen, as well as the establishment of national, regional and international green hydrogen markets, will depend on the widespread acceptance of tracking instruments certifying its origin. Tracking systems are necessary to track attributes across the entire value chain, create transparency, boost demand and encourage transferability (IRENA Coalition for Action, 2021).

Creating a cost-effective green hydrogen tracking system based on internationally agreed hydrogen principles will, however, require joint efforts by governments, industries, civil society organisations and science-based technical bodies. Among others, this includes addressing potential traceability and trackability shortcomings emanating from the separation of certificates and the physical flow of renewable electricity. Further, while certificates can contribute to promoting the use and production of green hydrogen, unless there are solid framing conditions and rules, these may not necessarily lead to the scaling-up of supply chains and increased renewable energy industry capacity. Finally, the emergence of a market for green hydrogen will also depend greatly on increased international co-operation.

This brief will provide an overview of technical considerations for green hydrogen tracking systems. Chapter 1 discusses the benefits and importance, as well as the challenges, of creating certification schemes for green hydrogen. Chapter 2 analyses practical cases of green hydrogen certificates implemented to date and highlights future projects with green hydrogen certificates. Finally, the last chapter elaborates on key recommendations for creating transparent and efficient green hydrogen certificates and standards that are widely accepted.[1]

1 This brief looks at the technical considerations for the certification of green hydrogen, and does not cover the required sustainability criteria for hydrogen by upstream producers across the globe.

Box 1 IRENA Coalition for Action Decarbonising End-Use Sectors Working Group

Established in 2020, the IRENA Coalition for Action Decarbonising End-Use Sectors Working Group examines – from the perspectives of policy, innovation, technology, socio-economics and institutions, among others – how end-use sectors can move away from fossil fuels and achieve complete decarbonisation by 2050.

The Group developed best practices and policy recommendations for green hydrogen in its first white paper (IRENA Coalition for Action, 2021). This brief on green hydrogen certification complements the previous paper by undertaking work on green hydrogen certification.

Coalition for Action white paper series – Decarbonising end-use sectors

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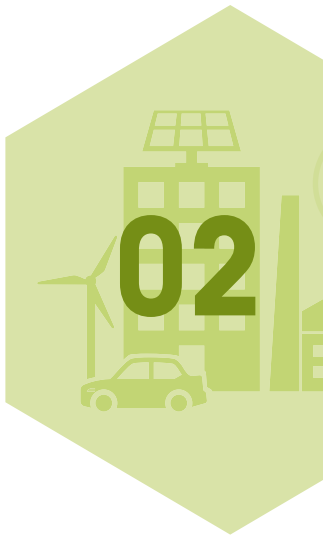
CONSIDERATIONS SURROUNDING GREEN HYDROGEN TRACKING SYSTEMS



To increase the uptake of green hydrogen, it is necessary to ensure an effective, secure and straightforward tracking system that guarantees its origin.

2.1 End-uses for green hydrogen

Tracking certificates for renewable energy help consumers identify the renewable attributes of the energy bought and prove its origin. These certificates are issued on registries where the renewable energy installations are listed, according to the requirements of the tracking system. Independently and credibly certifying the origin enables consumers to make claims on a certain volume of energy that has been generated (EKOenergy, 2021) (see Box 2).

Box 2 Tracking systems

Certificate registry

- Market participants (owners of production devices, traders, suppliers) can register their installations.
- The certificates are issued on the registry.
- Market participants can perform transactions of tracking certificates.

Tracking certificates

- Tracking certificates serve as an identification card/proof of energy generation.
- The certificates carry the energy attributes and make identification possible.
- The certificates help avoid double counting by enabling consumers to make claims on a certain volume of energy that has been generated.
- The certificates are redeemed for the consumption of the end-user and removed from circulation in the registry.

