Certification of Hydrogen and Its Derivatives in APEC Economies: Its Role in Driving the Market

APEC Energy Working Group

January 2026

Asia-Pacific
Economic Cooperation

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APEC Project: EWG 105 2024A

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APEC#226-RE-01.1

Acknowledgements

This publication was funded by APEC. The views expressed in this publication are the authors' alone and are not necessarily the views of APEC.

The Ministry of Energy of Chile extends its appreciation to all expert speakers and participants of the APEC Seminar "Certification of Hydrogen and its Derivatives in APEC Economies: its role in driving the market" for their valuable insights and contributions. Special thanks are extended to the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), a government-to-government partnership advancing the global hydrogen economy; María De la Cruz, Board Member at the I-TRACK Standard Foundation; Dr. Evgeniy Koloshkin, Chief Technologist at PJSC Gazprom; Mr. King Anthony Ting, Senior Science Research Specialist at the Renewable Energy Management Bureau, Department of Energy of Philippines; and Dr. Tudor Florea, Hydrogen Policy Advisor from the French Ministry in charge of Energy, Co-lead of the IPHE Hydrogen Certification Mechanisms Task Force.

Reference

This report can be referenced as:

Feijoo F., et al. (2025) *Certification of Hydrogen and its Derivatives in APEC Economies: Its role in driving the market*. Technical Report, report to APEC.

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Executive Summary

Hydrogen is gaining rapid momentum as a critical energy carrier in global decarbonization, and APEC economies are at the forefront of shaping and adopting certification frameworks for hydrogen and its derivatives. This report synthesizes two distinct but interconnected perspectives: (1) an economy-by-economy overview of a literature review of hydrogen policies and regulations, and (2) a survey-based assessment of readiness, barriers, and opportunities for harmonization among APEC members.

From Australia; China; and Japan's robust initiatives to smaller but emerging efforts in economies like Peru; the Philippines; and Viet Nam, a clear pattern is evident: hydrogen standards are evolving quickly, propelled by economy-wide goals for carbon neutrality and energy security. Advanced systems, such as Australia's Guarantee of Origin scheme (GO scheme) and China's evaluation standards, underline how robust certification can strengthen trust, attract investment, and expedite international market integration.

Survey findings reveal that, although many APEC economies consider themselves moderately ready to certify hydrogen, they often face shared challenges. Among these are emissions tracking availability, the high infrastructure cost, and limited technical expertise in deploying verification systems. Participants also highlight the importance of broader sustainability attributes—covering social, environmental, and labor criteria—to ensure that hydrogen's climate emission reductions benefits are both credible and equitable. Nearly all responses emphasize emissions accounting and verification as the cornerstone for successful certification schemes but also call for pragmatic frameworks that incorporate water use, land stewardship, and social impacts.

Confronting these gaps will require alignment of technical standards, cross-border collaboration, and financial incentives. Areas of potential cooperation include devising regionally consistent definitions for "low-carbon" or "green" hydrogen, developing chain-of-custody tools for real-time emissions tracking, and encouraging capacity-building across member economies. Internationally recognized approaches can serve as a foundation for coherent and interoperable certification, further boosting investor confidence and trade.

By coordinating policy action and sharing best practices, APEC economies stand to accelerate the deployment of certified hydrogen, providing a powerful mechanism to reduce emissions, catalyze innovation, and position the region as a global leader in clean energy transition.

1. Introduction

Hydrogen is rapidly emerging as a critical component in global strategies aimed at achieving decarbonization and meeting ambitious climate targets. Within this context, renewable hydrogen—produced entirely from renewable sources—represents an essential pathway for reducing emissions across multiple economic sectors, particularly in transportation, hard-to-decarbonize industrial processes, and energy storage. However, to unlock the potential of hydrogen and ensure its efficient integration into international energy markets, reliable, transparent, and harmonized standards and certification schemes are necessary. Such frameworks are essential not only for verifying the environmental credentials of hydrogen production but also for fostering consumer trust, facilitating international trade, and attracting investment into the burgeoning clean hydrogen sector. It is important to highlight that clean hydrogen certifications do not only pertain to its generation but also encompass various stages, including transportation, storage, transformation, and distribution. Certifying each stage ensures the integrity and sustainability of the hydrogen value chain, ultimately leading to genuine decarbonization impacts.

Over the past decade, several hydrogen certification mechanisms have been developed globally. In Europe, three voluntary certification schemes are formally recognized by the European Commission for demonstrating compliance with RED II/III and the related Delegated Regulations: **CertifHy, ISCC**, and **RedCert**. Each of these operates under the same legal standing and can be used by producers across all EU member states. **CertifHy** offers two chain-of-custody models: the **Guarantees of Origin** (book-and-claim), which is primarily used for disclosure and not uniformly accepted across the EU, and the **CertifHy RFNBO** (mass balance), which has been explicitly endorsed through Implementing Decision (EU) 2024/3180. ISCC and **RedCert** similarly provide RED-compliant certification pathways, ensuring traceability and life-cycle emissions accounting. Other private certification initiatives exist in Europe, but they must align with one of the EU-recognized voluntary schemes in order to have regulatory validity. More recently, the international I-TRACK (HX) standard has also been introduced, providing an interoperable, ex-post approach. In addition, domestic initiatives such as Australia's Guarantee of Origin scheme, Japan's hydrogen certification guidelines, or California's Low Carbon Fuel Standard (regional) have been developed to address specific market and regulatory contexts.

Despite the progress made, the global landscape of hydrogen certification remains fragmented, posing challenges for international collaboration and market expansion. Variations in life cycle assessment methodologies, renewable energy verification criteria, and carbon intensity thresholds often result in inconsistent market signals and potentially impede cross-border hydrogen trade. Consequently, in order to harmonize existing certification frameworks, aligning definitions, metrics, and methodologies is needed. Such harmonization not only will streamline international hydrogen transactions but also enhance the global credibility of clean hydrogen.

In this context, APEC economies have a unique opportunity to collaborate on aligning and advancing hydrogen certification schemes and mechanisms, driving regional and global progress toward climate goals. By fostering dialogue, standardization efforts, and shared best practices, APEC can position itself as a leading region in the development, certification, and deployment of low-carbon hydrogen. Therefore, adhering to high standards and regulatory requirements is essential for meeting environmental and social commitments while fostering transparency and credibility in international trade.

This report is structured into six chapters, each addressing a specific dimension of hydrogen certification, as outlined below:

- **Chapter 1** introduces the foundational concepts, including key terms, definitions, and technical aspects of certification systems, as well as the roles of principal stakeholders.
- **Chapter 2** reviews current international certification schemes and standards and provides a tabular overview.
- **Chapter 3** examines the current status of certification frameworks within APEC economies, identifying emerging initiatives from every economy.
- **Chapter 4** presents a comparative tabular overview of certification schemes and standards across APEC economies to facilitate comparison.
- **Chapter 5** synthesizes the findings by outlining commonalities and differences among certification approaches and offers policy and technical recommendations for harmonization.
- **Chapter 6** summarizes the key topics and discussions from the two-day APEC Workshop on "Certification of Hydrogen and its Derivatives in APEC Economies: Its role in driving the market" held in Santiago, Chile, on 5–6 May 2025.

1.1 Certification: Definition, Purpose, and Certificates

1.1.1 What is Certification?

Certification can be broadly defined as the process of evaluating whether a product complies with a given set of requirements [1]. In the context of energy, certification refers to the issuance of a statement by an independent entity confirming that a unit of an energy carrier possesses certain sustainability attributes upon its production and/or along the entire value chain. Typically, this statement is issued in the form of an electronic record, which can be transferred, bought, and sold on a market. Certification processes involve a range of actors, including: regulators or authorities who impose relevant legal requirements; certification scheme owners, who design the rules and governance structure; certification bodies and issuing bodies who administer and manage certificates; and independent auditors who are responsible for verification and assurance.

1.1.2 What Does Certification Provide?

Certification of hydrogen sustainability attributes provides reliable information about both environmental and social aspects of hydrogen production and use. These include, for example:

- **Environmental aspects:** greenhouse gas (GHG) emissions from production and transport, land and water use, and air quality impacts.
- **Social aspects:** rights of indigenous peoples, labour rights, local value creation, enhanced energy access, competence development, and promotion of diversity, equity, and inclusion.

1.1.3 Why is Certification Needed?

The need for hydrogen certification arises from multiple drivers. Two of the most prominent are:

1. **Regulatory compliance and access to incentives:** Certification provides evidence of compliance with requirements embedded in economy-wide or regional legislative frameworks, such as eligibility for tax credits, subsidies, or public funding.
2. **Voluntary disclosure and corporate reporting:** Certification enables companies to voluntarily disclose information to consumers, investors, or other stakeholders. This is increasingly relevant for Corporate Social Responsibility (CSR) and Environmental, Social, and Governance (ESG) reporting.

Accordingly, certification schemes can be broadly categorized into two types:

- **Compliance-oriented schemes:** Designed to ensure conformity with government-mandated requirements regarding product attributes or processes across production, conversion, storage, transport, or use.
- **Reporting-oriented schemes:** Designed for voluntary disclosure of product or process attributes, often linked to ESG or CSR reporting frameworks.

1.1.4 Types of Certificates Generated

Certification systems may generate different types of certificates depending on their scope and tracking methodology. Two primary types are:

1. **Energy Attribute Certificates (EACs):** These certificates (e.g., Guarantees of Origin (GO), Renewable Energy Certificates (REC), International Renewable Energy Certificates (I-REC)) provide information about the origin

of the energy, its renewable source, and related details such as date and location of production. EACs are often used in certification schemes underpinned by the book-and-claim model.

2. **Sustainability Certificates:** Sustainability certificates verify the broader sustainability attributes of a given product and ensure traceability along the supply chain from production to the consumption gate. These certificates are commonly issued under certification schemes based on a mass-balance tracking and tracing model.

Within the European Union, sustainability certification is strongly embedded in legislation. The EU Renewable Energy Directive (RED) requires disclosure of the energy's origin (Article 19) as well as verification of environmental sustainability and greenhouse gas performance (Articles 29 and 30). This has led to the emergence of certification schemes designed to demonstrate compliance with these regulatory requirements.

1.2 Certification: What is a Certification System and a Certification Scheme?

A *certification system* (or framework) refers to the entirety of the legal, institutional, procedural, and technical arrangements that govern the certification of a given product or process [1]. It provides the overarching framework within which certification takes place and typically includes the legal and regulatory requirements established by governments and competent authorities when certification serves a compliance purpose. In other contexts, certification systems may take the form of voluntary agreements administered by third-party organizations, particularly when the primary aim is reporting or disclosure. The nature of the actors involved—whether public regulators, private scheme owners, or independent auditors—depends on whether certification is intended to demonstrate regulatory compliance or to support *voluntary reporting*. Within a certification system, one or multiple certification schemes may operate at national or international levels.

A *certification scheme* (or mechanism) constitutes a more specific instrument within the certification system. It comprises the governance, assessment, and verification processes designed to ensure that the certified product (e.g., hydrogen or its derivatives) meets a defined set of requirements or criteria [1, 3]. In practice, certification schemes serve to evidence product attributes, such as sustainability characteristics of production, transport, and delivery. Four essential elements are generally recognized within certification schemes:

1. **Product attributes:** The technical and sustainability characteristics of the certified product.
2. **Operational set-up and procedures:** The rules, governance structures, and processes guiding the certification.

3. **Chain of custody:** The methodology by which certified attributes are tracked along the value chain.
4. **Information technology:** Registries and data systems that ensure transparency, reliability, and traceability.

Certification schemes may rely on voluntary technical standards, including standards that define methodologies for assessing product attributes or operational procedures. Importantly, the attributes evidenced by a scheme are often aligned to legislative requirements. For instance, schemes may be designed to verify compliance with GHG thresholds in order to qualify for tax credits, quota obligations, or other policy incentives.

The interaction between certification systems, schemes, and regulation varies by context. In some cases, legislation precedes the establishment of certification schemes, which then emerge to verify compliance with the law. A prominent example is the U.S. Production Tax Credit for hydrogen, which defines GHG emission thresholds for eligibility but is still in the process of developing recognized certification mechanisms. In other cases, certification schemes may pre- date formal legislation. For example, the International Sustainability and Carbon Certification (ISCC) scheme for synthetic fuels was established prior to the adoption of the EU Renewable Energy Directive (RED). The scheme has since sought formal recognition from the European Commission as an eligible mechanism to demonstrate compliance with RED targets, a process mirrored by other voluntary schemes.

In this way, certification systems provide the overarching regulatory or voluntary architecture, while certification schemes operationalize this framework through concrete rules, governance, and verification mechanisms that enable producers and consumers to demonstrate the sustainability and quality of hydrogen and its derivatives (see Figure 1.1).

Figure 1.1 An overview of certification system and certification scheme [1]

1.3 Standards and Labels

Building on the distinction between certification systems and certification schemes, it is important to highlight the complementary instruments that support and operationalize these frameworks. Certification schemes do not exist in isolation: they rely on standards to provide clear and consistent methodologies for assessing compliance, and they often communicate their outcomes through labels that make sustainability attributes visible and credible to markets, regulators, and consumers. In this way, standards, and labels function as integral components of the certification system—standards by defining the technical basis for assessment, and labels by translating certification results into recognizable signals in the marketplace.

In the context of hydrogen certification, a **standard** can define a methodology for identifying or calculating a particular sustainability attribute, such as the carbon footprint (CFP) of hydrogen production and transportation or the share of renewable content used in its generation. An international standard should not be confused with economy-wide laws and regulations. However, domestic, or regional legislation may refer to standards when specifying eligibility criteria; for example, the EU Taxonomy for Sustainable Finance refers to ISO standards for assessing the greenhouse gas (GHG) footprint of hydrogen production in order to determine whether an activity qualifies as sustainable. More broadly, technical standards establish formalized and shared methodologies for assessment, which can include boundaries, product specifications, GHG accounting rules, and other relevant aspects. They typically harmonize approaches across jurisdictions, provide procedures for conformity evaluation, and stipulate agreed terms and definitions, thereby facilitating international trade and ensuring comparability.

