TECHNICAL NOTE Nº IDB-TN-02861

Guide for the Implementation of a Hydrogen Certification System in Latin America and the Caribbean

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December 2023

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Cataloging-in-Publication data provide d by the
Inter-American Development Bank
Felipe Herrera Library

Guide for the implementation of a hydrogen certification system in Latin America and the Caribbean / Nuria Hartmann, Valentina Pradelli, Juan Sebastián Márquez, Christiaan Gischler, Eric Fernando Boeck Daza, Paola Galeano.

p. cm. — (IDB Technical Note ; 2861)

Includes bibliographical references.

1. Hydrogen as fuel-Latin America. 2. Hydrogen as fuel-Caribbean Area. 3. Hydrogen industry-Latin America. 4. Hydrogen industry-Caribbean Area. I. Hartmann, Nuria. II. Pradelli, Valentina. III. Márquez, Juan. IV. Gischler, Christiaan E. V. Boeck, Eric. VI. Galeano, Paola. VII. Inter-American Development Bank. Energy Division. VIII. Series.
IDB-TN-2861

JEL Codes: O13, O54, Q4, Q42, Q49, Q54

Keywords: Clean and Low-Carbon Hydrogen, Environmental Sustainability, Green Hydrogen, Regulatory Framework, Hydrogen Certification, Latin America and the Caribbean, Regional Collaboration, Renewable Energy Technologies

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Guide for the Implementation of a **Hydrogen Certification System** in Latin America and the Caribbean

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Acknowledgments

This report is part of the knowledge agenda developed by the Energy Division of the Inter-American Development Bank. The aim is to generate innovative knowledge products and provide technical assistance for the LAC countries. These products are designed to inform, guide, and offer recommendations to a diverse audience including policymakers and active participants in energy markets, such as consumers, utilities, and regulators. The report was prepared under the general direction of Marcelino Madrigal, Head of the Energy Division. Steering the work team was Christiaan Gischler, with substantial contributions from principal authors Nuria Hartmann, Valentina Pradelli, Juan Sebastián Márquez, Eric Daza, and Paola Galeano. Gratitude is extended to Lenin Balza, Maria Paz de la Cruz Sepulveda, and Augusto Cesar Bonzi Teixeira for their comments and review. The team gratefully acknowledges financial support from the technical cooperation "Regional Integration of the Green Hydrogen Value Chain" (RG-T3395).

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AEA	Ammonia Energy Association
CAPEX	Capital Costs
C.B.	Certification Body
CCS	Carbon Capture and Storage
CertHILAC	H2 Certification System for LAC
CO2	Carbon dioxide
DB	Database
DoE	Department of Energy
EC	European Commission
GCC	Green Certificate Company
GHG	Greenhouse Gas
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
GO	Guarantee of Origin
H2	Clean and/or low carbon Hydrogen
IB	Issuing Body
IDB	Inter-American Development Bank
I-REC	International Renewable Energy Certificate
LAC	Latin America and the Caribbean
NH3	Ammonia
OLADE	Latin American Energy Association (for its acronym in Spanish)
OPEX	Operational Costs
GDP	Gross Domestic Product
PPA	Power Purchase Agreement
RCF	Recycled Carbon Fuels
RED	Renewable Energy Directive from the European Union
RFNBO	Renewable Fuel of Non-Biological Origin,
SMR	Steam Methane Reforming
USA	United States of America
USD	United States Dollar

1. Introduction

The emerging market for clean and/or low-carbon1 hydrogen (H_2) in Latin America and the Caribbean (LAC) is rife with opportunities, albeit accompanied by challenges amid the global push for decarbonization. One of them revolves around the certification of H_2 and its derivatives, including ammonia, methanol and synthetic fuels. The primary goal of this certification is to furnish prospective buyers (off-takers) with comprehensive information about the key attributes of these premium[1] products.

This detailed information refers to crucial product attributes, ensuring clarity on factors such as emissions intensity as well as the specific details regarding the place, time, and form of production. Reporting specific attributes of the product becomes instrumental in establishing off-takers' confidence and willingness to purchase, especially when the product boasts carbon neutrality or a lower carbon footprint compared to alternative solutions. It is also important to adhere to the regulatory frameworks of specific markets, such as those laid out by the European Union, in their decarbonization strategies for industry and transport sectors.

Across the LAC region, several countries are engaged in developing H2 projects and derivatives, propelled by the abundance and high quality of cost-competitive renewable resources (IDB, 2023). This positions LAC as an enticing geography for H2 export and a region with immense potential to deploy H2 for decarbonizing its own economies. To fully realize this potential, **H2 producers in LAC must rigorously adhere to the regulations and standards set by various markets and diverse customers.**

[1] Referring to H2 that can be produced from renewable energy sources or biogas, from fossil energy sources with carbon capture, or through other sources or production technologies that comply with a certain level of GHG emissions.
[1] *Premium* since these are products more costly to produce, in monetary terms, to obtain a "cleaner product" with a lower carbon footprint than Business as Usual (BaU) alternatives.

While individual countries have the authority to establish their own standards and certification systems, this report advocates for a regional approach towards H2 certification within the LAC context. The rationale behind this proposal is to mitigate redundant efforts among countries and avert the development of divergent certification systems that lack harmonization. **It also seeks to streamline efforts in both intraregional and international markets,** maximizing product value and enhancing their eligibility across various markets and for diverse consumers.

The envisioned certification system aligns with global trends in H2 certification system development. It diverges from assigning pre-established labels or product categories, prioritizing the transparent reporting of key attributes of hydrogen and its derivatives. This responds to lessons learned from operational systems like CertifHy, which use colors or qualifiers ("yellow hydrogen") potentially obscuring diverse emission intensities. Such terminology has proven impractical in serving as a foundation for making contracting or financing decisions, dissuading potential investors.

Emphasizing the reporting of emission intensity without predefined labels also promotes flexibility in accommodating various production technologies, including hybrid[2] ones. This approach also ensures that national regulations and standards set by governments for hydrogen align, avoiding conflicts arising from differing definitions of clean and/or low-carbon hydrogen. Furthermore, this broadened scope enables the certification system to cater to the specific requirements of different target markets.

In this context, this report puts forth:

- A proposition for a H2 certification system tailored to the unique characteristics of LAC, under a harmonization approach, and considering essential attributes of social and environmental sustainability, acknowledging the region's distinctive challenges such as water scarcity and coexistence with indigenous communities, and
- An action plan for the implementation of this certification system, addressing specific actors and structures within the countries of the region.

The initial stride towards establishing a LAC certification system was marked by the signing of the Joint Declaration for the Implementation of the Clean Hydrogen and/or Low Emissions Certification System in Latin America and the Caribbean ("CertHILAC Declaration") on November 8, 2023. This landmark event involved the Ministries and Energy Secretariats of the Republics of Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Panama, Paraguay, Dominican Republic, and Trinidad and Tobago. Successful implementation of the system hinges on the coordination and commitment of all stakeholders. The ensuing guide furnishes tools and recommendations for the implementation of CertHILAC, positioning it as the regional certification system in LAC. The recommendations are grounded in a benchmark analysis tailored to the local-regional context.

[3] I.e., in cases where hydrogen or its derivatives are produced from more than one energy source or technology.

2. Background: Proposal for a LAC Regional Certification System

The impetus behind the conception of a certification system for clean and/or low-carbon hydrogen in LAC is rooted in:

1. Envisioning the medium to long-term trajectory of market development, wherein hydrogen and its derivatives are commercially traded not only among countries within the same region but also with importing regions like North America, Europe or Asia.

2. A commitment to forestall redundant efforts and resources in the creation of certification systems in different countries in the region.

3. The establishment of a regional "counterweight" among exporting nations to bolster negotiations in trade discussions, particularly when engaging with economic blocs like the European Union. This proactive stance aims to solidify regional positions and secure validations of the LAC certification system within these geographies.

4. The significance of incorporating region-specific attributes into the certification system, such as sustainable water use, reduced socio-environmental impact and others.

The proposed system is distinguished by its voluntary nature, with its primary objective not geared towards serving as a compliance tool for regulations and standards, given that such frameworks are still in the developmental stages in LAC. Despite this, the regional certification system can function as a tool for verifying compliance with national standards and targets, offering a mechanism to account for hydrogen emissions through certificates and ensuring alignment with country-level goals. The system's adaptability, free from rigid labels or thresholds, allows it to seamlessly adjust to the diverse requirements of individual countries. It can also enhance financing possibilities for H2 projects in the region if the environmental and social requirements of the projects align with those of financial institutions or multilateral organizations.

Anticipating the potential scenario where some LAC countries might establish goals and standards for clean and/or low carbon hydrogen and derivatives, the proposed system is designed with a flexible structure to ensure compatibility with future national regulations. Even though voluntary in nature, the system incorporates representatives of the public sector in its governance. This inclusion aims to ensure that the system's design complements governmental decarbonization policies and strategies. Additionally, it facilitates synergy with existing certification systems for other energy sources, such as renewable electricity, and aligns with national emission databases and inventories. Drawing inspiration from the voluntary Zero Carbon Certification System in Australia, which successfully engages both public and private sector representatives, this approach ensures a system that not only aligns with government guidelines but also supports broader national strategies (Clean Hydrogen Partnership, 2021).

In the LAC region, a notable challenge lies in the absence of a regional entity responsible for hydrogen certification on a scale comparable to the European Commission's role. Unlike the EU, which initiated the creation of a certification system for guarantees of origin in 2014, LAC lacks a central coordinating body. However, regional platforms like H2LAC and organizations such as OLADE (Latin American Energy Organization) or IAAC (Inter-American Accreditation Cooperation) will play instrumental supporting roles in this regional initiative.

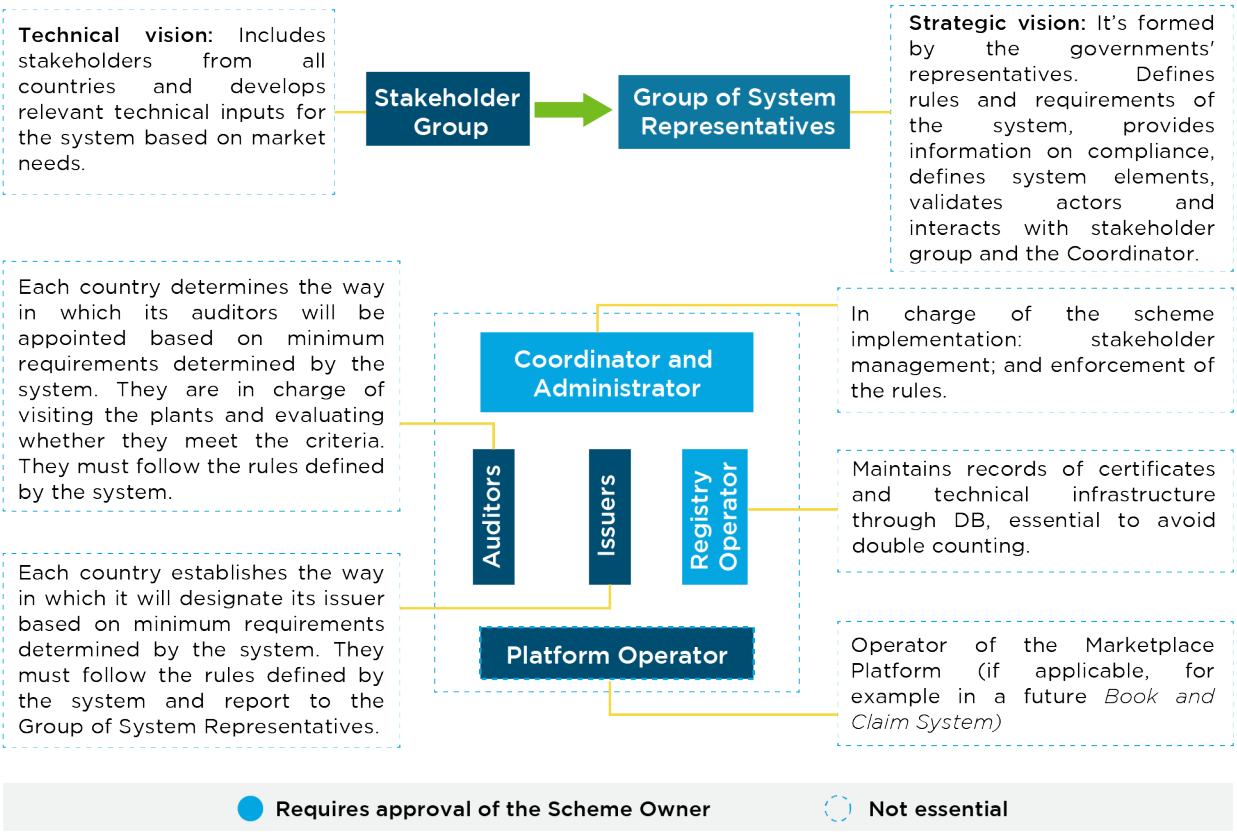
The implementation of a H2 hydrogen certification system in Latin America requires the designation of key players who will shoulder responsibilities related to the development, implementation and seamless operation of the system. In this context, various combinations of roles[3] are conceivable within the certification system that can be exercised at the regional or national level. In other words, the governance structure must define which processes will unfold regionally and which at the national level.

Figure 1, presented below, succinctly outlines the essential players crucial for the operation of a hydrogen and derivatives certification system, along with their respective functions. This overview draws upon insights gleaned from a review of hydrogen and renewable electricity certification systems worldwide.

It is important to note that in practical terms, **the roles and functions identified have been historically implemented through different strategies.** it is not uncommon for a single entity or organization to fulfill multiple roles, as elaborated upon below.