Tracking certificates of renewable electricity production are currently issued per megawatt hour (MWh). The redemption of one certificate from the database on behalf of a consumer means that no one else can claim using renewable electricity based on that same 1 MWh of generation, thereby avoiding the risk of double counting. In addition to certification systems for renewable electricity, it is also possible to draw on experience in tracking certificates for other energy products that can provide lessons for green hydrogen.

2.2 Green electricity tracking and lessons learnt

A growing number of countries have developed tracking systems for green electricity, mainly based on "book and claim" systems. Examples for tracking green electricity include Guarantees of Origin (GOs; Europe), Renewable Energy Certificates (RECs; North America), and International Renewable Energy Certificates (I-RECs; managed by a non-profit organisation), which enable producers to register key information on the electricity produced (i.e. origin, capacity, etc.). End-users can claim certificates to prove consumption of green electricity based on the information registered, and these certificates can be used as proof of renewable electricity purchase. Given their function in the market, many lessons can be drawn from their use that can be applied to green hydrogen (Van Stein-Callenfels et al., 2020):

- Tracking systems must be reliable and secure.
- Verification of all data on the systems must be performed by an independent third party.
- The purpose of the tracking certificate must be clear to the market participants, including what the specific effects on carbon emissions from buying a certificate are, so that consumers are also better informed about their carbon emissions neutrality when purchasing the tracking certificate.
- The identification and mitigation of all the operational risks emerging from the process of issuance, transfer and cancellation of certificates should be carried out through appropriate systems, controls and procedures.
- Objective and public disclosure standards should be applied to all participants in the system to create fair and open access to all market entrants.
- Suitable international communication strategies, processes and criteria should be created and used to ensure transfers to different countries are effective and secure.

2.3 Custody models

Tracking systems can be based on different chain of custody models, such as book-and-claim or mass-balancing.

Book and claim model: The "book and claim" system, more commonly used for renewable electricity, allows energy providers to "book" the renewable electricity they have produced in their systems and energy customers to "claim" the energy they have consumed as renewable. Proving a physical link for energy from the point of production to the point of consumption is not required in the book and claim model, meaning that the claim on consuming renewable energy is separate from the physical flow. In the case of green hydrogen, using these certificates will require temporal and geographical correlation between renewable energy generation and hydrogen production to ensure the renewable nature of their consumption of electricity.

Mass balancing: Mass balancing, more commonly used for biofuels, on the other hand, requires a physical link between the production and consumption of green energy, and consignments must be in contact (i.e. in a container, processing or logistical facility, site, etc.) to prove physical traceability. There are different possible gradations with varying levels of strictness. As an example, in the European Renewable Gas Registry, mass balancing requirements do not require tracking the physical movement of biomethane within the logistical facility, but simply documenting the mass balance between the injection and withdrawal points (ERGaR, n.d.). While in the Union Database defined in the European Union's (EU's) Renewable Energy Directive for tracing the biofuels used in the transport sector, mass balancing requirements are based on actual transactions between operators (European Union, 2018).

A noteworthy point is that definitions of mass balancing differ depending on each country. For instance, some countries require specific mass balancing rules to be applied within their jurisdiction, thus requiring economic operators to administer different mass balancing systems.

Tracking systems can be complemented with other instruments, such as ecolabels. These instruments do not replace tracking instruments but make use of internationally recognised labels to add extra benefits (see Box 3).

Box 3 Ecolabels for green electricity consumption

In an effort to strengthen transparency, civil society, non-profit organisations in an increasing number of countries have developed voluntary consumer labels for renewable energy to ensure that a green energy product does fulfil designated environmental and sustainability criteria and guarantee the proper tracking of energy as well as ensure double counting is avoided.

Some of these voluntary certificate labels also pledge a part of the revenue generated to funding new renewable energy projects.

Local labels for renewable electricity consumption include Bra Miljöval in Sweden, Grüner Strom in Germany, NatureMade in Switzerland and Svanemærket/EU-Blomsten in Denmark. Other ecolabels, such as EKOenergy from Europe and the American Green-e, are more and more present on the international market, especially in Asia and in Latin America (IRENA, 2018). Ecolabels are complementary to existing regulated schemes and provide additional information on attributes that are not necessarily considered by regulation.