A **label** or certification mark, by contrast, communicates the outcome of certification to markets and consumers. Labels serve as the visible interface for transparency and credibility, signaling that certain defined requirements have been fulfilled. For instance, a label may classify hydrogen as "renewable" when it is produced entirely from renewable energy sources and demonstrates a carbon footprint below a defined threshold. The Indian "green hydrogen" standard is one such example, setting a threshold of 2 kg CO2-eq per kg H2 for hydrogen to be recognized as green. More generally, labels provide standardized signals of sustainability attributes such as "renewable," "low-carbon," or "clean hydrogen." They are critical not only for enabling informed consumer choice and product differentiation in international markets, but also for demonstrating eligibility for policy incentives or compliance with import requirements. Their credibility ultimately depends on the robustness of the underlying standards and certification schemes, making them an indispensable link between technical verification and market recognition.

While standards provide the methodological foundation, certification mechanisms operationalize these rules through structured and independent verification. Certificates can serve two distinct purposes: compliance with regulatory frameworks (for example, when recognition is required under legislation such as RED

II/III), or disclosure in voluntary markets where transparency among market participants is the main objective. A certain level of ambiguity persists due to overlapping terminology, but what is integral to credibility is the governance and verification structure of the certification mechanism. Governance may rely entirely on ad-hoc rules or combine such rules with regulatory provisions and internationally recognized standards, such as those developed by ISO. Against this background, international initiatives are seeking to promote common standards and methodologies for low-emission fuel value chains. Yet no globally accepted framework currently provides a unified definition of low-emission hydrogen, and interoperability across jurisdictions remains the immediate focus of ongoing work [4].

1.4 Technical Aspects and their Classification for Hydrogen Certification schemes/standards

1.4.1 Types of Certificates Generated

Hydrogen life-cycle assessment (LCA) is shaped by a hierarchy of regulatory frameworks, standards, and certification schemes. These instruments define how greenhouse gas (GHG) emissions should be calculated, reported, and verified, but they differ in authority, function, and scope. Where a regulatory framework exists, it prevails over any voluntary initiative. In the absence of regulation, stakeholders may apply their own methodologies, often guided by internationally recognized standards. In some cases, regulatory frameworks may directly reference such standards (e.g., ISO 14040, 14044, 14067, or more recently ISO 19870).

- **Reporting schemes:** Reporting schemes are non-binding mechanisms developed by industry initiatives, private consortia, or international organizations. While not legally enforceable, they shape corporate sustainability practices, facilitate disclosure, and may pave the way for later regulatory uptake. Examples include private initiatives such as the *TÜV SÜD "GreenHydrogen" certification or the GH2 Standard, which remain outside of formal legislation and standardization frameworks*. These schemes frequently reference technical standards such as *ISO 14040, ISO 14044, or ISO 14067*, which provide methodologies for conducting LCA.
- **Compliance schemes:** Mandatory schemes are embedded in legislation and may be directly linked to eligibility for compliance markets and financial incentives. These frameworks are established by governments and regulatory authorities, often in consultation with standard-setting bodies. A government may choose to develop and own schemes themselves, or it may recognize schemes of independent organizations to carry out the certification. For example, The European Commission does not operate its own hydrogen certification scheme but recognizes three voluntary schemes (CertifHy, ISCC and REDCert) to verify compliance with the RED II/III targets for Renewable

Fuels of Non-Biological Origin (RFNBOs), the U.S. Section 45V Clean Hydrogen Production Tax Credit, India's Green Hydrogen Standard (GHS), California's Low Carbon Fuel Standard (LCFS), and the United Kingdom's Renewable Transport Fuel Obligation (RTFO). In such cases, compliance with the regulatory provisions is legally binding and certification is not optional but a prerequisite for market access, crediting, or compliance with statutory quotas.

1.4.2 Scope aspects

In the context of hydrogen, the concept of scope refers to the extent of life-cycle emissions that are included when calculating the greenhouse gas (GHG) intensity of hydrogen production for regulatory or certification purposes (see Figure 1.2). These categories are commonly aligned with the principles of life-cycle assessment (LCA) but are applied in different ways depending on whether the mechanism is voluntary or mandatory. The focus is always on the hydrogen value chain, and the definition of boundaries determines which emissions are considered.

- **Scope 1:** Direct emissions generated at the hydrogen production facility itself, such as on-site fuel combustion and process-related emissions.
- **Scope 2:** Scope 1 plus upstream emissions associated with the generation and delivery of inputs, most importantly electricity, steam, or fuels used in hydrogen production.
- **Scope 3:** Scope 2 plus downstream emissions along the hydrogen value chain, including conditioning, transport, storage, distribution, and end use, as well as capital expenditure (CAPEX) emissions from equipment manufacturing and other indirect sources (e.g., employee transport, office energy use, certification activities).

Most existing hydrogen-related certification schemes and regulatory programs concentrate on Scope 1 and 2 emissions. For example, the voluntary scheme CertifHy, as well as the voluntary schemes ISCC EU and REDcert, primarily assess operational and upstream emissions. In contrast, legislation such as the EU Renewable Energy Directive (RED II/III) and its delegated acts establish binding thresholds for Scope 1 and 2 performances for renewable fuels of non-biological origin (RFNBOs). A smaller number of mechanisms explicitly integrate Scope 3 emissions. Notably, the regulatory program California Low Carbon Fuel Standard (LCFS) incorporates end-to-end life-cycle emissions, while certain applications of ISCC EU for biofuels include full value-chain accounting. The integration of Scope 3 is particularly relevant for mechanisms that aim to deliver comprehensive carbon intensity metrics and facilitate international comparability.

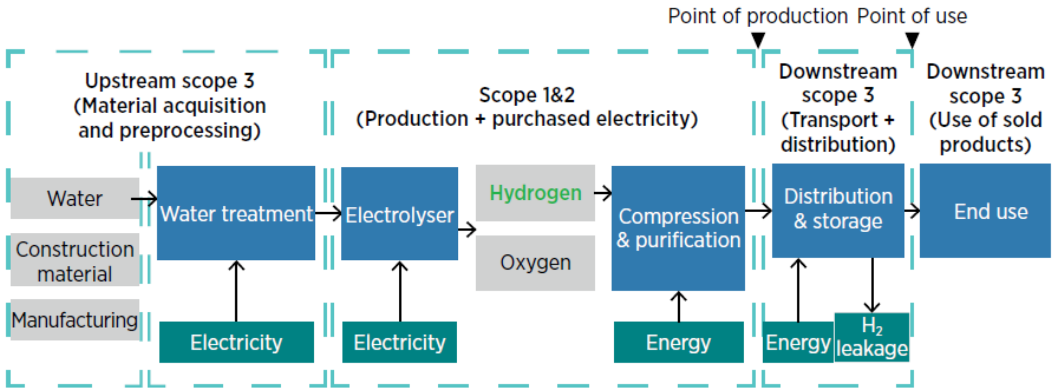

Figure 1.2 Defined scope of renewable hydrogen production according to its LCA [2]

1.4.3 System Boundary Aspect

The system boundary defines which processes and emissions are included in the calculation of environmental impacts, such as GHG emissions. In the context of hydrogen certification, the choice of system boundary directly influences the calculated carbon intensity and determines the eligibility under various standards. Hydrogen LCA and certification schemes typically adopt one of the following system boundary types:

- **Well-to-Gate:** Covers all emissions from feedstock extraction through hydrogen production and conditioning up to the plant gate. Excludes distribution or end-use. Examples include the U.S. Section 45V PTC and Japan's proposed Clean Hydrogen Certification System.
- **Cradle-to-Gate:** Extends well-to-gate to include emissions from equipment manufacturing or infrastructure. ISO-aligned methodologies often support this boundary type.
- **Well-to-Wheel:** Covers the full chain from feedstock extraction through hydrogen delivery and final use, including distribution and end-use conversion. This approach is used in fuel standards such as the California LCFS and the Oregon CFP.
- **Cradle-to-X:** A flexible formulation in which "X" represents a chosen system boundary such as tank, port, pipeline entry, or final use. An example is the TÜV SÜD CMS 70 scheme.

Some frameworks apply hybrid or extended boundaries. For example, in Japan's Hydrogen Society *Promotion Act,* boundaries vary by product: hydrogen and ammonia are assessed on a well-to-gate basis, while synthetic fuels and synthetic methane are measured on a well-to-wheel basis. Comprehensive cradle-to-grave analyses—covering extraction, production, conversion, storage, transport, and final use—are typically conducted within ISO LCA methodologies such as *ISO 14040/14044* [5]. Table 1.1 compares the coverage of selected current certification schemes and standards.

1.4.4 Chain of Custody Aspect

Hydrogen certification frameworks also differ in how certified attributes, such as renewable origin or carbon intensity, are transferred through the chain of custody. The choice of chain of custody system determines the level of traceability, the degree of regulatory compatibility, and the suitability for different market applications [1]. Two main operational models are commonly applied:

- **Book and claim:** In this decoupled model, certificates are traded independently of the physical delivery of hydrogen. Producers issue Guarantees of Origin (GOs) or equivalent certificates, which can be sold separately from the actual hydrogen molecule. This provides market flexibility and simplified logistics but does not ensure physical traceability of the product. Examples include Article 19 of the EU Renewable Energy Directive II (RED II), which establishes GOs, and the voluntary scheme CertifHy, which issues similar certificates.
- **Mass balance:** The mass balance model links certificates to the physical flow of hydrogen. Here, the energy product, its associated GHG emissions, and any sustainability attributes are all tracked together along the supply chain. This system offers greater assurance of traceability and is required in contexts where sustainability criteria must be enforced. Examples include regulatory instruments such as the EU Delegated Acts for renewable fuels of non-biological origin (RFNBOs) and the California Low Carbon Fuel Standard (LCFS).

Table 1.1 System boundary (process) coverage for some certification frameworks, schemes, and standards

Name	Geography	Type	Raw Material Extraction	Production	Conversion (on site)	Storage (on site)	Transport / Distribution	Conversion	Storage	Final Use
CertifHy / CertHiLAC	International Latin America	Certification scheme	✓	✓	✓	✓				
ISCC / ISCC PLUS	International	Certification scheme	✓	✓	✓	✓	✓	✓	✓	✓
Green Hydrogen Standard (GH2)	International	Certification scheme		✓	✓	✓				
TÜV SÜD CMS 70	International	Certification scheme	✓	✓	✓	✓				
RED II / RED III (Delegated Acts)	European Union	Regulatory framework	✓	✓	✓	✓	✓	✓	✓	
H2Global	International	Market mechanism		✓	✓	✓	✓	✓	✓	
Guarantee of Origin (GO scheme)	Australia	Certification scheme	✓	✓	✓	✓	✓	✓	✓	
Standard and Assessment for Low-carbon Hydrogen, Clean Hydrogen and Renewable Hydrogen Energy	People's Republic China	Standard	✓	✓		✓				
Clean Hydrogen Investment Tax Credit	Canada	Incentive scheme		✓						
Guarantee of Origin	France	Certification scheme	✓	✓	✓	✓				
Guarantee of Traceability	France	Certification scheme	✓	✓	✓	✓	✓	✓	✓	✓
Hydrogen Society Promotion Act	Japan	Regulatory framework	✓	✓	✓	✓				
Clean Hydrogen Certification System	Korea	Certification scheme	✓	✓						
Low Carbon Hydrogen Certification Scheme	United Kingdom	Certification scheme	✓	✓		✓				
Renewable Transport Fuel Obligation (RTFO)	United Kingdom	Regulatory framework	✓	✓	✓	✓	✓	✓	✓	✓
Section 45V Hydrogen Production Tax Credit	United States	Incentive scheme	✓	✓						
California Low Carbon Fuel Standard (LCFS)	United States (California)	Regulatory framework / Incentive program		✓	✓	✓	✓	✓	✓	✓

1.5 Key Players in Certification Systems

For a hydrogen certification process to function efficiently, there are multiple institutional actors whose roles range from rule-setting and governance to independent verification and market use (see Figure 1.3 for the bodies and the flow of information). Each actor contributes to ensuring credibility, transparency, and functionality of the system as a whole. The following subsections describe the key players and their responsibilities.

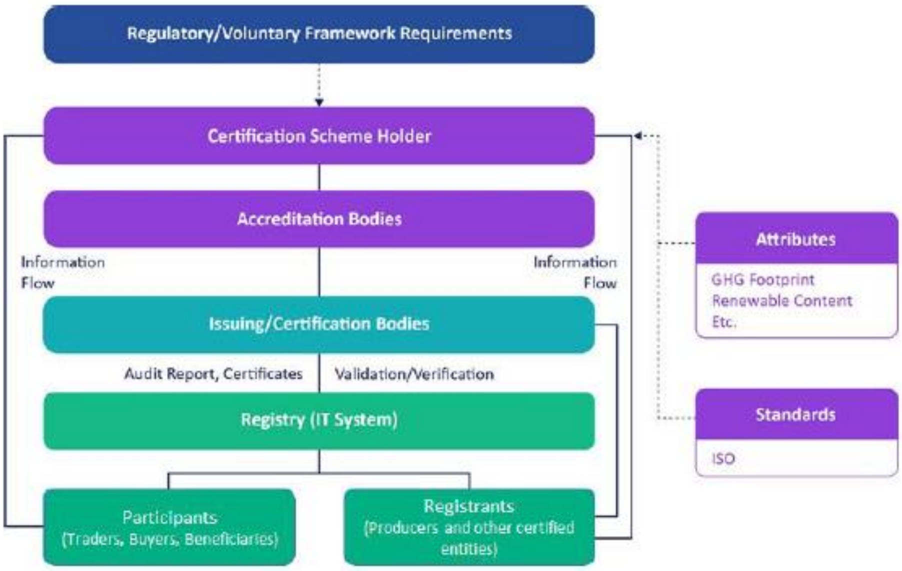

Figure 1.3 Overview of certification process: key players and information flow [1].