[3] For example, in the case of CertifHy, the roles of System Representative and Manager are played by the same entity. A different structure can be observed with I-REC, where the I-REC Foundation acts as the system owner and assigns the roles of administrator and registry operator to the company EVIDENT.

Figure 1. Main Roles Associated with the Governance of a Certification System



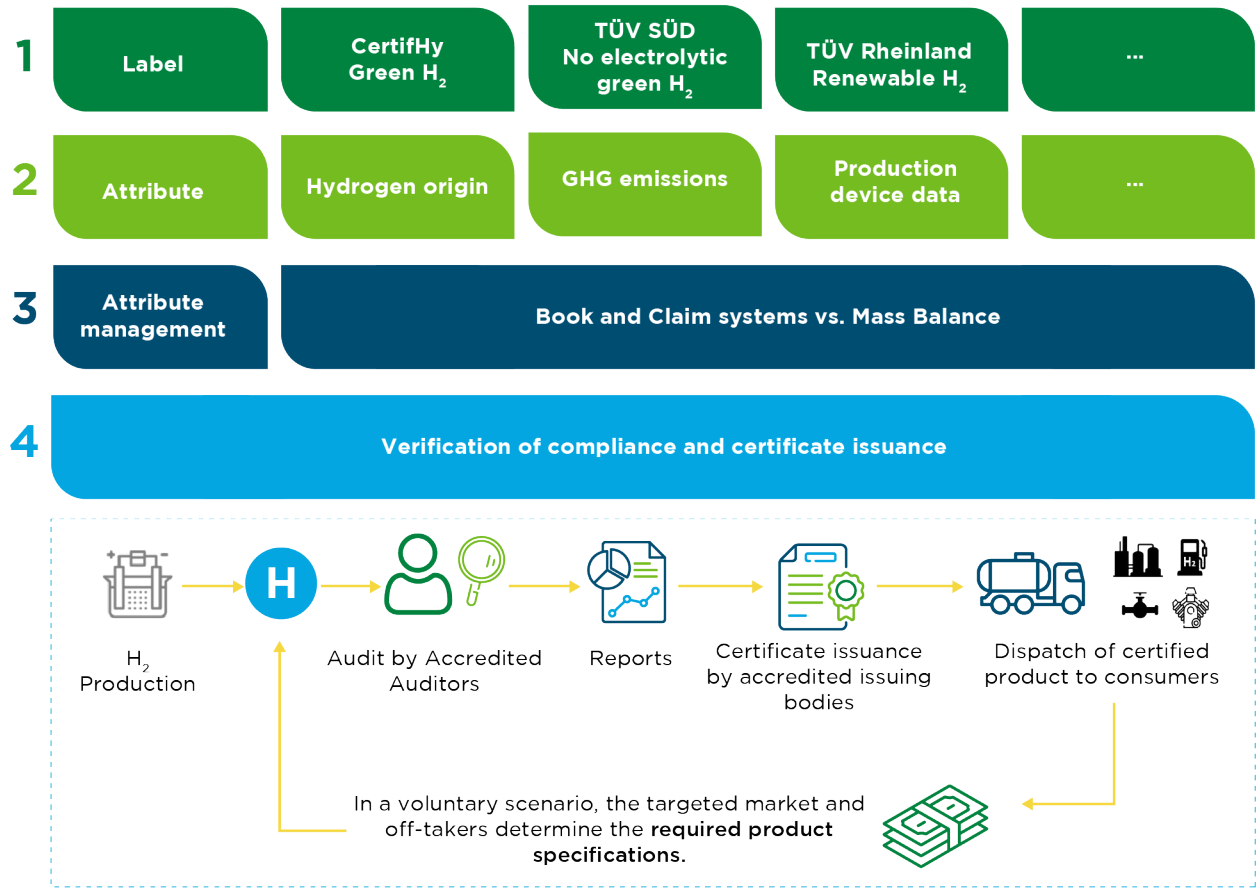
Source: Prepared by the Author (2023) based on (Instituto Totum, 2015)

Presently, the majority of voluntary systems lack active involvement from the public sector in pivotal roles. For instance, entities like the Ammonia Energy Association (AEA) and the CertifHy certification system operate as entirely private entities, with no representation from government officials on their Certification or Steering Committees. In contrast, as explained above, the starting point of the proposed certification system is to integrate government representatives, emphasizing their inclusion to foster harmonization with national regulations and standards, and to validate the emissions measurement methodology to ensure compliance with their emissions inventory.

3. General Scope of the Proposal for a Certification System

The outlined proposal comprehensively addresses all fundamental aspects of hydrogen certification systems. This includes (i) the attributes earmarked for certification; (ii) the management system for handling these attributes; and (iii) the governance structure for the administration and operation of the system, as illustrated in **Figure 2** below.

Figure 2. Presentation and Exemplification of the Components of the Hydrogen Certification System Covered in the Proposal



Source: Prepared by the Author (2023)

It is worth noting that the proposal considers a diverse array of energy sources and production technologies relevant to the countries in the LAC region. This thoughtful consideration is grounded in the region's expansive renewable potential, diverse resource profiles, the coexistence of both fossil and renewable biomass resources in certain countries, and their interest in harnessing one or multiple energy sources, at times incorporating carbon capture technologies. The proposal places a dual emphasis on both clean and low-carbon hydrogen, excluding hydrogen derived from fossil sources without carbon capture. This alignment resonates with the project's environmental and social sustainability approach.[4]

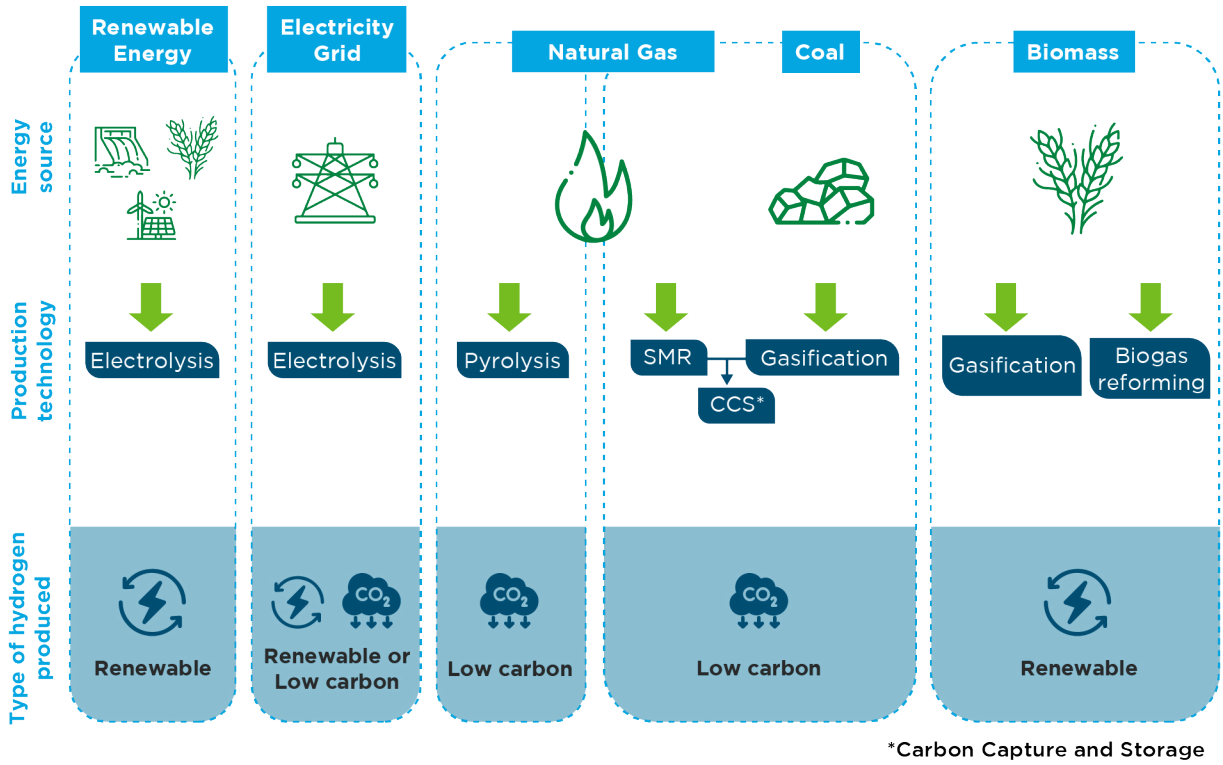
Recognizing the ever-evolving landscape of technological advancements, **the proposal maintains technological openness. In essence, it refrains from imposing restrictions on specific production processes or technologies**. This flexibility allows for the incorporation of new production technologies or methods already in use, subject to the decision of the System Representative.

Figure 3 illustrates the considered production technologies and sources, offering clarity on whether the produced hydrogen is classified as renewable (clean) or low carbon.[5]

[4] However, as mentioned earlier, the presented proposal serves as input, and it is ultimately the System Representative which will validate the final system.

[5] Hydrogen produced from grid electricity is only considered clean if the energy comes from a renewable power purchase agreement (PPA) or is accompanied by a renewable energy certificate of origin.

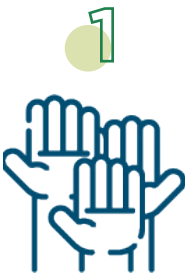
Figure 3. Energy Sources and Production Technologies Considered for the Proposed Regional Hydrogen Certification System



Source: Prepared by the Author (2023).

3.1. Fundamental Characteristics of CertHILAC

The proposed certification system is defined by five fundamental characteristics:



Voluntary

It is a 100% voluntary certification system. This choice stems from the fact that, as of the system proposal date, hydrogen standards or legal regulations in the region are either in development or nonexistent. Consequently, CertHILAC is not designed for regulatory compliance but rather targets producers seeking to enhance the market eligibility of their products. Similarly, it caters to consumers aiming to procure hydrogen certified as clean or low carbon to drive decarbonization in their operations.

It is crucial to underscore that the proposed system stands poised to serve as an input for countries that may choose to regulate clean and/or low-carbon hydrogen production and consumption in the future. In such cases, the certification system could be leveraged to verify compliance with forthcoming standards.

2

Precise

The certification system is crafted with a specific focus on key attributes pertinent to both the region and the global stage. This approach ensures that the certified elements not only align with the requirements and standards of target markets but also allow for easy and flexible implementation and utilization of the system.

Examples of attributes considered include the energy sources used, the positive social impact of projects, and the sustainable use of water.

3

Open to multiple production pathways

The proposal advocates for the incorporation of diverse energy sources and technologies in the production of clean and/or low-carbon hydrogen. This choice aligns with the expansive and varied renewable potential prevalent in the region. Simultaneously, it considers the abundance of fossil resources in some countries and their inclination to take advantage of a mix of energy sources. The focus is on both clean and low-carbon hydrogen with a deliberate exclusion of hydrogen produced from fossil sources without carbon capture, reflecting the overarching commitment to environmental and social sustainability principles.

4

Flexible

The envisaged system should facilitate certifications tailored for both local consumption and the export of hydrogen and its direct derivatives (such as ammonia, methanol and e-fuels). This flexibility allows stakeholders to choose the most fitting option according to the requirements of the markets of interest. Likewise, it is conceived as a dynamic system: adaptable to market requirements, trends and regulations.

Taking into consideration feedback from different representatives of the countries in the region, and recognizing the existence of projects utilizing different hydrogen production methods/technologies and inputs, the proposed certification system avoids the use of labels categorizing products. Instead, it centers on reporting the key characteristics of hydrogen and its derivatives, such as carbon intensity, energy sources, production technologies, and other certified attributes. This approach preserves flexibility, leaving room for compatibility with potential future regulations that might define specific product criteria at the country level.

3.2. Proposal of Attributes to be Certified

The selection of attributes earmarked for certification stems from a comprehensive analysis of hydrogen certification systems worldwide. This examination considers key aspects for the region in terms of its social, economic and environmental context. Thus, critical elements such as the sustainable use of water, protection of flora and fauna, and respect for neighboring communities and indigenous peoples were included.

Table 1 summarizes the proposed attributes to be certified, divided into three groups: the "base" attributes, indispensable for all hydrogen certification systems; attributes of high relevance for LAC, including social[6] and environmental sustainability aspects; and additional attributes required by RED II, which may not be directly pertinent to the trade of H2 and derivatives outside the European Union.