Many parts of the world still lack functional tracking systems. Impactful initiatives to enable voluntary use of renewable electricity, such as I-RECs or international ecolabels that improve transparency and additional impact, can facilitate further communication and raise awareness.

It is likely that as the green hydrogen market grows and matures, requirements applied to renewable electricity – as developed in the Scope 2 Guidance of the Greenhouse Gas Protocol – will also be applied to green hydrogen for the purpose of consumer disclosure. (see Box 4).

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Box 4 Greenhouse Gas Protocol

The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) have jointly, through a partnership, created the Greenhouse Gas Protocol. This protocol establishes a comprehensive framework based on global standards that allows private and public sectors to transparently measure, monitor and report the greenhouse gas (GHG) emissions of their operations. GHGs are categorised into three different scopes.

Scope 1 refers to direct GHG pollution by the specific entity in all its operations not limited to manufacturing. Scope 2 refers to the standardisation of how emissions are measured for bought or acquired electricity, heat, and cooling and/or GHG emissions in the supply chain for products. Scope 3 refers to the emissions a company is responsible for outside of its own wall (from the goods it purchases to the disposal of the products it sells) (WRI and WBCSD, 2013).

The Greenhouse Gas Protocol 2 guidance takes in new accounting requirements that account for energy contracts' emissions, the different criteria to be fulfilled by contractual instruments, as well as recommendations on how to disclose information transparently (WRI, 2015).

More specifically, the Scope 2 Guidance now requires that electricity and heat certificates must be used in the same energy market they have been produced in, and within a specific and limited timeframe. As the green hydrogen market develops, the same minimal requirements will likely be applied as well, although the geographical boundaries of hydrogen markets will be larger than electricity markets in most cases.

2.4 Benefits and challenges to the creation of green hydrogen certification schemes

Green hydrogen tracking systems are crucial in promoting and facilitating the consumption of green hydrogen. By granting consumers fully reliable information on the hydrogen supplied to them, such a tracking system can incentivise companies to commit to using green hydrogen, create social interest and promote consumer information, and therefore have the potential to accelerate the clean energy transition. The standardisation of these certificates can also allow and support the development of green hydrogen trading and accelerate the emergence and establishment of an international market. Finally, certification can also be used to give clear and granular investment signals for the efficient deployment of renewable energy according to consumers' needs (such as location, logistics costs, need for infrastructure, etc.).

There are a number of obstacles to the creation and implementation of green hydrogen tracking systems. First, it remains challenging to enforce clear regulations internationally, making it difficult to create compliance to the same standards and rules. In the absence of clear international regulations, multiple tracking systems will likely emerge and be implemented across the world.

Furthermore, given that hydrogen is not a primary energy, creating a bridge between certificates for green hydrogen and certificates for renewable electricity is necessary to avoid double counting the renewable attributes of its primary source of generation. However, two main challenges exist to creating this bridge:

- Communication issues between different tracking systems may lead to misuse.
- Transparency issues may come up if information on the production process and transport, particularly relating to links with non-renewables, is not clearly traced, documented and stated.

Finally, the growth and the development of a green hydrogen market should support the energy transition. Without a parallel increase in the medium and long term of renewable electricity capacity, the development of green hydrogen may negatively impact the energy transition. (See Chapter 3, Section 1, "additionality".)

Green hydrogen tracking systems based on different chain of custody models present different benefits and challenges in their creation and implementation (see Table 1).