1.5.1 Governments and Legislators

Governments and legislators set the legal and regulatory framework under which certification systems operate, particularly when the purpose of certification is compliance. They establish rules and requirements to ensure that certification schemes contribute to achieving regulatory targets and quotas, protect consumers, and include safeguards against double-counting and fraud. Importantly, governments are the only authority with the power of inquiry, inspection, and the imposition of fines or penalties in cases of non-compliance. In the case of national certification schemes, governments often play supervisory roles over scheme owners, ensuring that the governance of such schemes remains credible and aligned with public policy objectives [1].

1.5.2 Certification Scheme Owners

Certification scheme owners (also referred to as scheme holders) are responsible for the design and operation of hydrogen certification schemes. These may be non-profit organizations, private companies, or public institutions, depending on the scope and purpose of the scheme. They define the overall framework, including governance structures, sustainability criteria, monitoring and compliance mechanisms, and requirements that certification bodies must fulfill. In many cases, they also stipulate that certification bodies be accredited by independent accreditation bodies. Where schemes serve compliance purposes, governments may supervise scheme owners directly to ensure legitimacy and credibility [6, 1, 2].

Scheme owners also establish methodologies for assessing compliance, which may include life-cycle calculation approaches, rules for monitoring and verification, and criteria for addressing non-conformities. Without strong scheme ownership, certification risks becoming fragmented, lacking comparability, or insufficiently recognized across borders, thereby undermining its utility as a tool for enabling global hydrogen trade.

1.5.3 Certification Bodies

Certification bodies are independent third-party organizations tasked with verifying that producers, processors, and other supply chain actors comply with the criteria defined by scheme owners. Their assessments may include physical inspections of facilities, document analysis, data testing, and personnel competency evaluations. To ensure credibility, certification bodies must employ auditors with both technical knowledge of the sector and familiarity with the relevant methodologies [6, 1].

Certification bodies may also serve additional roles. In some cases, they provide pre-certification or capacity-building services to guide companies through certification requirements. In other cases, they may act as issuing bodies, formally issuing certificates once verification is complete. However, certification bodies must themselves be recognized by scheme owners and often require accreditation by economy-wide or international accreditation bodies. This dual approval system strengthens trust by ensuring that certification is impartial, technically sound, and globally comparable [2].

Private certification bodies can also play a central role in implementing voluntary schemes. These entities, often part of the global Testing, Inspection, Certification sector, act as independent auditors that verify compliance and issue certificates on behalf of the scheme owner. Well-established organizations in this space include TÜV SÜD, SGS, Bureau Veritas, Normec, TÜV Rheinland, Intertek, DNV, KIWA, TÜV Nord, Apave, Dekra, Applus, TÜV Austria, and Eurofins.

1.5.4 Accreditation Bodies

Accreditation bodies provide independent oversight of certification bodies, ensuring they operate with technical competence, independence, and reliability. They verify that certification bodies conform to international standards such as ISO 17065, which sets requirements for certifying products, processes, and services. At the economy-wide level, accreditation bodies often act as regulatory authorities on behalf of governments. Examples include ANAB in the United States and UKAS in the United Kingdom [6, 2].

Accreditation also functions at the global level. The International Accreditation Forum (IAF), an association of accreditation bodies, develops harmonized approaches to conformity assessment worldwide. This reduces risk for businesses and customers by assuring that accredited certificates and verification statements are reliable and comparable across jurisdictions [1]. By embedding accreditation into certification systems, trust is enhanced and interoperability of schemes across borders is facilitated.

1.5.5 Issuing Bodies and Registries

Issuing bodies and registries manage the issuance, tracking, transfer, and cancellation of certificates. Depending on the scheme, the issuing role may be performed by certification bodies themselves or by dedicated institutions. Their role is critical for ensuring traceability and avoiding double-counting. In hydrogen markets, registries often operate as digital platforms to record issuance, import, export, and cancellation of certificates. They provide transparency and accountability across borders, enabling compliance with sustainability requirements.

Examples from related sectors include Germany's Nabisy registry for biofuels and Austria's elNa system, both overseen by state authorities. In Chile, the proposed hydrogen registry also aims to integrate broader functions such as monitoring energy quotas and supporting national data management [7]. Whether publicly managed or operated by private providers, issuing bodies and registries act as both gatekeepers and facilitators of reliable certificate markets [1].

1.5.6 Traders, Suppliers, and End-Consumers

Market actors such as traders, suppliers, and end-consumers use certificates for both voluntary and compliance purposes. On a voluntary basis, certificates can serve corporate reporting, investor communication, or consumer information, demonstrating that hydrogen or its derivatives meet specific sustainability requirements. In compliance contexts, certificates are used to meet regulatory quotas, targets, or eligibility criteria for incentives. Their effective use depends on the credibility of upstream governance and verification processes, making them the final link in the chain that connects certification systems to real market behavior [1].

2. International Legal Frameworks, Schemes and Standards

This chapter outlines key international frameworks, mechanisms, and standards that define, verify, and track the sustainability and carbon intensity of hydrogen and its derivatives. Following this, a comparative overview of these initiatives is presented in Table 2.1, highlighting their scope, boundaries, and emission thresholds.

2.1 RED II / RED III

Although the Renewable Energy Directives (RED) II and III of the European Union are not certification schemes per se, but a binding legislation, they warrant inclusion in this discussion given their regulatory significance and central role in shaping hydrogen markets across Europe. The RED II/III framework provides a legal foundation for clean hydrogen and RFNBO certification across European member states. Compliance can be demonstrated through EU-recognized voluntary certification schemes or domestic certification systems. RED II, adopted in 2018, established key climate and energy targets, including that renewable energy must constitute at least 32% of EU energy consumption and 14% of transport energy consumption by 2030. It introduced sustainability and GHG savings criteria for biofuels and RFNBOs, including a GHG emissions methodology specifically for renewable hydrogen [8].

Building on RED II, RED III was adopted to support the European Green Deal and the “Fit for 55” package, which aims for a 55% reduction in EU GHG emissions by 2030. RED III increases the renewable energy target to 42.5% (with an indicative 2.5% additional flexibility). It introduces new targets for industry and transport: by 2030, at least 42% of hydrogen used in industry must be RFNBOs, increasing to 60% by 2035. For transport, member states must choose between a 29% renewable energy share or a 14.5% reduction in GHG intensity. Additionally, a binding sub-target of 5.5% for advanced biofuels and RFNBOs applies to renewable energy supplied in transport, with at least 1% RFNBOs required by 2030 [9]. The RED II and III frameworks establish fossil fuel comparator values of 94 gCO2eq/MJ for most energy uses and 183 gCO2eq/MJ for electricity used in transport. Producers may demonstrate compliance through either an EU-recognized such as voluntary scheme or a domestic certification system [10].

2.2 CertifHy and CertHiLAC

CertifHy is one of the earliest hydrogen certification schemes in Europe and globally. Initiated by the European Commission and funded by the Clean Hydrogen Partnership, the CertifHy Scheme manages certificate issuance, registry, and lifecycle through a centralized European database. CertifHy defines two primary labels:

"CertifHy Low Carbon Hydrogen" and "CertifHy Green Hydrogen." The former applies to hydrogen with a well-to-gate Product Carbon Footprint (PCF) at least 60% below a defined fossil benchmark, specifically below 36.4 gCO_2e/MJ, referencing emissions from Steam Methane Reforming (SMR). The latter includes the same emission savings criteria but adds the requirement that hydrogen is produced entirely from renewable sources such as biogas, hydro, wind, or solar energy. Hydrogen from non-renewable but low-carbon sources, such as nuclear or fossil fuels with CCS, may qualify under the low-carbon label. Importantly, this is the CertifHy Guarantee of Origin (GoO), which operates on a book-and-claim basis. It is not uniformly endorsed across all 27 EU member states, and—most critically—it cannot be used to demonstrate compliance with EU RED II/III requirements [8].

CertifHy operates a voluntary system with two branches: the "CertifHy Scheme" (GoO) and the "CertifHy Voluntary Scheme" (PoS). While the former CertifHy GoO certificates are issued electronically and expire one year after issuance, the latter are compliant with the Renewable Energy Directive II (RED II) and formally recognized by the European Commission. Auditing and verification are performed by independent third parties to ensure compliance with sustainability thresholds. The scheme facilitates international trade by offering traceable and tradable certificates, a feature that has inspired parallel efforts globally [2]. In Latin America, CertHiLAC is an emerging regional initiative partially modeled on CertifHy. It is discussed in detail in Section 3.6 of the following chapter in the context of Chile and Peru, both member economies of APEC in Latin America.

2.3 ISCC

The International Sustainability and Carbon Certification (ISCC) provides a global voluntary framework for certifying sustainable, low-carbon fuels and feedstocks, including hydrogen. The ISCC is an independent, multi-stakeholder organization that develops voluntary certification schemes for sustainable, low-carbon fuels and feedstocks. Its schemes include ISCC EU, ISCC CORSIA, and ISCC PLUS, which are designed to facilitate multiple market applications from a single audit process. ISCC EU is a voluntary scheme recognized by the European Commission for demonstrating compliance with RED II sustainability and GHG emission savings criteria. It also addresses broader ecological and social metrics, including land use change, water consumption, and labor conditions [8].

ISCC PLUS specifically extends coverage beyond EU biofuels to include food, feed, plastics, chemicals, textiles, and renewable hydrogen markets globally. The scheme can be customized for regional contexts and uses ISCC's PCF (Product Carbon Footprint) methodology, allowing cradle-to-gate or cradle-to-grave analysis. The standard employs various chains of custody models such as mass balancing, physical segregation, and controlled blending. For hydrogen, ISCC PLUS facilitates certification as a renewable fuel or RFNBO depending on the origin and emissions profile, and it complies with RED II thresholds where applicable. Certification is performed by third-party auditors and coordinated centrally by ISCC, making the system robust and internationally recognized [2, 8].

2.4 GH2 Standard

The Green Hydrogen (GH2) Standard was launched in May 2022 as a voluntary, global scheme that defines green hydrogen as hydrogen produced via water electrolysis powered by 100% renewable energy, and to have greenhouse gas emissions of no more than 1 kg CO2e per kg H2, averaged over a year. This threshold includes both Scope 1 emissions from the production process, such as desalination and water treatment, and Scope 2 emissions from on-site or purchased renewable electricity. The GH2 Standard encourages reporting of downstream emissions too [2, 11].

Certification against the GH2 standard is offered to project developers who meet the technical requirements and agree to licensing terms. Certified producers can trade GH2 certificates of origin and use the "GH2 Green Hydrogen" label. The scheme is also being expanded to cover hydrogen derivatives such as green ammonia. Although still voluntary, GH2 is actively engaging national governments to harmonize definitions and methods with the revised RED II and intends to serve as a recognized scheme under the EU framework. Importantly, GH2 certification allows for the acceptance of national systems that meet equivalent standards, reducing redundancy in documentation and audit burden [11].

2.5 TÜV SÜD

In addition to the EU-recognized voluntary schemes, a number of other private, voluntary initiatives exist in Europe. As an illustrative example, this section describes the TÜV SÜD scheme. TÜV SÜD is a German-based international certification body offering a voluntary scheme for green hydrogen production under its proprietary TÜV SÜD Standard CMS 70. The certification applies two boundary definitions: "point of use" for transport applications and "point of production" for all other uses. The system supports two chain-of-custody models: mass balance for transport, and book-and-claim for other applications. The CMS 70 scheme complies with CertifHy's GHG thresholds and aligns with the EU's Renewable Energy Directive II (RED II), including its delegated acts for RFNBO certification [2].

The CMS 70 scheme is used to provide two levels of certification: 'GreenHydrogen', awarded when basic sustainability and carbon intensity criteria are met, and 'GreenHydrogen+', which is granted when additional requirements are fulfilled. Both follow a cradle-to-gate system boundary and require Product Carbon Footprint (PCF) calculations based on ISO 14040 and 14044, as well as Annexes V and VI of RED II. TÜV SÜD uses comparator values of 80 or 94 gCO2-eq/MJ depending on application, and mandates at least a 70% GHG reduction compared to these values, or a maximum of 91 gCO2-eq/MJ [8]. TÜV SÜD also serves as a recognized certification body for other schemes, including CertifHy and

ISCC PLUS. This enables it to offer dual certification to both its CMS 70 standard and CertifHy's framework, which is an increasingly valuable advantage for producers navigating overlapping regulatory systems [12].

