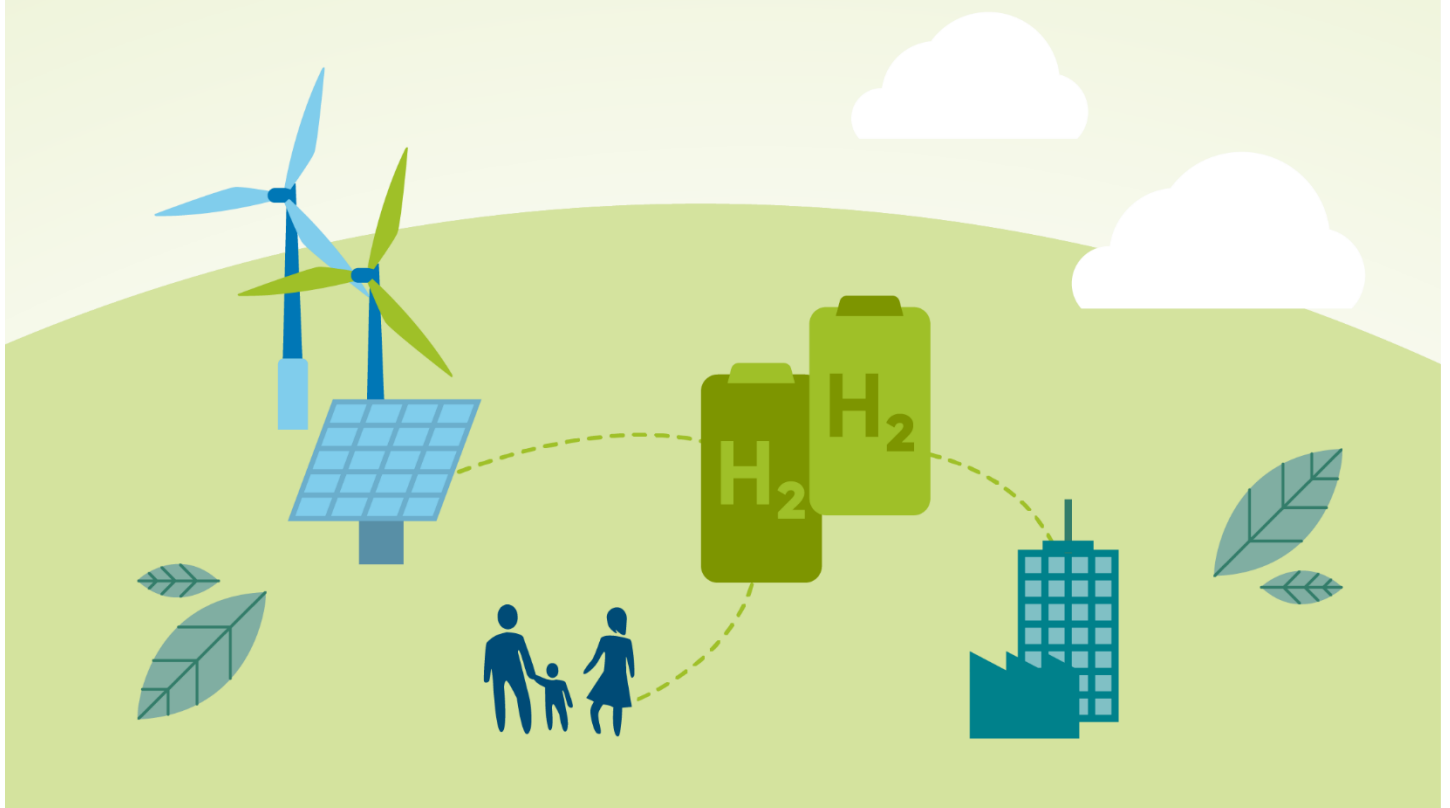


A Roadmap Identifying GH2 National Standards and Establishing Namibian Standards Institution (NSI) Role in the GH2 Value Chain

Part 1: Scoping Study



Supported by the

Disclaimer

On request of the Namibian Standards Institution (NSI) and with the support of the Namibia Green Hydrogen Programme (NGHP), the Green Hydrogen Business Alliance (H2BA) commissioned this scoping study and roadmap on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The study was conducted by LBST, RebelGroup and TÜV SÜD between December 2023 and October 2024.

The H2BA is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and supports the Namibian government in building up a sustainable and inclusive green hydrogen economy.

Several organisations contributed to the scoping study and roadmap through interviews, discussions and workshops. These included: Namibian Standards Institution (NSI), Ministry of Industrialisation and Trade (MIT), Ministry of Mines and Energy (MME), Namibia Green Hydrogen Programme (NGHP), Ministry of Works and Transport (MWT), Namibia Investment Promotion and Development Board (NIPDB), Namibia Green Hydrogen Research Institute (NGHRI), Daures Green Hydrogen, Hyphen Hydrogen Energy, ZHero, HDF Energy, Namport, Nampower, Electricity Control Board (ECB), Transnamib, Deutsches Institut für Normung (DIN) and Physikalisch-Technische Bundesanstalt (PTB).

Authors

RebelGroup: Laurens Cloete, Jennifer Zeiss

LBST: Matthias Altmann, Leo Diehl

TÜV SÜD: Thomas Frohn, Josef Peters

Contact

Green Hydrogen Business Alliance
c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Farhanja Wahabzada
wasserstoff@giz.de
www.giz.de

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Executive Summary

Overview

This scoping study was commissioned to assess the current status, gaps and opportunities related to technical standards for green hydrogen and sustainability certification in Namibia. The main objectives were to:

1. Assess the international landscape of technical standards and sustainability certification for green hydrogen.
2. Compare Namibia's existing standards and certification frameworks against international benchmarks.
3. Identify gaps and opportunities for Namibia to develop and implement relevant standards and certifications.
4. Provide recommendations for key Namibian stakeholders to enhance Namibia's capabilities in establishing a robust quality infrastructure for green hydrogen, particularly with respect to the standardisation aspects.

The study focuses on three key areas: Technical standards for green hydrogen, sustainability certification, and the role of the National Standards Institute (NSI) in supporting the hydrogen economy.

International Standards Landscape: The international green hydrogen standards landscape is comprehensive and well established, covering various aspects of the hydrogen value chain, including production, storage, transport, fuel cells and end-use applications. These standards ensure the safety, performance, interoperability and sustainability of hydrogen technologies.

Technical Standards for Green Hydrogen

1. Hydrogen Production and Conditioning

- International standards cover electrolysis, fuel processing technologies, pressure equipment, low-voltage, electromagnetic compatibility, explosion protection, and machinery safety.
- Namibia currently lacks specific standards for these technologies and needs to fill this gap by working with industry stakeholders to identify needs and develop relevant standards. The National Standardisation Strategy (NSS), which is currently under development, includes the required renewable energy/green hydrogen (GH2) standards. A hydrogen production unit deals with key issues such as pressure equipment, fire regulations, explosion protection, material suitability, electromagnetic compatibility, etc. These issues need to be addressed to ensure safety and efficiency. International ISO and IEC standards are available for these technical considerations and are continuously discussed in the relevant ISO/IEC committees. For example, a specific standard focusing on the safety and efficiency of hydrogen generators using water electrolysis - for industrial, commercial and residential applications - is ISO 22734.

- There are several interdisciplinary considerations that need to be taken into account when addressing gaps in hydrogen production and conditioning. However, the two main considerations for safety-critical aspects that are missing in the Namibian landscape are specific requirements for pressure equipment (>0.5 kPa) and Major Hazards Installation (MHI). This gap leaves open safety aspects relating to hazard categories, installation and inspection, and in-service activities. Hydrogen can contribute to the formation of an explosive atmosphere, which is a significant potential hazard and must be addressed by the requirements for a major hazard installation and therefore key issues such as zone classification and explosion protection measures.
- Section 3.6.1 provides an overview of relevant international standards and concludes with a table displaying the most important standards for this part of the value chain in terms of their relevance to Namibia's hydrogen sector. This could form the basis for Namibia to prioritise which standards to adopt or adapt as national standards.

2. Hydrogen Storage and Transportation

- International standards include safety specifications for liquid and gaseous hydrogen storage, transportable gas storage devices, and pressure relief devices.
- Namibia should develop and/or adopt relevant standards to ensure safe and efficient storage and transportation of hydrogen. This should be discussed and prioritised in the newly established TC, based on considerations of internationally available standards, technical and safety-critical discussions and applicability for the Namibian ecosystem.
- Similar to production equipment such as electrolyzers, hydrogen storage and transport systems are classified as pressure equipment and deal with the potential risk of an explosive atmosphere if not handled carefully. Therefore, the same two key considerations of pressure equipment and major hazard installation should be prioritised in the adoption/development of technical standards based on technical discussions.
- Section 3.6.2 provides an overview of the relevant international standards and concludes with a table showing the most important standards for this part of the value chain, assessed for their relevance to the hydrogen sector of Namibia.

3. Hydrogen Fuel Cells

- International standards cover fuel cell modules, stationary power systems, portable power systems, and performance test methods.
- Namibia might benefit from adopting these standards to support the deployment of fuel cell technologies across various applications.
- The requirements for fuel cells in industrial applications are mainly defined within IEC / TC 105 on fuel cell technologies and result in the IEC 62282 standard series. NSI should participate in this TC and the relevant working

groups before the adoption of the standards for pressure equipment and major hazard installations, as they are of lower priority and should be based on market-specific requirements.

- Section 3.6.3 provides an overview of relevant international standards and concludes with a table ranking the most important standards for this part of the value chain in terms of their relevance to the Namibian hydrogen sector.

4. Hydrogen Fuel Quality and Purity and Hydrogen Refuelling

- International standards define the quality and purity requirements for hydrogen fuel, ensuring compatibility with fuel cells and other end-use applications.
- Namibia is advised to establish similar standards to ensure high-quality hydrogen production and utilisation.
- Hydrogen fuel Quality and Purity is essential and should be prioritised accordingly. For this important topic, NSI should consider becoming part of ISO/TC 197/WG 27/28 which are discussing hydrogen fuel quality and quality control.
- International standards focus on hydrogen refuelling stations, dispenser hoses, and fuel quality control.
- To facilitate the safe and efficient refuelling of hydrogen vehicles, it is recommended that Namibia develop/adopt and implements these standards.
- No relevant standards (such as ISO 19880) have yet been adopted or developed in Namibia due to a lack of market demand. Similar to hydrogen production, storage and transport, the requirements for pressure equipment and major hazard installations are crucial and applicable to these applications. If this (mobility specific) issue becomes of significant importance in Namibia, NSI should consider joining the relevant ISO/TC 197 working groups, e.g. WG 19 on gaseous hydrogen fuelling station dispensers.
- Section 3.6.4 provides an overview of relevant international standards and concludes with a table assessing the relevance of the most important standards for this part of the value chain to the Namibian hydrogen sector.

5. Ammonia and Synthetic Fuels

- Ammonia production and use as a fuel, as well as synthetic fuels, are subject to several international standards that can support the safe and sustainable development of these technologies.
- Standards such as ISO 5149-1:2014 are relevant for managing cooling systems, providing safety and environmental guidelines. While important, these are secondary to hydrogen-specific standards in Namibia's context.
- Synthetic fuel standards like EN590 (biodiesel), EN14214 (FAME), and EN228 (bioethanol) have lower relevance for Namibia, as the primary focus is on hydrogen rather than other synthetic fuels.
- Environmental standards, including ISO 14001 and ISO 14044, play a key role in supporting sustainability and lifecycle assessments, critical for en-

hancing the export potential of hydrogen. Additionally, ISO 14046 emphasizes efficient water use, aligning with sustainability goals in hydrogen production.

- Section 3.6.5 provides an overview of relevant international standards and concludes with a table assessing the relevance of key standards for this part of the value chain to the Namibian hydrogen sector.

6. Non-hydrogen specific standards

- In addition to hydrogen-specific standards, there are several other important standards relevant to hydrogen installations. They address safety, environmental management, and risk management across the hydrogen value chain.
- Pressure Equipment: Standards like ASME Section VIII, ISO 4126, and EN 13445 ensure safety in the design, manufacture, and operation of hydrogen storage and transportation systems.
- Major Hazard Installations (MHI): Safety protocols for hydrogen handling facilities are guided by standards such as SANS 1461 and the ATEX Directive, which emphasise robust risk assessment and emergency planning.
- General Safety and Machinery Standards: Standards covering machinery safety, including EN 809 for pumps and IEC 61508 for functional safety, are crucial for safe operation across hydrogen production, transport, and storage.
- Environmental Management: ISO standards like 14044 (Life Cycle Assessment) and 14064 (Greenhouse Gas Reporting) help to ensure sustainable practices, efficient resource use, and compliance with environmental goals.
- Risk Management: Comprehensive risk assessment and maintenance protocols are supported by standards such as ISO 31000 and CWA 15740, essential for reliable and safe hydrogen infrastructure.
- Section 3.5 provides an overview of relevant international standards and concludes with a table that assesses the relevance of key non-hydrogen specific standards to the Namibian hydrogen sector.

Note: All relevant standards in the GH2 value chain should be identified and developed by the National Technical Committee, which should include stakeholders from the green economy or stakeholders affected by the GH2 economy.

Sustainability Certification: Internationally, sustainability certification schemes assess the environmental impacts, carbon footprints, and overall sustainability of hydrogen production processes. For Namibia, the focus should be on supporting project developers to meet the sustainability certification requirements of key export markets such as Europe, Japan, and South Korea.

Role of the NSI: The NSI's role in Namibia's hydrogen quality infrastructure is still evolving. Internationally, national standards bodies play a crucial role in research, standardisation, and policy support. Strengthening the NSI's capacity to develop standards, facilitate compliance, and support policy frameworks is essential for Namibia's hydrogen economy.

Preliminary recommendations

1. Establishing NSI's Role in the GH2 Value Chain

- The NSI should consider undertaking a comprehensive review of its current organisational structure, capabilities, and services to align its operations with the needs of Namibia's green hydrogen and green industrialisation strategies. These roles are set out in more detail in the document.
- It is recommended that the NSI take the lead in developing a H2 focused extension of the National Quality Policy, in collaboration with all relevant stakeholders of the hydrogen industry in Namibia.
- The functions of the NSI are well defined and separated to ensure that there is no conflict between standards development and conformity assessment, to ensure impartiality and to follow international best practice in close coordination with the regional accreditor, i.e. Southern African Development Community Accreditation Service (SADCAS). It is recommended that the NSI continuously monitor this matter and ensure close communication with SADCAS.
- Capacity building is required to equip NSI with the skills and knowledge to meet the demands of the hydrogen sector.

2. ISO/TC 197 Engagement

- It is recommended that the NSI establish a national Technical Committee and become a participating member in international committees to represent Namibia's interests. This mainly concerns ISO / TC197 for hydrogen technologies and its several working groups but can also be extended to IEC / TC 105 focusing on fuel cell technology. Priority should be given to standards related to the GH2 value chain and other cross-cutting technical areas, in particular pressure equipment, major hazard installations and fuel quality.

3. Regional Collaboration

- It is recommended that the NSI collaborate with Southern African countries via SADC or the African Hydrogen Partnership (AHP) and engages in global conversations. It should analyse and learn from other regional developments, and ensure regional schemes meet the standards of international target markets. This refers to trade zones in the region, but also to the principles of the World Trade Organisation.

4. Advising the Namibian Government on Regulation, Standards, and Sustainability Certification-Related Issues Relevant to National Legislation

- It is recommended that the NSI advise the Namibian government on the development of a regulatory framework in line with international standards and supports the development of policies that facilitate the growth of the green hydropower sector.
- NSI will play a major role in providing recommendations to the Namibian regulator for suitable health and safety standards and sustainability certification, based on the discussions and results of NSI TC / 197.

5. Facilitating Private Sector Standards Adoption and Compliance

- It is recommended that the NSI support private sector entities in adopting and complying with relevant standards. It should assess the needs of its stakeholders, create awareness of the current products and services that the NSI offers, provide training on currently published standards as well as new standards that have been or are being adopted specifically for the GH2 industry and their context within the legal and regulatory framework. Additionally, it should provide practical tools and guidelines to facilitate compliance and ensure competitiveness in local and international markets.
- This should be facilitated by ongoing discussions in the national TC 197 and by providing an accessible list of applicable standards.