Table 1: Benefits and challenges of establishing green hydrogen certificates based on different custody chains

BENEFITS AND POTENTIAL CHALLENGES OF APPROACHES WITH DIFFERENT DEGREES OF DECOUPLING		
	BENEFITS	**POTENTIAL CHALLENGES**
BOOK AND CLAIM	• The administrative costs and burden for economic operators are relatively low. • Management of the system is easier, and a smaller number of actors in the supply chain need to be checked. Smooth administration enables faster uptake. • The source of hydrogen and place of consumption are sufficient as necessary information, making linkage to other tracking systems easier. • Certification for all energy carriers following the same standards makes the harmonisation of tracking certificates easier, making energy carrier conversion convenient.	• Book and claim systems do not necessarily have a physical link to production. This can create confusion for consumers regarding their actual GHG emissions reduction. • The lack of a physical link may distort efficient and effective sector coupling; system flexibility (storage, Demand Side Response, etc.) would not be able to capture its actual value. • In case of the existence of multiple tracking systems, possible double certification should be avoided and measures be put in place to prevent double selling.
MASS BALANCING	• Mass balancing information could be integrated into a book and claim system. • Mass balancing is easier to understand for consumers. It also makes it easier to improve trust in the market as mass balancing can be seen as more resistant to fraud.	• All parties involved in the supply chain need to be checked, which adds complexity and administrative burden. • Detailed and different rules for specific energy carriers may increase difficulty for sector coupling and decrease liquidity in the certificates market.

IMPLEMENTED AND PLANNED GREEN HYDROGEN TRACKING SYSTEMS

3.1 Requirements for tracking systems

Classification of green hydrogen and requirements for tracking systems

There are two main ways to classify hydrogen. A qualitative approach is a colour-coded classification. In this, green hydrogen is defined as hydrogen produced through electrolysis powered by renewable energy. However, this approach does not provide information regarding GHG content.

The second classification is a quantitative one based on GHG footprint. Hydrogen produced within a certain limit of GHG emissions can be certified as having a certain label (e.g. low-carbon). This allows the variation of GHG emissions of different production methods to be taken into consideration; however, it does not allow for the distinction between green hydrogen origin and non-green hydrogen origin production.

There are four requirements that green hydrogen tracking systems should comply with: temporal correlation, geographical correlation, additionality and technological specification of the renewable electricity generation, particularly when there is no direct physical link across the value chain (see Figure 1).

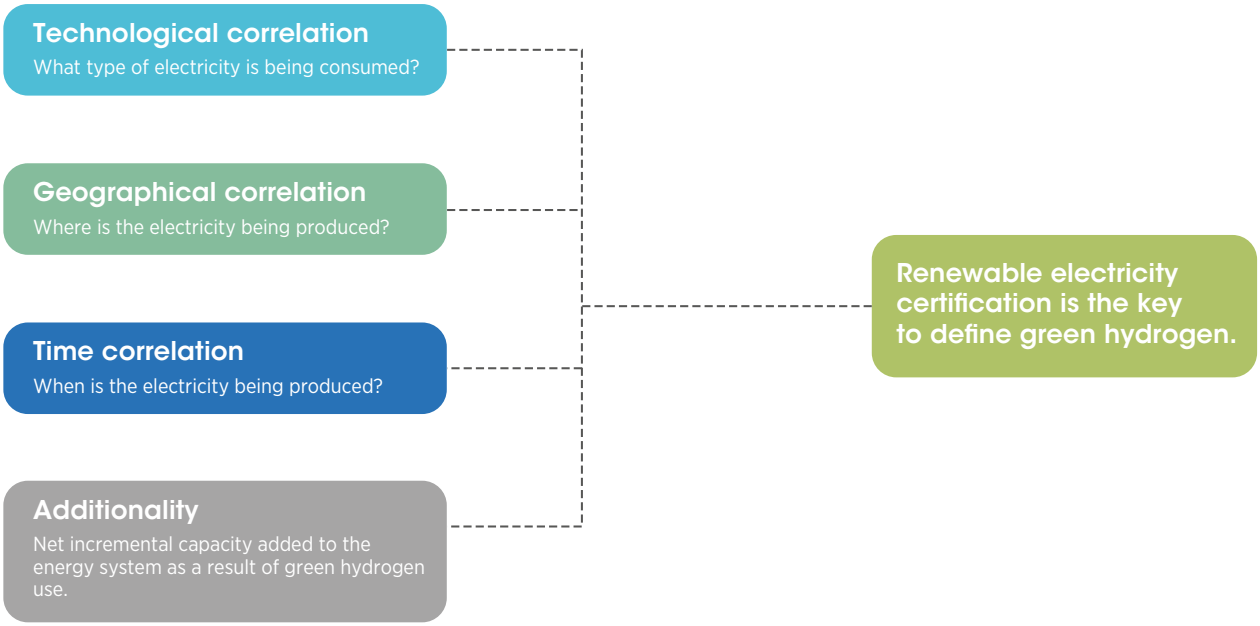
- **Temporal correlation:** To ensure that the electricity used in electrolysis is renewable, green hydrogen tracking systems should operate on an appropriate time interval that will both meet the demand and support the establishment of future power purchase agreements, as well as include available production forecasts.