Table 2.2.1 International hydrogen certification systems, standards, and mechanisms with life-cycle overview

Name	Type	Product Covered	Purpose	System Boundary	Status	Emission Intensity	Methodology / Standard
CertifHy / CertHiLAC	Certification **scheme**	Renewable and low-carbon H_2	Voluntary certification; traceability, consumer transparency, trade facilitation; EU alignment for RFNBOs	Cradle (well)-to-gate; LCA scope includes feedstock, production, energy input	Active	<36.4 gCO_2-eq/MJ; renewable H_2 should additionally be sourced from renewables.	ISO 14040/44 + RED II (for RFNBOs)
ISCC (EU, CORSIA, PLUS)	Certification **framework (scheme)**	Biofuels, RFNBOs, Renewable H_2, feedstocks, chemicals	Voluntary; supply-chain trace ability, RED II/III compliance, global market access	Flexible; cradle-to-gate or cradle-to-grave depending on application	Active	No fixed threshold; RED II/III GHG methodology applied	RED II/III + ISO 14040/44 (for PCF)
GH2 Standard	Certification **mechanism**	Renewable H_2 and derivatives (e.g. ammonia)	Voluntary; defines "green H_2," market recognition, investment assurance, supply chain transparency	Well-to-gate	Active (as standard)	≤1 kg CO_2-eq/kg H_2	IPHE H_2 Guidance Methodology
TÜV SÜD (CMS 70)	Certification body (Proprietary **scheme**)	H_2 (Green Hydrogen, GreenHydrogen+)	Voluntary; product labeling, dual certification; supports multiple chain-of-custody models	Cradle-to-gate (point-of- use for transport)	Active	≥70% GHG reduction; ≤91 gCO_2-eq/MJ	ISO 14040/44 + RED II + CMS 70 + CertifHy thresholds
I-TRACK (HX)	Certification + registry-based attribute tracking (I-TRACK Standard)	Hydrogen and derivatives	Ex-post, evidence-based certificates enabling digital traceability, interoperability and stacking with other product codes/labels; supports compliance and market claims	Flexible; evidence-based, hybrid chain-of-custody; lifecycle attributes tracked; ISO/TS 19870 applicable	Operational (pilots completed; additional projects underway)	No single fixed global threshold; three-tier data model + benchmark rating	Flexible; ISO/TS 19870 applied in pilots; supports Scope 2 stacking via I-REC(E)

3. International Legal Frameworks, Schemes and Standards

In this chapter, we provide a comparative assessment of the current hydrogen certification frameworks and clean fuel standards adopted across selected APEC economies. The focus is on understanding how different economy-wide and sub-economy authorities approach the development of certification mechanisms through dedicated schemes (like Guarantees of Origin), regulatory definitions of low-carbon hydrogen, or market-based crediting programs. Each section examines an individual economy or region, outlining the specific certification scheme in place, its methodology for carbon intensity calculation, alignment with international standards, and mechanisms for verification and trade. The assessment presents the frameworks and standards (in use or being developed) for major APEC economies like Australia; Canada; Chile; People's Republic of China; Japan; Korea; New Zealand; the United States (including key state-level initiatives), offering a structured overview of how hydrogen is being certified and integrated into clean energy strategies across diverse policy and regulatory environments.

3.1 Australia

3.1.1 Guarantee of Origin (GO) scheme

Australia's Guarantee of Origin (GO) scheme is an economy-wide certification framework that began operation in November 2025, aimed at tracking and verifying the emissions of various products, including hydrogen and hydrogen energy carriers (such as ammonia), and renewable electricity. Designed to provide lifecycle emissions transparency, the scheme covers the entire production chain from raw material acquisition through production, transport, and storage, up to the point of consumption or international departure. This corresponds to a "well- to-delivery gate" lifecycle boundary. The GO scheme is technology agnostic and does not set any emissions intensity thresholds; rather, it captures emissions from various production methods, beginning with hydrogen by electrolysis and expanding to include steam methane reforming, and solid and pyrolysis gasification and other low emission commodities such as green metals and biomethane. Over time, the GO scheme will expand to include certification of other hydrogen carriers such as methylcyclohexane, ammonia, and liquefied hydrogen [15].

The scheme will operate on a voluntary basis. Eligible participants include producers of hydrogen and hydrogen derivatives as long as their production pathways are covered under the scheme's emissions accounting methodologies. Participation requires meeting regulatory obligations such as proper approvals, data accuracy checks, and fit and proper person requirements [15]. A Product GO certificate will be issued per one functional unit of the certified product, with kilogram being the functional unit for hydrogen, and is designed to be traded alongside the physical product, although flexible arrangements are allowed given molecular interchangeability in transport and storage [15].

The GO scheme will also support Australia's Hydrogen Production Tax Incentive, a refundable tax offset of AUD2 per kilogram of eligible hydrogen produced between 1 July 2027 and 30 June 2040, for a maximum of ten years. This financial mechanism targets medium- to large- scale renewable hydrogen production, and the associated GO certificates will be a means of verifying eligibility for such incentives [16].

Stakeholders in the development process have emphasized the importance of a minimal domestic tracking scheme that includes production technology, location, and scope 1 and 2 emissions, while recognizing the need to align with broader international standards. Although the favored system boundary is "well-to-gate", the Australian framework is being designed with sufficient flexibility to extend to a full lifecycle perspective, if necessary, particularly for international comparability. Current GO scheme emissions coverage includes upstream emissions from feedstock procurement, direct emissions from production, and downstream emissions associated with transport and storage [15,17].

3.1.2 Green Hydrogen Organisation (GH2) Certification

The GH2 certification, led by the Green Hydrogen Organisation, represents an industry-driven international standard that is being applied in Australia. The certification defines green hydrogen strictly as hydrogen produced via electrolysis powered by 100% or near 100% renewable energy. The GH2 standard is designed to allow producers to label their product as "GH2 Green Hydrogen" and access a certificate of origin that is tradable for both green hydrogen and its derivatives, such as green ammonia [18].

The standard imposes a maximum greenhouse gas emissions threshold of 1 kg CO2e per kg H2, incorporating emissions from the entire electrolysis process. GH2 uses the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) methodology with certain modifications, as the original IPHE framework does not fully address storage, conversion, or delivery processes, nor does it set an emissions threshold for these processes. The GH2 standard thus goes further in mandating carbon intensity ceilings and ensuring renewable energy sourcing while also requiring producers to demonstrate system feasibility and compatibility with existing energy markets [18].

3.1.3 Zero Carbon Certification Scheme

Launched by the Smart Energy Council in December 2020, the Zero Carbon Certification Scheme (ZCC Scheme) is another voluntary, industry-led mechanism operating in Australia. The ZCC Scheme functions similarly to a Guarantee of Origin system by certifying that hydrogen and its derivatives, such as ammonia, are produced entirely from renewable energy sources and assigns an embedded carbon intensity rating to the certified product [18].

The certification has been applied in real-world contexts such as ActewAGL's hydrogen refuelling station in Canberra, which sources green hydrogen from 100% renewable inputs and reports zero carbon emissions. It also extends to facilities like Yara International's green ammonia plant under development in Western Australia's Pilbara region, which has already been granted pre-certification under the ZCC Scheme. In addition to hydrogen and ammonia, the scheme also includes emissions assessments for steel production [2]. While technical thresholds or lifecycle coverage parameters are not explicitly detailed, the certification strongly emphasizes renewable inputs and zero-carbon outcomes [18]. The Council is also cooperating with the Green Hydrogen Organisation to develop a global standard for green hydrogen [2].

3.2 Canada

3.2.1 Clean Hydrogen Investment Tax Credit

The Clean Hydrogen Investment Tax Credit of Canada provides fiscal incentives based on the carbon intensity of the hydrogen produced, measured in kg CO2e/kg H2 [19]. Projects that generate hydrogen with a carbon intensity below 0.75 kg CO2e/kg H2, such as those based on electrolysis powered by renewable energy sources, are eligible for the maximum credit rate of 40%. For hydrogen with a carbon intensity between 0.75 and 2 kg CO2e/kg H2, the applicable tax credit is 25%, while a carbon intensity between 2 and 4 kg CO2e/kg H2 qualifies for a 15% credit. Hydrogen with a carbon intensity equal to or greater than 4 kg CO2e/kg H2 is not eligible for this incentive [20]. In the case of ammonia, the credit applies only when it is produced from hydrogen with a carbon intensity below 4 kg CO2e/kg H2, and in such instances, the credit is fixed at 15%, regardless of the specific carbon intensity value within that range [21]. These tax benefits apply to newly acquired and installed equipment up to the year 2033. In 2034, the credit rates are reduced by half, and the program is scheduled to expire entirely after that year.

3.2.2 Clean Fuel Regulations

The Clean Fuel Regulations of Canada aim to reduce the carbon intensity of liquid fuels through a credit-based compliance system. Hydrogen can generate such credits when used as an alternative transportation fuel with a CI lower than that of the fossil fuels it displaces. The Clean Fuel Regulation specify default carbon intensity values of 110 g CO2e/MJ for compressed hydrogen and 150 g CO2e/MJ for liquefied hydrogen [22]. However, producers may report lower values if supported by verified life cycle data. This framework incentivizes the use of low-carbon hydrogen, particularly in fuel cell vehicle applications, and supports investment in related infrastructure and technologies [22].

3.2.3 Low Carbon Fuel Standard

Low Carbon Fuel Standard of British Columbia establishes targets to reduce the carbon intensity of transportation fuels through a credit-based system. Hydrogen can generate credits if its carbon intensity, measured in g CO2e/MJ, is lower than that of the displaced fossil fuels. A default carbon intensity value of 123.96 g CO2e/MJ is assigned to hydrogen [23]. However, producers may apply for lower values supported by verified life cycle data. This mechanism encourages the adoption of clean hydrogen and supports investment in low-carbon infrastructure and technologies within the province [23].

3.3 Chile

3.3.1 Green Hydrogen Action Plan 2023-2030

The framework of Green Hydrogen Action Plan 2023–2030 of Chile proposes mechanisms to ensure alignment with international standards and a phased implementation strategy. Emphasis was placed on regulatory harmonization with key export markets and on the role of certification in fostering credibility and transparency within the hydrogen value chain [24].

It is important to note that the Plan itself does not include a detailed proposal, but rather provides the mandate to develop it. In response to this mandate, a first strategic proposal was prepared through a study supported by GIZ [7], which describes a preliminary phased approach for implementation (2025–2030), guiding principles, and initial sustainability attributes. This proposal serves as a reference framework and remains subject to further refinement and potential changes.

A goal of this final phase is to establish the basis for international recognition of Chilean certificates through bilateral or multilateral agreements, with a focus on ensuring the system meets the stringent EU requirements, particularly those of CertHiLAC, with special emphasis on the Latin America Region [24] (see Section 3.6).

3.4 People's Republic of China

3.4.1 Standard and Evaluation of Low-Carbon Hydrogen, Clean Hydrogen and Renewable Hydrogen

People's Republic of China has established technical criteria to classify hydrogen based on its carbon intensity. According to these criteria, low-carbon hydrogen is defined as hydrogen whose production emits less than 14.5 kg CO2e/kg H2, while clean or renewable hydrogen must emit less than 4.9 kg CO2e/kg H2 [25]. These thresholds enable a technical differentiation between production technologies. However, the 14.5 kg CO2e limit is relatively high compared to conventional grey hydrogen (typically ranging from 10 to 13 kg CO2e/kg H2), and the 4.9 kg CO2e value is more tolerant than the threshold adopted by the European Union under the CertifHy scheme (4.37 kg CO2e/kg H2) [25, 26]. Nevertheless, these standards reflect an approach aimed at facilitating the progressive adoption of clean hydrogen in People's Republic of China, while promoting certification frameworks and traceability mechanisms that are compatible with future international requirements.

3.5 Japan

3.5.1 Hydrogen Society Promotion Act

Japan's Hydrogen Society Promotion Act, enacted in May 2024, serves as the primary regulatory framework to accelerate the adoption and utilization of hydrogen and its derivatives as low-carbon energy carriers. As a regulatory scheme, it integrates certification with national level incentives administered by the Japan Organization for Metals and Energy Security (JOGMEC) [27]. Central to the Act is the formalization of carbon intensity thresholds for various hydrogen-derived products, expressed as the CO2 emissions associated with the production of a unit quantity of hydrogen or its derivative.

The Act sets a lifecycle emissions boundary based on the product category. For hydrogen and ammonia, the emissions are calculated on a "well-to-gate" basis, incorporating emissions from feedstock acquisition through to the point of product manufacture. Specifically, the carbon intensity thresholds are defined as 3.4 kg CO2-eq/kg H2 for hydrogen and 0.87 kg CO2-eq/kg NH3 for ammonia, both reflecting a 70% reduction in emissions relative to their conventional gray equivalents [28, 29].

For synthetic fuels and synthetic methane, both derived from low-carbon hydrogen and captured CO2, the Act requires a "well-to-wheel" emissions boundary. This broader lifecycle scope includes emissions not only from production and transportation but also from end-use combustion. The carbon intensity thresholds for these fuels are defined as 39.9 g CO2-eq/MJ for hydrogen-based synthetic fuels and 49.3 g CO2-eq/MJ for synthetic methane [29].

3.5.2 Tokyo Green Hydrogen Certification Scheme

In 2024, the Tokyo Metropolitan Government announced a voluntary hydrogen certification scheme specifically tailored for commercial entities operating within Tokyo. This initiative is designed to incentivize the local use of green hydrogen through a retrospective verification of a company's green hydrogen usage during the previous year. The system certifies businesses according to three categories based on hydrogen sourcing: on-site, local production and use, and off-site supply chains [30].

The certification verifies both the source and environmental profile of the hydrogen consumed. In particular, it confirms that the hydrogen was produced using renewable electricity and assesses the carbon intensity of the entire supply chain, including emissions associated with production and transportation. By distinguishing between various supply modalities and focusing on renewable provenance and emissions transparency, the scheme serves both to encourage demand and set a regional standard for urban hydrogen sustainability [30].

3.5.3 Aichi Low-Carbon Hydrogen Certification Scheme

Since April 2018, Aichi Prefecture has operated a regional low-carbon hydrogen certification initiative with a specific focus on production-side emissions. The scheme certifies hydrogen production projects that utilize renewable electricity, biogas, or byproduct hydrogen obtained from sodium hydroxide processes. It emphasizes direct emissions from production rather than broader lifecycle impacts [31].

To qualify, projects must use electrolysis powered by renewable energy, steam reforming of biogas, or hydrogen captured as a byproduct from sodium hydroxide manufacturing. Once certified, the actual CO2 emissions associated with the hydrogen production process are measured and recorded. This regionally led certification reflects Aichi's strong industrial presence and commitment to low-carbon innovation, particularly given its association with Toyota Motor Corporation [31].