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Abbreviations

ADD	Additionality
AG	Advisory Groups
AHG	Ad-Hoc Groups
AHP	African Hydrogen Partnership
ANM	Agence Nationale de Métrologie
ANME	National Agency for Energy Conservation
ANPE	National Agency for Environmental Protection
ANSI	American National Standards Institute (USA)
API	American Petroleum Institute
APU	auxiliary power units
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials (USA)
ATEX	Atmosphères Explosives
ATR	Autothermal reformer
BAM	Federal Institute for Materials Research and Testing (Bundesanstalt für Materialforschung und -prüfung)
BECCS	Bioenergy with carbon capture and storage
BetrSichV	Betriebs-Sicherheitsverordnung Operational safety ordinance
BImSchG	Bundes-Immissionsschutzgesetz Federal Immission Control Act (Germany)
BImSchV	Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes Ordinance for the implementation of the Federal Immission Control Act (Germany)
BIPM	International Bureau of Weights and Measures
BMZ	Federal Ministry of Economic Cooperation and Development
BNetzA	Federal Network Agency
BNQ	Bureau de normalisation du Québec Standardization Office of Québec (Canada)
BS	British Standards
CAB	Conformity Assessment Bodies
CAPEX	Capital expenditure
CB	Certification Body
CBAM	Carbon Border Adjustment Mechanism
CCEE	Hydrogen and Derivatives Certification System.
CCS	Carbon capture & storage
CEN	European Committee for Standardization

CENELC	European Committee for Electrotechnical Standardization
CerTHILAC	Latin American Certification Scheme
CGH2	Compressed H2
CNRS	National Center for Scientific and Technical Research
COPANT	Latin America Standardisation Body
CSIR	Council for Scientific and Industrial Research
DAkKS	German Accreditation Body
DIN	Deutsches Institut für Normung German Institute for Standardisation
DNV	Det Norske Veritas
ECB	Electricity Control Board
EMC	Electromagnetic Compatibility Directive
EN	Euro Norms
EOR	Enhanced Oil Recovery
ESI	Electricity Supply Industry
EU	European Union
EUR	Europe
FAME	Fatty Acid Methyl Ester
FC	Fuel Cell
FCEV	Fuel Cell Electric Vehicle
FSMS	Food Safety Management System
GH2	Green Hydrogen
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GO	Guarantee of Origin
GSP	Good Standardisation Practice
GT	Gas Turbine
GTR	Global Technical Regulation (UN)
H ₂	Hydrogen
HGV	Hydrogen Vehicle Standards
HRS	Hydrogen Refuelling Station
HySA	Hydrogen South Africa
HZG	Hydrogen Research Network
IAF	International Accreditation Forum

IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers (USA)
INNORPI	National Institute of Standardisation
IPHE	International Partnership for Hydrogen and Fuel Cells in the Economy
IRAM	Instituto Argentino de Normalización y Certificación
ISCC	International Sustainability & Carbon Certification
ISSET	Higher Institute of Technological Studies
ISO	International Organisation for Standardisation
JOGMEC	Japanese Organisation for Metals and Energy Security
JWG	Joint Working Group
KZR INiG system	An EU Voluntary certification scheme for biofuels, bioliquids and raw materials
LAC	Latin America and Caribbean
LBST	Ludwig-Bölkow-Systemtechnik
LCA	Life-Cycle Assessment
LH ₂	Liquid Hydrogen
LNG	Liquefied Natural Gas
LOHC	Liquid organic hydrogen carriers
M&E	Monitoring and Evaluation
MENA	Middle East North Africa
MeOH	Methanol
MINTEK	South Africa's national mineral research organisation
MIT	Ministry of Industrialization and Trade
MME	Ministry of Mines and Energy
MSME	Ministry of Micro, Small and Medium Enterprises
MEFT	Ministry of Environment, Forestry and Tourism
MFPE	Ministry of Finance and Public Enterprises
MT	Maintenance Teams
MWT	Ministry Of Works & Transport
NAMS	Namibian Standards
NCRST	National Commission on Research, Science and Technology
NGHP	Namibia Green Hydrogen Programme
NGHRI	Namibia Green Hydrogen Research Institute

NH3	Ammonia
NIPDB	National Investment Promotion and Development Board
NMI	National Metrology Institute
NMISA	National Metrology Institute of South Africa
NPC	National Planning Commission
NPL	National Physical Laboratory
NRCS	National Regulator for Compulsory Specifications
NSB	National Standards Body
NSC	Namibian Standards Council
NSI	Namibian Standards Institution
NSS	National Standardisation Strategy
NWU	North-West University
OHS	Occupational, Health and Safety
OJEU	Official Journal of the European Union
OPEX	Operating expenditure
OSH Act	Occupational, Health and Safety Act
PASC	Asia-Pacific region Standardisation Body
PEFC	Polymer electrolyte Fuel Cell
PEMFC	Proton-exchange Membrane Fuel Cells
PGMs	Platinum Group Metals
PoS	Proofs of Sustainability
PPA	Power Purchase Agreement
PRD	Pressure relief device
PRM	Primary reference mixtures
PTB	National Metrology Institute of Germany (Physikalisch-Technische Bundesanstalt)
PtX	Power-to-X (any derivatives produced from electrolytic hydrogen)
QI	Quality Infrastructure
QMS	Quality Management System
RCS	Regulations, Codes and Standards
RED	Renewable Energy Directive
REDII	Renewable Energy Directive Recast
REGO	Renewable Energy Guarantee of Origin
RFNBO	Renewable fuels of non-biological origin
RSA	Republic of South Africa

SA	South Africa
SABS	South African Bureau of Standards
SANS	South African National Standards
SADC	Southern African Development Community
SADCAS	Southern African Development Community Accreditation Service
SANAS	South African National Accreditation System
SANEDI	South African National Energy Development Institute
SANS	South African National Standards
SAPP	Southern African Power Pool
SDC	Standards Development and Coordination Department
SMR	Steam methane reformer
SOFC	Solid Oxide Fuel Cells
TBT	Technical Barriers to Trade
TC	Technical Committee
TPRD	Thermal pressure relief device
TUNAC	Tunisian Accreditation Council,
UAE	United Arab Emirates
UCT	University of Cape Town
UDB	Union Database
UK	United Kingdom
UL	UL Research Institutes, UL Standards & Engagement and UL Solutions
UN	United Nations
UNAM	University of Namibia
UNECE	United Nations Economic Commission for Europe
UNIDO	United Nations Industrial Development Organisation
USA	United States of America
UTICA	Tunisian Industry, Commerce, and Handicrafts Union
UWC	University of the Western Cape
VAT	Value added tax
VCS	Verified Carbon Standard
VTa	Vehicle Testing Association
WG	Working Group
WTO	World Trade Organisation

1. Introduction

1.1. Context and Background

The global transition to green hydrogen (GH2) is gaining momentum as countries seek sustainable energy solutions to combat climate change and achieve energy security. Green hydrogen, produced through the electrolysis of water using renewable energy sources, offers a carbon-free alternative to traditional fossil fuels¹.

Globally, the GH2 industry is witnessing substantial investments and policy support. Countries such as Germany, Japan, and Australia have already made significant strides in establishing robust GH2 ecosystems, integrating production, distribution, and utilisation within their energy frameworks^{2,3}. These developments are supported by comprehensive technical standards and sustainability certification schemes that ensure the reliability, safety, and environmental integrity of green hydrogen throughout its value chain.

Namibia, endowed with abundant renewable energy resources, is strategically positioned to become a key player in the global GH2 market. The country's vast solar and wind potential provides an excellent foundation for large-scale GH2 production, which can not only meet domestic energy needs but also position Namibia as a major exporter of green hydrogen⁴. Recognising this potential, the Namibian government, supported by international partners such as GIZ, is committed to developing and implementing a comprehensive GH2 strategy⁵.

An important component of this strategy is the establishment of a robust quality infrastructure that includes technical standards and sustainability certification. These elements are essential for ensuring that Namibia's GH2 products meet international benchmarks, thereby facilitating market access and fostering investor confidence⁶. The Namibian Standards Institution (NSI) will play a significant role in this process, leading the development, adoption and implementation of national standards that align with global best practices.

This study's objective is to contribute to identifying GH2 National Standards and establishing the NSI role in the GH2 Value Chain. The study answers several questions that are essential for the successful implementation of a process flow and the advancement of Namibia's participation in the global green hydrogen market.

¹ International Energy Agency (IEA). (2021). The Future of Hydrogen. Available at: <https://www.iea.org/reports/the-future-of-hydrogen>.

² Federal Ministry for Economic Affairs and Climate Action (Germany). (2023). National Hydrogen Strategy Update. Available at: <https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/national-hydrogen-strategy-update.html>

³ International Organization for Standardization (ISO). Hydrogen Technologies Standards. Available at: <https://www.iso.org/committee/54560.html>. ↵

⁴ World Bank. (2022). Hydrogen in Sub-Saharan Africa: Opportunities and Challenges. Available at: <https://openknowledge.worldbank.org/handle/10986/37200>

⁵ GIZ Namibia. (2023). Namibia Green Hydrogen Strategy. Available at: <https://www.giz.de/en/worldwide/99043.html>.

⁶ International Renewable Energy Agency (IRENA). (2022). Green Hydrogen: A Guide to Policy Making. Available at: <https://www.irena.org/publications/2020/Nov/Green-hydrogen-A-guide-to-policy-making>.

The study was conducted in two parts:

- Part 1: A scoping study of existing international and Namibian standards in the green hydrogen/power-to-x industry, drawing on existing studies and extensive stakeholder engagement
- Part 2: A concrete roadmap for the next steps and proposals for industrial standards to enter the administrative adoption process in Namibia.

This scoping study, which forms part 1 of the overall study, provides an overview of the existing international and Namibian norms and standards in the green hydrogen and Power-to-X (PtX) industry. It focuses on technical norms and standards for production, transport, trade, and application. By comparing these standards, the study identifies existing gaps and provides recommendations for the adoption or definition of new norms and standard. for Namibia. This covers the entire value chain, including electricity and water supply quality, hydrogen production, storage, pipelines, compressors, and export infrastructure, with a particular focus on safety, quality, purity, and infrastructure issues⁷. The study also takes into account aspects that are relevant for determining the renewability or greenness of products.

1.2.Objectives of the Study

The aim of the study is to contribute to the development of the identification of GH2 national standards and to define the role of the Namibian Standards Institution (NSI) in the GH2 value chain. The study addresses several issues that are critical to the successful implementation of a process flow and the advancement of Namibia's participation in the global green hydrogen market.

The specific objectives of this study:

- Provide an overview of existing international and Namibian standards and identify gaps in the hydrogen industry using existing studies.
- Distinguish between types of standards, by clearly differentiating between technical standards (e.g., safety, quality, purity, infrastructure) and aspects relevant to identifying the renewability or greenness of the products (e.g., EU requirements for renewable energy).
- Develop recommendations: Formulate concrete recommendations for defining standards and norms beneficial to the Namibian hydrogen economy. Suggest next steps for the introduction of these standards into the administrative adoption process in Namibia, including outlining relevant international processes such as the ISO/TC 197 Committee on Hydrogen.
- Stakeholder engagement: Review the preliminary findings and recommendations with relevant stakeholders to ensure comprehensive and applicable outcomes.

Questions addressed in this study:

- What are the international (technical) standards and regulatory frameworks relevant to certifying green hydrogen and its derivatives in Namibia?

⁷ Physikalisch-Technische Bundesanstalt (PTB). (2024). Hydrogen Strategy: Metrology and Safety Technology for Hydrogen Applications. Available at: <https://www.ptb.de/cms/en.html>

- What technical specifications and verification processes are required for ensuring the quality and sustainability of green hydrogen in Namibia?
- What are the requirements/processes from the perspective of the Namibian private sector to meet national and international standards, thereby creating an enabling environment for certification and standards of hydrogen and its derivatives?
- What legal and policy frameworks are necessary to support the National Certification Scheme?
- How can Green Hydrogen and its derivatives be included in the Standards Act 18 of 2005 if they are sold domestically?
- What are the potential deficiencies in the National Standards Institution and what recommendations can be made to address these deficiencies?

1.3. Methodology

The methodology of this scoping study included the following steps to ensure a comprehensive and thorough analysis of existing standards and sustainability certification schemes for the Green Hydrogen (GH2) and Power-to-X (PtX) industries, both internationally and in Namibia.

- **Desktop Study:** A detailed desktop study was conducted to gather and analyse existing international and Namibian standards and certification schemes relevant to the hydrogen industry. This included reviewing technical standards, regulatory frameworks, and certification processes from various global sources.
- **Stakeholder Mapping:** Relevant stakeholders involved in the GH2 and PtX value chain in Namibia were identified and mapped. This included government agencies, industry players, regulatory bodies, research institutions and international partners.
- **Stakeholder Interviews:** Interviews with key stakeholders were conducted to gain insight into the current standards and practices, identify gaps, and understand the specific needs and challenges faced by the Namibian hydrogen industry. These interviews provided valuable qualitative data to complement the findings of the desktop study.
- **Review Workshop:** A review workshop was organised to present preliminary findings and recommendations. This workshop provided a platform for stakeholders to discuss the initial findings and provide additional inputs and data.
- **Comparison and Analysis:** International and Namibian standards were compared to identify gaps and discrepancies. This analysis focuses on technical standards for the production, transport, trade, and application of hydrogen and its derivatives as well as the need for sustainability certification for target markets.
- **Development of Recommendations:** Based on the analysis and stakeholder input, specific recommendations were developed for the definition and adoption of standards and norms beneficial to Namibia's hydrogen economy.

As a follow-up to this scoping study, a roadmap for the implementation of the identified recommendations has been developed. The study will conclude with a validation workshop to present the recommendations and roadmap to key stakeholders. This workshop will provide a platform for stakeholders to discuss and validate the findings of the

study, ensuring that the recommendations are practical and aligned with industry needs.

1.4. Stakeholder Engagement Plan

A key aspect of the project was to ensure that the findings were relevant to Namibia. Therefore, a structured stakeholder engagement process was followed to gather insights from key stakeholders in the Namibian GH2 industry.

a) Planning

A Stakeholder Engagement Plan was developed in conjunction with NSI and GIZ. Key stakeholders were identified along the value chain in both the private and public sectors. They were then categorised into high-level categories (see Figure 1) and mapped according to their interest and influence in developing national standards and defining the role of NSAs in the GH2 value chain (see Figure 2). This led to the development of a detailed plan including stakeholder groups, communication channels and an interview guide.