The attributes collectively constitute two certification categories, each of which will be described in detail below.[7]

[6] **Ensuring compliance with the "Positive social impact of the project on neighboring communities / indigenous peoples" attribute necessitates, at a minimum, a community consultation for the respective production project. The final methodology for measuring this attribute must undergo validation by the System Representative.**

[7] **More attributes can be found within the hydrogen certification systems worldwide. However, the proposed selection incorporates those considered key for the region and for export to international markets.**

Table 1. Proposed Attributes to be Included in a Regional H2 Certification System in LAC

Atributtes	Justification	Certification category
Primary energy source and energy production plant information	**Present in all certification systems worldwide**	H_2 Certification LAC Region 
H_2 production plant information		
Intensity and scope of GHG measurement		
Positive social impact of the project on neighboring communities / native peoples	**Highly relevant to the LAC Region**	
Sources and sustainable use of water		
Measures to minimize the environmental impact of the project		
Wastewater treatment (brine, when applicable)		
Compliance with international labor standards		
Location and use of sustainable and socially and environmentally harmonious land use (excluding land conflicts)		
H_2 production time versus energy*	**Necessary to comply with time correlation criteria required by European regulations*.**	H_2 Certification for EU markets 

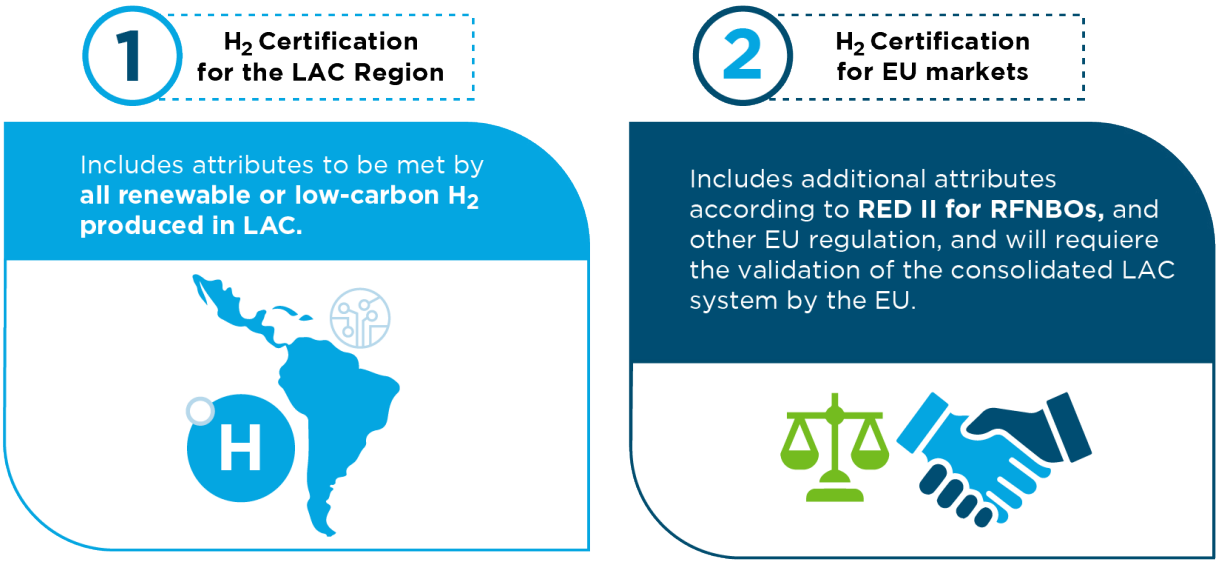
(*) Measurable geographic correlation and additionality criteria through the attribute "H2 production plant information".

Source: Prepared by the Author (2023)

3.3. Proposed Certification Categories

The proposed certification system comprises two categories of hydrogen certification, each designed to meet specific market requirements as outlined in the preceding table. The first category caters to local/regional markets as well as those beyond the European Union. The second category builds upon the requirements of the first and includes additional European Union's standards or regulations **(Figure 4):**

Figure 4. Proposed Certification Categories for a Regional System for LAC



Source: Prepared by the Author (2023).

I) H2 Certification for the LAC Region

As delineated in Table 1, the "H2 Certification for the LAC Region" category encapsulates the essential environmental and social sustainability criteria applicable to all clean and/or low-carbon hydrogen products produced within the region. These specific attributes for LAC consider previous studies undertaken by IDB that analyzed main risks, impacts, and mitigation measures of activities related to H_2 and its derivates in LAC, as well as the environmental and social aspects that should be considered (IDB, 2023).

Notably, it is recommended not to implement a labeling system for this category. The rationale is to avoid potential controversies and disagreements among participating countries, particularly when assessing hybrid project configurations (i.e., those that combine multiple energy sources or production technologies). The lack of clarity about which labels a producer could apply in certain cases might lead to exclusion, pose opposition risks, and erect adoption barriers for the system.

Furthermore, contemporary certification systems still under development, such as the ammonia system[8] in the United States and globally, have embraced an approach devoid of specific labels. In contrast, the proposed framework suggests that producers aspiring for certification must meet a determined GHG emissions threshold. Hydrogen certificates, under this proposal, should detail all energy sources and production technologies employed, along with other certified attributes. This shift is intended to enhance transparency for consumers.

Aligning the design of a regional certification system for LAC with the previously described approach, which considers recent developments in ammonia certification systems, holds significant strategic merit for two primary reasons:

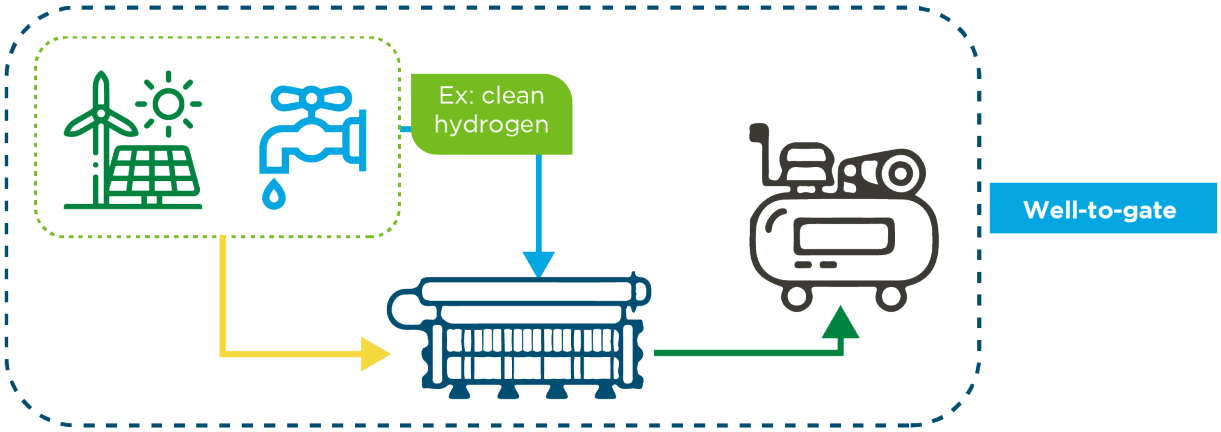
- The growing prominence of ammonia as a principal hydrogen-derived product for international trade underscores the advantage of implementing a hydrogen certification model consistent with the prerequisites set by ammonia certification systems. This alignment will streamline project development for export within the region.

- The goal of the regional certification system is to achieve harmonization with other international systems, steering clear of "rigid" product labels. Instead, it aims to document key product attributes, circumventing potential trade barriers and facilitating commercial exchanges.

Regarding the scope of GHG emissions accounting, the proposal advocates for an extension up to the point of hydrogen production (quantification of "Well-to-Gate" emissions), as shown in **Figure 5**. This approach aligns with the predominant practice adopted by voluntary hydrogen certification systems worldwide.

[8] **Ammonia Energy Association Certification System, under development.**

Figure 5. Proposed Scope of Emissions Accounting for the "H2 Certification for the LAC Region" Category



Source: Prepared by the Author (2023)

In terms of the methodology for measuring GHG emissions associated with production, international practices based on ISO should be considered. Notably, the IPHE approach, currently under development, draws on various ISO standards relevant to this context. The responsibility for defining the methodology to calculate the carbon footprint of clean and/or low-carbon hydrogen rests with the System Representative.

II) H2 Certification for EU markets

The certification of H2 intended for EU markets seeks to secure eligibility in European markets, specifically by complying with the regulations for renewable non-biological origin fuels (RFNBOs). These regulations define specific requirements for a hydrogen-derived product to be deemed eligible for its contribution to the decarbonization of energy and industrial sectors in Europe.

The attributes proposed for certification in the H2 Certification for EU markets mirror those identified for the H2 Certification for LAC. In addition, other attributes are introduced, such as the time of hydrogen production relative to electricity generation– an essential reporting criterion to fulfill the temporal correlation requirement demanded by the RED II regulation. Compliance with the EU standards necessitates that hydrogen production meet specific criteria, including additionality and geographical correlation, which would be reported through the attribute 'Information of the hydrogen production plant', as exhibited in **Table 2.**

Table 2. Proposed Attributes for H2 Certification for EU Markets

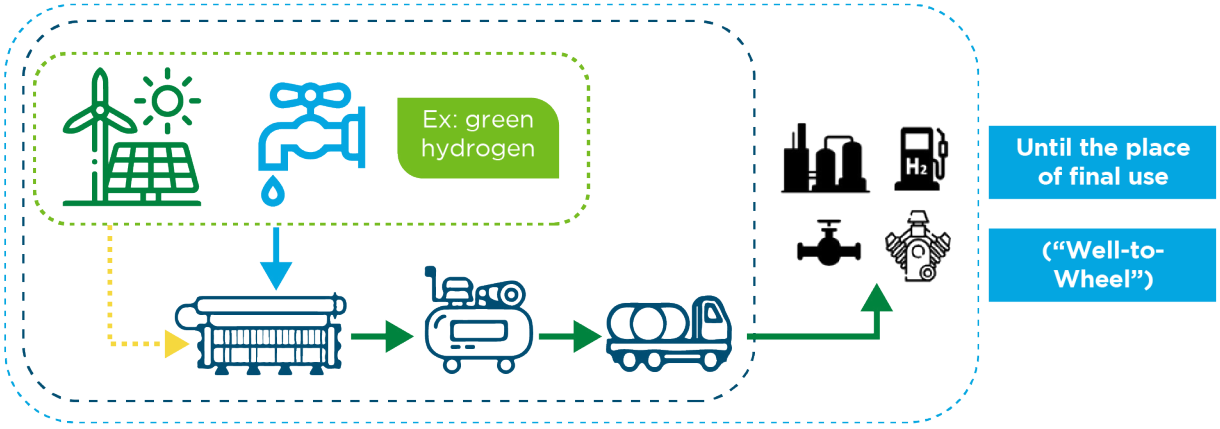
Atributtes	Justification	Certification category
Primary energy source and energy production plant information H_2 production plant information Intensity and scope of GHG measurement	Present in all certification systems worldwide	H_2 Certification for EU markets
H_2 production time versus energy*	Compliance with the requirements of the European RED II regulation must be verified through: • Additionality • Geographical Correlation • Temporal Correlation	

(*) Measurable geographic correlation and additionality criteria through the attribute "H2 production plant information".

Source: Prepared by the Author (2023)

Furthermore, adhering to the stipulations of the European RED II regulation, the quantification of GHG emissions for this certification category must extend up to the point of final use (or “Well-to-Wheel”).

Figure 6. Proposed Scope of Emissions Accounting for the “H2 Certification for EU Markets” Category



Source: Prepared by the Author (2023)

Given the intricacies associated with certain attributes, particularly those required to satisfy the RED II regulations published in July 2023 (specifically, additionality and the geographical correlation criterion), a decision was made to create a distinct certification category for LAC and other regions. This category is designed to provide a system for H2 and derivative producers in LAC countries that addresses the specific needs of the region, as previously explained. In this setup, if a producer intends to sell their H2 or derivative products to European markets, certification must be obtained using a system validated by the Certifying products exportable to Europe with a European system accepted by the EC.

As of July 2023, two certification systems are currently undergoing validation by the EC: CertifHy RFNBO compliant system[9] (A) and ISCC EU (B). Along this line, a producer with the ambition to market their products in Europe and command premium prices must exhibit regulatory compliance with the REDII criteria. This involves the use of certificates under system (A),or (B), or any other future accepted system.

Once CertHILAC is defined and reaches a state of consolidation, it would be possible to seek acceptance by the European Commission, albeit facing a complex process. An additional section is included below to outline the steps involved in pursuing this accreditation. Considering the above, it is advisable to initially opt for the first category and, upon the successful consolidation and operation of the regional system, progress towards the second category.

In parallel, the system should also implement a methodology to recognize or validate other systems that may operate in the region.

Additional Section: Recognition of a Certification System with the EU

To secure recognition of the regional system (specifically the category "Certification of H2 Exportable to Europe") by the European Commission, reliability, transparency, and auditing standards mandated by the Renewable Energy Directive (RED) must be met, specifically as identified in Directive 2018/2001. This entails demonstrating and verifying that the system aligns with sustainability criteria (e.g., origin of electricity source) and attains the required greenhouse gas savings for H2 and its derivatives compared to "conventional" products (European Commission, 2020).

The following explains the procedure for obtaining recognition of a certification scheme with the European Commission. The EC has published two evaluation protocols for voluntary schemes under RED. The first protocol is a general protocol detailing the certification schemes for bioliquids and biomass fuels. The second protocol is an additional guideline for schemes also focused on RFNBOs (Renewable Fuels Non-Biological Origin) and RFCs. According to publicly available information from the European Commission, the recognition of certification systems for bio-liquids and biomass fuels, as well as of RFNBO hydrogen and its derivatives and recycled carbon fuels (RFCs) by the European Union requires compliance with the following conditions:

[9] **As of the preparation date of this report, the proposal for the so-called CertifHy RFNBO compliance voluntary scheme, as well as ISCC EU, are still under review by the European Council with an estimated launch date until the end of 2023.**

- Raw material producers must meet the sustainability criteria of the revised Renewable Energy Directive and its implementing legislation.
- Information regarding sustainability characteristics must be traceable back to the origin of the raw material.
- Thorough documentation of all pertinent information is required.
- Companies undergo audits before participating in the scheme, and periodic retrospective audits must be conducted.
- Auditors must possess the necessary generic and specific auditing competencies in relation to the system's criteria.

The recognition process begins when the European Commission extends an invitation to all voluntary schemes to apply for acknowledgement. To do so, a comprehensive set of documents detailing how the certification will demonstrate compliance with sustainability and greenhouse gas savings criteria, along with the provision of necessary guarantees, must be submitted. Once all applications are received, the Commission assesses scheme compliance with appropriate reliability, transparency, and auditing standards, according to a protocol attached to the corresponding application. The decision to recognize a voluntary scheme typically carries a legal validity period of 5 years (European Commission, 2020).

The steps to follow to achieve this verification should be the following:

- Scheme Representatives are required to submit their application to the European Commission via email.
- Applications undergo review by an assessor, hired by DG ENER,[10] who assesses them based on the two protocols published in the EU website, adhering to the eligibility criteria for RFNBOs as dictated by RED II.
- In the event of a positive evaluation, a final recognition protocol is signed between the scheme and DG ENER.
- Following the signing of the recognition agreement, the scheme attains official status as a voluntary scheme or system of the EU.