3.6 Latin America and Caribbean

3.6.1 Clean Hydrogen Certification System for Latin America and the Caribbean

In Latin America, CertHiLAC is a developing regional initiative modeled partly on CertifHy. Backed by the Inter-American Development Bank and the Latin American Energy Organization, CertHiLAC has brought together 14 governments to form a coordinated certification framework for clean and low-carbon hydrogen. The initiative is in its early stages of development [3]. It is a voluntary regional certification system for clean and/or low-carbon hydrogen. This system aims to harmonize efforts among economies in the region, enhance hydrogen traceability, and facilitate its integration into international markets, particularly the European Union [32]. Unlike other schemes that rely on labels such as "green" or "blue," CertHILAC focuses on reporting key product attributes, including carbon intensity, measured using international methodologies (e.g., ISO, IPHE) following either a "Well-to-Gate" or "Well-to-Wheel" approach, depending on the target market. This allows for a transparent assessment of emissions associated with hydrogen production, enabling comparability and certification without imposing rigid technological classifications [32].

3.7 New Zealand

New Zealand does not currently possess a comprehensive, hydrogen-specific mandatory certification scheme. Instead, it is participating in ongoing international standardization efforts while encouraging the voluntary development of local schemes. The Government supports mutual recognition of international schemes and is actively engaging with industry stakeholders. Progress includes the adoption of the international ISO/TS 19870:2023 standard on hydrogen lifecycle emissions, with more standards expected by 2025 [33]. APEC has also funded research on regional alignment with international emissions-based methodologies such as the IPHE framework [3].

3.7.1 New Zealand Certificate System (NZ-ECS)

While not specifically tailored to hydrogen, the New Zealand Energy Certificate System (NZECS) provides a platform for certifying the renewable or zero-carbon attributes of energy production through the issuance and trading of Energy Attribute Certificates (EACs). These NZ-ECs serve as proof that energy consumed or produced originates from renewable or zero-carbon sources, enabling both bundled (with physical energy) and unbundled (separate from energy supply) transactions [34]. As of October 2023, the NZECS has expanded to include renewable gas, including hydrogen (and derivatives) produced via low- or zero-carbon pathways such as electrolysis [35].

The NZ-ECS operates as a voluntary mechanism, driven largely by the interests of consumers seeking to meet decarbonization goals and by producers looking to market clean energy. The system is administered by Certified Energy, which maintains both the registry and the rulebook governing issuance, transfer, and redemption of NZ-ECS [34]. The certification framework includes verification of production methods and rules for certificate attribution [35]. The NZ-ECS aligns with global reporting frameworks such as the Greenhouse Gas Protocol and ISO 14064-1 to ensure credibility and interoperability in international reporting [34]. Further flexibility to integrate broader sustainability metrics, such as land use impact and cultural considerations, is being considered as they are increasingly relevant in New Zealand's context [35].

3.8 Peru

3.8.1 Green Hydrogen Roadmap

Peru does not yet have an operational hydrogen certification system, but ongoing legislative and regulatory developments demonstrate strong commitment to establishing one. The 2022 Hydrogen Roadmap set clear annual targets, leading to the approval of the Law for the Promotion of Low Carbon Hydrogen in 2024, which includes provisions for a certification strategy [36, 37]. In 2025, the Peruvian Hydrogen Association, in collaboration with the British Embassy in Lima, presented a proposed regulation to implement the law [38]. Peru is also actively engaged in regional efforts to harmonize certification through initiatives such as CertHiLAC under the IDB's LAC Green Hydrogen Action framework (see Section 3.6).

3.9 Korea

3.9.1 Clean Hydrogen Certification System

Korea officially implemented its national hydrogen certification system in December 2023 through the Clean Hydrogen Certification System. This regulatory scheme aims to promote the production and importation of low-emission hydrogen by granting certifications based on lifecycle GHG emissions. Hydrogen is certified as "clean" when emissions from its production or importation process fall below the defined carbon intensity threshold of 4.0 kg CO2-eq/kg H2 [39].

The certification relies on a "well-to-gate" system boundary, encompassing emissions from raw material extraction to hydrogen production, and GHG quantification encompasses all three scopes [40]. Temporarily, however, emissions from maritime transport for raw material procurement and CO2 transport are excluded, as Korea currently has limitations in domestic hydrogen feedstock supply and zero-emission shipping technologies [39]. The certification is further stratified into four grades based on GHG intensity: 0.00–0.10 kg CO2-eq/kg H2 for Grade 1; 0.11–1.00 kg CO2-eq/kg H2 for Grade 2; 1.01–2.00 kg CO2-eq/kg H2 for Grade 3; and 2.01–4.00 kg CO2-eq/kg H2 for Grade 4.

To obtain certification, applicants must first complete construction of a hydrogen facility, obtain all required legal permits, and submit a formal application to the designated certification operating institution. Once verified, the certified clean hydrogen volume is determined based on either the first domestic sale (for domestic producers) or the port unloading approval (for imports) [40].

Amendments to the Hydrogen Act have introduced additional classifications including: (i) zero-carbon hydrogen, which entails no GHG emissions during production or importation, and (ii) low-carbon hydrogen compounds, covering hydrogen carriers used for transportation purposes, such as ammonia, that meet specific GHG thresholds. Furthermore, the law imposes mandatory clean hydrogen usage obligations on specific categories of businesses, particularly fuel supply facilities and hydrogen users. Entities failing to meet these quotas are subject to fines [41].

3.9.2 Clean Hydrogen Portfolio Standard (CHPS)

Korea has also developed the Clean Hydrogen Portfolio Standard (CHPS), a market- based, mandatory supply scheme integrated into the domestic hydrogen strategy. The CHPS was initiated under the Hydrogen Act of 2020 and differs from the conventional Renewable Portfolio Standard (RPS) by excluding hydrogen and fuel cells from RPS coverage and creating a dedicated mechanism for hydrogen-based energy. The CHPS mandates power retailers to procure a specific quota of hydrogen- and ammonia-based electricity annually [42].

Although officially implemented in 2024, the CHPS will open a forward trading market in 2027. This market structure allows for long-term contracts (up to 15 years) between the government and clean hydrogen power producers. The goal is to stimulate investment in clean hydrogen power generation through purchase guarantees and price certainty [39, 43]. The CHPS design distinguishes between two compliance pathways: "general" and "clean," thereby allowing for a transitional shift towards lower-emission hydrogen in power generation [42].

3.10 United States

3.10.1 Clean Hydrogen Production Standard (CHPS)

The Clean Hydrogen Production Standard (CHPS) was released in draft form by the U.S. Department of Energy (DOE) in September 2022. Although it is not binding, it defines a carbon intensity benchmark intended to guide DOE's strategic funding decisions under Title VIII of the Energy Policy Act of 2005, including support for the Regional Clean Hydrogen Hubs and the Clean Hydrogen Research and Development Program [44]. The CHPS provides critical guidance for DOE's funding decisions under the Infrastructure Investment and Jobs Act (BIL) and the Inflation Reduction Act (IRA). While the BIL defines clean hydrogen narrowly as that produced with less than 2 kgCO2e/kg H2 at the production site, the IRA supports a broader interpretation using lifecycle emissions below 2 kgCO2e/kg H2 as the clean hydrogen threshold [45].

The CHPS sets an initial lifecycle carbon intensity limit of 4 kgCO2e/kg H2, calculated on a well-to-gate basis. This benchmark aligns with a majority of stakeholder feedback and serves as the eligibility basis for DOE-supported programs [44]. The methodology accounts for upstream emissions including feedstock and process emissions, excluding construction emissions. Additionally, it sets expectations for technology cost goals and decarbonization targets across the hydrogen value chain. The GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) model is the primary tool used for emissions calculation, enabling consistency in evaluating hydrogen production technologies and pathways. Although CHPS is not a certification in the traditional legal sense, it acts as a de facto standard to shape project development, signal environmental quality, and inform market actors of acceptable carbon performance.

3.10.2 Section 45v Hydrogen Production Tax Credit (PTC)

The Section 45V Hydrogen Production Tax Credit (PTC) provides a scalable financial incentive for clean hydrogen production in the United States. Established under the IRA and effective from 2023 through 2033, the PTC allows hydrogen producers to claim a tax credit of up to USD3 per kilogram of qualifying clean hydrogen. The value of the credit is tiered based on lifecycle greenhouse gas (GHG) emissions intensity, with the maximum credit awarded to hydrogen that meets the clean hydrogen threshold of $\leq$ 4 kgCO2e/kg H2 [46]. To calculate emissions, producers must use the 45VH2-GREET model, which employs a well-to-gate approach excluding construction-related emissions [3].

To qualify for the highest subsidy, producers must meet wage and apprenticeship criteria, and document electricity use via Energy Attribute Certificates (EACs), which verify incrementality, temporal matching, and deliverability. Projects that meet prevailing wage and apprenticeship standards are eligible for bonus credits, making the credit a key tool in linking decarbonization with social policy objectives [3]. The tax credit supports multiple hydrogen pathways, including electrolysis and methane reforming, while disqualifying emissions-intensive methods. Hydrogen production using biogas or renewable natural gas (RNG) must originate from the first productive use of methane to qualify [47]. Additionally, producers may opt for an alternative investment tax credit (ITC) under Section 48 or combine the PTC with Section 45Q carbon capture credits where applicable. The IRS finalized regulatory guidance on verification, facility retrofits, credit election, and emissions accounting in June 2024 [48]. As such, the 45V tax credit effectively lowers the cost gap between clean and grey hydrogen, reduces investment risk, and creates a functional certification-like mechanism that signals carbon intensity compliance for market access, procurement eligibility, and public-private financing [48, 47].

3.10.3 California Low Carbon Fuel Standard (LCFS)

Established in 2011 and administered by the California Air Resources Board (CARB), the Low Carbon Fuel Standard (LCFS) is a government-led, market-based incentive scheme designed to reduce the carbon intensity of transportation fuels in California [49]. The program is mandatory for fuel suppliers and operates on a Book & Claim model. It aims to achieve a 30% reduction in carbon intensity by 2030 and a 90% reduction by 2045, relative to a 2010 baseline [50].

The LCFS covers a broad range of fuels, including gasoline, diesel, CNG, LNG, electricity, and hydrogen. Hydrogen producers can generate LCFS credits if the fuel is used for transportation, either via fuel cells or as a chemical feedstock [49].

These credits are tradeable within the LCFS Credit Market. The carbon intensity (CI) of hydrogen is calculated based on its production pathway. The corresponding emission range for hydrogen fuel production is between 1.3 and 18.1 kgCO2eq/kgH2, with renewable hydrogen at the lower end and SMR without carbon capture and storage (CCUS) at the higher end [2].

The LCFS applies a Well-to-Wheel (WTW) lifecycle boundary, encompassing all emissions from feedstock extraction to fuel use. Credit generation is possible via three mechanisms: fuel- based crediting, project-based crediting through CCS, and capacity-based crediting for zero- emission vehicle infrastructure [49]. Since its inception, the LCFS has successfully displaced 75% of the diesel used in California with lower-carbon alternatives and reduced over 320 million metric tons of CO2 [49]. The amended LCFS is set to begin implementation on 1 July 2025, following approval from the Office of Administrative Law.

3.10.4 Oregon Clean Fuels Program

The Oregon Clean Fuels Program (CFP) was established in 2016 and is administered by the Oregon Department of Environmental Quality. It is a mandatory, statewide market-based incentive program designed to lower the carbon intensity of transportation fuels used within Oregon. The program uses a lifecycle-based methodology that considers all stages of fuel production and distribution, including extraction, refining, dispensing, and combustion [51].

The baseline year for the CFP is 2015. The program mandates a 10% reduction in carbon intensity by 2025, a 20% reduction by 2030, and a 37% reduction by 2035 relative to baseline levels [52, 51]. These targets apply separately to gasoline and gasoline substitutes, diesel and diesel substitutes, and alternative jet fuels. Regulated entities include importers and producers of gasoline, diesel, ethanol, biodiesel, and renewable diesel. Voluntary participants can include providers of hydrogen, electricity, propane, and natural gas, depending on whether they own the dispenser or charger [52].

The program supports compliance through a credit system. Credits are earned when a fuel provider exceeds annual carbon intensity reduction targets. These credits, measured in metric tons of avoided greenhouse gas emissions, can be banked, traded, or sold to other regulated parties. Obligated entities must reconcile credits and deficits annually through the Oregon Fuels Reporting System [52].

3.10.5 Clean Washington Clean Fuel Standard (CFS)

The Washington Clean Fuel Standard (CFS), implemented in January 2023 and enforced by the Department of Ecology, mandates a 20% reduction in the carbon intensity of transportation fuels by 2034, relative to a 2017 baseline. The CFS is a mandatory, market-based policy targeting the full lifecycle emissions from transportation fuels [53].

The CFS distinguishes between mandatory and opt-in fuels. Mandatory fuels include fossil- derived gasoline, diesel, LNG, CNG, and various hydrogen blends. Opt-in fuels include electricity, renewable propane, and alternative jet fuels. The program allows credit generation, credit banking, and the use of a Credit Clearance Market to balance annual obligations. Fuel suppliers must register and report via the Washington Fuels Reporting System [50].

Recent legislative updates under HB 1409, passed in March 2025, further strengthen the CFS. The bill enhances pollution reduction goals and increases funding for clean transportation investments. Public and private providers of hydrogen fueling services and EV charging infrastructure are eligible to generate and sell clean fuel credits under the program. Ecology has established a registry to manage these credits, and third-party service providers may assist with registration, reporting, and credit market operations [54].

3.11 APEC economies without current certification framework/ scheme

3.11.1 Brunei Darussalam

Brunei has no hydrogen certification system in place. However, the approval for I-REC(E) certificate issuance by the International REC Standard Foundation aims to support its clean energy ambitions, targeting 30% renewables by 2035 [55].

3.11.2 Chinese Taipei

Chinese Taipei is progressing toward international alignment on hydrogen certification, though no dedicated system exists yet. It operates the T-REC system for renewable energy and recognizes the need to close regulatory gaps for low-carbon hydrogen certification and market development [56].