- **Geographical correlation:** Green hydrogen tracking systems should require some degree of physical link to ensure that electrolysis powered with renewables is involved in the process of producing hydrogen that is claimed to be green.

- **Additionality:** Green hydrogen development should contribute to the build-out or financing of new electricity capacity, to avoid its development leading to increased shares of fossil-generated electricity elsewhere in the electricity system. Therefore, green hydrogen certificates should have an additionality requirement attached to them. It is worth noting that given that the green hydrogen market is still nascent, a transitional period could be allowed during which the electrolyser used to produce the hydrogen is enabled to take electricity from existing renewable plants, backed by renewable electricity certificates (i.e. guarantees of origins, etc.). The introduction of any short term transitional measure shall ensure that the certification's robustness, integrity, and credibility vis-à-vis consumers are not undermined.

- **Technological specifications:** It is essential that specifications provide full transparency and information on the resource used to produce electricity and ensure its renewable nature.

Figure 1: Requirements for green hydrogen tracking certificates



Green hydrogen tracking systems and GHG emissions

Greenhouse gas emissions in green hydrogen production may be caused by the electrolyser or during the electrolysis process, as well as during the distribution and transport of the electricity used.[2] Therefore, to credibly certify green hydrogen, tracking certificates should inform on the GHG content in each produced kilogramme of green hydrogen that can occur along the value chain, from production to transport:

- On the production side, the tracking system should inform on potential GHG emissions and air pollution occurring if the electricity used is from the grid.
- On the transport side, in addition to tracking the emissions from the transportation mode, the emissions produced in the event of conversion should also be considered (ammonia, synfuels such as renewable methane, reconversion, etc.).

2 *The International Partnership and Fuel Cells in the Economy* is undertaking work on establishing globally agreed methodology and calculation on Greenhouse Gas emissions related to the production of hydrogen, including green hydrogen. In addition, the *Green Hydrogen Organisation* aims to issue a Green Hydrogen Standard to exemplify best practice in producing and transport green hydrogen, with an overall threshold of carbon emissions.

3.2 Current certification scheme proposals for green hydrogen

Some countries have already started developing proposals and projects for green hydrogen certification. An advanced example is CertifHy, which has been working on a project to design, for the first time, a green hydrogen GO in the European Union. The project aims to create a standardised definition of green hydrogen across the European Union, GOs for green hydrogen that can be deployable in all of Europe, as well as an implementation roadmap. It will also define the processes and procedures for the whole life cycle of the GO, which will include audits of hydrogen production plants; the certification of production batches; and the issuing, trading and "usage" of GOs. One of CertifHy's main objectives is to ensure that green hydrogen GOs are compatible with EU legislation, including the recast Renewable Energy Directive (RED II) (FCH 2 JU, 2019) (see Box 5).