Figure 1 Key Stakeholder Groupings

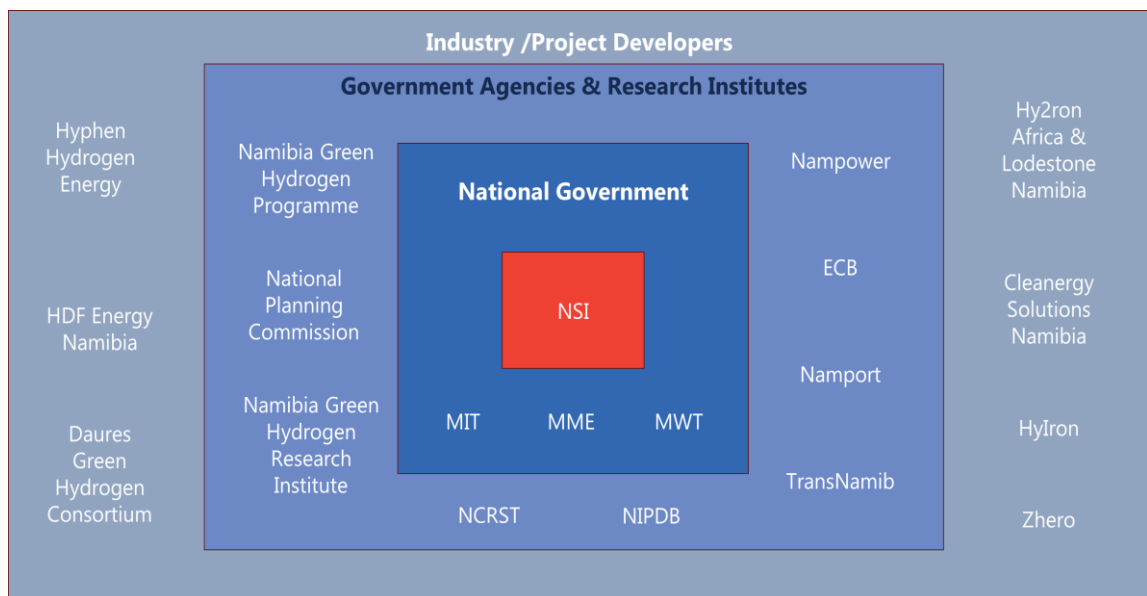
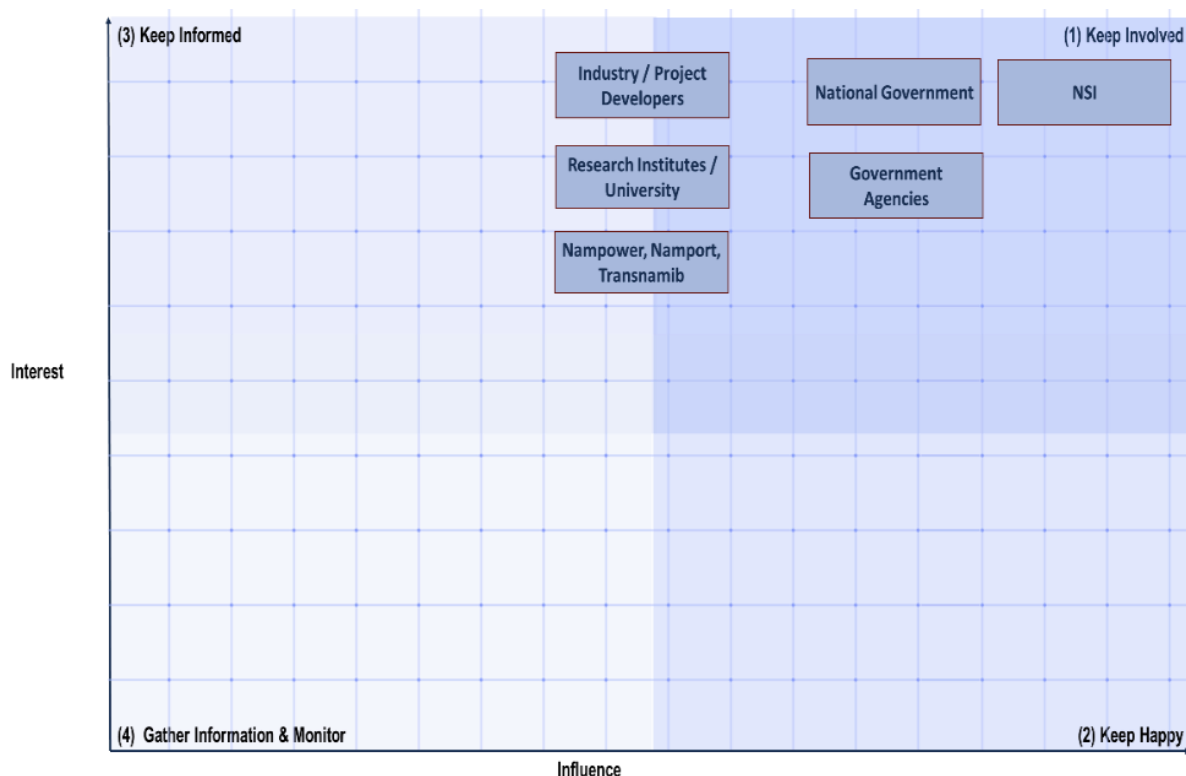


Figure 2 Stakeholder Interest / Influence Diagram



b) Engagement

Stakeholders were interviewed between April and July 2024, using an established interview guide that introduced the participants, shared the project objectives and asked structured questions.

Stakeholders were also involved in a Review Workshop held in Paris on 6 June 2002, the purpose of which was to (i) present the preliminary findings and recommendations of the Scoping Study and (ii) obtain feedback on the findings and recommendations from key national stakeholders to inform the final recommendations. The Workshop was well attended and included key presentations by NSI, GIZ and NGHP. The workshop report can be found in Appendix A.

2. Green Hydrogen Quality Infrastructure

2.1. Overview

A Quality Infrastructure (QI) is the system of organisations (public and private), policies, relevant legal and regulatory frameworks and practices needed to support and improve the quality, safety and environmental soundness of goods, services and processes. It includes various aspects related to initiatives, institutions, organisations, activities and people.

A QI is necessary for the effective functioning of a domestic market and its ability to access foreign markets. It is a critical element in promoting and sustaining economic development and environmental and social well-being.

The key pillars of QI:

1. **Standards Development:** Establish and maintain technical standards for production, storage, and transportation.
2. **Certification Systems:** Ensure products meet established standards through certification.
3. **Testing and Metrology:** Conduct tests and calibrations to verify compliance with standards.
4. **Inspection:** Carry out regular inspections and accreditation of facilities and processes.
5. **Regulatory Framework:** Develop legal and regulatory requirements to enforce standards and certifications.

A QI contributes to competitiveness and global market access by improving the quality of products and services in a country and ensuring that products and services meet international requirements. In addition, a well-established quality infrastructure in a country attracts investors by reducing project risk (combined with global acceptance) and promotes a country's public policy objectives through effective enforcement of legislation aimed at protecting people and the environment. An important element in the structure of a QI is the World Trade Organisation (WTO) Agreement on Technical Barriers to Trade (TBT), which aims to ensure that technical regulations, standards and conformity assessment procedures are non-discriminatory and do not create unnecessary barriers to trade. A QI will contribute to a common understanding of the safety critical aspects, performance requirements and sustainability attributes (green attributes) of the green hydrogen sector and of green hydrogen as a product to be traded domestically or to global off-taker markets.

2.2. Good Practices Internationally

The WTO provides suggestions and requirements for good practice to ensure that valuable principles are met. These include transparency, impartiality, effectiveness and relevance, coherence, stakeholder involvement, due process or national adoption or implementation of international and regional standards.

According to the WTO, a green hydrogen QI contributes to the following main aspects:

- To ensure sustainability (GHG emission reduction)
- To ensure safety and performance (metrology, technical standards, certification and accreditation)
- Principles to develop a quality infrastructure aligned with trade policies (TBT)

This study focuses on the technical standards required to implement Namibia's hydrogen strategy and the sustainability certification required. Other aspects of hydrogen QI have been examined to provide context for these aspects. High level recommendations for hydrogen QI are made, including the development of an overarching strategy for hydrogen QI.

2.3. Case Study 1: Germany

Germany has developed a sophisticated QI, which has been further developed to support its ambitious hydrogen strategy. This infrastructure is necessary to ensure the safety, quality and sustainability of hydrogen production, storage and use. The institutions and frameworks that make up Germany's hydrogen quality infrastructure include standards organisations, regulatory bodies, accreditation bodies, testing and certification agencies and extensive metrology services.

Key Institutions in Germany's Quality Infrastructure

- 1. German Institute for Standardisation (DIN)**
 - **Role:** Development and maintenance of national standards.
 - **Status Relative to Hydrogen:** DIN is involved in developing hydrogen-specific standards, ensuring they align with international standards. There are at least 41 hydrogen related DIN standards published by DIN (see Appendix E). The organisation is working with industry stakeholders to develop comprehensive guidelines for hydrogen technologies. DIN has developed a Standardisation Roadmap for Hydrogen Technologies, which outlines the necessary standards for the entire hydrogen value chain from production to utilization. This roadmap is a collaborative initiative involving a wide range of stakeholders from industry and academia and aims to support the market introduction of hydrogen technologies by defining terminology, interfaces, safety, system and quality requirements, as well as testing and certification principles.
- 2. Federal Institute for Materials Research and Testing (BAM)**
 - **Role:** Research, testing, and certification.
 - **Status Relative to Hydrogen:** BAM plays a fundamental role in testing and certifying hydrogen technologies. It provides scientific and technical services to support the safe implementation of hydrogen applications.
- 3. German Accreditation Body (DAkkS)**
 - **Role:** Accreditation of conformity assessment bodies.
 - **Status Relative to Hydrogen:** DAkkS accredits laboratories, inspection bodies, and certification bodies⁸ assessing hydrogen technologies, ensuring they meet the required standards.

⁸ „Certification bodies are independent third parties that validate or verify both the conformity of a methodology applied by a given production facility with the standard requested by the certification scheme and the actual determination of the attributes according to the methodology.“ IPHE, IEA H2 TCP, IRENA, Hydrogen Council, International Power-to-X Hub: Hydrogen Certification 101, 2023

4. Federal Network Agency (BNetzA)

- **Role:** Regulation of energy networks.
- **Status Relative to Hydrogen:** BNetzA oversees the integration of hydrogen into the national energy infrastructure, regulating hydrogen pipelines and ensuring compliance with safety standards.

5. National Metrology Institute of Germany (PTB)

- **Role:** Maintenance and development of national measurement standards.
- **Status Relative to Hydrogen:** PTB ensures the accuracy and reliability of measurements related to hydrogen, including pressure, temperature, and flow rates, which are crucial for quality control and certification processes. PTB's hydrogen strategy focuses on developing measurement technologies and standards that support the hydrogen economy, contributing to the safe and efficient use of hydrogen in various applications. PTB's objectives include ensuring hydrogen quality, safety, fair billing, knowledge transfer, and promoting innovation. Specific measures include the development of new metrological methods, the establishment of a safety technology infrastructure and the support of international co-operation to improve the hydrogen quality infrastructure worldwide.⁹

6. Hydrogen Research Network (HZG)

- **Role:** Research and development.
- **Status Relative to Hydrogen:** The HZG focuses on the development of advanced hydrogen technologies and works with other institutions to improve Germany's hydrogen infrastructure.

Table 1 Germany's Quality Infrastructure for Hydrogen

QI Function	Responsible Institution	Status
Development of National Standards	German Institute for Standardisation (DIN)	Develop hydrogen-specific standards, ensuring alignment with international standards.
Testing and Certification	Federal Institute for Materials Research and Testing (BAM)	Conduct testing and certification for hydrogen technologies to ensure safety and compliance.
Accreditation of Conformity Assessment Bodies	German Accreditation Body (DAkkS)	Accredit laboratories, inspection bodies, and certification bodies that assess hydrogen technologies.
Regulation of Energy Networks	Federal Network Agency (BNetzA)	Regulate hydrogen pipelines and integrate hydrogen into the national energy infrastructure.
Metrology	National Metrology Institute of Germany (PTB)	Ensure accurate and reliable measurements for hydrogen-related quantities such as pressure, temperature, and flow rates.

⁹ PTB's Hydrogen Strategy https://www.ptb.de/cms/fileadmin/internet/forschung_entwicklung/Innovationscluster_der_PT/Innovationscluster_Energie/Hydrogenstrategie_PT/2024_eng.pdf

QI Function	Responsible Institution	Status
Research and Development	Hydrogen Research Network (HZG)	Develop advanced hydrogen technologies and enhancing hydrogen infrastructure through research collaborations.

Conclusion

Germany's quality infrastructure for green hydrogen is comprehensive and involves several key institutions, each playing a crucial role in ensuring that hydrogen technologies are safe, reliable and meet international standards. With a robust framework and collaborative efforts, Germany is well positioned to lead the global hydrogen economy and support the transition to climate neutrality.

As Namibia develops its hydrogen sector, several elements of Germany's hydrogen quality infrastructure may be worth considering:

- **Standards Development (DIN):** Germany's DIN works closely with industry to develop hydrogen-specific standards that are aligned with international standards. This approach ensures that the standards are both practical and globally relevant, providing a useful model for others.
- **Testing and Certification (BAM):** BAM plays a key role in testing and certifying hydrogen technologies for safety and compliance. This focus on rigorous testing ensures that technologies are safe, reliable, and internationally competitive.
- **Metrology (PTB):** Germany's PTB ensures accurate measurements throughout the hydrogen value chain, including production, storage and transport. Reliable metrology supports fair trade and safety, especially for international exports.
- **Accreditation (DAkkS):** The German DAkkS accredits bodies that certify hydrogen technologies, ensuring that they meet the required standards. This provides a framework for maintaining high quality throughout the hydrogen sector..
- **Research and Development (HZG):** Industry in Germany plays a significant role in driving research and development in hydrogen technologies, ensuring that innovation is aligned with market needs and practical applications.
- **Industry Leadership:** In Germany, much of the development of the hydrogen quality infrastructure is industry-led, reflecting a strong collaboration between public institutions and private sector actors.

2.4. Case Study 2: Tunisia

Tunisia's QI for green hydrogen is mainly guided by the collaborative efforts of TUNAC, INNORPI, and ANME. TUNAC, the Tunisian Accreditation Council, is responsible for the accreditation of certification bodies. In the future, this may include certification bodies for green hydrogen products and processes to ensure that certifications are credible and internationally recognized. This also applies to testing and calibration laboratories with regard to testing and calibration competence. By providing these accreditation services, TUNAC ensures that all accredited entities operate under relevant quality management systems, contributing to the overall reliability and effectiveness of Tunisia's quality infrastructure.

INNORPI represents the National Institute of Standardisation and Industrial Property. Its main task is the development of standards. INNORPI is responsible for the development, adoption and maintenance of technical standards, including standards for the green hydrogen sector. In the future, this may include standards for the production, storage and transport of green hydrogen. INNORPI is seeking cooperation with international standardisation bodies to ensure that Tunisian standards are aligned with global benchmarks, facilitating international trade and cooperation, and promoting the importance and benefits of standardisation among industry stakeholders to encourage compliance and adoption of best practices. INNORPI is also responsible for the management of intellectual property. INNORPI's role in managing industrial property rights ensures that innovations such as those in green hydrogen technologies are protected.

For metrology, Tunisia has the Agence Nationale de Métrologie, but to date it has not communicated any involvement or activities related to hydrogen.

On the political side, two important actors are the Ministry of Energy, Mines, and Renewable Energies and the National Agency for Energy Conservation (ANME). The ANME works closely with the Ministry in the implementation of national policies and strategies related to energy conservation and renewable energy, ensuring that the green hydrogen initiatives are in line with Tunisia's overall energy goals. ANME also provides technical support to stakeholders involved in the energy sector, offering expertise and resources while developing and managing incentive programs like grants and subsidies to encourage further investments in the energy sector. In addition, ANME conducts public awareness campaigns and educational programs to inform and educate the public and industry stakeholders the benefits and challenges, for example, of developing the green hydrogen sector.

Table 2 Table: Tunisia's Quality Infrastructure for Hydrogen

QI Function	Responsible Institution	Status
Development of National Standards	INNORPI	Develop standards applicable to hydrogen technologies, ensuring alignment with international standards. Establishment of TC 197 for comprehensive hydrogen standards development.
Enforcement of Specifications	ANME	Create regulatory frameworks
Accreditation of Conformity Assessment Bodies	TUNAC	Accredit bodies that assess various facilities.
Metrology	ANM	Ensure accurate and reliable measurements for quantities like pressure, temperature, and density, but no hydrogen-specific services.

Other potentially relevant actors for the Tunisian quality infrastructure:

- The National Agency for Environmental Protection (ANPE) conducts environmental impact assessments and compliance verification.
- The National Centre for Scientific and Technical Research (CNRS) focuses on scientific research and the collaboration with academia.
- The Higher Institute of Technological Studies (ISET) focuses on technical education, training and industry collaboration to ensure that educational programmes are aligned with the needs of the sector.
- The Tunisian Industry, Commerce, and Handicrafts Union (UTICA) provides support to businesses and policymakers with direct industry knowledge.

In summary, green hydrogen QI in Tunisia is supported by an extensive network of institutions, each playing a different role in ensuring the functioning of the sector. TUNAC, INNORPI, and ANME form the core of this infrastructure, with additional support from ANPE, CNRS, ISET, and UTICA.