3.11.3 Hong Kong, China

Hong Kong, China is advancing its hydrogen agenda through the Hydrogen Development Strategy released in 2024 [57], which address the technical challenges in the six major areas of safety, suitable technologies, infrastructure, cost effectiveness, capacity building, and public acceptance, as well as the unique situation of Hong Kong, China [57]. Formulating an approach for certifying a hydrogen standard is mentioned in one of the major strategies. While a dedicated certification system for hydrogen is not yet in place (under development), efforts are underway to align market practices and to link up with the financial sectors. Collaborations with Chinese Mainland authorities on standardization and other quality infrastructure establishments are part of the cross-boundary plans to support the industry on green energy transformation, which are also backing by green financing. Hong Kong, China is also closely monitoring international developments, including ISO technical specifications, with the goal of establishing a tailored hydrogen certification system by 2027. These initiatives are coordinated under the Environment and Ecology Bureau and the Electrical and Mechanical Services Department [58].

3.11.4 Indonesia

Indonesia accounts for 41% (the largest) of ASEAN's total hydrogen production. Indonesia plans to integrate green hydrogen across key sectors—transport, industry, power, and commodities. The 2023 National Hydrogen Strategy outlines phased development of its hydrogen economy. Phase 2 (2031–2040) includes regulatory frameworks for certification, guarantee of origin, and technical standards for production, storage, and transport. This phase will also address licensing protocols, define purity thresholds, and set safety and metering standards to ensure traceability and compliance with international export requirements [59].

3.11.5 Malaysia

Malaysia is the leading exporter of hydrogen among the ASEAN economies, with exports to are China; India; and Japan. In October 2023, Malaysia launched its Hydrogen Economy and Technology Roadmap (HETR). There are three goals, five strategic thrusts, nine strategies and 29 action plans over three phrases: short term (2022-2030), midterm (2031 – 2040) and long term (2041-2050) in the Hydrogen Roadmap [60]. However, it lacks a unified policy and certification framework. Institutions like SIRIM are expected to develop safety standards and certification schemes to support industry needs. Implementation will require clear transition timelines, regulatory alignment, and financial incentives to attract investment, while domestic entities like PETRONAS need to lead infrastructure and compliance development [61].

3.11.6 Mexico

Mexico currently lacks a specific regulatory framework for hydrogen, despite recent legislative and strategic efforts to support its development. In 2024, the Ministry of Energy introduced the Guidelines on Hydrogen to establish a roadmap for clean hydrogen deployment [62], while the Clean Hydrogen Industrial Strategy outlined plans to integrate hydrogen in key sectors such as mining, public transportation, metallurgy, others [63]. Regulatory instruments, both binding and nonbinding, aim to promote decarbonization and enable hydrogen integration into the energy system. The Energy Regulatory Commission is reviewing existing rules to allow hydrogen blending with natural gas in combined cycle plants. The updated National Electric System Development Programs PRODESEN 2023 to 2037 and 2024 to 2038 identify green hydrogen as a key technology for Mexico's energy transition [64, 65]. However, regulatory uncertainty persists, and hydrogen-related technical standards remain under development. In 2020, efficiency measurement methods for hydrogen were introduced and updated in 2023, requiring a minimum of 70 % efficiency for hydrogen to qualify as clean energy [66, 67].

3.11.7 Papua New Guinea

Papua New Guinea as part of efforts to diversify energy sources and mitigate climate change, the economy aims to leverage these resources for green hydrogen, reducing fossil fuel dependence and enhancing energy security. This strategy seeks to establish Papua New Guinea as a role in the global hydrogen market, attract investment, and promote sustainable development. Nevertheless, a dedicated green hydrogen strategy has yet to be established [1]. Therefore, Papua New Guinea does not have regulations related to hydrogen certification and standards as of now.

3.11.8 The Philippines

The Philippines plans to establish a national hydrogen certification system that will be aligned with international standards. While a formal certification framework has yet to be developed, the Department of Energy has already begun adopting hydrogen-related international standards as part of its regulatory approach. In parallel, the government is also working on the formulation of a National Hydrogen Roadmap, which will serve as a strategic guide for advancing the economy's hydrogen industry.

3.11.9 Russia

Russia lacks a formal hydrogen certification system despite actively developing low-carbon hydrogen based on natural gas industry resources (methane and hydrogen sulphide) and hydrogen based on nuclear energy. Engagement with the BRICS economies on sustainability standards and certification alignment could be beneficial. Joint research and infrastructure development may foster future cooperation [68].

On the corporate level PJSC Gazprom among other leading companies including Rosatom leads the charge in developing hydrogen energy in Russia (section "Hydrogen Energy Development and Industry and Transport Decarbonization Driven by Natural Gas" of the Hydrogen Energy Development roadmap). To support this high-tech area, the Russian Government and PJSC Gazprom signed a Letter of Intent, under which the Company continues to develop competitive domestic technologies and pilot hydrogen energy projects such as technology for producing hydrogen from natural gas and hydrogen sulfide with limited GHG emissions, creation and use of molten-carbonate fuel cells, technical solutions for production of natural hydrogen. The key tool for furthering this Letter of Intent is the joint implementation of the Hydrogen Energy Development roadmap through 2030, which was approved by the interdepartmental working group on hydrogen energy in the Russian Federation.

3.11.10 Singapore

Singapore is developing a certification framework for low-carbon hydrogen to support trade and supply chain scaling under its National Hydrogen Strategy. Efforts include interoperable Guarantee of Origin methodologies and partnerships with Australia; Chile; Japan; and New Zealand to enable cross-border certification and standards development [69, 70].

3.11.11 Thailand

Thailand is the second largest hydrogen producer among ASEAN economies and accounts for 20% of its volume. Thailand's energy policy is defined in its PDP 2024, which has a four-pillar strategy: market incentives, R&D, infrastructure, and standards. According to the policy, transport- related hydrogen standards are scheduled for Phase 3, post-2040 [71]. Export viability depends on carbon pricing and international certification readiness. While green hydrogen production is targeted for the 2030s, comprehensive measurement protocols and standards remain undefined, limiting long-term competitiveness against low-cost producers such as India; Australia; and the Middle East [72].

3.11.12 Viet nam

Viet Nam is currently developing hydrogen certification, standards, and related technical attributes, though no formal certification system has been adopted or aligned with international frameworks. Since 2020, the economy has integrated hydrogen into its energy strategy, initially targeting the transport sector [73]. In 2024, Viet Nam introduced a green hydrogen strategy to complement its domestic energy roadmap and global decarbonization trends, with a focus on renewable-based hydrogen production [74]. Ongoing efforts include the development of technical regulations on hydrogen safety, blending with natural gas, and infrastructure adaptation, as well as the review and revision of national regulations covering production, storage, transport, and CCS/CCUS to align with international standards [75].

4. Mapping of Hydrogen Certifications in APEC economies

In this chapter, we present a consolidated tabular mapping of hydrogen certification schemes and related clean fuel standards across APEC economies. Whereas the previous chapter provided a detailed, narrative analysis of individual economy-level approaches, this chapter distills those insights into two comparative tables. These tables offer a consolidated view of key characteristics, enabling an at-a-glance comparison of the schemes' purposes, coverage, system boundaries, implementation statuses, and emission intensity thresholds.

The economies of Australia; Canada; People's Republic of China; Japan; Korea; New Zealand; and the United States, all of which have implemented or are considering certification and standardization schemes for low-emission fuels. A shared characteristic among these economies is their membership in the G20 and their significant influence on the global economy, either as advanced economies or, in the case of People's Republic of China, as an emerging power. From an energy perspective, these economies exhibit high per capita energy demand, driven by factors such as industrialization, climatic conditions, and dependence on transport and energy-intensive industries. Despite structural differences, all have committed to achieving carbon neutrality, with most aiming for the year 2050 and China targeting 2060. They are actively pursuing energy transition strategies, including the development of renewable energy, hydrogen technologies, carbon capture and storage, and electric mobility. Furthermore, these economies have a significant climate footprint, whether measured by historical, current, or per capita emissions, and are actively engaged in multilateral forums such as APEC, the Paris Agreement, and initiatives focused on clean energy and climate innovation.

Table 4.1 summarizes high-level features of each identified certification scheme/ standards, including its name, jurisdiction, hydrogen, or derivative products covered, stated purpose, life cycle boundary applied, current status, and any defined carbon intensity thresholds. Table 4.2 complements this by mapping the specific process stages each scheme accounts for, i.e., ranging from raw material extraction and production processes to downstream conversion, storage, and final use. Together, these tables provide a structured reference for understanding the heterogeneity and emerging convergence in how APEC economies define and operate hydrogen certification.

Table 4.1 Hydrogen (and derivatives) certification and fuel standards in APEC economies and their life-cycle overview

Name	Economy	Type	Product Covered	Purpose	System Boundary	Status	Emission Intensity
GO scheme	Australia	Certification scheme	Hydrogen, Ammonia, Methylcyclohexane	Voluntary certification for renewable H_2 and derivatives; enables tax credit eligibility	Well-to-delivery	Planned (2025)	None specified
GH2 Green Hydrogen Standard	Australia	Certification scheme	Green hydrogen, green ammonia	Voluntary; supports labeling, trading, and market recognition of green hydrogen, green ammonia	Well-to-gate (electrolysis)	Active	≤ 1 $kgCO_2e/kg$ H2
Zero Carbon Certification Scheme	Australia	Certification scheme	Renewable hydrogen and ammonia	Voluntary; provides Guaran- tees of Origin and carbon in- tensity labeling for renewable H2 and ammonia	Production only	Active	Project-specific zero emissions
Hydrogen Society Promotion Act	Japan	Standard / Regulatory framework	Low-carbon hydrogen, ammonia, synthetic fuels, synthetic methane	Regulatory; supports hydro- gen promotion, incentives, and low-carbon energy adoption	Well-to-Gate (H2 and NH3); Well-to-Wheel (synfuels and methane)	Active	H2: 3.4 kgCO2e/kg; NH3: 0.87 kgCO2e/kg; Synfuels: 39.9 gCO2e/MJ; Syn. methane: 49.3 gCO2e/MJ
Tokyo Green Hydrogen Certification Scheme	Japan	Certification scheme	Green hydrogen	Voluntary; verifies corporate green hydrogen use within Tokyo region	Production + Transport + Use (local)	Planned (2024)	None specified
Aichi Low-Carbon Hydrogen Certification	Japan	Certification scheme	Low-carbon hydrogen	Voluntary; regional low-carbon hydrogen certification to support decarbonization	Production only (direct emissions)	Active	Project-specific
Clean Hydrogen Certification System	Korea	Certification scheme	Hydrogen, hydrogen compounds	Voluntary; supports labeling and incentive-linked certification for hydrogen and derivatives.	Well-to-Gate (excl. ship emissions)	Active	Grade 1: 0–0.1; Grade 2: 0.11–1.0; Grade 3: 1.01–2.0; Grade 4: 2.01–4.0 kgCO2e/kg H2
Clean Hydrogen Portfolio Standards (CHPS)	Korea	Standard / Regulatory framework	Clean hydrogen for power generation	Regulatory; market-based mandate for clean hydrogen in power generation	Well-to-Gate	Planned (2024 full, 2027 market)	None specified (clean hydro- gen)
New Zealand Energy Certificate System	New Zealand	Certification scheme	Renewable electricity and gas (incl. hydrogen/ derivatives)	Voluntary; supports labeling and reporting for renewable electricity and gas, including hydrogen/derivatives	Production (can be flexible)	Active	None specified (low/ zero- carbon)
Clean Hydrogen Production Standard (CHPS)	United States	Standard	Clean hydrogen	Voluntary; provides guidance for DOE funding eligibility and technical criteria for clean hydrogen	Well-to-Gate (may include distribution and end-use)	Drafted(guidance,non-binding)	≤ 4 kgCO2e/kg H2
Section 45V Hydrogen	United States	Incentive	Clean hydrogen	Regulatory/incentive; pro- vides tiered	Well-to-Gate (via	Active (as of 2023)	Tier 1: 2.5–4; Tier 2:

Pro- duction Tax Credit (PTC)		scheme	(electricity and methane)	tax credits for lifecycle-based clean hydro- gen production	45VH2-GREET)		1.5–2.5; Tier 3: 0.45–1.5; Tier 4: 0-0.45 kgCO2e/kg H2
California Low Carbon Fuel Standard (LCFS)	United States (California)	Regulatory / Incentive scheme	Hydrogen and biofuels	Regulatory; market-based mechanism to reduce carbon intensity of transportation fuels including hydrogen	Well-to- Wheel	Active	1.3–18.1 kgCO2e/kg H2 depending on pathway
Oregon Clean Fuels Program (CFP)	United States (Oregon)	Regulatory / Incentive scheme	Hydrogen and biofuels	Regulatory; market-based mechanism to reduce carbon intensity of transportation fuels, incl. hydrogen	Cradle-to-Wheel	Active	CI reduction: 10% by 2025; 37% by 2035
Washington Clean Fuel Standard (CFS)	United States (Washington)	Regulatory / Incentive scheme	Hydrogen and biofuels	Regulatory; market-based mechanism to reduce carbon intensity of transportation fuels, incl. hydrogen	Cradle-to-Wheel	Active	CI reduction: 20% by 2034 vs. 2017
Assessment for Low-carbon Hydrogen, Clean Hydrogen and Renewable Hydrogen Energy	People's Reublic of China	Standard	Hydrogen	Voluntary; promotes high-quality development of China's hydrogen energy industry and facilitates target achievement.	Well-to-gate	Active	Low-carbon hydrogen: 14.5 ; Renewable hydrogen, clean hydrogen: 4.9 kgCO2eq/kgH2
Clean Hydrogen Investment Tax Credit	Canada	Incentive scheme / Standard	Hydrogen and Ammonia	Regulatory/incentive; provides tax credits for clean hydrogen and ammonia production.	Well-to-gate	Active	clean hydrogen: < 0.75, 0.75-2, 2-4 kgCO2eq/kgH2 ; Ammonia <4 kgCO2eq/kgH2
CertHILAC	Chile; Peru	Certification scheme	Hydrogen	Voluntary; flexible mechanism supporting national hydrogen goals in Chile and Peru	Cradle-to-gate (ISO / CertifHy based)	Under development by the InterAmerican Development Bank and Organización Latinoamericana de Energía	Undefined