[10] **DG ENER: European Commission Directorate-General for energy.**

For RFNBO, the Commission has introduced two "Delegated Acts." The first defines the conditions under which hydrogen, hydrogen-based fuels, or other energy carriers can be considered renewable fuels of non-biological origin. On the other hand, the second establishes the methodology for calculating the reduction of GHG emissions from RFNBOs and carbon-recycled fuels. Therefore, any certification scheme must demonstrate verifiable adherence to these requirements or standards for it to be recognized as an authorized voluntary scheme in the European Union (Commission, 2018).

3.4. Proposal for the Chain of Custody System

The Chain of Custody system is integral to safeguarding the traceability of certified hydrogen across the value chain, encompassing the procedures necessary to achieve control and documentation of the product, thus guaranteeing its origin (clean and/or low carbon).

In the implementation of a Chain of Custody system for managing the certification system, **it is recommended to commence with the adoption of a Mass Balance system.** This system allows for the blending of certified and non-certified products, as long as tracking and monitoring of certified product volumes are maintained throughout the supply chain until reaching end consumers. At the same time, this approach prepares for and aligns with the requirements for export to the European Union, eliminating the necessity for a separate certificate trading platform separated from the product that would be necessary for a Book and Claim system, while minimizing logistical and administrative efforts.

However, it should be noted that this management system demands substantial time and financial investments to ensure the traceability of products throughout the extensive value chain, mitigating the risk of potential fraud—a task that can be particularly challenging in large regions as LAC. Furthermore, due to the inherent complexity of implementation, this model may present entry and operational barriers for producers. In a voluntary market, producers might opt for alternative markets or simpler certification systems.

The recommendation to start with a Mass Balance system finds support in its widespread adoption internationally, not only for H2 Certification but also for other products such as biomass. Nonetheless, other systems have also implemented Book and Claim systems, such as CertifHy, which uses a platform called GREXEL for certificate transactions. In the case of CertifHy, achievement in this realm required substantial effort and coordination among European Union member countries—an indispensable factor in establishing such a management system and its associated certificate registration and trading platform.

It is essential to underscore the dynamic nature of the H2 market, where decisions concerning aspects like the management system can undergo changes. **Therefore, it is advisable to continually monitor market developments. In alignment with global decisions regarding management systems, a strategic selection can be made regarding whether to transition towards a Book and Claim system in the long term, based on what proves most advantageous for the LAC Region.**

The adoption of a Book and Claim system, if chosen, would not only ease the marketing of clean and low-carbon hydrogen over longer distances (not limited to geographic proximity of production and consumption) but also facilitate the traceability process.

3.5. Governance Framework Definition

The specific governance structure for the regional certification system should consist of a group of key stakeholders selected by the System Representative. These stakeholders will assume diverse yet relevant roles, as comprehensively analyzed in the subsequent section.

In an ideal scenario, an approach would involve a single certificate issuer, a database, and a system operator at the regional level. This would eliminate the need for disparate entities at the national level, promoting enhanced credibility and security. However, achieving complete regional coordination among diverse countries, each with its established structures and representatives, may pose challenges.

Within this context, **the governance framework can manifest in various configurations, determined by the combination of two critical characteristics. These characteristics and their combinations yield different possibilities:**

(1) The role of the issuer (the entity issuing certificates):

A) A single issuing entity operating regionally. or

B) Local issuing entities in each country, accompanied by a certain collaboration mechanism and regional information exchange, akin to the functioning of the AIB (Association of Issuing Bodies[11]) in Europe.

[11] **The Association of Nationally Appointed Issuing Bodies comprises 27 issuing bodies, 27 national registries, and a trading hub managed by AIB to enable certificate transfers between countries participating in the certification system from one database to another.**

(2) The scope of the Certificate Database (CDB):

A) A unified database for regional record, or

B) Each country maintaining its own database, with a mechanism for regional centralization to ensure coherence and transparency.

Implementing these characteristics in various ways presents a spectrum of advantages and disadvantages, detailed in the following table (**Table 3**).

Table 3. Advantages and Disadvantages of Choosing Regional or National Certificate Issuers and Record Databases.

	Options	Advantages	Disadvantages
Issuer or Issuing body	One for the whole region	A centralized control of the emission and registry of certificates streamlines administrative and management requirements.	Difficulty in countries reaching consensus on a single issuer entity, due to the presence of different local issuers in each country.
		Eliminates the need for harmonization among national entities.	High coordination efforts required by the regional issuer entity with the different players in each country.
	One or several for each country	Utilizing a local issuer leverages existing capacities and fosters local market development at the country level.	The chosen issuer must adapt to the specificities of each country. Requires the formation of an association of issuing entities or a similar arrangement to ensure certificate compatibility, incurring transaction costs.

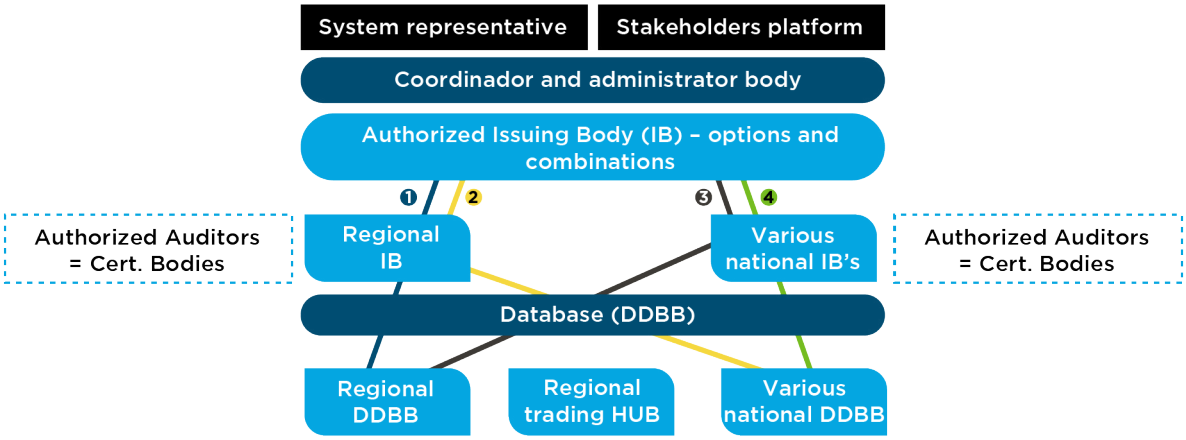
	Options	Advantages	Disadvantages
Registry Database	One for the whole region	Simplifies user control for errors and misbehavior. Uniform data format across countries. Mitigates the risk of double counting in registries.	Countries may be reluctant to share certain sensitive national information (e.g., project details). Can hinder the use of data for national purposes, such as emissions reduction registry.
	One for each country	Enhances tracking of hydrogen projects to meet national objectives, such as emissions accounting and mitigation.	Requires substantial efforts from each country to maintain and contribute to both national and regional databases. Demands extensive coordination for harmonization, with the possibility of uneven progress among countries.

Source: Prepared by the Author (2023).

The options refer to the different combinations of characteristics as presented in the figure below. These are:

1. A regional issuing body and a regional record database
2. A regional issuing entity and national-level record databases
3. Different issuing entities per country and a regional record database
4. Different issuing entities and national-level record databases

Figure 7. Diagram of Possible Configurations of National or Regional Issuing Body and Record Database.



Source: Prepared by the Author (2023).

While theoretically, all combinations are possible, attention is drawn to **combination number 2, marked in orange, involving a regional issuing body and national databases. This configuration raises concerns related to operability, the likelihood of achieving consensus, and the validation of a sole issuer at the regional level by participating countries (as represented through the System Representative).**

Given the considerations, the recommended configuration is number 3 (depicted in grey). This entails having national-level issuing bodies, ideally with established presence and related experience, along with a regional record database.

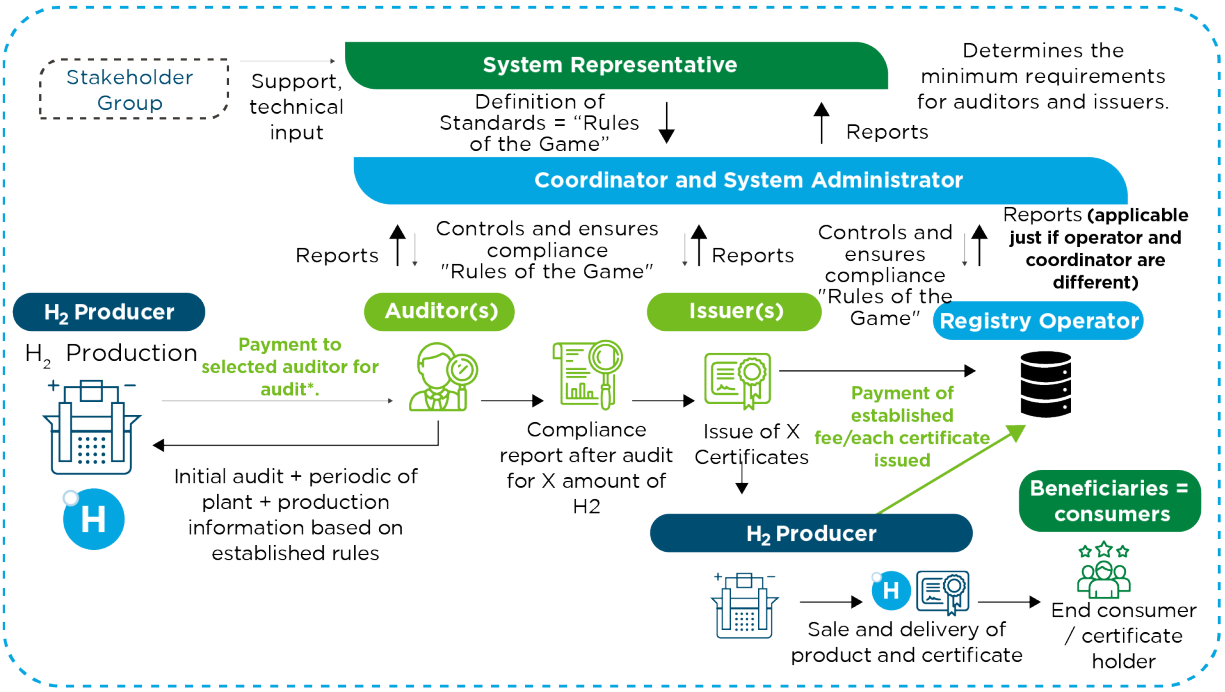
Concerning national issuers, countries such as Argentina, Brazil, Chile, Colombia, and Uruguay already boast local issuers of renewable energy certificates. These established entities, upon certification, can seamlessly transition into fulfilling the role of issuers for hydrogen and derivatives. This aspect has been affirmed through prior discussions with representatives from the public sector in these countries. This setup offers a dual advantage, allowing participating countries to internally access pertinent information from their national issuers. This information proves valuable for purposes like quantifying hydrogen production and gauging greenhouse gas emission reductions within the context of their respective national strategies and policies.

In contrast, a recommended approach is to adopt a unified, centralized regional record database, considering the broad regional scope of the proposed certification system. This central repository would aggregate data from different national issuing bodies, all adhering to standardized rules. This ensures that national databases remain consistent and can be integrated, avoiding discrepancies.

The management of this regional record database could be entrusted to the same coordinator/administrator overseeing the system. This consolidation aligns with the overarching goal of streamlining governance and minimizing complexities arising from diverse players and role differentiations. Embracing a methodology of simplification and unification of roles logically, this approach not only enhances coordination and monitoring but also has the potential to reduce implementation costs and the managerial burden associated with maintaining multiple national-level databases.

To elucidate the governance structure of the proposed certification system, a simplified diagram is presented. This illustration delineates the interactions among the various players involved and outlines the producer's journey in securing the final certificate for their products.

Figure 8. Certification Process Cycle and Interactions of Governance Players for Each Step.



*** Costs defined per Auditor, which usually vary according to capacity and type of production plant; more auditors validated = higher price/rate competitiveness.**

Source: Prepared by the Author (2023).

Table 4 depicts the different roles required for the operation of the certification system, charting the corresponding requirements and presenting a specific proposal on potential entities to assume these roles within a regional LAC certification system. In order to simplify and minimize coordination efforts at the outset, individuals or entities capable of fulfilling multiple roles are identified to reduce the number of involved players and expedite the initial identification process for these pivotal roles.