Conclusion

Although Namibia has certain institutions and processes in place for QI, a closer look reveals several weaknesses. For example, in terms of alignment with international standards, INNORPI is a member of only a few Technical Committees of ISO. The Technical Committees are the places within ISO where standards are discussed and developed by experts. Membership is therefore often recommended as a way of gaining more insight into the implementation of specific standards. A prominent case of this is ISO TC 197 (Hydrogen Technologies), of which INNORPI is neither a member nor an observer. Similarly, TUNAC is not a member of the International Accreditation Forum (IAF), an association of international accreditation bodies. Its main objective is to ensure that accredited certification of management systems, products, services, personnel and other programmes is reliable and accepted worldwide. Its members work together to develop and harmonise accreditation practices and ensure global consistency. Accreditation bodies that are members of IAF gain global recognition for their accreditation programmes, thereby enhancing the credibility of their certifications. Tunisia, or TUNAC, is not a member of IAF and therefore does not benefit from it, which diminishes the value or status of their accreditations.

Tunisia is in the early stages of developing its hydrogen quality infrastructure, and although progress is limited, its efforts provide some relevant context for Namibia:

- **Standards Development (INNORPI):** INNORPI is starting to work on hydrogen standards but has limited involvement in key international platforms such as **ISO TC 197**. Strengthening international participation remains an important step for Tunisia.
- **Accreditation (TUNAC):** UNAC accredits bodies that certify hydrogen technologies, but Tunisia's absence from the **International Accreditation Forum (IAF)** limits global recognition. Building international credibility in accreditation is still an area for growth.
- **Metrology (ANM):** Tunisia's Metrology Agency has not yet developed hydrogen-specific capabilities, which are critical to ensure accurate and reliable measurements in the hydrogen value chain.

- **Policy and Enforcement (ANME):** Tunisia's ANME is working with ministries and international partners to integrate hydrogen into energy policies, but full regulatory integration is still in progress.
- **Training and Capacity Building:** Tunisia is working with GIZ, IRENA, and PTB to build expertise through training, focusing on preparing public and private sector stakeholders for the hydrogen sector.

2.5. Case Study 3: South Africa

South Africa has developed a relatively advanced national QI supporting various industries, and initiatives are underway to support the emerging green hydrogen sector. This infrastructure is essential to ensure the safety, quality and sustainability of green hydrogen production, storage and use. The key institutions that make up South Africa's QI include regulatory bodies, standards organisations, accreditation bodies, testing and certification agencies, and metrology institutions.

Key Institutions in South Africa's QI

1. South African Bureau of Standards (SABS)

- **Role:** Development and maintenance of national standards, including the publication of South African National Standards (SANS).
- **Status Relative to Hydrogen:** SABS is involved in the development of standards applicable to, but not specific to, hydrogen technologies, as well as some fuel cell specific standards (see Appendix E for a list of 25 SANS standards), ensuring alignment with international standards. The establishment of Technical Committee (TC) 197 by SBAS is an important step towards the development of comprehensive hydrogen standards in South Africa.

2. National Regulator for Compulsory Specifications (NRCS)

- **Role:** Enforcement of compulsory specifications to ensure public health, safety, and environmental protection.
- **Status Relative to Hydrogen:** NRCS works on regulatory frameworks focusing on safety and environmental standards.

3. South African National Accreditation System (SANAS)

- **Role:** Accreditation of conformity assessment bodies, including laboratories, certification bodies, and inspection bodies.
- **Status Relative to Hydrogen:** SANAS accredits testing and certification bodies assessing various facilities.

4. National Metrology Institute of South Africa (NMISA)

- **Role:** Maintenance and development of national measurement standards.

- **Status Relative to Hydrogen:** NMISA provides accurate and reliable measurements related to various sectors but does not currently offer hydrogen specific services. However, NMISA provides many services relevant to the green hydrogen sector, such as measurements of quantities such as pressure, temperature and density.

Other relevant institutions

In addition to these institutions, which are explicitly part of the national QI, the following institutions also play a role relevant to hydrogen quality.

5. Council for Scientific and Industrial Research (CSIR)

- **Role:** Research and development in various scientific and industrial fields.
- **Status Relative to Hydrogen:** CSIR conducts research on hydrogen technologies, including production, storage, use, and contributes to the development of technical standards and best practices.

6. South African National Energy Development Institute (SANEDI)

- **Role:** Promotion of energy research, development, and innovation.
- **Status Relative to Hydrogen:** SANEDI is involved in hydrogen research projects and collaborates with other institutions to promote the adoption of hydrogen technologies.

7. HySA Centres of Competence

- **Role:** Research and development for hydrogen production, storage, and use.
- **Status Relative to Hydrogen:** The HySA (Hydrogen South Africa) initiative includes three centres of competence: HySA Infrastructure, HySA Catalysis, and HySA Systems. They are hosted by North-West University (NWU) and the Council for Scientific and Industrial Research (CSIR), University of Cape Town (UCT) and MINTEK, and the University of the Western Cape (UWC). These centres focus on developing cost-competitive solutions for hydrogen production, storage, and distribution, addressing the specific needs of South Africa and promoting the beneficiation of Platinum Group Metals (PGMs) in hydrogen technologies.

Table 3 Table: South Africa's Quality Infrastructure for Green Hydrogen

QI Function	Responsible Institution	Status
Development of National Standards	South African Bureau of Standards (SABS)	Develop standards applicable to hydrogen technologies, ensuring alignment with international standards. Establishment of TC 197 for comprehensive hydrogen standards development.
Enforcement of Specifications	National Regulator for Compulsory Specifications (NRCS)	Create regulatory frameworks focusing on safety and environmental standards.

QI Function	Responsible Institution	Status
Accreditation of Conformity Assessment Bodies	South African National Accreditation System (SANAS)	Accredit bodies that assess various facilities.
Metrology	National Metrology Institute of South Africa (NMISA)	Ensure accurate and reliable measurements for quantities like pressure, temperature, and density, but not offering hydrogen-specific services.

South Africa's QI is underpinned by a network of institutions, each playing a different role in developing standards, enforcing regulations, accrediting conformity assessment bodies and ensuring accurate measurements. With initiatives such as the establishment of TC 197 by SABS, South Africa is advancing its hydrogen standards framework.

South Africa has developed a relatively advanced quality infrastructure supporting various industries, with ongoing efforts to adapt it to the green hydrogen sector. Through its involvement in industries such as petrochemicals and energy, South Africa has been dealing with hydrogen and its derivatives for several decades. This long experience provides a solid foundation for the development of the country's hydrogen quality infrastructure.

Key institutions and their roles:

- **Standards Development (SABS):** The South African Bureau of Standards (SABS) develops and maintains national standards, including the establishment of Technical Committee (TC) 197 for hydrogen standards, ensuring alignment with international norms. South Africa has a history of international collaboration on standards that supports the development of comprehensive hydrogen standards.
- **Regulatory Enforcement (NRCS):** The National Regulator for Compulsory Specifications (NRCS) enforces safety and environmental standards, playing a key role in hydrogen-related regulatory frameworks.
- **Accreditation (SANAS):** The South African National Accreditation System (SANAS) accredits testing and certification bodies, ensuring facilities meet necessary standards for hydrogen technologies.
- **Metrology (NMISA):** The National Metrology Institute of South Africa (NMISA) provides accurate measurement services relevant to the hydrogen sector, although hydrogen-specific metrology capabilities are still under development. NMISA has participated in international metrology collaborations, that may facilitate future developments in hydrogen-specific measurement services.
- **Research and Development (CSIR and HySA Centres):** The Council for Scientific and Industrial Research (CSIR) and the HySA Centres of Competence are focusing on hydrogen research, including production, storage and use. These initiatives are key to developing technical standards and advancing hydrogen technology, particularly the use of South Africa's Platinum Group Metals (PGMs) for hydrogen applications.

3. Overview of International Standards

3.1. Introduction

To provide a clear overview of hydrogen-related standardisation, this chapter is structured as follows: Section 3.1 introduces the global context and explains why international standards are essential to ensure quality and safety throughout the hydrogen value chain. Section 3.2 describes the standardisation process, including an example from South Africa to illustrate how countries implement and adapt international standards. Finally, section 3.3 examines technical standards at ISO and IEC levels, detailing those relevant to production, storage, transport and fuel cell technologies within the hydrogen ecosystem.

3.2. Global Context

The global context of international standards is important to understand the relevant areas that require attention. The following section discusses the importance of standards, international organisations active in the hydrogen field, and international standardisation for accreditation, which allows not only local compliance but also global trade under the regional accreditation body. The obligations of a manufacturer are also discussed, showing the hierarchy of regulatory requirements in relation to standards.

Standards are essential to facilitate the development of a quality infrastructure and often determine the feasibility of projects at their various stages. Standards are critical to creating a globally accepted and safe environment for several reasons:

- **Quality and Safety** – It is important to set minimum requirements for the quality and safety of hydrogen and its derivatives, especially as it is a potentially hazardous chemical agent.
- **Interoperability** – Technical standards will ensure that products obtained from different manufacturers can work together seamlessly.
- **Efficiency** – By providing clear guidelines and specifications, technical standards can streamline production processes and reduce costs.
- **Innovation** – Technical standards establish a common framework that encourages innovation by providing a clear baseline. This baseline allows manufacturers to focus on developing improved products and processes without having to worry about basic compatibility, safety or quality requirements, which are already addressed by technical standards. In this way, innovation is supported by the stability, interoperability and efficiency that technical standards provide.
- **Regulation and Compliance** – Internationally recognised technical standards can help regulatory bodies such as the ECB to ensure that hydrogen and PtX systems and components meet legal and regulatory requirements, thereby facilitating trade and market access.
- **International Trade** – Technical standards can reduce technical barriers to trade by harmonising product requirements for hydrogen and PtX technologies, thereby facilitating the export process.
- **Procedures** – Standards provide technical definitions, guidelines and instructions for design, manufacture, inspection, testing and maintenance in alignment with component or performance requirements.

Standards can be divided into hierarchical levels - international standards, regional standards and national standards. In Namibia, the NSI acts as the national standards body. The NSI is a correspondent member of the International Organisation for Standardisation (ISO), which enables it to participate in ISO's global standardisation activities. However, the NSI is not a full member of IEC but participates in the IEC Affiliate Country Programme, which supports Namibia in adopting and implementing IEC standards. These affiliations help Namibia align with international standards, promoting global trade compatibility and safety. Inside ISO, NSI is a participating member of 13 TCs. These TCs include food products (TC34), quality management and quality assurance (TC176), environmental management (TC207), among others¹⁰. Furthermore, NSI is an observing member, focusing on topics such as hydrogen at scale and horizontal energy systems (TC197), solar energy (TC180) financial services (TC68), concrete, reinforced concrete and pre-stressed concrete (TC71), fruit and vegetables and their derived products (TC34), occupational health and safety management (TC283), and more. As for the IEC, 89 countries are either full or associate members of the relevant technical committees. South Africa (SABS), for example, is one of the full members (72 TCs as participating member, 63 TCs as observing member). NSI does not participate in IEC committees as of now.

Both ISO and IEC have developed a strategic partnership with the World Trade Organisation (WTO), which is a crucial element of international standardisation, see reasons above. International standards contribute to the Technical Barriers to Trade (TBT) Agreement, which aims to ensure that technical regulations, standards and conformity assessment procedures are non-discriminatory and do not create unnecessary barriers to trade. The International Standards are published by ISO or IEC and become an international document developed by representatives of the ISO or IEC member bodies.

The existence of international voluntary or health and safety standards for the hydrogen industry in individual countries or regions contributes to the above-mentioned TBT Agreement. Global fair competition should be based on common interpretations and references recognised between countries and regions (mutual recognition).

ISO and IEC are the two main international standards development organisations, with ISO standards generally dealing with machinery related issues and IEC standards dealing with technical considerations for electrical fields.

ISO and IEC standards have a hierarchical structure:

- **Type A Standards:** Basic standards dealing with basic safety concepts and design principles.
- **Type B Standards:** Standards that deal with only one aspect of safety and are based on Type A measures such as safety distances, interlocks, emergency stops, EMC and explosion protection.
- **Type C Standards:** Standards that define further detailed safety conditions for certain machines, such as tools or robots.

¹⁰ <https://www.iso.org/member/1569.html?view=participation&t=OT>

Accreditation in the regional and international context for Namibia

In addition to domestic use, Namibia aims to export hydrogen to global consumers. In this context, the implementation of international accreditation standards for conformity assessment bodies (CABs) is important, such as ISO 17025 (laboratories), ISO 17020 (Inspection Bodies), ISO 17021 (Management System Certification Bodies), ISO 17065 (Product Certification Bodies) and ISO 17029 (Verification & Validation Bodies), among others.

This implementation of international accreditation standards is essential for global acceptance as part of the concept of mutual recognition. Namibia currently utilizes the regional accreditation body SADCAS (Southern African Development Community Accreditation Service) as the local accreditation body. SADCAS is a member of the International Accreditation Forum (IAF) and is therefore covered by the Mutual Recognition Agreement (MRA), which means that certifications for the different scopes are accepted worldwide and vice versa. Under the terms of the Mutual Recognition Agreement, trade between exporters and importers is levelled due to global acceptance, similar costs and qualification requirements.

ISO¹¹, for example, defines the role of national standards organisations as follows:

- They publish, and may write, their own national standards.
- They represent their country in regional and international standard-setting fora.
- They hold a reference library of national, regional and international standards
- They sell copies of standards.
- Some also offer conformity assessment services such as accreditation, certification or other commercial activities.

However, it should be noted that ILAC-IAF emphasises the importance of impartiality and avoidance of conflicts of interest in the standards development and conformity assessment processes. It considers a combination of these activities in one body to be problematic (e.g. due to financial interests, insider knowledge, perception of bias, threat of self-review, separation of roles). This could compromise the principles of mutual recognition. Therefore, it should be noted that a mandate of a national standards body as publisher of certain standards and at the same time responsibility as a conformity assessment body (CAB) may lead to a potential conflict of interest under IAF. NSI has separated the activities to avoid a potential conflict of interest in different functions / departments. This situation is generally expected for smaller economies, where limited resources often necessitate such arrangements. This separation of functions within the NSI for standards development and conformity assessment, as required by the Standards Act, requires continuous review and monitoring to ensure impartiality and maintain operational independence. The functions of the NSI are well defined and separated to ensure that there is no conflict between standards development and conformity assessment. However, this should be monitored in close coordination with the national/regional accreditor, i.e. SADCAS.

¹¹ https://www.iso.org/sites/ConsumersStandards/1_standards.html

General obligations of a manufacturer and harmonisation of standards

Standards alone are not automatically mandatory or so-called harmonised/compulsory standards. Standards developed or adopted are initially recommendations (guidelines). Only a direct reference in regulations makes them harmonised and therefore mandatory. The figure below shows a typical hierarchy of a top-down approach in the regulatory framework, which also refers to the obligation of manufacturers.

It is important to bear in mind that hydrogen technologies do not only deal with hydrogen specific safety issues, but also with interdisciplinary issues such as pressure equipment, explosion protection, materials assessment, fire regulations and low and high voltage, among others.

Figure 3 Regulatory Framework: “Top Down” Approach; own source.



The hierarchy should be read from top to bottom, indicating that the law refers to the regulation, which itself refers to the *harmonised or mandatory standards* as mandatory requirements. These requirements should not contradict each other, with the top level representing the highest significance. An important piece of legislation that could be applicable to the development of hydrogen and PtX regulations, codes and standards in many countries is a national *Occupational Health and Safety (OHS) Act* or *Labour Code*, which refers to several applicable regulations.

Laws and regulations are highly binding, meaning a manufacturer must comply with these requirements. However, they are often not very detailed. Contrary, harmonized standards are more detailed and directly referenced in regulations. They are mandatory, whereas regulatory guidelines and best practice are not mandatory and only refer to the state of science and technology.

For the technical aspects mentioned above, Namibia has already incorporated several harmonised international standards (e.g. for management systems or the food industry) regarding world trade and regional independence. This incorporation process is based on technical and formal discussions in Namibia to ensure global trade according

to national circumstances and the WTO. In the set of regulations, health and safety standards are referred to under a regulation. In this context, an important role of the NSI is to make recommendations to the Namibian regulator on appropriate health and safety standards for the future.

Regulatory frameworks are usually stable for several years, which is why there are acceptable harmonized or Harmonised Standards and Specifications (HSS) in form of a Government Gazette, which makes them legally binding. This gazette contains a list of standards that are all the same level, so a manufacturer can choose what's most appropriate. This is further explained in the following chapter on the standardisation process. In addition to complying with legislation and meeting applicable standards, a manufacturer has a natural interest in providing safety as part of its duties as a manufacturer and user. Where standards are not incorporated as HSS, they are referred to as regulatory guidelines or international best practice and are therefore in the natural interest of a manufacturer to incorporate as part of due diligence and product liability.