Table 4.2 Process stage coverage for the certifications and standards in APEC economies

Name	Economy	Raw Material Extraction	Production	Conversion (on site)	Storage (on site)	Transport / Distribution	Conversion	Storage	Final Use	References
GO scheme	Australia	✓	✓	✓	✓	✓	✓	✓		[17]
GH2 Green Hydrogen Standard	Australia		✓	✓	✓					[15]
Zero Carbon Certification Scheme	Australia		✓							[15]
Hydrogen Society Promotion Act	Japan	✓	✓	✓	✓					[28, 29]
Tokyo Green Hydrogen Certification Scheme	Japan	✓	✓	✓	✓	✓	✓	✓	✓	[30]
Aichi Low-Carbon Hydrogen Certification	Japan		✓							[31]
Clean Hydrogen Certification System	Korea	✓	✓							[39, 40]
Clean Hydrogen Portfolio Standards (CHPS)	Korea	✓	✓							[39]
New Zealand Energy Certificate System	New Zealand		✓	✓		✓	✓			[34]
Clean Hydrogen Production Standard (CHPS)	United States	✓	✓							[44]
Section 45V Hydrogen Production Tax Credit (PTC)	United States	✓	✓							[3, 47]
IPHE LCA Methodology	International (incl. U.S.)		✓	✓	✓	✓				[44]
California Low Carbon Fuel Standard (LCFS)	United States (**California**)		✓	✓	✓	✓	✓	✓	✓	[49]
Oregon Clean Fuels Program (CFP)	United States (**Oregon**)	✓	✓	✓	✓	✓	✓	✓	✓	[51]
Washington Clean Fuel Standard (CFS)	United States (**Washington**)	✓	✓	✓	✓	✓	✓	✓	✓	[53]
Standard and Assessment for Low-carbon Hydrogen, Clean Hydrogen and Renewable Hydrogen Energy	People's Republic of China	✓	✓		✓					[25]
Clean Hydrogen Investment Tax Credit	Canada		✓							[76, 77, 78]
CertHILAC	Chile; Peru	✓	✓	✓		✓				[32, 4]

5. Summary and Recommendations

5.1 Advancing Hydrogen Certification Across APEC Economies

Hydrogen and its derivatives are becoming central to decarbonization strategies across APEC economies. However, the development of certification systems is uneven, potentially undermining cross-border trade and investor confidence. Further, with both hydrogen exporters and importers among its members, APEC economies have a unique opportunity to lead on hydrogen certification policy. By coordinating standards and scaling certification practices, APEC economies can accelerate low-carbon trade, build trust, and position themselves as a global clean energy hub.

5.2 Technical Assessment of Hydrogen Certification Stage Coverage in APEC Economies

Table 4.1 and Table 4.2 collectively offer a dual lens on APEC certification schemes: Table 4.1 maps the schemes and their associated life-cycle boundaries, while Table 4.2 dissects the granularity of process stage coverage. Together, they show both structural convergence and policy fragmentation across the region. Next, the common aspects shared among economies are discussed.

5.2.1 Common Ground

Analysis of progress across economies shows that economies already share the main elements needed for credible trade: a clear purpose for certification, use of carbon-intensity metrics, and routine inclusion of the production stage. These choices are already in operation and can support practical steps toward interoperability. Some aspects are described next:

- **Certification Purpose Convergence:** Table 4.1 highlights that most schemes aim to support incentive eligibility, labeling, or investment visibility purposes, which are operationally aligned with covering upstream emissions, especially Scope 1 and 2.
- **Emissions Intensity as a Unifying Metric:** Multiple schemes apply thresholds (Table 4.1), such as 3.4 kgCO2-eq/kg H2 in Japan or <1 kgCO2-eq/kg H2 in GH2, even if system boundaries differ. This creates a shared technical language for future harmonization.
- **Voluntary Frameworks with Regional Scope:** Initiatives like CertifHy and GH2 cover multiple process stages and serve transnational objectives, setting potential templates for interoperability within APEC economies.

- **Production Stage Coverage:** Nearly all certification systems in APEC economies include the production stage (electrolysis, reforming, etc.). This convergence highlights a shared understanding that the emissions associated with hydrogen generation are critical for classification as "clean" or "low-carbon" hydrogen.
- **Raw Material Extraction:** While not universally included, several schemes incorporate raw material extraction (e.g., CertifHy, GH2 Standard), showing a growing interest in upstream emissions accounting. This is particularly relevant for fossil-based or hybrid hydrogen production pathways.
- **Voluntary Coverage of Storage and Transport:** Some voluntary schemes, such as Japan's Tokyo Certification and the GH2 Standard, include storage and distribution phases. These inclusions reflect increasing awareness of infrastructure-related emissions, especially in economies targeting hydrogen exports.
- **Carbon Intensity Metrics:** Most schemes apply CI thresholds using LCA frameworks. Despite variability in numerical thresholds, the presence of quantifiable CI targets offers a technical entry point for harmonization.

From the points described above, convergence on purpose helps explain current boundary choices. Systems that determine eligibility for support programs or labels focus on emissions at the facility, where data are available, and verification is straightforward. This is why many schemes use well-to-gate accounting and concentrate on production. The approach yields stable certificates that investors and regulators can use. It also implies that comparisons across derivatives or long supply chains require additional information on storage, transport, and conversion when those steps affect results. Also, using emissions intensity as a common metric enables comparison even when thresholds differ. Publishing life-cycle numbers for hydrogen and other derivatives (like ammonia) allows claims to be read in comparable terms. Where boundaries are not identical, values can be recalculated to a common frame for cross-border use. This supports mutual recognition based on documented methods rather than new terminology.

The analysis also shows that voluntary, multi-jurisdiction frameworks can be used as templates. They combine established accounting rules with registry operations that handle conversion between carriers and the transfer of attributes through the supply chain. Domestic systems can retain their legal structure while adopting these operational features to facilitate hydrogen trade. Also, coverage of the production stage is now widespread and shows that measurement and verification are feasible at the plant level. This reduces the marginal effort required for interoperability because economies can compare production claims directly. Where raw-material extraction is included, systems present a more complete view of upstream impacts. This is relevant for pathways that combine different electricity sources or use fossil feedstock with capture. Inclusion of extraction does not require a full well-to-wheel scope; it ensures that up-stream differences are reflected when important. Voluntary inclusion of storage and transport shows readiness to extend beyond the plant gate when trade flows depend on it. Accounting for steps such as liquefaction, shipping, regasification, or cracking improves confidence in claims at the point of use.

Finally, emphasis on clear carbon-intensity figures and accompanying calculation methods is a direct way to turn common ground into practice. Transparent information and methodologies allow registry-to-registry pilots and straightforward equivalence notes that explain acceptance conditions. On this basis, economies can progress from aligned concepts to workable recognition pathways without redesigning existing systems.

5.2.2 Divergences Across APEC Economies

Despite a shared focus on production-related emissions, hydrogen certification schemes in APEC economies differ significantly in lifecycle scope, methodological approaches, and treatment of derivatives. These divergences could impede regional harmonization and trade interoperability. Building on the existing overlap in production coverage and carbon intensity accounting, a common framework could foster broader lifecycle coverage while enhancing mutual credibility. Key divergences identified in this assessment are summarized below.

- **Lifecycle Coverage Fragmentation:** While a few schemes (e.g., CertifHy, GH2) adopt well-to-wheel boundaries, most APEC economies apply well-to-gate limits. Differences in downstream coverage, such as conversion to ammonia or e-fuels and final use in fuel cells or combustion, complicate cross-jurisdictional comparisons of environmental impacts.
- **System Boundary and Process Stage Variability:** Some economies (e.g., Australia; Japan) include storage, transport, and downstream processing, whereas others (e.g., Chile; Korea) focus primarily on production. Such inconsistencies affect traceability of emissions and the comprehensiveness of lifecycle accounting.
- **Certification Type versus Depth of Coverage:** Regulatory and incentive-linked frameworks (e.g., Canada's ITC; Japan's mandatory act) often restrict scope to production for simplicity and compliance, whereas voluntary standards (e.g., GH2, CHPS) typically encompass broader process stages. This shows that the instrument type (voluntary vs. mandatory) does not necessarily guarantee lifecycle comprehensiveness.
- **Hydrogen Derivatives Treatment**: Inclusion of ammonia, methanol, and e-fuels is inconsistent. Several schemes omit these derivatives, despite their increasing relevance for international trade and decarbonization strategies.
- **Monitoring, Reporting, and Verification (MRV) and Traceability:** Approaches vary widely. Some certifications employ mass balance methods (e.g., RED II) while others use book-and-claim systems (e.g., CertifHy).

Differences in MRV rigor and reporting transparency directly impact comparability, trust, and market confidence.

The points above show that the main source of variation is the choice of boundaries and product scope. Some systems report results for hydrogen and ammonia from well to gate, while others extend coverage to transport, storage, or final use (only in certain applications). When a result prepared under one boundary is presented to another party that uses a different boundary, the numbers are not directly comparable. Variation also comes from how electricity purchases are treated. Some programs require close temporal matching and location rules, while others accept annual matching with looser conditions. A further gap appears in downstream stages (compression, liquefaction, shipping, regasification, pipeline movement, cracking, and similar steps), which are often left outside the certified value.

Differences also appear in how attributes are handled and transferred. One program may allow a book and claim for electricity, while another requires a physical approach or mass balance for molecules. The immediate concern is double-counting. A minimum set of data on every certificate (for example, batch identifiers or process descriptions) supports traceability regardless of the model used. Upstream extraction and allocation choices create additional variation, especially when fossil feedstock with capture or multiple co-products are involved. Recognition can still proceed if the method is disclosed, applied consistently, and can be recalculated to a reference method on request. Treatment of capture and storage also differs. Some systems give credit at the point of capture, while others require evidence of transport, injection, and monitoring before credit is granted. Clear documentation of rates, infrastructure, and monitoring periods allows importing authorities to assess durability without rejecting otherwise valid claims. Finally, verification practices, registry, and the inclusion of social and environmental aspects are not uniform and import rules may differ from domestic rules. Publishing verification protocols, using common batch identifiers, enabling data exchange between registries in limited corridor pilots, and issuing plain language notes that state which foreign certificates are acceptable (and under what conditions) provide the translation layer needed to reconcile these differences.

5.2.3 Key Findings

Based on the common ground and divergences identified before, the key findings indicate that APEC economies are converging on a workable foundation for trade in hydrogen and derivatives while still differing in scope, depth, and implementation speed. The common use of carbon-intensity metrics and the broad inclusion of the production stage provide a comparable base for claims, which lowers transaction costs for early projects and gives lenders and buyers a clearer view of risk. At the same time, differences in boundary choices, electricity procurement rules, and treatment of downstream stages explain why similar products can carry non-comparable numbers. This does not undermine the findings, but it does require transparent documentation and the ability to recast results to a reference frame when needed. The mapping also shows that inclusion of ammonia and synthetic fuels is advancing, with some programs beginning to handle conversions across carriers and the transfer of attributes through the supply chain. Verification practices and registry operations emerge as practical determinants of credibility. For instance, when audit frequency, data checks, batch identifiers, and transfer records are clear, recognition by importing authorities becomes a procedural matter. A related finding is that targeted corridor pilots (linking an exporter's registry to an importer's acceptance rules) can validate these mechanics at a limited scale before broader uptake, reducing uncertainty around double-counting or boundary translation. Finally, differences in administrative capacity and market maturity mean that not all economies will move at the same pace. The evidence suggests that model rules, calculation files, and equivalence notes are effective tools to narrow gaps without forcing uniform designs. Taken together, the findings point to validating the production stage, extending coverage to material downstream steps where trade flows depend on it, disclosing the methods that affect results, and testing cross-border exchange in pilots that can later be scaled.

- **Diverse Readiness Levels:** Economies such as Australia; Japan; Korea; and the United States, have multiple certification schemes. In contrast, others, including Brunei Darussalam; Indonesia; and Mexico, lack formal certification systems.
- **Dominance of Voluntary Schemes:** Over 70% of current schemes are voluntary, highlighting a preference for flexibility and market-led development during early adoption stages.
- **Partial Lifecycle Coverage:** Most certifications focus narrowly on production (well-to- gate), with limited inclusion of transportation, storage, conversion, or final use stages.
- **Varying Carbon Intensity Thresholds:** Carbon intensity thresholds are defined by legal frameworks. For example, 1 kgCO2e/kgH2 in the EU Delegated Acts and 4.9 kgCO2e/kg H2 in China. Voluntary schemes, such as the GH2 Standard, must align with these values to gain recognition. This reveals a fragmented landscape.
- **Hydrogen Derivatives Underserved:** Few schemes explicitly cover ammonia, methanol, or synthetic fuels, despite their significance for international trade.