Table 4. Role Description, Requirements, and Player Proposal for Governance
Source: Prepared by the Author (2023

Position	Role	Requirements	Proposal
System Representative	It is in charge of defining the system's rules; ensuring proper functioning of system components; selecting involved stakeholders; proposing, voting on, and validating system modifications; and defining requirements for the Coordinator and the Administrator.	It should be individuals: • from a technical entity from the public or public-private sector, • with positions of low turnover and minimal political fluctuations, and • with knowledge of the country's hydrogen ecosystem (minimum) and the region (highly advantageous).	The signatory countries should designate 2 representatives from: • Energy ministries and secretariats • National development agencies and/or • Electricity market operators (due to their importance in certifying renewable attributes).
Coordinator and System Administrator	This role comprises the execution and management of the system, taking charge of transparent processes and clear rules, as well as providing operational support to various stakeholders, offering assistance and guidance to different issuers, certification bodies and auditors.	In general, this role requires a understanding of the market and technologies that it certifies. Additionally, it requires capabilities and expertise in management and coordination to carry out this task.	The same System Representative could manage the system with 3-4 designated individuals, but given the time constraints and varying availability of government representatives, (even those with technical expertise, not purely political), contracting or designing an external entity might be a more efficient approach to fulfill this role, which would bring the experience and capabilities required to perform this function. Additionally, the composition of the System Representative, comprising representatives from different countries, introduces a

Position	Role	Requirements	Proposal
	• Examples: Avance (I-REC H2); Evident (I-REC electricity); Smart Energy Council (Zero Carbon Certification System).		challenge in identifying primary responsible parties. With the aim of reducing the number of players involved and opting for governance simplicity, it is proposed that the coordinating entity of the system could assume the role of system administration, once established. This would facilitate coordination since the entity would be familiar with the certification system; it could also have initial ownership of the system, in case the decision is made to transfer ownership to a private entity to facilitate system operation.
Registry operator	Organization that maintains records and technical infrastructure of certificates. It is fundamental to prevent double counting.	It must operate under the close supervision of the system administrator or be a contractor of the system administrator, in case of any modifications it requires. The operator is an experienced major IT company that runs the registry database with high levels of security.	A single integrated regional certificate registry is proposed for all participating countries. For the role of operator of this registry, an entity experienced in performing such a task is recommended, for example: Evident (operator of the I-REC and I-REC H2 systems). At the same time, this role can be assumed by the system administrator, who may have previously served as the coordinating entity. This may be possible depending on the capabilities and expertise of the coordinating entity/administrator.

Position	Role	Requirements	Proposal
			OLADE, as the coordinating entity, could also serve as administrator. To operate the certificate platform, it should involve an IT company as a contractor for this role.
Certificate Issuer	This role is operational, adhering to the rules set by the System Representative. It works closely with hydrogen facilities/plants seeking to certify their production, providing guidance throughout the process until certificates are issued. They may also be responsible for training certification bodies and auditors according to established rules. • Examples: Santiago Climate Exchange (official issuer for I-REC[12] in Chile); The Green Certificate Company (official issuer for I-REC in countries lacking a local issuer); Hydrogen Australia (within the Zero Carbon Certification System).	An organization that follows the system's rules and ensures their implementation while also respecting each country's regulations. The Issuer must comply with the requirements imposed by the System Representative during the system's development and be authorized by it to fulfill this role.	The issuer can be international if a country decides this. However, having a regional entity facilitates the function due to its proximity to the facilities and its understanding of the countries. The proposal is for the issuer to be national for cost-effectiveness and local market development, as well as to ensure regulatory compliance. This depends on the capacities of each country and it will be decided in the national governance established by each signatory country. The Green Certificate Company (the issuer of I-REC in countries without a designated and trained issuing body) could fulfill the role of the Issuing Body in countries without a designated issuing body capable of performing the required role. The proposal to have national issuers is also based on the experience of I-REC in Latin America, which shows that this system has mainly been organized with national

[12] **In the case of I-REC in renewable electricity certification, the issuer also performs the role of auditor. According to I-REC sources, this is feasible for renewable energy certification due to transparent information checks of public data from electricity market operators.**

Position	Role	Requirements	Proposal
			institutions as issuers. In fact, the local issuers of I-REC that could potentially cooperate with hydrogen certification include: - Instituto Argentino de Normalización y Certificación (IRAM) in Argentina; - Totum Institute in Brazil; the Santiago Climate Exchange (SCX) in Chile; and - ECSIM Foundation in Colombia.
Auditors	They are in charge of visiting the plants and evaluating whether they meet the criteria and attributes established by the system. They must follow the system's rules.	Each country determines the way in which its auditors will be appointed based on minimum requirements determined by the system. It is advisable to standardize audit requirements and procedures among authorized auditors. This is important to obtain mutual recognition at the regional level.	It is recommended to designate several auditors who are accredited and therefore authorized to exercise this role, also called certification body. The appointment of auditors can be progressive, that is, start with 1-2 auditors and as the market grows, it is proposed to add more auditors, which will provide dynamism and introduce competition to the market. Although in theory the role of the auditor could also be exercised by the same issuers, it is better to have two different entities to avoid fraud and provide greater credibility to the system.

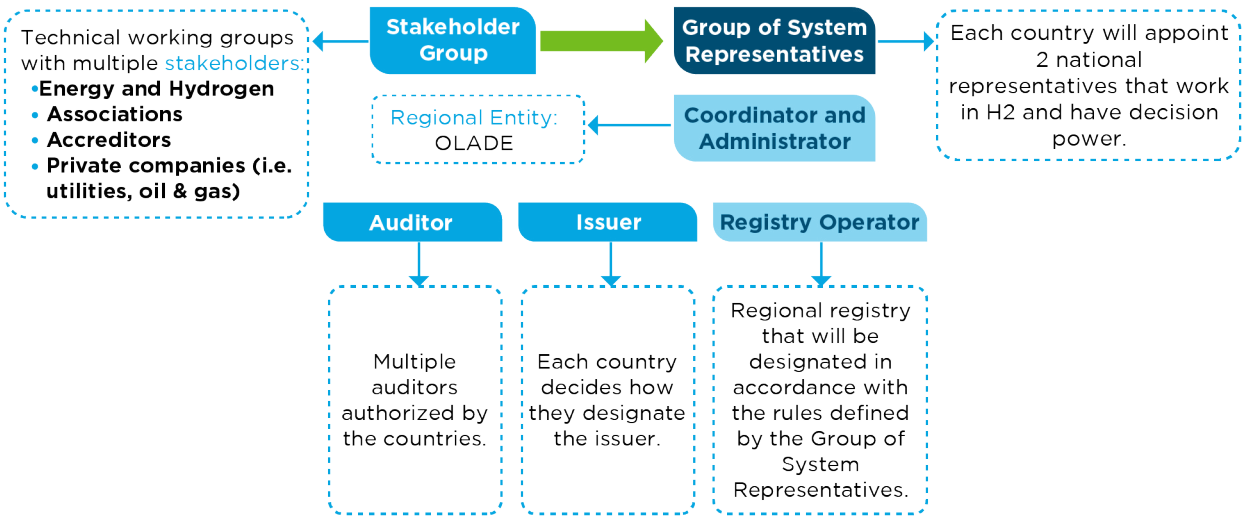
[13] **In an interview conducted within the context of this study, I-REC suggests that having local institutions offers advantages in terms of market dynamics within national contexts and lower costs.**

Position	Role	Requirements	Proposal
Trade Platform Operator	This is a "Marketplace" system to consolidate the supply and demand of certificates, applicable in the certificate trading phase.	An international organization is recommended for this role. It is not an essential function for the system, especially in its early stages during the framework definition phase.	This role is required for a more advanced phase when certificate trading is in effect, e.g., within a book and claim system.
Regulatory Body	Not required role, given the voluntary nature of the system.[14]	Not applicable, since it is a voluntary system.	Not applicable, since it is a voluntary system. Public entities are considered in the System Representative.
Labeling Partner	An organization with independent criteria assigning labels to facilities or other certifications. For example, I-REC ensures attribute traceability but does not provide labels. • Example: Green-e, (I-REC).	The proposal does not consider labels. Therefore, it does not apply.	The proposal does not consider labels. Therefore, this role does not apply.

[14] **However, as mentioned earlier, the participation of governments is considered desirable and important to support and expedite the local implementation of the system and enhance credibility. Furthermore, the certification system can contribute to the tracking and monitoring of emissions reduction commitments (e.g., in accordance with a country's respective NDC), which is why the involvement of public sector is proposed through the composition of the System Representative, as outlined in previous sections.**

Subsequent to this overview, a more tangible proposal delineates potential players for each of the roles required and previously described in the certification system:

Figure 9. Roles and Players Comprising the Governance of Each Step



Source: Prepared by the Author (2023)

In line with the recommendations provided in this study, emphasizing the adoption or alignment with existing systems can streamline the implementation of a certification system in the LAC region, leveraging the wealth of existing international knowledge and experience. Specifically, for the "H2 Certification for LAC Region" category, it is advised to orient and reference more mature systems, such as the Zero Carbon Certification System, which also incorporates social and environmental attributes within its certificates.

Conversely, for the "H2 Certification for EU markets" category, in case the LAC system aspires to receive validation from the European Commission, a potential strategy involves partnering, supporting, or collaborating with systems making significant strides in the EU, such as RED-Cert EU or ISCC EU. These systems are presently undergoing official validation by the European Commission as a recognized certification system, demonstrating adherence with the RED II regulations, notably the criteria for RFNBOs. In this context, international players deeply involved in one of these systems could potentially fulfill the roles of "Administrator" or "Registry Operator."

A noteworthy case deserving special attention is Brazil, where CCEE (Electricity Trading Chamber) has emerged as a driving force in promoting the implementation of a hydrogen certification system. This system encompasses two distinct certifiable product categories: 1) 100% renewable hydrogen generated from wind, solar, or hydropower; and 2) partially renewable hydrogen, complemented with another thermo-electric source, yet to define a specific emissions threshold. Therefore, it is recommended that CCEE assume a key role within a regional certification system becoming an integral part of the Stakeholder Group. Leveraging its expertise, CCEE could also operate as a national issuing body, capitalizes on its existing experience, work and networking in the field.

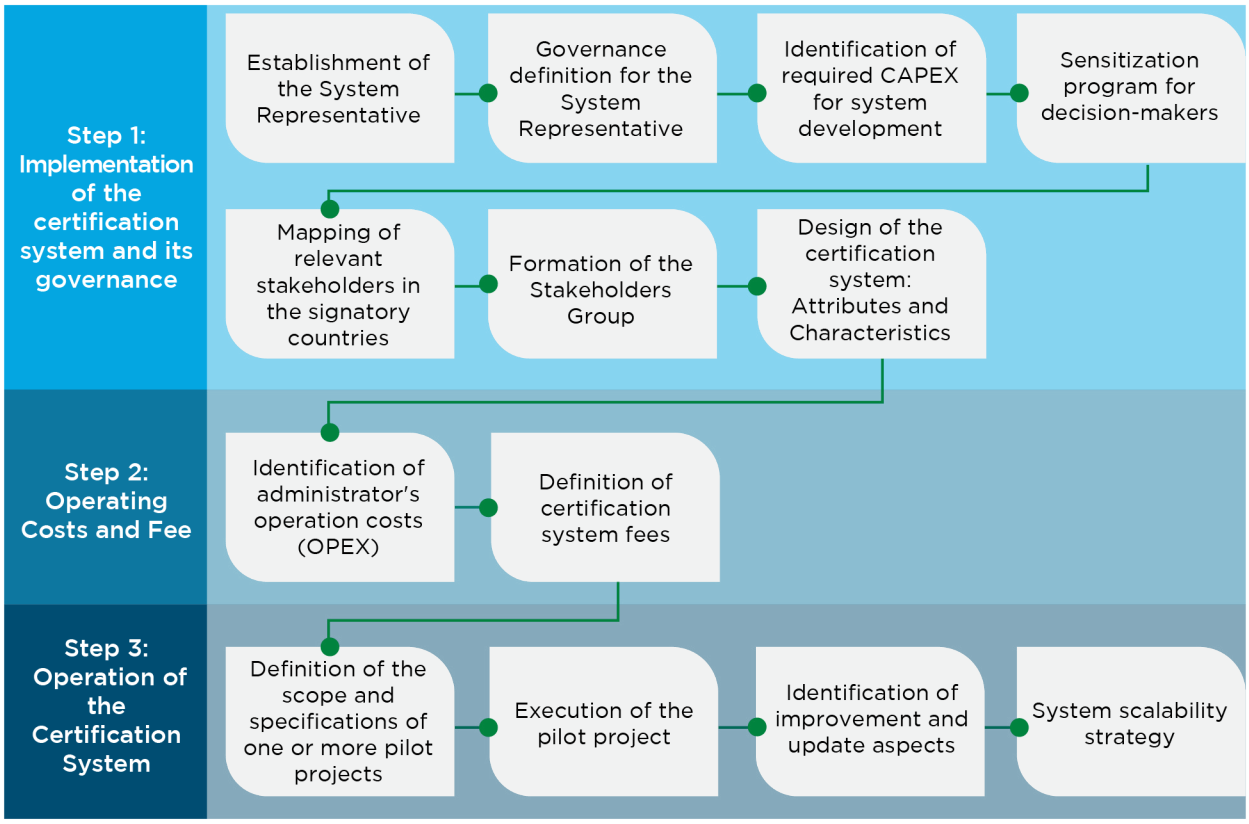
4. Action Plan for the Implementation of the Harmonized H2 Certification System for LAC - CertHILAC

Moving forward, the action plan for implementing the CertHILAC is detailed in the subsequent section. Designed as a tool to facilitate future national and regional trade of H2 and its derivatives, this action plan aims to synchronize the efforts of participating countries and institutions. The goal is to minimize coordination and execution complexities, ensuring a well-designed and efficiently implemented system. The plan is crafted to accommodate the specific requirements and unique characteristics of the region, embracing a harmonized approach to regional certification. As the system's governance takes shape, this proposal remains adaptable, subject to potential adjustments by the appointed System Representative in the future.

In devising the proposed implementation steps, inspiration was drawn from processes successfully employed in other global certification systems yet remaining steadfast in the commitment to a regional approach, acknowledging the unique characteristics of each participating country. This tailored approach also takes into account the existing structures and governance models that prove relevant to the design considerations. Specifically, the terms of reference used by the European Union for tender process for the CertifHy Guarantee of Origin Scheme were taken into consideration as a key input.

The steps proposed in this Action Plan are crafted to guide the design and implementation of CertHILAC, and are summarized in the following figure:

Figure 10. Diagram of the Proposed Action Plan for the Implementation of the Harmonized CleanH2 Certification System in the LAC Region (2023)



Interaction governance: refers to the governance of the system design process, encompassing stakeholder collaboration methods, voting procedures, and other activities (further detail will be provided in the following section).