In 2021, the Commission approved a recast of the Renewable Energy Directive (RED II), which outlines green hydrogen and its derivatives as a key aspect of the European Union's net zero strategy European Commission, 2021). To facilitate the growth of this market, new rules regarding the certification and traceability of these fuels will be introduced. Renewable fuel of non-biological origin (RFNBO), including green hydrogen, will be tracked and certified under a new mechanism, which will likely be part of a newly set up "Union Database" or through certification schemes such as CertifHy. The Commission also established a limit of 70% GHG emission reductions compared to the benchmark of existing fossil-based transportation fuels.

Outside the European Union, other countries have been working towards devising a strategy for tracking systems for green hydrogen, such as the US, UK and China (dena/World Energy Council – Germany, 2022).

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Box 5 Green hydrogen tracking systems proposals and initiatives

CertifHy: CertifHy is a European project split into three phases. These include Phase 1 (2014 and 2016), Phase 2 (2017 and 2019) and a current third phase. CertifHy GOs aim to provide transparency and information at the production level of green hydrogen, as well as to provide information on elements such as time of production, energy source and GHG emissions (FCH 2 JU, 2019).

To date, two labels have been implemented: hydrogen is classified as either "green hydrogen" or "low-carbon hydrogen". For both categories, there is a GHG emission limit of 60% reduction from a benchmark based on hydrogen produced from natural gas without Carbon capture and storage (CCS). "Green hydrogen" then refers to hydrogen produced from water electrolysis powered by renewable energy sources such as wind, solar, hydro or biogas, while "low-carbon hydrogen" refers to hydrogen produced by water electrolysis powered by non-renewable, low-emission power sources such as nuclear energy, or hydrogen produced from fossil fuels with CCS.

CertifHy GOs can be used across the European Union as the scheme decouples the physical hydrogen supply from the environmental attribute. CertifHy's pilot operation is designed to ensure compatibility with EU legislation, particularly RED II, and to address any issues arising from the implementation of the GO scheme for hydrogen.

Private sector initiatives fostering green hydrogen tracking applications: The private sector is similarly developing various initiatives to help end-users track and quantify the impact of their consumption of green hydrogen. For instance, the Spanish developer ACCIONA Energía has put forward the GreenH2chain® platform based on blockchain technology to guarantee the renewable origin of green hydrogen. The initiative allows access to a real-time digital platform in which the green hydrogen value chain can be verified and visualised, thereby enabling the decarbonisation of energy consumption to be quantified, recorded and monitored (ACCIONA Energía). This platform will be implemented in the Power to Green Hydrogen project, designed to create a green hydrogen ecosystem on the island of Mallorca, Spain (ACCIONA, 2021).

3.3 Considerations for a successful green hydrogen tracking system and its implementation

To successfully establish and implement tracking systems for green hydrogen, a number of elements and actions are required. These can increase transparency for the consumer, avoid misuse and limit fraud, as well as support the development of a trading market for green hydrogen. Proper certification will require implementing the following actions:

- Using a reporting and verification tool for renewable and/or emission reduction targets
- Ensuring transparent custody transfer across the entire supply chain, as points of hydrogen production and consumption may vary
- Employing a well-developed tool that enables the limitation of fraudulent activity in the market that may occur due to different prices and subsidies applying only for certain production pathways
- Guaranteeing that green hydrogen becomes a tradable commodity across regional markets
- Adherence to recognised standards at all points along the tracking system.

KEY RECOMMENDATIONS

To ensure that tracking systems meet green hydrogen sector demand and achieve the established green hydrogen and decarbonisation goals, the Coalition for Action proposes a series of key recommendations. By providing transparency and incentivising the use of green hydrogen, tracking systems can positively impact green hydrogen development and lead to a more rapid deployment of the green hydrogen sector. Green hydrogen certification can support the rapid deployment of the sector and help reduce generation costs.

1. **Develop a harmonised definition of green hydrogen.** A consensual definition of green hydrogen should be developed, based on a transparent methodology in order to avoid fragmentation of the market.