5.2.4 Policy Recommendations

The recommendations listed below form a sequenced pathway from alignment on basic definitions to demonstrated cross-border recognition. The immediate priority is to publish clear product definitions, calculation files, and boundary statements for hydrogen, ammonia, and synthetic fuels. This creates a minimum common baseline that lowers transaction costs and allows stakeholders to understand results without ambiguity. Building on that baseline, corridor pilots between selected key stakeholders across the supply chain can test certificate issuance, transfer, and redemption across registries while checking for double-counting when products are stored, transported, converted, or blended. These pilots should rely on a shared data schema (e.g., batch identifiers, process descriptions, transfer events, conversion records, and the accounting method used) so that results can be traced and, when necessary, recalculated to a reference boundary. In parallel, strengthening registry capabilities and verification practices is essential. Calculation tools, transparent audit protocols, and consistent identifiers make equivalence assessments procedural rather than negotiable. Capacity support for economies in an early stage helps close implementation gaps. Aligning incentives with verified carbon intensity and publishing predictable transition timelines reduces policy risk and clarifies eligibility for support programs. Over the medium term, extending coverage beyond production to material downstream steps should be treated as a key aspect. Production results remain the base, and documented increments are added where storage, transport, or conversion affects outcomes. Some actionable items summarizing the recommendations are listed next:

1. **Establish Mutual Recognition Frameworks:** Develop an APEC-wide certification interoperability mechanism to harmonize methodologies and reduce transaction costs.
2. **Support Emerging Economies:** Provide technical assistance, model frameworks, and knowledge sharing to accelerate certification readiness in lower-capacity members.
3. **Align Carbon Accounting Methodologies:** Encourage adoption of ISO and compliant lifecycle assessment methodologies to ensure consistency and credibility.
4. **Expand Certification Scope:** Include downstream processes and Scope 3 emissions and extend certification to key hydrogen derivatives like ammonia and e-fuels.
5. **Leverage Regional Initiatives**: Build upon CertHiLAC and ASEAN platforms to pilot cooperative frameworks and share best practices.
6. **Mobilize Incentives:** Link tax credits, procurement programs, and market access to certified hydrogen products to drive private sector participation.

5.3 Conclusions

This report maps how APEC economies are approaching hydrogen certification and what that means for future trade in hydrogen and its derivatives. It reviews economy-wide and regional initiatives compares system boundaries and stage coverage and summarizes discussion from a regional workshop. The goal is to give decision-makers a clear picture of what is already aligned, what still differs, and which steps can make cross-border recognition practical.

Hydrogen is moving from strategy to implementation across the region. Some economies are building or operating certification systems linked to incentives or import rules, while others are designing for the first time. Most systems measure carbon intensity at the point of production and use life-cycle methods to support that measurement. Several programs also look upstream at raw materials, and some extend coverage to storage, transport, and conversion when these steps matter for trade. In parallel, regional, and voluntary schemes offer developed methods that many economies can adopt or adapt.

Differences remain. The most important relate to system boundaries, how electricity purchases are accounted for, and whether logistics and conversion are included. Thresholds for carbon intensity are not the same across systems, and treatment of hydrogen derivatives is uneven. Monitoring, reporting, and verification practices vary as well, and registry features are at different levels of maturity. These differences affect comparability and can raise questions for buyers, regulators, and lenders when certificates cross borders.

Despite these gaps, the building blocks for trade are already in place. There is a common purpose for certification (to support eligibility, inform labels, and give investors clarity) and a common metric (carbon intensity). Programs that add upstream and downstream steps show that their results can be read alongside others with only limited translation. This creates a workable base for recognition if economies publish their boundary choices and methods in clear terms and allow recalculation to a reference frame when needed.

6. APEC Workshop Summary Report

As part of the APEC project EWG 105 2024A, this international workshop was held on 5– 6 May 2025, in Santiago, Chile. It brought together representatives from eleven APEC economies to address the development of hydrogen certification systems. The event aimed to support member economies in designing credible regulatory frameworks that facilitate cross-border trade, enhance environmental integrity, and strengthen confidence in the emerging hydrogen market. The two-day agenda included technical presentations, panel discussions, and interactive sessions. Participants shared national experiences, examined regulatory and methodological gaps, and proposed steps toward the harmonization of certification systems across the APEC economies.

6.1 Agenda

The workshop was inaugurated with the participation of authorities from the Ministry of Energy of Chile, who highlighted the objectives of the workshop and introduced the Chilean National Green Hydrogen Action Plan 2023–2030. The opening sessions focused on the state of the art in international regulation, the relevance of certification, and the main challenges for building trust in emerging markets. Economy-wide experiences and comparative perspectives on existing certification schemes were presented, complemented by a panel discussion that brought together representatives from industry, international organizations, and the public sector.

On the second day, the focus moved to how certification systems can be put into practice and made compatible across economies. Experts from Chile; China; Europe; and Peru, shared ongoing initiatives, along with insights on how hydrogen markets are developing and how hydrogen can connect with power systems. The discussions underlined the need for common approaches that support international trade while keeping hydrogen production and use transparent and easy to track throughout the value chain.

The workshop concluded with a dedicated session on achieving interoperability of certification across APEC economies. Practical guidelines for regional harmonization, regulatory approaches, and common challenges were examined, with active contributions from international experts. With the participation of 66 representatives from eleven economies. Finally, the official agenda of the event is presented, providing a detailed record of the sessions, presentations, and panel discussions held over the two days.

Day 1

Asia-Pacific Economic Cooperation
EWG_105A_2024
Certification of Hydrogen and Its Derivatives: Its Role in the Driving Market
DAY 1
08:30 - 9:00
Registration
09:00 - 9:15
Welcome Remarks from Ministry of Energy of Chile's authority
Mrs. Maria Helena Lee | Head of Strategic Planning and Sustainable Development Division | Ministry of Energy of Chile
09:15 - 9:35
Keynote address: Green Hydrogen Action Plan 2020-2030
Mr. Gabriel Bravo Leiva | Head of New Energy Carriers and Fuels Division | Ministry of Energy of Chile
TOPIC 1
STATE OF THE ART OF THE GLOBAL HYDROGEN REGULATION FOR CERTIFICATION
09:35 - 10:35
Overview of Global Hydrogen and Derivatives Regulations and the Role of Certification
Ms. Isabella Villanueva | Head of Planning and Climate Change Unit | Ministry of Energy of Chile
Hydrogen Technologies and National Standards in the Russian Federation
Mr. Evgeniy Koloshkin | Chief Technologist | Gazprom PJSC
10:35 - 11:00
Group Photo | Coffee Break
TOPIC 2
WHY HYDROGEN CERTIFICATION MATTERS?
11:00 - 12:00
Building Trust for the Hydrogen Market
Ms. María Paz de la Cruz | Board Member | I - TRACK Foundation
Overview of Existing Certification Schemes and International Outlook
Mr. Jan Stelter| IPHE Task Force Co - Lead | Germany
12:00 - 14:00
Lunch break
TOPIC 3
CERTIFICATION SCHEMES: FROM PRODUCTION TO OFFTAKERS
14:00 - 15:00
Demonstration, Operation and Certification of Renewable Energy Energy-Based Hydrogen-Power Integration Systems
PhD Zhang Leiqi| Senior Engineer | State Grid Corporation of China
Panel Discussion: Perspectives and Opportunities from APEC Economies
Moderator: Ms. Paula González | New Energetics Unit | Ministry of Energy of Chile
Panelists:
• Ms. María Paz de la Cruz | Board Member | I - TRACK Foundation
• Mr. Evgeniy Koloshkin | Chief Technologist | Gazprom PJSC
• Ms. Isabella Villanueva | Head of Planning and Climate Change Unit | Ministry of Energy of Chile
15:00 - 15:35
Wrap up and Closing Remarks
Networking Coffee

Day 2

Asia-Pacific Economic Cooperation

EWG_105A_2024

Certification of Hydrogen and Its Derivatives: Its Role in the Driving Market

DAY 2

08:30 - 9:00 **Registration**

09:00 - 9:15 **Summary of Day 1 and Day 2 Objectives**

09:15 - 9:35 **Keynote address: What Do We Talk About When We Talk About Certification?**
PhD Tudor Florea | Hydrogen Policy Advisor | General Directorate for Energy and Climate of the French Ministry of Industry and Energy

TOPIC 4 **MAJOR GLOBAL DEVELOPMENTS AND INITIATIVES**

09:35 - 11:00

Chilean Hydrogen Association H2CHile: Market outlook
MSc. Ricardo Rodriguez | Director Studies | Chilean Hydrogen Association H2Chile

Indonesia's National Hydrogen Strategy and the Path to Hydrogen Standardization
Mr. Zulfan Zul | Senior Energy Planner | Ministry of Energy and Mineral Resources of Indonesia

Hydrogen Outlook: Advances from Peru
Mr. Jorge García Manrique | Advisor | Ministry of Foreign Affairs of Peru

Development Experience and Outlook of Renewable Energy and Electricity-Hydrogen Synergy in China
PhD Sun Guangzeng | Researcher | State Grid Corporation of China

11:00 - 11:20 **Coffee Break**

TOPIC 5 **CONSIDERATIONS FOR ACHIEVING INTEROPERABLE CERTIFICATION SCHEMES AMONG APEC ECONOMIES**

11:20 - 12:40

How to Address Certifications in Regulations?
PhD(c) Francisca Gallegos | Expert on Hydrogen Market and Regulation | University of Eastern Finland

A Step-by-Step Guide for Regional Harmonization: How to Implement a Certification Scheme in the Economies
Ms. Isabella Villanueva | Head of Planning and Climate Change Unit | Ministry of Energy of Chile

Panel Discussion: Identifying Barriers and Challenges in APEC Economies
Moderator: Ms. Adelaida Baeriswyl | International Relations Office | Ministry of Energy of Chile
Panelists:
- PhD(c) Francisca Gallegos | Expert on Hydrogen Market and Regulation | University of Eastern Finland
- PhD Tudor Florea | Hydrogen Policy Advisor | General Directorate for Energy and Climate of the French Ministry of Industry and Energy
- MSc Ricardo Rodriguez | Director Studies | Chilean Hydrogen Association H2Chile

12:40 - 13:00 **Wrap up and Closing Remarks**
Networking Coffee

6.1.1 Day 1: Understanding Certification and Key Challenges

The first day of the workshop focused on exploring the status and complexity of hydrogen certification across APEC economies. It featured national experiences from Chile; People's Republic of China; and Russia, and reviewed global methodologies and regulatory approaches.

Summary of Day 1: Understanding Certification and Key Challenges

The first day of the workshop focused on exploring the status and complexity of hydrogen certification across APEC economies. The day was divided into two sections: the first, titled Understanding Certification and Key Challenges, and the second, Chain of Certification: Main Barriers and Challenges. It featured domestic experiences from Chile; People's Republic of China; and Russia, and included a review of global methodologies and regulatory approaches.

Three core topics were addressed:

1. **Global Landscape and Domestic Experiences:** Chile presented a phased roadmap for its economy-wide certification system aligned with EU standards. Russia discussed its technological innovations in low-carbon hydrogen production based on natural gas industry resources (methane, hydrogen sulphide) and emphasized the diversity of emissions thresholds globally and difficulties of hydrogen market development.
2. **The Importance of Certification:** Speakers introduced systems such as I-TRACK and compared international certification schemes, revealing divergences in terminology, emissions accounting, and chain of custody approaches.
3. **Value Chain and Operational Challenges:** People's Republic of China highlighted demonstration projects using 100% renewable power, showing how certification supports energy system flexibility and integration.

A multi-stakeholder panel emphasized the need for strong government leadership, standardized sustainability criteria, and regional coordination.

In summary: Day 1 provided a comprehensive understanding of certification systems' foundational role in enabling hydrogen markets, the regulatory and methodological inconsistencies between economies, and the importance of collaboration to promote harmonization.

6.1.2 Day 2: Toward Implementation and synergism

The second day of the workshop focused on practical implementation and achieving synergy among certification frameworks across APEC economies. The day was structured around a single section titled Moving Towards Implementation and Interoperability. It combined policy insights, national case studies, and technical perspectives.

Two main topics were covered:

1. **Regulatory Progress and National Roadmaps:** Chile outlined its position as a future green hydrogen exporter, with 14 pilot projects underway. Peru presented its Green Hydrogen Promotion Law and ongoing regulatory development. People's Republic of China showcased its electricity–hydrogen integration strategy, addressing flexibility, infrastructure, and scale-up pathways.
2. **Toward Harmonization:** Experts discussed the regulatory, legal, and technical conditions for interoperability, including the need to align life-cycle assessment boundaries, chain of custody models, and verification procedures. Chile's phased approach was again highlighted as a replicable model.

During the interactive session, participants expressed their opinions on challenges and areas of importance:

- Top challenges included regulatory gaps, lack of methodology harmonization, and financing.
- The most difficult attribute to certify was GHG emissions across the value chain.
- Aligning emissions accounting methodologies and defining "green" hydrogen were seen as urgent for regional coordination.
- Most economies expect to be ready for harmonized certification by 2030.

In summary: Day 2 emphasized the transition from design to implementation, underscored the value of regional alignment and digital traceability tools, and reiterated the strategic role of certification in enabling sustainable and trade-ready hydrogen markets.

6.1.3 Speakers

The workshop was supported by ten speakers from key sectors such as industry, government, and academia. This diversity of stakeholders enabled a comprehensive discussion on hydrogen certification, incorporating multiple perspectives, including regulatory frameworks and scientific advancements. The importance of establishing common standards to ensure the sustainability and quality of hydrogen within the context of energy transition was emphasized. Below is a brief introduction to each of the speakers.

- **Isabella Villanueva:** Head of Planning and Climate Change Unit | Ministry of Energy of Chile
- **Evgeniy Koloshkin:** Chief Technologist | Gazprom PJSC
- **Maria Paz de la Cruz:** Board Member, I-TRACK Standard Foundation
- **Jan Stelter:** IPHE Task Force CoLead
- **Leiqi Zhang:** Senior Engineer | State Grid Corporation of China
- **Tudor Florea:** Hydrogen Policy Advisor | General Directorate for Energy and Climate of the French Ministry of Industry and Energy
- **Ricardo Rodriguez:** Director Studies | Chilean Hydrogen Association H2Chile
- **Jorge García Manrique:** Advisor | Ministry of Foreign Affairs of Peru
- **Sun Guangzeng:** Researcher | State Grid Corporation of China
- **Francisca Gallegos:** Expert on Hydrogen Market and Regulation | University of Eastern Finland

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