Source: Prepared by the Author (2023)

4.1. STEP 1: Implementation of the Certification System and its Governance

Given the endorsement of the CertHILAC Declaration by at least 14 countries, the forthcoming action plan is aimed at the design and implementation of CertHILAC. Central to this plan is the collaborative effort of key stakeholders, uniting to shape the final design of the certification system and define its governance. The execution of this plan is entrusted to OLADE, the coordinating body designated by the countries in the CertHILAC Declaration.

The following activities are identified and recommended:

4.1.1. Establishment of the System Representative

The System Representative is the entity tasked with delineating the rules and requirements governing the certification system, as well as the operation rules of the system. Its responsibilities span the provision of transparent operational information, the enforcement of established standards, and the oversight of all components within the certification system, guaranteeing their functionality.

Similarly, the System Representative holds the authority as the ultimate final decision-maker and executor of any system changes. Its scope extends to selecting and approving the stakeholders that will conduct the specific certification processes, including the interaction with the coordinating body for system implementation. In addition, the System Representative maintains continuous engagement with stakeholders to ensure that certified products align with the interests of producers and consumers.

The formation of the System Representative[15] involves a collective effort from the signatory countries of the CertiHILAC Declaration, with each country appointing two representatives. Ideally, the representatives should hold stable leadership positions, ensuring independence from changes in government. Furthermore, it is imperative to include representatives actively engaged in and knowledgeable about the hydrogen ecosystem in their respective countries.

[15] **Most of the certification systems reviewed for the preparation of this Guide use the concept of Scheme Owner to designate the representatives of this role, which, as mentioned above, do not consider the participation of the public sector. Given that the proposal in this Guide is to include representatives from the public sector, the name System Representative was proposed instead, in order to avoid problems with respect to the system's governance associated with public or public-private representatives. Therefore, the System Representative has no implicit relationship with the legal ownership of the certification system or any of its parts, but rather is a voluntary representative of the system for each country involved.**

Table 5 offers a glimpse into potential institutions involved in shaping the System Representative for each country, along with the requirements they should meet.

Table 5. Potential Institutions for the Establishment of the System Representative for the Regional Certification System

Position	Role	Requirements	Proposal
System Representative	• Define system's rules • Ensure proper functioning of system components • Select and approve involved stakeholders • Propose, vote on, and validate system modifications • Define requirements for the Coordinating Entity and the Administrator • Specify players that should comprise the Stakeholder Group	• Individuals from a technical entity from the public or public-private sector • Individuals with positions of low turnover and minimal political fluctuations • Knowledge of the country's hydrogen ecosystem (minimum) and the region (highly advantageous)	• Energy ministries and secretariats • National development agencies and/or • Electricity market operators (due to their importance in certifying renewable attributes)

Source: Prepared by the Author (2023)

4.1.2. Governance Definition for the System Representative

Once the System Representative is established, the next crucial step is for its members to collectively define their mode of interaction and associated protocols. In particular, the following questions should be addressed:

A) How will collaboration among the players take place? (type, format, and frequency of meetings)

B) What will the composition of the Stakeholder Group be as an Advisory Body? (stakeholders' profiles, for example, inclusion of Non-Governmental Organizations active in the relevant field)

C) What Technical Working Groups should be present within the Stakeholder Group? (profiles, objectives, members, etc.)

D) What will the voting procedure be? (e.g., on system design modifications)

E) What will the voting requirements and protocols be? (e.g., who has how many votes?)

F) What will the methodology and tools be to ensure the involvement of relevant external players? (e.g., through surveys)

G) Financial aspects: How will the different steps of the system implementation process be financed? What will the cost be ("pricing") of this process?

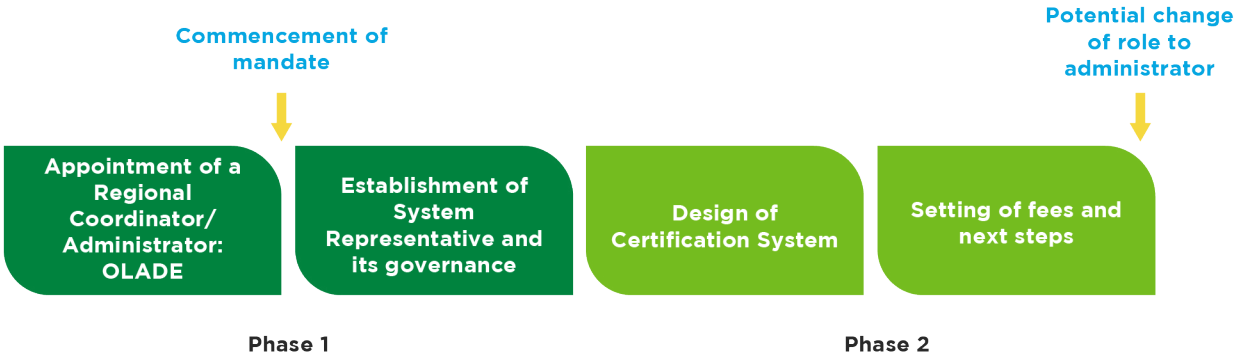
Signatory countries will bear the responsibility of defining their governance structure at a national level.

The governance should also consider the interaction with the OLADE, the coordinating agent designated by the countries in the CertHILAC Declaration to execute this action plan. Given that the representation of the System Representative will be public and country-specific, **the coordinating body must also unify intentions and visions, ensuring that decisions prioritize the collective good over individual country interests.**

For effective monitoring and progress verification, it is advisable that the coordinating agent adheres to a protocol. This protocol should identify a clear methodology, articulating mechanisms and deadlines for progress monitoring. In this context, it is advisable to agree on a schedule of progress, overseen through periodic meetings.

To streamline the execution methodology, it is recommended to bifurcate the responsibilities of the coordinating entity and administrator into two consecutive phases.

Figure 11. System of the Implementation Process to Be Performed by the Coordinating Agency



Call: Implementation of the Harmonized H2Ren Certification System for the LAC Region

Source: Prepared by the Author (2023)

In navigating this intricate process, the coordinating agent assumes the responsibility of risk management, employing an early identification procedure, coupled with a risk mitigation strategy. The proposed methodology is based on the successful regional tender conducted by the European Commission for the implementation of CertifHy, establishing it as a reference case for emulation.

4.1.3. Identification of the Required CAPEX for the Development of the System

Early in the implementation stage of the certification system, it is paramount to gauge the investment costs (CAPEX) essential for its development. Also, estimating the available budget from external (multilateral) financing becomes crucial for initiating the system's setup. It is worth mentioning that the CAPEX requirement is intricately linked to the number of participating countries, since the coordination effort is positively correlated with the number of actors involved.

Although the actual CAPEX will require an independent analysis for CertHILAC, examples of investment costs associated with existing certification systems at the international level are presented below as a reference of the potential cost of developing an LAC system.

Investment Costs (CAPEX) for the Development of Certification System

In considering the estimated CAPEX for the development of certification systems, the cases of CertifHy and the Australian Zero Carbon Certification System provide valuable reference points:

CertifHy. As the inaugural operative hydrogen certification system globally, its development cost ranged between 1.5 and 2 million USD including the design and setup of the requisite software. However, it should be noted that this process had a gradual learning curve due to its pioneering status within hydrogen certification systems.

Zero Carbon Certification System in Australia. Orchestrated by Hydrogen Australia, the development cost was approximately 300,000 to 500,000 USD (500,000 - 1,000,000 Australian dollars).

It is crucial to recognize that the maturity of the hydrogen certification market and the limited number of systems developed to date contribute to significant variability in CAPEX, **depending on the complexity of the system and the number of stakeholders involved. This has an impact on the intensity of coordination and, consequently, the overall system cost.** Considering the nascent stage of hydrogen certification systems, the CAPEX for developing a system in the LAC Region is expected to be relatively lower, capitalizing on lessons learned and insights gained from previous efforts.

Furthermore, it should be noted that when engaging regional players, service costs, such as software development, tend to be more economical compared to rates in the in the European Union, Australia, or other global locations. This presents an opportunity for cost savings in the project.

Funding for the Development of a Certification System

Once the required budget has been defined for the setup and the initial phase, the next step is to identify the funding source. Two potential alternatives have been identified to cover the investment required for the development of regional certification system for clean and/or low carbon hydrogen and its derivatives.

Alternative 1: The first approach involves seeking funding through collaboration among all the countries participating in the development of the system. This collaborative effort entails countries jointly allocating funds to cover the expenses associated with setting up the regional system.

However, this option could potentially present difficulties, considering budget allocations for such purposes are typically limited. Furthermore, it could lead to inequality, as countries with varying GDPs may be requested to contribute similar amounts.

Alternative 2: The second approach suggests opting for comprehensive or partial funding, potentially co-financed alongside the countries, from a supranational entity, such as the IDB.[16] It is advised that the funding from the supranational entity be directed to the chosen regional coordinating body responsible for implementing the system. The selected regional coordinating entity would then assume the responsibility of managing the funding and covering the expenses of system development. This involves meeting predetermined milestones and providing progress updates to secure the full funding.

The second alternative mirrors the funding methodology employed by the European Commission for the development of the CertifHy scheme. The CertifHy scheme received funding through the Fuel Cells and Hydrogen Joint Undertaking, now known as the Clean Hydrogen Partnership, under the Seventh Framework Programme of the European Community for research and technological development including demonstration activities (FP7).

[16] **It is important to note that any funding provided by countries should undergo thorough review to ensure that they do not assume the form of subsidies to private entities, a scenario that may not be acceptable to public entities.**

4.1.4. Initial Trainings: Sensibilization Program for Decision Makers

Once the CAPEX has been determined and funding has been secured, or in parallel, the initiation of an extensive training program tailored for signatory countries should begin. The objective is to harmonize their knowledge on the certification of hydrogen and its derivatives, fostering a shared foundation of understanding, as well as leveling the information and knowledge[17] landscape.

The Coordinator should schedule a series of training sessions targeting representatives designated by each participating country. These sessions can be organized into multiple modules, covering diverse and relevant topics, such as the basic definitions of a certification system (elements and possible configurations), justification and added value, the current global landscape of certification system development, the characteristics of the region in terms of clean and/or low carbon hydrogen production, among other subjects of interest.

The expected outcome of the training program is to achieve a shared understanding among the countries and thus facilitate their interaction in the governance.

4.1.5.Mapping of Relevant Stakeholders

Identifying the key stakeholders from public, private, academia and civil society sectors to comprise the Stakeholders Group involves a process both at the signatory countries and regional levels. The main categories of relevant stakeholders that should be identified for signatory countries are listed below:

- **Public or private entities engaged in renewable energy and/or hydrogen certification activities in the LAC Region:** hydrogen certification efforts should capitalize on the progress made by existing public or private entities involved in renewable energy and hydrogen certification in the LAC Region. Leveraging lessons learned from these initiatives is vital for the thoughtful design of a regional system. It would be relevant to include entities with experience in analogous roles at the national level.

- **Regulatory Agencies in the Energy Sector:** Entities such as Ministries of Energy and Environment, as well as other regulatory bodies or Energy/Electricity Commissions, are indispensable stakeholders. Given hydrogen's potential role in the decarbonization of energy and transport sectors across different countries, their involvement is key. Simultaneously, these stakeholders regulate energy input production integral to hydrogen production processes and oversee aspects related to hydrogen itself, such as product quality specifications. Therefore, the inclusion of these actors from participating countries in the regional system is crucial during the validation process to ensure alignment with national standards, norms, or regulations.

[17] Cost to be considered in the CAPEX

- **Electricity Market Operators:** Due to their significant role in certifying renewable energy in some countries, such as Brazil and Uruguay, and the importance of electricity supply for hydrogen production, Electricity Market Operators are integral stakeholders. They possess a wealth of information related to consumption patterns, the national electricity grid, and potentially, insights into electricity certification systems. This data becomes a valuable input for effectively managing and mitigating the risk of double counting in H2 certification systems.

- **Renewable Energy Associations (especially those already involved or expressing interest in hydrogen and certification matters):** as renewable energy generation forms the foundation for clean and/or low-carbon hydrogen production.

- **National Hydrogen Associations:** These entities play a pivotal role in coordinating private sector efforts, bridging connections with the public sector, and establishing collaborative networks with associations from other countries. Additionally, the existence of a regional initiative of hydrogen associations, the LAC Green Hydrogen Action, underlines the importance of these associations in aligning and mobilizing various stakeholders. This alliance, involving hydrogen associations from Chile, Mexico, Peru, Colombia, and Costa Rica, along with the collaboration of the Brazilian Hydrogen Association and GIZ, aims to drive the development of the green hydrogen market in the region through concrete goals and actions.

  Among the reported goals of this Alliance are to *"Accelerate the adoption of an internationally recognized green hydrogen certification system to ensure compliance with ambitious climate commitments, differentiating it from other types of hydrogen;"* and *"disseminating the minimum attributes and the importance of having a certified green hydrogen through a communication campaign."*[18] Thus, the inclusion of LAC Green Hydrogen Action is recommended, once the System Representative is formed, to support the dissemination of the CertHiLAC initiative and be part of the proposed stakeholders group.

- **Certifiers and Issuers of Renewable Energy Certificates:** Acknowledging that renewable energy certification is a prerequisite for clean hydrogen certification.

- **National Development Agencies:** These organizations can offer funding for the adoption of certification systems and capacity development. Given their public-private nature, they are well-positioned contenders for the role of System Representative, representing their respective countries.

- **Regional Hydrogen Collaborative Platforms (in particular H2LAC):** H2LAC, as a regional collaborative platform to boost the hydrogen economy in the LAC Region, can be a valuable and high-impact ally for the consolidation of a regional certification system, mainly by connecting actors and disseminating information.