3.3. Standardisation Process

The standards development process within ISO and IEC is carried out by various *Technical Committees* (TC), which work with National Mirror Committees from different countries as ISO Member Bodies, see NSI participation in international committees above. NSI is mandated to represent Namibia and its ecosystem in these activities and to gain important insights as well as to represent Namibia's interests in these committees. This participation is important to keep abreast of technical considerations and global developments in the field of standardisation in accordance with the Namibian Standardisation Act. It also provides valuable insights into the possible adoption/adaptation of ISO/IEC standards in relation to the above-mentioned WTO Agreement. Standardisation TCs are unincorporated technical organisations dedicated to drafting standards in specific areas. It is recommended that national mirror committees are formed to represent the country's interests at the international level and to reflect the standardisation work.

A national organisation such as the NSI provides unified management, oversight and overall co-ordination of standardisation work at national level and, as an ISO Member Body, sends representatives to the ISO/IEC TCs. These representatives may come from the national standards organisation itself and/or from various industry stakeholders in a country. ISO and IEC participation is possible as a member body (active), correspondent member (observer) or subscriber member (informative).

At national level, the TC for a particular industrial sector discusses whether and for which technologies it makes sense to adopt, adapt or develop a completely new standard. This distinction between adoption, adaptation and development is necessary to move the standardisation process forward and to comply with the WTO's Good Standardisation Practice (GSP) at national level.

Table 4 Standards adoption, adaptation and development

Adoption	Adaptation	Development
• Adoption of international standards (ISO / IEC) as regional or national standards, translation if applicable • Options of identical or modified adoption • By far the fastest option • Often identical standard number, e.g. Fuel Cells IEC 62282 ↔ DIN EN IEC 62282 or General criteria for the operation of various types of bodies performing inspections ISO/IEC 17020 ↔ SANS/ISO 17020 • In line with GSP 9: National adoption or implementation of international and regional standards	• Adapted to take local circumstances into account. • Country-specific adaptation of the texts to a specific market • Stakeholders are designated and changed, so that local organisations, etc. are considered. • Mostly needed to avoid wording difficulties	• A whole new standard is developed. • Long process (it can take months or years to develop a standard). • Strong industrial input needed. • E.g. SABS low-carbon hydrogen standard to ensure local legal compliance for hydrogen production and acceptance for global trade* *under development.

These GSPs outline essential guidelines for the development of standards to ensure that they facilitate international trade and are widely accepted. These principles have been further developed by ISO and are now routinely applied at regional and national levels. As mentioned above, international standards contribute to the TBT Agreement, which aims to ensure that technical regulations, standards and conformity assessment procedures are non-discriminatory and do not create unnecessary barriers to trade. An important GSP in this context is the *GSP Principle 9: National adoption or implementation of international and regional standards*, with the following objectives:

Coherence with International and Regional Standards

- National standards should align with international and regional standards to avoid trade barriers.
- The WTO's TBT Agreement encourages the use of international standards as a basis for national standards to ensure consistency.

Adoption of International Standards

- National Standards Bodies (NSBs) should persuade technical committees to adopt international standards with minimal changes.
- Local industry may resist this to create hidden trade barriers through differing national standards.

Permissible Changes

- Changes should be based on solid technical evidence.
- Examples include adjustments for larger voltage variations or major climatic differences.

Countering Local Resistance:

- NSBs must work hard to prevent the creation of unnecessary barriers to trade through differing standards.
- Such tendencies can be reduced by active participation in the development of international and regional standards.

Regarding GSP Principle 9, it is not normally necessary to develop a national standard, as international standards are usually adopted or adapted. The adoption or adaptation of standards to make them harmonised standards is a common and usually faster way of implementing mandatory requirements, as a regulatory framework is stable for several years.

National standards bodies can also participate in regional cooperation to produce regional standards. This can be particularly valuable in the context of regional adaptation of international standards, as local circumstances, such as units used or wording, are already taken into account.

In Europe, and in the interest of the EU Trade Area Agreement, national standards bodies are also members of the European Committee for Standardisation (CEN) and ISO. Other regional standardisation groups exist, for example in Latin America (CO-PANT), the Asia-Pacific region (PASC) or Southern Africa (SADC).

South African Conventions and Processes

South Africa joined ISO in 1946 as one of 25 founding members. It is also a member of IEC. The SABS is the national standardisation institution in South Africa, established in terms of the Standards Act, 1945 (Act No. 24 of 1945) and continues to operate in terms of the latest edition of the Standards Act, 2008 (Act No. 8 of 2008) as the national standardisation institution in South Africa. SABS is mandated to develop, promote and maintain South African National Standards (SANS). Furthermore, it promotes quality in connection with commodities, products and services and renders conformity assessment services.

The SABS has a duty, according to section 3(a) of the Standards Act, 1993 (Act No 29 of 1993), to:

- maintain a South African presence in the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC) and the); and
- contribute to the formulation of international standards, especially those which are applicable to South Africa.

SABS's policy is to promote the convergence of international and national standardisation activities by maintaining contact with all IEC and ISO member bodies by means of correspondence, voting and attending meetings (when appropriate). This enables the SABS to help industry keep abreast of trends in international standardisation. It also enables SABS to influence the formulation of standards to ensure that any international standard adopted can be accepted as a national standard. However, South Africa does not adopt ISO and IEC standards automatically. There are clearly defined processes for the adoption of standards.

Figure 4 Standardisation Process in South Africa; own source.



SABS has several Technical Committees (TCs). Once a TC has decided that a new standard needs to be developed or adopted (based on input from industry or government), it convenes a Working Group (WG) consisting of a panel of experts. The WG then drafts the new standard or uses existing international standards. Following these discussions, SABS publishes applicable standards as SANS standards in South Africa. Standards are not legally binding on their own but can become compulsory if they are published as part of a regulation (only regulations under an Act of Parliament are legal statutes). There is a process which allows the conversion of SABS standards to formal regulations. This process is managed by the National Regulator for Compulsory Specifications (NRCS). If standards are referred to in regulations, then an RSA organisation must use these standards. These are typically ISO/IEC, Euro Norms (EN), ASME or API (in the case of safety standards).

In Namibia, this may be the case for the NSI, which establishes a TC 197 and appoints a responsible person. It can facilitate the activities of WGs, which then identify standardisation needs and investigate international standards as highlighted above. This leads to a decision by the NSI and the TC 197 WG to either adopt an international standard or to develop a new standard, noting that the adoption of a standard is much quicker and in line with good standardisation practices as defined by the WTO. A standard can then be published under NSI and recommended to the ministry or regulator for inclusion as an HSS.

In the South African example, harmonised (or health and safety) standards are incorporated into certain regulations in the South African Government Gazette. Figure 5

shows the incorporation of health and safety standards into the Pressure Equipment Regulations (2009).

Figure 5 South African Government Gazette; Excerpt from the South African Pressure Equipment Regulation, 2009

DEPARTMENT OF LABOUR

NO. R. 262

24 MARCH 2017

OCCUPATIONAL HEALTH AND SAFETY ACT (ACT NO.85 OF 1993), AS AMENDED

INCORPORATION OF HEALTH AND SAFETY STANDARDS INTO THE PRESSURE EQUIPMENT REGULATIONS, 2009

Schedule

Extracts from
SA:
GOVERNMENT
GAZETTE

1	2
American standards	
ASME Section I	Rules for construction of power boilers
ASME Section III	Rules for construction of nuclear facility components (divisions 1, 2 and 3)

Australian standards	
AS 2634	Chemical plant equipment made from glass-fibre reinforced plastics (GRP) based on thermosetting resins
British standards	
BS 1113	Design and manufacture of water-tube steam generating plant (including super heaters, reheaters and steel tube economizers)
BS 4994	Specification of the design and construction of vessels and tanks in reinforced plastics

European standards	
2010/35/EU	Council Directive 2010/35/EU 16 June 2010 on transportable pressure equipment
EN 286-1	Simple unfired pressure vessels designed to contain air or nitrogen – Part 1: Pressure vessels for general purposes
EN 303-1	Heating Boilers – Part 1: Heating boilers with forced draught burners – Terminology, general requirements, testing and marking

South African standards	
SANS 347	SANS 347: Categorization and conformity assessment criteria for all pressure equipment
SANS 151	Fixed electric storage water heaters
SANS 10228	Identification and classification of dangerous goods for transport

Extracts from
SA:
GOVERNMENT
GAZETTE

This list of harmonised standards will be assessed and adapted by the regulators based on their safety requirements and technical discussions. This also allows a manufacturer to choose from a range of available global standards as recognised standards in the country.

3.4. Technical Standards

The most prominent developments for hydrogen standards are carried out under ISO and IEC technical committees. Technical standards on international level are important to address technical issues, unified opinions and ensuring of quality and safety.

ISO hydrogen-related standards:

On ISO level, the Technical Committee for Hydrogen Technologies – ISO TC 197 – focuses on the scope of standardisation in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen. As of October 2024, ISO/TC 197 has published 22 standards, while 25 standards are currently under development. (Source: [ISO TC197](#)).

The Subcommittee 37 of the ISO/TC 22 is specialized in Electrical Propelled Vehicles, incl. discussions on hydrogen cell road vehicles. Within ISO/TC 197 there are several Working Groups focusing on different subtopics. In total there are 18 Working Groups (WG), listed in the table below.

Table 5 ISO/TC 197 Working Groups

ISO/TC197	Title
SC 1	Hydrogen at scale and horizontal energy systems
AHG 1	Permanent
AHG 2	Update gaseous and liquid hydrogen dispensing
JWG 30	Joint ISO/TC 197 - ISO/TC 22/SC 41 WG: Gaseous hydrogen land vehicle fuel system components
TAB 1	Technical Advisory Board
WG 1	Liquid hydrogen - Land vehicles fuel tanks
WG 5	Gaseous hydrogen land vehicle refuelling connection devices
WG 15	Cylinders and tubes for stationary storage
WG 18	Gaseous hydrogen land vehicle fuel tanks and TPRDs
WG 19	Gaseous hydrogen fuelling station dispensers
WG 21	Gaseous hydrogen fuelling station compressors
WG 22	Gaseous hydrogen fuelling station hoses
WG 23	Gaseous hydrogen fuelling station fittings
WG 24	Gaseous hydrogen – Fuelling protocols for hydrogen-fuelled vehicles
WG 27	Hydrogen fuel quality
WG 28	Hydrogen quality control
WG 29	Basic considerations for the safety of hydrogen systems
WG 31	O-rings
WG 32	Hydrogen generators using water electrolysis
WG 33	Sampling for fuel quality analysis
WG 34	Hydrogen generators using water electrolysis test protocols and safety requirements
WG 35	Liquid Hydrogen Land Vehicle Fuelling Protocol
WG 36	Gaseous hydrogen land vehicle refuelling connection devices - Cryo-compressed H2 gas

Other TCs are not focused on hydrogen per se but consider hydrogen to be relevant to their activities. These TCs are:

- “ISO/TC 220 Cryogenic vessels”.
- “ISO/TC 58 Gas cylinders.
- “ISO/TC 22/SC 41 Gaseous fuels-specific issues”

IEC hydrogen-related standards

At the IEC level, the Technical Committee on Fuel Cell Technologies - ISO/TC 105 - specialises in the development of standards for fuel cell technologies for different types of fuel cells and various related applications, resulting mainly in the IEC 62282-x standards. The scope of TC 105 includes the preparation of international standards on fuel cell (FC) technologies for all types of FC and various related applications. These include, for example, stationary FC power systems for distributed generation and cogeneration, FCs for transport such as propulsion systems (see note below), range extenders, auxiliary power units, portable FC power systems, micro-CC power systems, reverse cycle FC power systems and general electrochemical flow systems and processes. NOTE: Projects with road vehicle applications will be coordinated with ISO TC 22 and its relevant SCs using the modes of cooperation defined in the ISO/IEC Directives.

IEC/TC 105 standards are intended to cover the market demand of:

- Component, sub-system and fuel cell suppliers
- Fuel cell and system installers.
- Fuel cell and system manufacturers.
- Testing and certification bodies
- Regulators, authorities, approval organisations
- Original equipment manufacturers

As of August 2024, ISO/TC 105 has published 15 standards, with 16 standards currently in active projects ¹².

Table 6 Examples of IEC TC105 working groups.

IEC/TC105	Title
WG 105	General safety standard for fuel cell power systems
WG 106	Calculation of rated power and power density of a stack/module
WG 212	Stationary fuel cell power systems - Performance of small systems with/without supplementary heat generators for multiple units' operation by an energy management system
WG 305	Safety of PEMFC-Systems for the maritime sector
WG 402	Micro fuel cell power systems - Safety

¹² Source: IEC TC105

WG 406	Power, data interchangeability and performance test methods for Fuel Cell Power Systems for laptop computers
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These working groups are supported by a number of Maintenance Teams (MT), Joint Working Groups (JWG), Advisory Groups (AG) and Ad-Hoc Groups (AHG) with different scope and focus on potential fuel cell applications. These teams and groups cover topics such as terminology, fuel cell performance, fuel cell safety, fuel cell installation, solid oxide fuel cells (SOFC), proton exchange membrane fuel cells (PEMFC) and more. More detailed information can be found at IEC TC 105 - Working Groups and Maintenance Teams and Safety considerations within the hydrogen system boundary.

However, it is important to consider that safety-related standards for hydrogen technologies cannot be reduced to the implementation of a few selected standards. The implementation of hydrogen technologies consists of interdisciplinary considerations and a variety of technical aspects to be considered for electrical, electronic and related technologies (e.g. IEC) and standards for trusted goods and services (e.g. ISO). A hydrogen storage system, for example, deals not only with several hydrogen-related aspects and standards, but also with non-hydrogen-specific issues and standards as part of the overall system safety concept, such as:

- Hydrogen specific influences
- Mechanical influences
- Electromagnetic compatibility
- Functional safety
- Fire / Temperature protection.
- Conceptual / installation requirements
- Material requirements
- Pressure equipment
- Explosion protection
- Environment

An overview with a selection of such international standards that are not specific to hydrogen can be found in the table below.

Table 7 International non-hydrogen specific standards relevant to hydrogen

Standard International	Description
Machinery	
EN 809	Pumps and pump units for liquids – common safety requirements
EN 12100	Safety of machinery – general principle for design – risk assessment and risk reduction
ISO 13849-1:2023	Safety of machinery – safety-related parts of control systems – Part 1: General principles for design
ISO 12499:1999	Industrial fans – Mechanical safety of fans – Guarding
ISO 13850:2015	Safety of machinery – Emergency stop function – Principles for design
ISO 13857:2020	Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs

Standard International	Description
Fire	
ISO 13943:2017	Fire safety – Vocabulary
ISO 14520-1:2015	Gaseous fire-extinguisher systems – Physical properties and system design – Part 1: General requirements
ISO 17398:2004	Safety colours and safety signs – Classification, performance and durability of safety signs
ISO 7010:2019	Graphical symbols – Safety colours and safety signs – Registered safety signs
ISO 7240-1:2014	Fire detection and alarm systems – Part 1: General and definitions
ISO 31000:2018	Risk management – Guidelines
ISO 31010:2019	Risk management – Risk assessment techniques
Electrical	
EN 61508-x	Functional safety of electrical/electronic/programmable electronic safety-related systems
EN 60204-1	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
Environment	
ISO 5667-1	Water quality – Sampling – Part 1: Guidance on the design of sampling programmes and sampling techniques
ISO 14001	Environmental management systems – Requirements with guidance for use
ISO 14004	Environmental management systems – General guidelines on implementation
ISO 14006	Environmental management systems – Guidelines for incorporating eco-design
ISO 14007	Environmental management – Guidelines for determining environmental costs and benefits
ISO 14009	Environmental management systems – Guidelines for incorporating material circulation in design and development
ISO 14030	Environmental performance evaluation – Green debit instruments
ISO 14031	Environmental management – Environmental performance evaluation – Guidelines
ISO 14033	Environmental Machinery / Fire / Electrical protection & safety / Environment management – Quantitative environmental information – Guidelines and examples
ISO 14040	Environmental management – Life Cycle Assessment – Principle and framework
ISO 14044	Environmental management – Life Cycle Assessment – Requirements and guidelines
ISO 14046	Environmental management – Water footprint – Principles, requirements and guidelines
ISO 14064-1	Greenhouse gases — Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals
ISO 14064-2	Greenhouse gases — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements
ISO 14064-3	Greenhouse gases — Part 3: Specification with guidance for the verification and validation of greenhouse gas statements

3.5 Non-hydrogen specific standards

This subsection reviews the main international non-hydrogen specific standards for a hydrogen facility and provides an initial assessment of the most relevant standards for Namibia. Namibian stakeholders, particularly the hydrogen industry, should review and prioritise standards for adoption based on local circumstances. The NSI and other stakeholders will also need to assess the necessary regulation and advise the Namibian Government.