2. **Certify the renewable origin of the energy used to produce hydrogen.** A reliable justification of the renewable origin of electricity must be ensured. It must be a sine qua non condition to grant the green hydrogen certificate. Renewable electricity used for hydrogen production will be defined by the following vectors:

    a. **Technological correlation:** Limitations should be supported by tracking systems that ensure that the electricity comes from renewable sources.

    b. **Geographical correlation:** Physical constraints in transporting the electricity must be considered in defining geographical boundaries to ensure that the renewable electricity is physically used in the electrolysis process.

    c. **Temporal correlation:** Time constraints criteria should be considered for green hydrogen certificates to ensure that the origin of the electricity used is renewable.

    d. **Additionality:** Additionality is necessary to ensure that the development of the sector is not detrimental to the energy transition as a whole. Additionality requirements should be mandatory to ensure that the growth of the green hydrogen market leads to the growth of the renewable energy sector and positively impacts the energy transition.

    Creating a strong and reliable tracking system based on these requirements is essential for transparently informing the public and private sectors about the origin of the hydrogen. Nevertheless, a degree of flexibility in regard to the geographical, temporal and additionality requirements should be taken into account in the short term to ensure that the nascent green hydrogen market can develop. Any short term transitional measure, however, will need to ensure that the system's robustness and integrity, as well as its credibility to its consumers is not compromised.

3. **Ensure that certificates contain sufficient information for consumers and policy makers.** To ensure consumer uptake, certain information must be readily available in the certificates. Consumers are primarily concerned with the origin of the units of hydrogen being purchased – that is, where they come from and how they were produced – as well as the quantification of the GHG emissions of the production process. Certificates can also enable governments to measure progress towards targets and policy objectives.

4. **Simplify the green hydrogen tracking system to avoid administrative burdens.** Certificates generate a market that can accelerate the deployment and uptake of green hydrogen. By avoiding administrative burdens and barriers that could stop or delay project development are averted, these certificates' positive impact on the green hydrogen market will be greater.

5. **Implement a cost-effective tracking system.** To create a market for green hydrogen, cost-effective tracking systems for hydrogen based on internationally cohesive green hydrogen standards and certification principles must be established. A credible hydrogen tracking system could generate some costs; hence, where possible, innovative approaches and the use of cost-effective technologies should be leveraged to bring down certification costs for clients. This is crucial for promoting green hydrogen uptake given that it is presently not cost competitive with grey or blue hydrogen.

6. **Put in place appropriate control systems to avoid misuse or lack of transparency.** Identify and devise mitigation strategies as well as appropriate systems, controls and procedures to avoid operational risks associated with the issue, transfer and cancellation of certificates.

7. **Consider interactions with existing tracking systems.** Key interactions between existing and newly established tracking systems will happen when one energy carrier that qualifies for a certificate is then converted into another energy carrier that also qualifies for a certificate under a different scheme. The coexistence and interaction of different schemes could threaten the credibility and accuracy of all existing schemes. To create a well-functioning green hydrogen tracking certificate system, it is crucial to evaluate and identify the conditions under which wanted interactions can occur as well as to develop mitigation strategies to avoid unwanted interactions between the different existing schemes.

8. **Avoid double counting.** If two systems coexist, for example in different countries, mechanisms must be put in place to ensure that multiple certificates are not issued for the same unit of green hydrogen.

9. **Use taxonomy and green finance criteria to encourage compliance with green hydrogen certification requirements.** Green hydrogen projects are cost-intensive, meaning financial support and access to capital are needed for project development. Hence, the design could consider green finance principles to open up access to global funds that are reserved solely for green projects that fulfil green hydrogen tracking system requirements.

10. **Promote international co-operation to establish globally accepted rules and requirements.** The green hydrogen export industry is promising and without a scheme in place might be delayed, reducing its value. Using internationally recognised rules will make it easier for export markets to understand how GHG emissions for the traded green hydrogen are calculated, facilitating their placement in the market.

In summary, both renewable electricity and green hydrogen tracking systems need to follow the principles of transparency, reliability, simplicity and flexibility, while being backed by industry and managed by non-profit organisations or other official entity.

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