[18] **Information provided by LAC Green Action (2023).**

- **National Accreditation Bodies:** They assume a fundamental role in facilitating the adoption of the certification system in various countries. They oversee the accrediting actors with relevance for a certification system, such as certification bodies and auditors.

This stakeholder mapping serves as a tool for identifying potential contributors to the governance of the system and Stakeholders Group. It should be regularly updated by the participating countries.

4.1.6. Formation of the Stakeholder Group and Its Technical Committees

The next step in the journey toward the implementation of the regional certification system involves the establishment of a Stakeholder Group. This group represents a diverse assembly of key players within the hydrogen ecosystem of the region, spanning both public and private sector interests.

Encompassing entities such as private hydrogen producers and potential consumers, as well as public authorities from participating countries, the primary function of this group is to liaise with the System Representative, ensuring that the certification system contributes to both the commercial development of the sector and the policy objectives of the countries.

These players are expected to: **a) assume an advisory role and b) contribute technical inputs,** such as studies or analyses and data. These inputs aid the decision-making process of the System Representative and facilitate the adoption of potential modifications to the system. For the successful formation and operation of this group, the following considerations are proposed:

- The composition and size of the Stakeholder Group should strike a balance between adequately representing all relevant stakeholders and ensuring efficient decision-making. As a reference, the Stakeholders Platform of CertifHy in its third phase of development currently consists of approximately 130 key players, organized into technical working tables.

- A process should be established for the selection and incorporation of new members. This process must guarantee that the group's composition adequately represents all relevant sectors for the certification system, including hydrogen producers and consumers, energy sector regulators (covering electricity and gas), renewable energy certifiers, and fuel cell companies, to ensure a suitable and balanced representation.

- While the proposed certification system is voluntary, and the Stakeholder Group functions in an advisory capacity rather than as a regulatory body, it is deemed important to include public sector players. Their participation can bridge the proposed procedures and standards with decarbonization strategies, national hydrogen strategies, and potential future regulations of the different countries.

- To streamline decision-making and ensure harmonization among all stakeholders, the establishment of an executive committee is recommended. This committee should comprise representatives from various thematic working groups identified within the Stakeholder Group.

- To provide a structured approach, potential technical working groups, inspired by the framework of CertifHy (CertifHy Consortium, 2022), could include: **1)** structure and procedures of the certification system; **2)** requirements for certificate issuance (hydrogen producers); **3)** marketing and use of certificates (hydrogen consumers); **4)** regulation and standards; and 5) certificate issuance.

- The working group dedicated to certificate issuance requirements holds particular significance, playing a pivotal role in defining key elements such as the methodology for calculating GHG emissions and the information to be reported on the certificates.

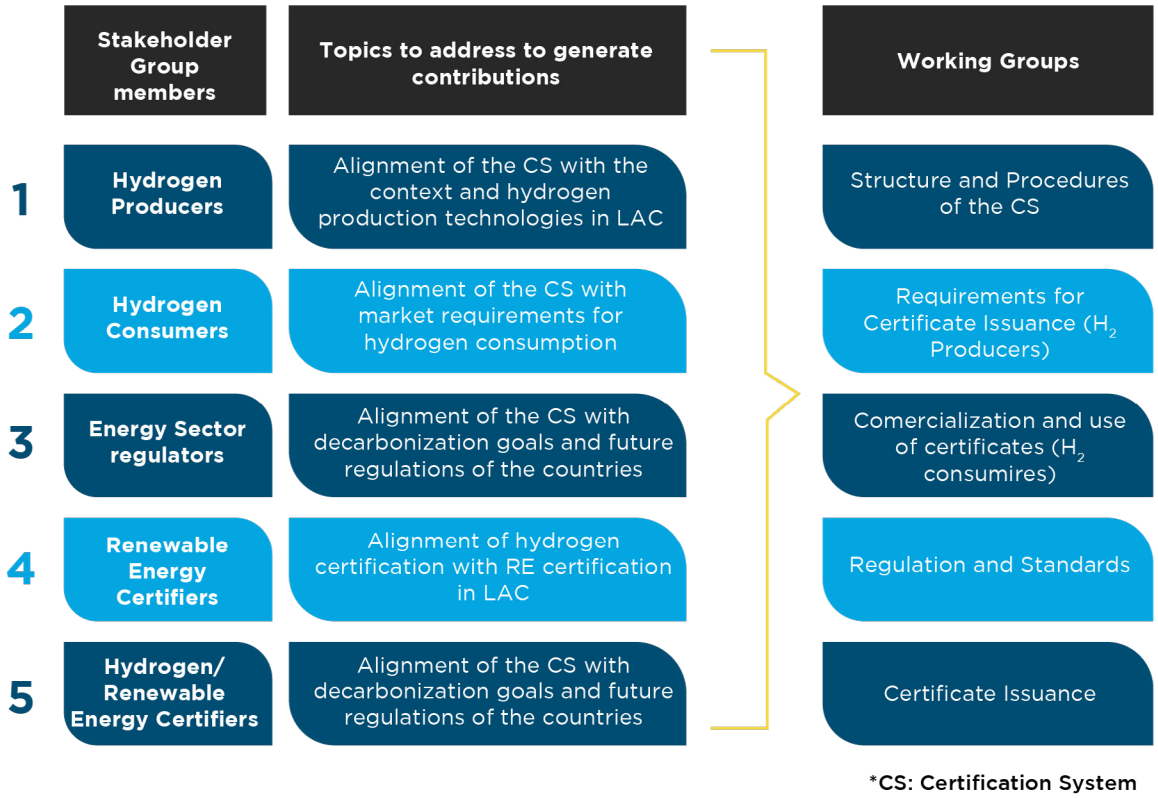
- The regulation and standards group could be in charge of seamlessly integrating the certification system into the procedures and systems of different countries. It is essential to highlight the significance of incorporating accrediting bodies/National Standardization Institutes from participating countries into this Technical Group to ensure a flow of feedback fostering alignment between the system's design and operation, with the internal processes of respective countries, particularly in the context of defining and adopting standards for hydrogen production–a realm currently advancing in more developed countries, such as Colombia and Chile.[19] Additionally, it is recommended to involve social organizations from the countries to achieve the envisioned social benefits within the system.

- Lastly, as a cross-cutting task for the entire Stakeholder Group, it is advisable to ensure the encompassing and integration of existing or developing certification systems within the region. This can be achieved by incorporating leading entities from these systems into the regulation and standards group. For instance, in the case of Brazil, inclusion of CCEE will be fundamental, and for Colombia, involving the inter-institutional hydrogen technical committee is essential.

The possible members of the Stakeholder Group, their objectives and the working groups that could be formed is summarized in **Figure 12** below:

[19] **Aspect validated through bilateral interviews conducted within the framework of this Guide, with INN Chile and Colombian ONAC.**

Figure 12. Proposed Stakeholder Group Members and Working Groups



Source: Prepared by the Author (2023)

It is recommended that the Stakeholder Group convenes at least once per quarter. These sessions would provide a platform for members to stay informed about progress, share insights, and contribute their perspectives to ongoing initiatives. This approach draws inspiration from successful certification systems such as "CertifHy," which has maintained a stakeholder platform since 2014. CertifHy's platform operates within various Technical Working Groups, providing inputs with the Scheme Representative and Manager through defined communication channels.

4.1.7. Definition of the Certification System Design: Attributes and Characteristics

The proposed Regional Certification System for LAC is based on:

- Analysis and comparison of international hydrogen certification systems,
- Feedback from key stakeholders in countries within the region that have made significant progress in developing their hydrogen ecosystems, and
- Considerations of the social, environmental, economic, and regulatory context of the LAC Region.

The proposal serves as a foundational input or "best practice" for the **final definition of the certification system to be determined and validated by the System Representative.** The System Representative, responsible for making conclusive decisions and implementing necessary modifications, will rely on the proposed framework and conducted analyses.

During this step the System Representative will determine the issues referred to in Section 3.

4.2. STEP 2: Identification of Required Data, Operating Costs and Definition of the Certification System Fee

The next step in the Action Plan involves the collaborative effort of the Stakeholder Group and the System Representative to compile a list of data required from various countries for populating the certificate database. This list, developed in the early stages, will facilitate the work for system operators (issuers), certification bodies, auditors, and producers (economic operators). Additionally, it will offer crucial insights to the public sector about the information needed by the system, (involving details such as whether a production plant has received subsidies, statistical data about the power grid, congestion/curtailment information, and availability of specific plant production data on an hourly basis.

This data compilation is particularly important for scenarios involving the export of H2 and derivatives to other economies. It aids in preparing for future phases and anticipated information requirements for non-European export markets, such as the US and Asia.

Another significant initiative during this phase is the identification of the operational costs of the system and the definition of a fee that producers must pay to obtain certification for hydrogen produced in the LAC region.

The goal of this sub-section is to furnish insights into the potential overall costs of this process, delving into two perspectives:

1. The perspective of the certification system developer.

2. The perspective of the producer seeking certification.

The shared information is grounded in the collective experiences of globally developed certification systems, acknowledging the limited existing information in this domain.

4.2.1.Identification of Certification Systems Operating Costs (OPEX) for Administrators

Accurately gauging OPEX that can be extrapolated to a certification system in the LAC region poses a challenge, given its direct dependence on the regional context in which it is embedded (e.g., employee costs and system update needs).

Drawing from CertifHy's experience, the estimated key costs for operating a certification system, mainly falling into two categories: registry operation and setting and updating system standards.

- **Registry Operation on behalf of the certificate registry operator:** It includes expenses such as software licensing and system administration (contemplates user support): these costs range between USD $25,000-$35,000.
- **Setting and Updating System Standards:** The costs for these items are contingent on the system's development phase. In the initial launch phase, higher costs are expected due to potential substantial modifications. Nevertheless, a significant decrease is expected during the operational phase, being limited to necessary updates, which are typically less extensive.

4.2.2. Definition of Certification System Fees

Concerning the operational costs of the certification system (OPEX), it is considered appropriate that the user, i.e., project developers or producers of hydrogen and its derivatives, to fund these costs through the payment of an equivalent fee.

To determine the fee value that producers should pay for certification necessitates an in-depth analysis that considers the context of all countries in the region. It is recommended to conduct an estimation of clean and/or low-carbon hydrogen production per country, projected in line with corresponding demand. This allows for the proportional distribution of annual operating costs across the total volume intended for certification in the region. Additionally, some costs are more readily assignable, as they directly vary based on the volume to be certified or plant characteristics.

Given the absence of public information on the costs borne by producers for accessing these certifications, approximate fees ranges will be presented for the different stages of the process that producers typically encounter.

Specifically, the hydrogen and derivative certification process incurs **costs related to registrations, audits, and other fees**. These operational costs mainly comprise initiation costs, annual costs, and Guarantees of Origin (GO) issuance costs.

- **Initiation costs** are one-time expenses to commence the certification process, covering elements such as the account opening fee for certification, registration fee for a new production unit, and the audit process for a new plant. The opening costs are estimated to be between USD $550 - 650. The equipment registration fee could vary between USD $400-3,000 depending on the type and capacity of the plant. Finally, audit costs vary for new or already certified plants, and may range depending on the production technology (e.g. electrolysis or biomass pyrolysis), with estimated values between USD $3,000-10,000.

- **Annual costs** are fees for operating the certification system. These may include an annual renewal fee for the certification account or periodic audits to verify the hydrogen's origin. Estimations range between USD $250 – 350 per year.

- Finally, **GO issuance costs** are those incurred to certify the quantity of produced hydrogen the producer wishes to certify. These costs differ depending on whether the certification system issues certificates at the plant level (certifies the plant as a whole and not each production quantity by volume) or by "batches" or production volumes. This cost must cover at least the value of the issuing body to perform this task.

Table 6.Certification Costs for Producers

		Cost (USD $)	Comments
Initiation Costs	Certification Account Opening Fee	550 – 650	Paid once
	Production Equipment Registration Fee	400 – 3,000	Depending on the type and capacity of the plant
	New Plant Audit	5,000 – 10,000	Depending on the technology
Annual Costs	Certification Account Annual Payment	250 - 300	Annual cost
	Plant Verification Account	3,000 – 6,000	Depending on the technology
Issuing	Certification Issuing	Depending on the type of certificate	

Source: Prepared by the Author (2023)

As an illustration, the costs associated with a new producer aiming to certify a 1 GW electrolytic renewable hydrogen production plant, assuming a conservative plant factor of 45% (dependent on available renewable resources), and yielding approximately 76,000-ton H2 per year.

According to this information, in the first year, the producer would face an approximate certification cost of USD$9,000 - USD$20,000, factoring in an initial audit and an additional audit in the same year. These costs would drop to USD$6,000- USD$12,000 if we consider a plant already registered (maintaining two audits per year). Additionally, the cost of issuing the certificate, for which no information was found, needs to be added to these values.

When translated to the cost per kilogram of H2 certified per year, this amounts to a range of USD$0.1/ton H2-year to USD$0.26/ton H2-year in the first year. In subsequent years, it would be equivalent to USD$0.08/ton H2-year to USD$0.16/ton H2-year. Finally, considering a levelized cost of hydrogen of 1 USD/kg H2, the plant certification would represent less than 0.03% of this levelized cost (LCOH).

4.3. STEP 3: Operation of the Certification System and Its Governance

Once the certification system design and governance have been finalized, the next step involves taking the proposed certification system to the next level, transitioning from conceptualization to operational execution phase.

To achieve this, it is recommended to conduct a pilot project designed to validate the system's functionality and potential scalability. The pilot project aims to obtain feedback for future enhancements and contribute to the dissemination of the system within the LAC Region. This phase is recommended to commence following the finalization of the certification system by the System Representative and the coordinating entity. Decision-making authority for the pilot lies with the System Representative, and the execution process should involve collaboration with the system administrator (who may or may not be the same entity as the coordinating entity), along with other players in the system's governance according to their respective roles.