3.5.1 Pressure Equipment

Pressure equipment is critical throughout the hydrogen value chain, especially given the need to handle hydrogen at pressures up to 700 bar. Standards for such equipment outline essential requirements for manufacturers and operators, including safety inspections and pressure testing for systems above 0.5 kPa. These standards cover hazard classification, conformity assessment, installation and maintenance. Our review of international standards was guided by the South African Pressure Equipment Regulations, which provided a basis for comparison with global practice.

In the tables below pressure equipment standards that are considered most relevant to hydrogen have been selected. A full list from the South African Pressure Equipment Regulations (2009) is given in Appendix D.

Table 8 Safety Standards for Pressure Equipment

Standard	Description	Relevance to Namibia	Reason for Relevance
ASME Section VIII	Rules for construction of pressure vessels (divisions 1, 2, and 3)	High	Crucial for ensuring the safety of pressure vessels in hydrogen storage and transportation.
ISO 4126 (All parts)	Safety devices for protection against excessive pressure	High	Essential for safety in pressure systems, relevant to hydrogen storage and pipelines.
SANS 10227	Criteria for operation of inspection authorities for Pressure Equipment Regulations	High	Ensures compliance and safety in the inspection of pressure systems.
SANS 10019	Transportable metal containers for compressed gas – Basic design, manufacture, use, and maintenance	High	Critical for safe handling and transport of hydrogen in compressed form.
EN 13445	Unfired pressure vessels	High	Ensures design and manufacturing safety of pressure vessels, applicable to hydrogen storage.

IEC 61508	Functional Safety of electrical/electronic/programmable electronic safety-related systems	High	Essential for ensuring safe operation of control systems in hydrogen facilities.
ANSI/ISA 84.00.01	Functional safety - Safety instrumented systems for the process industry sector	Medium	Relevant for safety measures, especially in automated hydrogen production facilities.
ISO 14692 (All Parts)	Glass-reinforced plastics (GRP) piping for petroleum and natural gas industries	Medium	Could be relevant for certain hydrogen applications where non-metallic piping is used.

Table 9 Machinery Standards for Pressure Equipment

Standard	Description	Relevance to Namibia	Reason for Relevance
ASME B31.3	Process piping	High	Provides comprehensive safety guidelines for piping systems, important for hydrogen production.
ASME Section X	Fibre-reinforced plastic pressure vessels	Medium	Could be applied in specific hydrogen storage solutions.
EN 13480	Piping	High	Ensures the safe design and construction of piping, critical for hydrogen transport infrastructure.
SANS 1748 (All Parts)	Glass-fibre-reinforced thermosetting plastics (GRP) pipes	Low	Relevant for specific applications, though less common in hydrogen systems.
SANS 10260	Industrial gas pipelines	High	Essential for safe construction and operation of hydrogen pipelines.

Table 10 Environmental Management for Pressure Equipment

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 14025	Environmental labels and declarations – Type III environmental declarations	Medium	Supports sustainability practices by providing guidelines for environmental product declarations.

ISO 14040	Environmental management – Life Cycle Assessment – Principle and framework	High	Crucial for assessing the environmental impact of hydrogen production projects.
SANS 10147	Refrigeration systems, including plants associated with air-conditioning systems	Medium	Could be relevant for managing thermal aspects in hydrogen cooling systems.

Table 11 Risk Management

Standard	Description	Relevance to Namibia	Reason for Relevance
CWA 15740	Risk-based inspection and maintenance procedures for industry (RI MAP)	High	Supports risk management by establishing maintenance protocols, critical for hydrogen infrastructure.
ISO 31000	Risk management – Guidelines	Medium	Provides general risk assessment tools, applicable across various aspects of hydrogen projects.

3.5.2 Major Hazard Installation (MHI)

Standards for hydrogen installations as major hazardous installations are necessary to ensure safety due to the flammability and explosive potential of hydrogen. Regulations for such installations generally require facilities to carry out risk assessments, establish safety management systems and implement emergency response plans. Relevant South African regulations were used as a reference for this analysis, in particular the framework under the Occupational Health and Safety Act. These regulations set criteria for facilities that handle hazardous substances, including hydrogen, and emphasise strict safety protocols in line with international standards.

In the context of hydrogen, installations exceeding certain storage or handling thresholds are classified as Major Hazardous Installations (MHIs) and must comply with stringent safety measures. These thresholds categorise hazard levels as follows:

- Low Hazard: 2.5 tonnes
- Medium Hazard: 5 tonnes
- High Hazard: 50 tonnes

Facilities storing or handling hydrogen at or above these levels must follow appropriate safety protocols to minimise risks. The table below lists the main standards for the management of hydrogen facilities relevant to MHI.

Table 12 Standards relevant to Major Hazard Installations

Standard	Description	Relevance to Namibia	Reason for Relevance
SANS 1461	South African National Standard: Major Hazard Installation – Risk Assessments, as amended from time to time.	High	Ensures robust risk assessment protocols for handling hydrogen, minimizing safety risks.
SANS 1514	South African National Standard: Major Hazard Installation: Emergency Response Planning, as amended from time to time.	Medium	Establishes guidelines for effective emergency response in case of hydrogen-related incidents.
IEC 60079-27	Electrical apparatus for explosive gas atmospheres – Part 27: Fieldbus intrinsically safe concept (FISCO) and Fieldbus non-incendive concept (FNICO).	Medium	It contains details of apparatus, systems and installation practice for use with the Fieldbus Intrinsically Safe Concept (FISCO) and the Fieldbus Non-Incendive Concept (FNICO).
ATEX Directive (Directive 94/9/EC)	The approximation of the laws of Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.	High	This Directive is an important international best practice for prevention of explosive atmospheres, originated in the EU. It covers a large range of equipment in areas where a potentially explosive atmosphere may be present.

3.5.3 Other Non-Hydrogen Specific Standards

The following tables assess other non-hydrogen specific standards in terms of their relevance to the Namibian hydrogen sector.

Table 13 General Safety Standards

Standard	Description	Relevance to Namibia	Reason for Relevance
EN 809	Pumps and pump units for liquids – Common safety requirements	High	Ensures safety in systems handling liquids, relevant for hydrogen production.

ISO 13850:2015	Safety of machinery – Emergency stop function – Principles for design	High	Important for safety protocols in facilities where rapid shutdown may be needed.
ISO 12499:1999	Industrial fans – Mechanical safety of fans – Guarding	Medium	Relevant for safety in ventilation systems, though not critical to hydrogen.
ISO 13857:2020	Safety of machinery – Safety distances to prevent hazard zones being reached	Medium	Supports operator safety, useful in industrial setups handling hydrogen.
ISO 13943:2017	Fire safety – Vocabulary	Medium	Standardizes fire safety terms, supporting safety protocols in storage and production.
ISO 7010:2019	Graphical symbols – Safety colours and safety signs – Registered safety signs	High	Essential for clear communication of safety protocols in facilities.
EN 61508-x	Functional safety of electrical/electronic/programmable electronic safety-related systems	High	Ensures control systems operate safely, critical across industrial applications.
EN 60204-1	Safety of machinery – Electrical equipment of machines – General requirements	High	Addresses electrical safety, relevant across multiple points in the hydrogen value chain.
ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems	High	Supports safety measures in control systems, crucial for hydrogen-related machinery.
ISO 12100:2010	Safety of machinery – General principles for design – Risk assessment and risk reduction	High	Important for design safety, though not exclusive to hydrogen systems.

Table 14 Environmental Management Standards

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 14001	Environmental management systems – Requirements with guidance for use	High	Supports general environmental compliance. Useful for hydrogen plants adopting green practices.

ISO 14004	Environmental management systems – General guidelines on implementation	Medium	Complements ISO 14001 by providing implementation guidance.
ISO 14044	Environmental management – Life Cycle Assessment – Requirements and guidelines	High	Ensures comprehensive environmental assessments, crucial for sustainability goals.
ISO 14046	Water footprint – Principles, requirements and guidelines	Medium	Relevant for managing water use, a key factor in electrolysis-based hydrogen production.
ISO 14064-1	Greenhouse gases — Specification with guidance for quantification and reporting	High	Supports emissions monitoring and compliance, essential for meeting environmental goals.
ISO 31000:2018	Risk management – Guidelines	Medium	Ensures broader risk management across environmental factors.
ISO 14031	Environmental management – Environmental performance evaluation – Guidelines	Medium	Assists in evaluating the environmental performance of projects, relevant to broader sustainability practices.

Table 15 Risk Management Standards

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 31010:2019	Risk management – Risk assessment techniques	Medium	Provides techniques for risk evaluation, enhancing safety and operational planning.
ISO 12100:2010	Safety of machinery – Risk assessment and risk reduction	High	Supports comprehensive risk assessment for machinery, useful across sectors.

Table 16 Machinery Standards

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 12499:1999	Industrial fans – Mechanical safety of fans – Guarding	Medium	Ensures safety for mechanical equipment, applicable to various industrial systems.

EN 809	Pumps and pump units for liquids – Common safety requirements	Medium	Crucial for ensuring safe operation of pumps, which are widely used across industrial systems.
ISO 12100	Safety of machinery – General principles for design – Risk assessment and risk reduction	Medium	Provides a broad framework for designing safe machinery, relevant in multiple contexts.
EN 60204-1	Safety of machinery – Electrical equipment of machines – General requirements	High	Addresses safety in electrical machinery, essential across sectors.

Table 17 Standards Covering Additional Considerations

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 14064-3	Greenhouse gases — Verification and validation of greenhouse gas statements	High	Supports compliance with carbon reduction commitments, essential for the green hydrogen strategy.
ISO 14064-2	Greenhouse gases — Quantification, monitoring, and reporting at the project level	High	Ensures accurate accounting of emissions reductions, useful for project planning and sustainability.
ISO 14007	Environmental management – Guidelines for determining environmental costs and benefits	Medium	Aids in understanding the environmental trade-offs in project planning.
ISO 14040	Environmental management – Life Cycle Assessment – Principle and framework	Medium	Helps in assessing lifecycle impacts, relevant across industrial projects.
ISO 14031	Environmental management – Environmental performance evaluation – Guidelines	Medium	Supports environmental performance assessments, relevant for evaluating sustainability.

3.6 Standards along the Hydrogen Value Chain

The hydrogen value chain is long, and most hydrogen-specific standards are driven by industry to ensure interoperability and safety. The hydrogen value chain includes production, storage, transport, fuelling stations/infrastructure and possible end-use applications. The available ISO and IEC standards are highlighted below, taking into account the following sub-categories:

- 1) Hydrogen Production and Conditioning
- 2) Hydrogen Storage and Transportation

- 3) Hydrogen Fuel Cells
- 4) Hydrogen Refuelling Stations and Fuel Quality
- 5) Ammonia and Synthetic Fuels

The following sub-chapters list and explain the applicable and state-of-the-art standards at ISO and IEC level that are available along the entire hydrogen value chain. In addition to ISO and IEC standards, there are also regional and local activities and therefore standards available, such as DIN (Germany), EN (Europe), BS (UK), GB/T (China), ASME Codes (USA), etc. These national standards are not included in this study.

3.6.1 Hydrogen Production and Conditioning

In the context of GH₂ production, the standard analysis focuses on electrolysis from water, for which the following two ISO/IEC standards for hydrogen production by electrolysis from water are available:

- ISO 22734-1:2008 Hydrogen generators using water electrolysis process – Part 1: Industrial and commercial applications.
- ISO 22734-2:2011 Hydrogen generators using water electrolysis process – Part 2: Residential applications.

In addition, ISO 16110:2010 focuses on hydrogen generators using fuel processing technologies.

It is important to note that other relevant directives and requirements for hydrogen production equipment (e.g. water electrolysis hydrogen generators) cover topics such as pressure equipment, low voltage, electromagnetic compatibility, explosion protection or machinery safety.

Hydrogen conditioning deals with compression (CGH₂), liquefaction (LH₂) or Hydrogenation (MeOH, LOHC, NH₃). An applicable standard would be EN 1012-1:2010. This standard applies specifically to compressors and compressor units with an operating pressure greater than 0.5 bar. Safety requirements are classified in this standard.

Table 18 assesses the relevance of the most important international standards for the production and conditioning of hydrogen for Namibia.

Table 18 Key International Standards for Hydrogen Production and Conditioning

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 22734-1:2008	Hydrogen generators using water electrolysis process – Industrial and commercial applications	High	Essential for establishing hydrogen production using renewable energy, ensuring safety and efficiency.

ISO 22734-2:2011	Hydrogen generators using water electrolysis process – Residential applications	Low	Important for residential use but less important than industrial and commercial applications.
ISO 16110:2010	Hydrogen generators using fuel processing technologies	High	Important for integrating hydrogen production through fuel processing, which supports broader applications.
EN 1012-1:2010	Compressors and compressor units - Safety requirements	High	Necessary for safety protocols in the use of compressors within hydrogen production systems.

3.6.2 Hydrogen Storage and Transportation

There are four standards available for the storage of hydrogen.

- ISO 13985:2006 Liquid hydrogen – Land vehicle fuel tanks
- ISO 16111:2018 Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride.
- ISO 19881:2018 Gaseous hydrogen – Land vehicle fuel containers
- ISO 19882:2018 Gaseous hydrogen – Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers

Furthermore, international regulations for hydrogen only exist in the mobile sector. These regulations are organised and agreed at UN level. The most prominent are the United Nations Global Technical Regulation N°13 (UN GTR 13) and the derived United Nations Economic Commission for Europe Regulation N°134 (UNECE R134) which focus on the approval of hydrogen-powered vehicles and mainly their safety aspects with regard to the hydrogen storage system.

In addition, the EU has published legal requirements for the approval of a hydrogen storage system in the EU, namely (EC) 2021/535 and (EC) 79/2009 incl. (EU) 406/2010 (repealed on 5 July 2022). Table 19 below shows which components and physical states of hydrogen are considered in each of the above regulations.

Table 19 Components considered in Reg. (EC) 79/2009, UN Regulation No 134 and Reg. (EU) 2021/535

Components	Reg. (EC) 79/2009	UN Regulation No 134	Reg. (EU) 2021/535
Compressed gaseous hydrogen (CGH2)			
Hydrogen container	x	x	x
Pressure relief device (PRD)	x	x	x
Automatic shut-off valves	x	x	x
Check valves	x	x	x
Pressure relief valves	x		

Components	Reg. (EC) 79/2009	UN Regulation No 134	Reg. (EU) 2021/535
Heat exchangers	x		
Refuelling connections	x	(x)	(x)
Receptacles	x	(x)	(x)
Pressure regulators	x		
Sensors for hydrogen systems	x	(x)	
Flexible fuel lines	x		
Fittings	x		
Hydrogen filters	x		
Removable storage system connectors	x		
Liquid hydrogen (LH2)			
Hydrogen container	x	N/A	x
Pressure relief device (PRD)	x		x
Automatic shut-off valves	x		x
Check valves	x		x
Boil-off system	x		x
Heat exchangers	x		
Refuelling connections or receptacles	x		(x)
Pressure regulators	x		
Sensors	x		
Flexible fuel lines	x		

Table 20 assesses the importance of the most important international standards for the storage and transport of hydrogen for Namibia

Table 20 Hydrogen Storage and Transportation

Standard	Description	Rele- vance to Namibia	Reason for Relevance
ISO 13985:2006	Liquid hydrogen – Land vehicle fuel tanks	Medium	Supports the safe transport of liquid hydrogen, which is necessary for long-distance transport infrastructure but is unlikely to be a
ISO 16111:2018	Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride	Medium	Relevant for portable applications where reversible metal hydrides are utilized.