The ensuing steps briefly outline the process to achieve this objective:

- **Definition of the scope and specifications of one or more pilot projects:** Detailed definition of the pilot project(s) and identification of all aspects to be tested are essential to validate the operational viability of the system in the LAC region. Given the heterogeneity among LAC countries, the possibility of conducting multiple pilots to cover various validation aspects in different scenarios is suggested.

Elements slated for testing and subsequent feedback include the audit system, creation and operation of the registry, issuer activities, verification of hydrogen attributes, and the lifecycle of a certificate (from issuance to cancellation). This step will precisely determine the elements requiring piloting and the appropriate methodologies.

- **Execution of the pilot project:** Testing key system elements and the certification process, including certificate usage, with potential users is a critical phase. Employing a clear methodology for monitoring and feedback collection from users and pertinent stakeholders becomes paramount at this juncture, maximizing the impact of the study in a cost-effective manner.

- **Identification of improvement and update aspects of the system:** Following the data and insights obtained from the pilot project, a thorough analysis must be conducted to pinpoint potential areas for improvement. To introduce relevant changes to the system, the same methodology presented in this guide for the initial system design should be followed. Collaboration with members of the Stakeholder Group and other interested parties will be instrumental in discussing and seamlessly integrating the identified modifications.

- **System scalability strategy:** Once the system's applicability and scalability have been tested and confirmed, initial steps for deploying it on a larger scale within the LAC Region should be defined.

The steps outlined above draw inspiration from the processes undertaken by the European Commission in establishing CertifHy after the system design was completed. Adopting this staged implementation methodology proves beneficial to ensure proper functioning prior to full-scale deployment, accommodating adjustments in the early stages and considering the diversity of countries that would use the system.

4.4. Summary of Proposed Next Steps

Drawing on processes carried out in other regions and considering existing local structures and governance, a summary of the Action Plan for the realization and implementation of the CertHILAC has been prepared. This summary encapsulates actions slated after the signature of the CertHILAC declaration. The summary is outlined in **Table 7** below:

Table 7. Proposed Next Steps for the Implementation of a LAC Certification System.

Step	Goal	Timeline
1	Official announcement of the CertHILAC Regional Initiative with its participants and coordinator (OLADE) at COP 28.	November - December 2023
2	Joint definition of the specific governance for the representative's interaction (e.g., work structures, voting procedures, internal working groups).	2024 onward
3	Formation of the **Stakeholder Group with Technical Committees** comprising key stakeholders that represent public and private sector interests.	2024 onward
4	Agreement on the final design of the system based on the proposal: - Validation of system attributes and characteristics - Emissions calculation methodology - Governance structure of the proposed system	2024 onward
5	Definition of costs and fees for the regional certification system, based on and depending on the previous definitions	2024 onward
6	Operation of the certification system	2024 onward

Source: Prepared by the Author (2023)

5. Practical Indications for Countries Interested in Participating in the Initiative Considering the Guide's Recommendations

The guide described above presents a series of recommendations and indications at the regional level to promote and facilitate the development of a harmonized certification system at the LAC level. These recommendations will then be broken down at the national level, so that the various countries interested in participating in the initiative are aware of the parallel processes they need to undergo to move forward on their own, and thus, aiding in making the regional system a reality.

1. Designation of the national representatives: The countries that have signed the CertHILAC Declaration must designate their two national representatives, according to the suitable profiles described in this guide.

2. Participation in initial set-up trainings: The national representatives, together with their technical advisors, are urged to be proactive in participating in the awareness programs and trainings, and early decision-making processes related to the system's governance.

3. Establish the national governance schemes: Each country must formulate its national governance schemes, determining the procedures for designating auditors and issuers. These schemes will outline whether additional requirements beyond the system's standards need to be met.

It is vital to identify potential actors for roles such as the system representative, auditors, and issuers, selecting the most qualified, and prioritize early actions for the training of these individuals. For example, to identify issuers, each country can initiate conversations with those issuers that already have a national presence and participate in other certification systems, in order to accelerate the internal selection process.

5. Ensure the participation of stakeholders in decision-making: Once the governance structures are in place, each country must ensure the participation of each of the stakeholders that represent national interests in the different system development processes. This signifies facilitating the involvement of national system representatives in supervising the regional coordinator and participating in regular coordination and follow-up meetings.

6. Collect national information as input for the system: Finally, in preparation for the design and decision-making process of the certification system, each country must carry out an information gathering initiative and provide inputs that can help to define key aspects. For example, information on whether a production plant received any subsidy; statistical data on the electricity grid (including information on congestion/discharge); availability of production data from specific plants at the hourly level. At the same time, in order to establish a meaningful charging tariff, each country must furnish information related to the potential demand for certificates. Conducting a comprehensive market study at the national level becomes necessary for this purpose.

At the same time, a series of actions are presented that can be performed by interested countries as a preliminary to the implementation of a system and the establishment of the governance structure.

- **Define the regulatory aspects of hydrogen and its derivatives:** In the context of certification, it is said that “certification is the mirror of regulation”. To better represent national interests in a regional certification system, it is essential to understand the regulations or other requirements (e.g., additional requirements around social or environmental sustainability) of each country for these products. Clear regulations facilitate smoother processes and ensure better representation of national interests in a regional certification system.
- **Promote inter-ministerial and regional collaborations:** Encourage the mobility of people and goods at the national and regional level, allowing the sharing of best practices and resources to enhance expertise. This collaborative approach accelerates national participation across the region, contributing to the credibility of the regional certification system.

- **Establish national working and discussion roundtables:** These forums serve as knowledge-sharing hubs for understanding the hydrogen ecosystem and certification processes. They serve as an instrument to identify national interests on key topics in the development of a regional system. This would facilitate the future selection and integration of these stakeholders into governance, and their optimal collaboration in the process of designing and updating the regional certification system, providing a group of public and private sector representatives with knowledge of the country's needs.

- **Survey and understand national certification systems:** Mainly those of other ecosystem products, in order to identify aspects that can be integrated into the regional system: important takeaways in the development process and its operation; tools that can be replicated or used as input in a regional system (e.g. emission accounting methodologies); relevant information on certification systems of raw materials for H2 production (e.g. certificates delivered to national electricity or biomass); and recognize actors involved in the process that can play a relevant role at the regional level.

- **Promote standardization in national certification systems for hydrogen and its derivatives:** In the case of developing a hydrogen certification system at the national level, it is considered important to include international methodologies and avoid product labels, allowing the standardization of processes in the certification system. This approach not only supports the development of a robust national system but also lays the groundwork for future integration or harmonization of attributes and requirements with a regional system.

Conclusions

1. According to the proposed Action Plan for implementing a Certification System, the process advocates a sequential and progressive approach. This methodology ensures the flexibility to make necessary adjustments to the system's design as issues arise as operational challenges emerge. However, the activities within each step and the regional and national processes may be undertaken simultaneously.

2. The proposed design for CertHILAC should be understood as an initial roadmap. While it has amalgamated insights from several countries in the region, and experiences from already implemented voluntary systems, it must be validated and completed by the System Representative, advised by representatives from the private sector through the Stakeholder Group. Official validation involving all key stakeholders, as outlined in this guide, becomes imperative to establish credibility and garner widespread acceptance for the system.

3. The current momentum toward establishing a regional alliance in this field is driven by the keen interest of numerous countries in developing their H2 certification systems. Despite this enthusiasm, a critical hurdle lies in securing funding for the setup of these systems. In the EU, the European Commission spearheaded the CertifHy system through a coordinating consortium funded by European resources. In the absence of a comparable entity in LAC, multilateral support will probably be essential to navigate this financial challenge.

4. Representatives from countries in the region express substantial interest in collectively addressing issues pertaining to the certification of clean and/or low-carbon hydrogen and its derivatives, with the expectation of collaborating with neighboring countries. A unified line of work holds the promise of various regional benefits, including achieving a fair energy transition by minimizing individual efforts and maximizing gains for the entire region.

5. In a global hydrogen economy scenario, the strategic exporting alignment of the region becomes paramount. Establishing a unanimous definition of sustainability criteria, encompassing economic and environmental, and social is key. Such a unified stance can set the region apart positively, especially when compared to other competing regions in the global hydrogen market.

Bibliography

CCEE. (2022). Certificación de hidrógeno. Retrieved from https://www.ccee.org.br/en/web/guest/certificacao_de_energia

CEN-CENELEC. (2022). *CEN/CLC/JTC 6 - Hydrogen in energy systems.* Retrieved from https://standards.cencenelec.eu/dyn/www/f?p=205:110:0::::FSP_PROJECT,FSP_LANG_ID:73437,25&cs=17701B9DF85BF730262EFE59CEF406EF3

CertifHy. (2020). *CertifHy*. Retrieved from CertifHy enters into phase 3 to build a H2 GO market as well as a H2 certification scheme for REDII: https://www.certifhy.eu/sin-categoria/certifhy-enters-into-phase-3-to-build-a-h2-go-market-as-well-as-a-h2-certification-scheme-for-redii-2/

CertifHy. (2022). *New milestone: 100000 certificates issued.* Retrieved from https://www.linkedin.com/feed/update/urn:li:activity:6981486589923188736/

CertifHy. (2023). *General Scheme Information Available*. Retrieved from CertifHy: https://www.certifhy.eu/certifhy-documents/

CertifHy Consortium. (2022). Retrieved from https://www.certifhy.eu/stakeholder-platform/

CIUR. (2020). *Standard and evaluation of low-carbon hydrogen, clean hydrogen and renewable hydrogen*. Retrieved from http://www.fuelcellchina.com/cnt_143.html

Clean Hydrogen Partnership. (2021). *CertifHy: Accelerating the Certification of Hydrogen*. Retrieved from https://www.clean-hydrogen.europa.eu/get-involved/hydrogen-certification_en

Comission, E. (2018). *Reference Regulatory Framework*. Retrieved from EU Science Hub: https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework_en

Commonwealth of Australia. (2021). *A Hydrogen Guarantee of Origin scheme for Australia*. Retrieved from https://storage.googleapis.com/converlens-au-industry/industry/p/prj1a3de348a6c0ad7d282f7/public_assets/Discussion%20paper %20-%20A%20Hydrogen%20Guarantee%20of%20Origin%20Scheme%20for%20Australia.pdf

European Comission. (2020). *Recognition of voluntary schemes under Article 30(4) of the revised.*

European Comission. (2023). *Voluntary schemes*.

GH2. (2022). *Green Hydrogen Organization*. Retrieved from https://gh2.org/about/our-principles

Hydrogen Central. (2022). *Oracle Power – LOI with TÜV SÜD on Green Hydrogen & Green Ammonia Certification.* Retrieved from https://hydrogen-central.com/oracle-power-loi-tuv-sud-green-hydrogen-green-ammonia-certification/

IDB, Gischler, C. et al. (2023). Unlocking Green and Just Hydrogen in Latin America and the Caribbean. Retrieved from: https://publications.iadb.org/en/unlocking-green-and-just-hydrogen-latin-america-and-caribbean

IDB, Signoria, C. & Barlettani, M. (2023). Environmental, Health, Safety, and Social Management of Green Hydrogen in Latin America and the Caribbean. Retrieved from: https://publications.iadb.org/en/environmental-health-safety-and-social-management-green-hydrogen-latin-america-and-caribbean

Instituto Totum. (2015). I-REC. Retrieved from https://institutototum.com.br/index.php/servicos/279-i-rec

Siemens Energy. (2022). *Clean Energy Certificate*. Retrieved from https://www.siemens-energy.com/global/en/priorities/future-technologies/clean-energy-certificates.html

Smart Energy Council. (2021). *Smart Energy Council: About*. Retrieved from https://smartenergy.org.au/about/

Smart Energy Council. (2023). *Zero Carbon Certification Scheme*. Retrieved from https://smartenergy.org.au/zero-carbon-certification-scheme/

The International REC Standard. (2022). *I-REC Hydrogen Product Code*. Retrieved from https://www.irecstandard.org/i-rec-for-hydrogen-code/

TÜV Rheinland. (2021). *TUV RHEINLAND Standard H2.21: Carbon-Neutral Hydrogen.* Retrieved from https://www.tuv.com/content-media-files/master-content/global-landingpages/images/hydrogen/tuv-rheinland-hydrogen-standard-h2.21_v1.0-en.pdf

TÜV SÜD. (2020). *TÜV SÜD provides Green Hydrogen Certification.* Retrieved from https://www.tuvsud.com/en/press-and-media/2020/february/tuev-sued-provides-greenhydrogen-certification

TÜV SÜD. (2021). *TÜV SÜD Standard CMS 70: Production of Green Hydrogen.* Retrieved from https://www.tuvsud.com/en/-/media/global/pdf-files/brochures-and-infosheets/tuvsud-cms70-standard-greenhydrogen-certification.pdf

TYMLEZ. (2022). *End to End Verification of the Green Hydrogen Supply Chain.* Retrieved from https://tymlez.com/guarantee-of-origin/green-hydrogen

US DOE. (2022). *Regional Clean Hydrogen Hubs.* Retrieved from https://www.energy.gov/oced/regional-clean-hydrogen-hubs#:~:text=Clean%20hydrogen%20hubs%20will%20create,store%20tremendous%20amounts%20of%20energy

Wei, L., Yanming, W., Yalin, X., & Pengbo, G. h.-c. (2022). *Green hydrogen standard in China: Standard and evaluation of low-carbon hydrogen, clean hydrogen, and renewable hydrogen*. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0360319921042737

Yoon-Seo, Lee. (2022). *S. Korea to introduce new hydrogen rating scheme in 2024*. Retrieved from https://www.koreaherald.com/view.php?ud=20220720000816

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