ISO 19881:2018	Gaseous hydrogen – Land vehicle fuel containers	High	Important due to safety and storage requirements for hydrogen-powered vehicles.
ISO 19882:2018	Gaseous hydrogen – Thermally activated pressure relief devices	High	Addresses safety aspects in hydrogen storage, focusing on specific applications.
UN GTR 13	Global Technical Regulation for hydrogen-powered vehicles	Low	Less relevant due to its specific focus on international vehicle regulations.
UNECE R134	Economic Commission regulation for hydrogen storage systems	Medium	Useful for aligning with international standards on storage compliance.
EC 2021/535	EU regulation for hydrogen storage systems	Low	Lower Relevance, as these regulations are not immediately applicable locally.
EC 79/2009	Previous EU regulation for hydrogen storage systems	Low	Outdated regulation, largely replaced by newer frameworks.

3.6.3 Hydrogen Fuel Cells

IEC standards are available for fuel cells and their various applications, with different standards available under IEC 62282. Details are given below:

Terminology and symbols: The only ISO / IEC standard which is focusing on terminology and symbols is the following:

- IEC 62282-1:2013: Fuel Cell Technologies – Part 1: Terminology

Hydrogen safety:

- IEC 62282-2-100:2020: Fuel cell technology - Part 2-100: Fuel cell modules – Safety
- IEC 62282-3-100:2019: Fuel cell technologies - Part 3-100: Stationary fuel cell power systems – Safety
- IEC 62282-3-200:2015: Fuel cell technologies - Part 3-200: Stationary fuel cell power systems - Performance test methods
- IEC 62282-4-101:2022 Fuel cell technologies - Part 4-101: Fuel cell power systems for electrically powered industrial trucks – Safety
- IEC 62282-5-100:2018 Fuel cell technologies - Part 5-100: Portable fuel cell power systems – Safety
- IEC 62282-6-100:2010 Fuel cell technologies - Part 6-100: Micro fuel cell power systems – Safety
- IEC 62282-6-101:2024: Fuel cell technologies - Part 6-101: Micro fuel cell power systems - Safety - General requirements

- IEC 62282-6-106:2024: Fuel cell technologies - Part 6-106: Micro fuel cell power systems - Safety - Indirect Class 8 (corrosive) compounds
- IEC 62282-6-107:2024: Fuel cell technologies - Part 6-107: Micro fuel cell power systems - Safety - Indirect water-reactive (Division 4.3) compounds
- IEC PAS 62282-6-150:2011 Fuel cell technologies - Part 6-150: Micro fuel cell power systems - Safety - Water reactive (UN Division 4.3) compounds in indirect PEM fuel cells

Hydrogen Performance and Installation:

- IEC 62282-3-200:2015: Fuel cell technologies - Part 3-200: Stationary fuel cell power systems - Performance test methods
- IEC 62282-3-201:2017+AMD1:2022 CSV: Fuel cell technologies - Part 3-201: Stationary fuel cell power systems - Performance test methods for small fuel cell power systems
- IEC 62282-3-300:2012: Fuel cell technologies - Part 3-300: Stationary fuel cell power systems – Installation
- IEC 62282-3-400:2016: Fuel cell technologies - Part 3-400: Stationary fuel cell power systems - Small stationary fuel cell power system with combined heat and power output
- IEC 62282-4-102:2022: Fuel cell technologies - Part 4-102: Fuel cell power systems for electrically powered industrial trucks - Performance test methods
- IEC 62282-4-202:2023: Fuel cell technologies - Part 4-202: Fuel cell power systems for propulsion and auxiliary power units - Unmanned aircrafts - Performance test methods
- IEC 62282-4-600:2022: Fuel cell technologies - Part 4-600: Fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APU) - Fuel cell/battery hybrid systems performance test methods for excavators
- IEC 62282-6-200:2016: Fuel cell technologies - Part 6-200: Micro fuel cell power systems - Performance test methods
- IEC 62282-6-300:2012: Fuel cell technologies - Part 6-300: Micro fuel cell power systems - Fuel cartridge interchangeability
- IEC 62282-6-400:2019: Fuel cell technologies - Part 6-400: Micro fuel cell power systems - Power and data interchangeability
- IEC TS 62282-7-1:2017: Fuel cell technologies - Part 7-1: Test methods - Single cell performance tests for polymer electrolyte fuel cells (PEFC)
- IEC 62282-7-2:2021: Fuel cell technologies - Part 7-2: Test methods - Single cell and stack performance tests for solid oxide fuel cells (SOFCs)
- IEC 62282-8-101:2020: Fuel cell technologies - Part 8-101: Energy storage systems using fuel cell modules in reverse mode - Test procedures for the performance of solid oxide single cells and stacks, including reversible operation.
- IEC 62282-8-102:2019: Fuel cell technologies - Part 8-102: Energy storage systems using fuel cell modules in reverse mode - Test procedures for the performance of single cells and stacks with proton exchange membrane, including reversible operation.
- IEC 62282-8-201:2024: Fuel cell technologies - Part 8-201: Energy storage systems using fuel cell modules in reverse mode - Test procedures for the performance of power-to-power systems.

- IEC 62282-8-301:2023: Fuel cell technologies - Part 8-301: Energy storage systems using fuel cell modules in reverse mode - Power-to-methane energy systems based on solid oxide cells including reversible operation - Performance test methods.
- IEC TS 62282-9-101:2020: Fuel cell technologies - Part 9-101: Evaluation methodology for the environmental performance of fuel cell power systems based on life cycle thinking - Streamlined life cycle considered environmental performance characterization of stationary fuel cell combined heat and power systems for residential applications
- IEC TS 62282-9-102:2021: Fuel cell technologies - Part 9-102: Evaluation methodology for the environmental performance of fuel cell power systems based on life cycle thinking - Product category rules for environmental product declarations of stationary fuel cell power systems and alternative systems for residential applications.

Table 21 assesses the relevance of the most important international standards for hydrogen fuel cells for Namibia.

Table 21 Hydrogen Fuel Cells

Standard	Description	Relevance to Namibia	Reason for Relevance
IEC 62282-1:2013	Fuel Cell Technologies – Terminology	Medium	Supports standardizing terminology but is not immediately critical for local industry development.
IEC 62282-2-100:2020	Fuel cell modules – Safety	High	Necessary to ensure the safe operation of hydrogen fuel cells in various applications.
IEC 62282-3-100:2019	Stationary fuel cell power systems – Safety	High	Ensures safe and reliable operation of fixed installations, which is important for broader adoption.
IEC 62282-3-200:2015	Stationary fuel cell power systems - Performance test methods	Medium	Useful for verifying performance but less critical than safety regulations.
IEC 62282-4-101:2022	Fuel cell power systems for electrically powered industrial trucks – Safety	Low	Limited relevance due to specific industrial truck applications.
IEC 62282-5-100:2018	Portable fuel cell power systems – Safety	Medium	Supports safety in portable fuel cell applications, with moderate Relevance.
IEC 62282-6-100:2010	Micro fuel cell power systems – Safety	Low	Lower Relevance due to specialized applications of micro fuel cells.

3.6.4 Hydrogen Refuelling Stations and Fuel Quality

There are several hydrogen standards that focus on hydrogen refuelling stations, mainly published under the ISO 1988x series of standards.

- ISO 13984:1999 Liquid hydrogen -- Land vehicle fuelling system interface.
- ISO 17268:2012 Gaseous hydrogen land vehicle refuelling connection devices.
- ISO 19880-1: Gaseous hydrogen — Fuelling stations — Part 1: General requirements
- ISO 19880-3:2018: Gaseous hydrogen — Fuelling stations — Part 3: Valves
- ISO 19880-5:2019: Gaseous hydrogen — Fuelling stations — Part 5: Dispenser hoses and hose assemblies
- ISO 19880-8:2019: Gaseous hydrogen — Fuelling stations — Part 8: Fuel quality control
- ISO 19880-9:2024: Gaseous hydrogen — Fuelling stations – Part 9: Sampling for fuel quality analysis
- ISO 19885-1:2024: Gaseous hydrogen — Fuelling protocols for hydrogen-fuelled vehicles – Part 1: Design and development process for fuelling protocols
- Enquiry phase: ISO 19887 - Gaseous Hydrogen — Fuel system components for hydrogen fuelled vehicles.

Table 22 assesses the relevance of the most important international standards in relation to hydrogen refuelling stations and fuel quality for Namibia.

Table 22 Hydrogen Refuelling Stations and Fuel Quality

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 17268:2012	Gaseous hydrogen land vehicle refuelling connection devices	High	Important for ensuring compatibility and safety at refuelling stations.
ISO 19880-1	Gaseous hydrogen — Fuelling stations — General requirements	High	Supports the development of reliable and efficient refuelling infrastructure.
ISO 19880-3:2018	Gaseous hydrogen — Fuelling stations — Valves	High	Ensures that components meet safety standards, which is necessary for smooth operations.
ISO 19880-5:2019	Gaseous hydrogen — Fuelling stations — Dispenser hoses and hose assemblies	High	Critical for the efficient and safe operation of refuelling systems.
ISO 19880-8:2019	Gaseous hydrogen — Fuelling stations — Fuel quality control	High	Relevant for quality control, ensuring hydrogen meets purity requirements.

ISO 19880-9:2024	Gaseous hydrogen — Fuelling stations – Sampling for fuel quality analysis	Medium	Supports quality assurance during sampling processes.
ISO 19885-1:2024	Gaseous hydrogen — Fuelling protocols for hydrogen-fuelled vehicles	Medium	Important for establishing protocols for vehicle integration.

3.6.5 Ammonia and Synthetic Fuels

For the ammonia production and end usage as fuel the following standards are applicable:

- ISO 5149-1:2014: Refrigerating systems and heat pumps — Safety and environmental requirements – Part 1: Definitions, classification and selection criteria
- ISO/WD 23397: Ships and marine technology — Ammonia fuel systems for ships — Vocabulary
- Committee Draft: ISO/CD TS 21343: Fuel ammonia — Requirement and Guideline for boilers for power generation — Environmental performance
- EN590 (biodiesel)
- EN14214 (FAME)
- EN228, EN15736 (bioethanol)

Table 23 assesses the significance of the most important international standards for ammonia and synthetic fuels for Namibia.

Table 23 Ammonia and Synthetic Fuels

Standard	Description	Relevance to Namibia	Reason for Relevance
ISO 5149-1:2014	Refrigerating systems and heat pumps — Safety and environmental requirements	Medium	Useful for managing cooling systems but not a primary focus for hydrogen development.
EN590	Biodiesel standard	Low	Lower Relevance as biodiesel standards are less relevant for hydrogen projects.
EN14214	FAME standard	Low	Similar to EN590, with limited relevance in a hydrogen-centric energy strategy.
EN228	Bioethanol standards	Low	Low relevance, given the focus on hydrogen over other synthetic fuels.
ISO 14001	Environmental management systems – Requirements with guidance for use	Medium	Supports broader environmental management but secondary to hydrogen safety.

ISO 14044	Life Cycle Assessment – Requirements and guidelines	High	Ensures comprehensive lifecycle assessments, enhancing the export potential of hydrogen.
ISO 14046	Water footprint – Principles, requirements and guidelines	Medium	Important for ensuring water efficiency and sustainability in hydrogen production.

4 Overview of International Sustainability Certification

4.1 Why sustainability certification?

Sustainability certification of hydrogen is essential to enable and facilitate trade. It ensures that products meet established environmental, social and governance criteria and provides a common standard for sustainability. Certification enables standardised tracking and verification of hydrogen's greenhouse gas intensity and other key attributes. These are critical for regulatory compliance, market acceptance and consumer confidence, thereby promoting a reliable and transparent market that enables seamless international trade.

Certification is required to:

- Prove the properties of a product in terms of greenhouse gas intensity and other sustainability criteria (e.g. environmental and/or socio-economic impacts).
- Ensure reliable accounting of traded hydrogen volumes for specific consumers and/or countries and their production path.
- Avoid double counting.

An energy product is mainly characterised by its physical and chemical properties. This makes it possible, for example, to distinguish between different types of crude oil or different crude oil-based products such as petrol, diesel or paraffin. While the hydrogen molecules produced and transported by different routes are chemically identical, their sustainability characteristics, such as carbon footprint, can vary depending on the production, transport and use routes.

The sustainability characteristics of hydrogen and its derivatives - including the carbon footprint, the use of renewable energy in the production process, water use, land use and the socio-economic aspects of project development - may also vary according to the different assessment frameworks used to evaluate these characteristics.

Certification will play an important role in ensuring that the sustainability attributes of hydrogen can be demonstrated, tracked and verified in a robust, reliable and credible manner. Certification will therefore play an essential role in the development of the hydrogen economy, as the value of hydrogen should be determined not only by the value of the physical product, but also by the value of the accompanying electronic certificate attesting to its sustainability attributes.

Robust, reliable and tradable certification schemes for hydrogen that attest to its sustainability attributes will play a key role in...

- Demonstrating hydrogen's sustainability attributes (in particular carbon footprint and renewable origin, as well as land use, water use and socio-economic impacts) in a credible and internationally consistent manner.
- Creating transparency for consumers and enable them to make choices based on sustainability characteristics

- Building confidence between potential importers and exporters and promote global and cross-border trade in hydrogen based on its sustainability credentials.

4.2 International Overview

Several certification schemes and standards for hydrogen and its derivatives have been developed over the last decade, most of them relatively recently. In general, certification schemes and standards need to be differentiated.

“A certification scheme (or mechanism) is a set of governance, assessment and verification processes used to ensure that the considered product (e.g. hydrogen) produced and consumed meets a given set of requirements or criteria. It is an instrument that provides for evidencing attributes (such as sustainability attributes) of production, transport and delivery of hydrogen and/or derivative products. [...] Certification schemes are informed by and refer to regulatory frameworks and/or standards, including standard defining methodologies for assessing the attributes evidenced by the schemes.”¹³

The “International Organization for Standardization (ISO) defines a standard as ‘a document, established by a consensus of subject matter experts and approved by a recognized body that provides guidance on the design, use or performance of materials, products, processes, services, systems or persons.’ Standard Development Organisations such as ISO produce global voluntary standards, which can be used as reference across regulatory and voluntary frameworks internationally.”¹³

However, in most cases the schemes and standards listed below combine elements of both schemes and standards. They often define their own methodologies for identifying or calculating the sustainability attributes, rather than referring to standards developed by a standards development organisation such as ISO. Nevertheless, they are usually based on specific standards, such as ISO standards 14040, 14044 and 14067 on life cycle assessments and product carbon footprints.

Table 24 provides an overview of the main (national) certification schemes/standards around the world. Most have recently become operational or are in the process of doing so. The California Low Carbon Certification Scheme applies to transport fuels consumed in California (and other US states that have joined the scheme over time); fuel imports are possible. The Chinese standard applies to hydrogen produced in China. The Japanese JOGMEC guidelines apply to the production of hydrogen for consumption in Japan. The UK Low Carbon Hydrogen Standard applies primarily to hydrogen produced in the UK, but does not exclude imports. The Australian GO scheme applies to production in Australia and aims to support domestic consumption and exports to targeted markets. The EU Guarantees of Origin scheme is limited to production in the EU and targets voluntary markets.

The voluntary schemes target hydrogen and derivatives (RFNBOs) used in Europe in connection with the fulfilment of a legal obligation set out in RED II. Hydrogen and

¹³ IPHE, IEA H2 TCP, IRENA, Hydrogen Council, International Power-to-X Hub: Hydrogen Certification 101, 2023

derivatives exported to the European Union, which is a strategic objective for Namibia, must be certified according to RED II requirements under recognised voluntary schemes. This makes RED II and voluntary schemes particularly relevant for Namibia. The other certification schemes mentioned above are not relevant for the export of hydrogen from Namibia to Europe.

Table 24: Standards/ Certification Schemes in Legal/National Frameworks

Scheme Key criteria	Low Carbon Fuel Standard	Standard T/CAB 0078-2020	Guideline: GHG and CI acc. Framework.	UK Low Carbon H ₂ Standard	Australian GO scheme	H ₂ GO (RED II art. 19)	Voluntary Schemes (RED II art. 25-30)
Jurisdiction	California, USA	People's Republic of China	Japan	UK	Australia	European Union	European Union
H₂ production geography	international	People's Republic of China	international	Focus on UK, international	Australia	European Union	international
Scheme holder	CARB ¹⁴	CIUR ¹⁵	JOGMEC ¹⁶	UK DESNZ ¹⁷	Clean Energy Regulator ¹⁸	Member States	Voluntary Schemes ¹⁹
Products covered	Hydrogen, transport fuels incl. electricity	Hydrogen	LNG ²⁰ / Hydrogen / Ammonia	Hydrogen	Hydrogen and H ₂ derivatives	Renewable Hydrogen	RFNBO (Renewable fuels of non-biological origin)
Attribute(s)	Carbon Footprint	Carbon Footprint	Carbon Footprint	Carbon Footprint	Carbon Footprint	Renewable origin	Carbon Footprint, ADD/TEMP/ GEO ²¹
Pathways	Any (lower CFP ²² as to fossil benchmark)		Any (low carbon)	Any, incl. bio-mass-based	EL ²³ , coal gasif. and SMR ²⁴ (CCS ²⁵), more in future	Renewable	Renewable (& recycled carbon fuels)
Green H₂/ derivatives	✓	✓	✓	✓	✓	✓	✓
Low Carbon H₂/ deriv.	✓	✓	focus	✓	✓	X	X
By-product H₂	✓ e.g. H ₂ from NaClO ₃ production	ü	Not specified	X	X	✓	✓

¹⁴ California Air Resources Board; <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard>

¹⁵ China Industry-University-Research Institute Collaboration Association; <https://www.antpedia.com/standard/en/1949734495.html>

¹⁶ Japan Organization for Metals and Energy Security; <https://www.jogmec.go.jp/english/hydrogen/index.html>

¹⁷ Department for Energy Security and Net Zero; <https://www.gov.uk/government/publications/uk-low-carbon-hydrogen-standard-emissions-reporting-and-sustainability-criteria>

¹⁸ <https://cer.gov.au/schemes/guarantee-origin>

¹⁹ https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/voluntary-schemes_en

²⁰ Liquefied natural gas

²¹ Additionality, temporal and geographic correlation

²² Carbon footprint

²³ Electricity

²⁴ Steam methane reforming

²⁵ Carbon capture and geological storage

Scheme Key criteria	Low Carbon Fuel Standard	Standard T/CAB 0078-2020	Guideline: GHG and CI acc. Framework.	UK Low Carbon H₂ Standard	Australian GO scheme	H₂ GO (RED II art. 19)	Voluntary Schemes (RED II art. 25-30)
Allocation	Own definitions	Hierarchical, similar to ISO 14044	following ISO 14044	Energy allocation	System expansion and energy allocation	n/a	Based on legal text
Chain of Custody	MB ²⁶ ("B&C" for gas grid)	B&C ²⁷	B&C	n/a	MB	B&C	MB
Registry	✓	✓	n/a	n/a	✓	n/a	
Eligible carbon source	Defined	Out-of-scope	n/a	n/a	Defined	n/a	Delegated Act (draft)
Scope	Well-to-Grave	Well-to-Gate	Well-to-Gate	Well-to-Gate	Well-to-Delivery gate	Well-to-Gate	Well-to-Grave
CCS²⁸	✓ if CCS protocol app.	✓	✓	✓	✓	X	X
CCU²⁹	✓	No information	No information found, but CCU under relatively loose conditions	X	X	X	X
Offsetting of emissions accepted?	✓ if listed as compliance offset protocol within Cap-and-Trade Prog.	X	X, but under discussion	X	X	X	X

National schemes set up by governments can be distinguished from independent schemes run by private players, although these are less important for export purposes (see table below for an overview of independent schemes).

- I-TRACK operates renewable electricity certification in many countries of the world since many years; the coverage of hydrogen is rather recent.
- CMS 70 of TÜV SÜD has been established in 2011 in Germany but is applicable internationally.
- Bureau Veritas certifies the carbon footprint of hydrogen based on its proprietary standard.
- The Green H₂ standard is applicable internationally to hydrogen production through electrolysis (and derivatives produced from it).

²⁶ Mass Balancing

²⁷ Book & Claim

²⁸ Carbon capture and geological storage

²⁹ Carbon capture and utilization

- The CertifHy NGC (Non-Governmental Certificate) scheme is compatible with European Guarantee of Origin schemes (see Table 24) and is operational in this EU Member States that do not have a national hydrogen GO scheme.
- CertHILAC is a scheme developed by several signatory countries in Latin America and the Caribbean.
- The IPHE has developed a working paper detailing a methodology for calculating the carbon footprint of hydrogen and derivatives production. This is the starting point for the development of the ISO 19870 (currently in progress).

Table 25: Independent Standards/ Certification Schemes

Scheme	I-TRACK for Hydrogen	CMS 70	Vol. Certifi. H2 CFP	GH2 Green H2 Standard	CertifHy NGC	CertHILAC	IPHE Working Paper Ver3
Key criteria							
Scheme holder	Avance Labs ³⁰	TÜV SÜD ³¹	Bureau Veritas ³²	The Green Hydrogen Organisation ³³	CertifHy ³⁴	CertHILAC ³⁵ ; System representative by sign. countries	IPHE ³⁶ Hydrogen Production Analysis Task Force
Products covered	Hydrogen, derivatives (e.g. ammonia)	Hydrogen	Hydrogen	Hydrogen, derivatives (e.g. ammonia)	Hydrogen	Hydrogen, derivatives (e.g. ammonia)	Hydrogen, Ammonia, LOHCs
Attribute(s)	Carbon Footprint	Carbon Footprint	Carbon Footprint	Carbon Footprint	Carbon Footprint, Renewability	Carbon footprint + sustainability aspects (e.g. water)	Carbon Footprint
Pathways	Any	Any (renewable)	Any (low carbon)	Electrolysis	Any (specific pathways pre-assessed)	Any (low carbon)	EL ³⁷ , coal gasif., SMR ³⁸ (w/ CCS), ATR ³⁹ , by-product
Green H₂/ derivatives	✓	✓	✓	✓	✓	✓	✓
Low Carbon H₂/ deriv.	✓	X	✓	X	✓	✓	✓
By-product H₂	✓	✓	Not specified	Not specified	✓	Not specified	✓
Allocation	across process boundaries possible	Both energy based and market value	Tangible relationship of products, to be justified	Reference to ISO 14040	ISO 14067 (14044)	Not specified	ISO 14044
Chain of Custody	B&C, MB, FS	n/a	n/a	B&C	B&C	Start with MB, switch to B&C	n/a

³⁰ <https://www.trackingstandard.org/product-code/hydrogen/>

³¹ <https://www.tuvsud.com/en/themes/hydrogen/hydrogen-services-that-enable-safety-for-your-ideas/green-hydrogen-certification>

³² <https://www.bvna.com/news/hydrogen-certification-scheme>

³³ <https://gh2.org/our-initiatives/gh2-green-hydrogen-standard>

³⁴ <https://www.certifhy.eu/ngc-certification/>

³⁵ <https://publications.iadb.org/en/guide-implementation-hydrogen-certification-system-latin-america-and-caribbean>

³⁶ International Partnership for Hydrogen and Fuel Cells in the Economy; <https://www.iphe.net/working-groups-task-forces>

³⁷ Electricity

³⁸ Steam methane reforming

³⁹ Autothermal reforming

Scheme	I-TRACK for Hydrogen	CMS 70	Vol. Certifi. H2 CFP	GH2 Green H2 Standard	CertifHy NGC	CertHILAC	IPHE Working Paper Ver3
Key criteria						remains long-term option	
Registry	✓	X	X	✓	✓	✓	X
Eligible carbon source	defined	Out-of-scope	Out-of-scope (no derivatives)	No requirements defined	No requirements defined	?	n/a
Scope	Cradle-to-Cradle	Well-to-Gate (optional to point of use)	From "Cradle to Gate" to "Cradle to Grave"	Well-to-Gate	Well-to-Gate	"Well-to-Gate" for LAC ⁴⁰ region; "Well-to-Wheel" for exports to EU market	Well-to-Consumption Gate
CCS ⁴¹	✓	Only BECCS	✓	X	✓	✓	✓
CCU	Not specified	X	Not specified, but likely	X	not eligible for CertifHy label "low carbon H ₂ "	Not specified	Not specified, but unlikely
Offsetting of emissions accepted?	Permitted, if certified by I-REC	Yes, under conditions (for CCU)	X	Not specified	X	Not specified	Permitted, but not recommended

In Europe, the Renewable Energy Directive (RED II) provides a framework for the certification of hydrogen and its derivatives, either by national schemes or by so-called voluntary schemes, which are independent and owned by private actors. Voluntary schemes must be recognised by the European Commission before they can start certifying.

In general, legal requirements and independent schemes as listed in the two tables above define GHG emission thresholds based on the carbon footprint (see lines 5 or 3, respectively, "attribute(s)"), which allow hydrogen and its derivatives to be labelled 'renewable', 'green', 'low carbon' and similar. In addition, renewable or green hydrogen must be produced from renewable energy sources, while low-carbon hydrogen can also be produced from fossil sources such as natural gas if the CO₂ emissions are captured and geologically stored rather than released into the atmosphere. Figure 6 provides an overview of the different thresholds defined at international level.

⁴⁰ Latin America and Caribbean

⁴¹ Carbon capture and geological storage

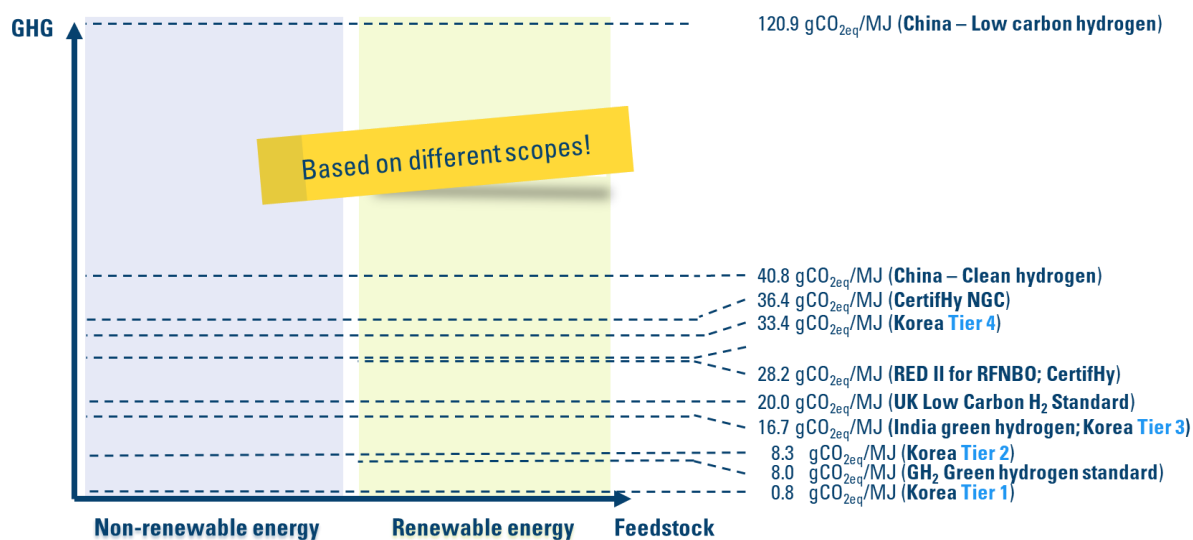


Figure 6: Overview of different GHG thresholds across global jurisdictions; Source: Own chart based on sources from the various jurisdictions.

To overcome this fragmentation of certification approaches at the international level, while recognising that full harmonisation of systems at the global level may not be achievable in the short to medium term, the concept of 'mutual recognition of certification systems' is being actively developed. At COP 28, a Declaration of Intent for the Mutual Recognition of Certification Schemes for Renewable and Low-Carbon Hydrogen and Hydrogen Derivatives was signed by over 40 countries. This initiative, co-led by Namibia, Germany, and Japan, is an important step towards establishing a global framework for the mutual recognition of hydrogen certification schemes, facilitating international trade and ensuring transparency in the hydrogen market.⁴²

At the international level, the IPHE and the IEA Hydrogen TCP are working to promote the mutual recognition of certification schemes.⁴³ These organisations are working on technical solutions to enable global alignment of certification schemes. Rather than aiming for full harmonisation in the short term, the focus is on creating a framework for mutual recognition that allows different countries to align their certification schemes without imposing uniform standards globally. For NSI, this means keeping abreast of these developments and ensuring that any national hydrogen certification schemes are consistent with the evolving global framework. Engaging with international partners and participating in discussions led by IPHE and the IEA Hydrogen TCP could help the Namibian hydrogen industry to access international markets more efficiently once such schemes are recognised by hydrogen importing countries.

⁴² BMUV Press Releases COP28: Transition away from fossil fuels <https://www.bmuv.de/en/pressrelease/united-nations-climate-change-conference-commits-to-a-transition-away-from-fossil-fuels>

⁴³ The concept of mutual recognition of certification schemes is concisely described in IPHE, IEA H2 TCP, IRENA, Hydrogen Council, International Power-to-X Hub: Hydrogen Certification 101, 2023. See also H2Global Foundation & Hydrogen Europe, Policy Brief 5/2023: "Standardizing Hydrogen Certification: Enhance Traceability, Transparency, and Market Access", Sept. 2023

4.3 International Examples

The following section provides insights from different jurisdictions on their status with respect to defining green or renewable hydrogen and, in particular, establishing certification schemes. These cover the main import market and countries with different approaches and strategies to participate in the global hydrogen market.

4.3.1 European Union

For exports to Europe, renewable ("green") hydrogen or derivatives such as ammonia, methanol, synthetic hydrocarbons, including jet fuel derived from green hydrogen, must be certified to be recognised as "green" in Europe. This recognition allows green products to command a price premium in Europe over conventional products based on fossil fuels.

The main piece of legislation relevant in this context is the Renewable Energy Directive recast⁴⁴ ("RED II"). RED II has been transposed into national law in the EU Member States; it requires EU Member States to impose an obligation on fuel suppliers to increase the share of renewable transport fuels (RFNBO – renewable fuels of non-biological origin⁴⁵) over time in the transport fuels they put on the market. Fuel suppliers can meet this obligation by blending biofuels into conventional fuels, by providing RFNBO for transport applications and/or by using electricity for transport, in particular in battery electric vehicles.

With more ambitious targets, the European institutions have spent the last two years drafting and reaching agreement on amendments to RED II (often referred to as 'RED III', which is technically incorrect as it is an adaptation of the existing RED II). The revised Directive (RED III) was published in the Official Journal of the EU on 31 October 2023 and entered into force on 20 November 2023. The provisions of these amendments must be transposed into national law in the EU Member States within 18 months of the final adoption of the amendments. The RED II amendments include policy objectives for the use of RFNBOs (no longer limited to use as transport fuels) and thus H₂ and derivatives. Importantly, RED II defines the (a) sustainability and (b) greenhouse gas reduction requirements for RFNBOs through two Delegated Regulations:

- a) Commission Delegated Regulation 2023/1184 of 10.02.2023, supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin, which is related to RED II Art. 27(3) (DA27(3))
- b) Commission Delegated Regulation 2023/1185 of 10.02.2023, supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse

⁴⁴ Directive (EU) 2018/2001 of the European Parliament and the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast), OJ L 328/82, 21.12.2018.

⁴⁵ The full term and definition is: 'renewable liquid and gaseous transport fuels of non-biological origin' means liquid or gaseous fuels which are used in the transport sector other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass; Art. 2(36) RED II.

gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels, which is related to RED II Art. 28(5) (DA28(5)).

DA27(3) details the requirements that renewable electricity must meet in order for the hydrogen produced from it to be recognised as RED II compliant.

DA28(5) details the methodology for calculating the GHG intensity of hydrogen, or more generally of the RFNBO, and the GHG reduction compared to the fossil fuel benchmark, the 'fossil fuel comparator'.

Figure 7 provides an overview of the provisions of the two Delegated Regulations. It shows the three different cases of electricity supply, and the sub-cases related to supply through the public grid as defined in DA27(3).

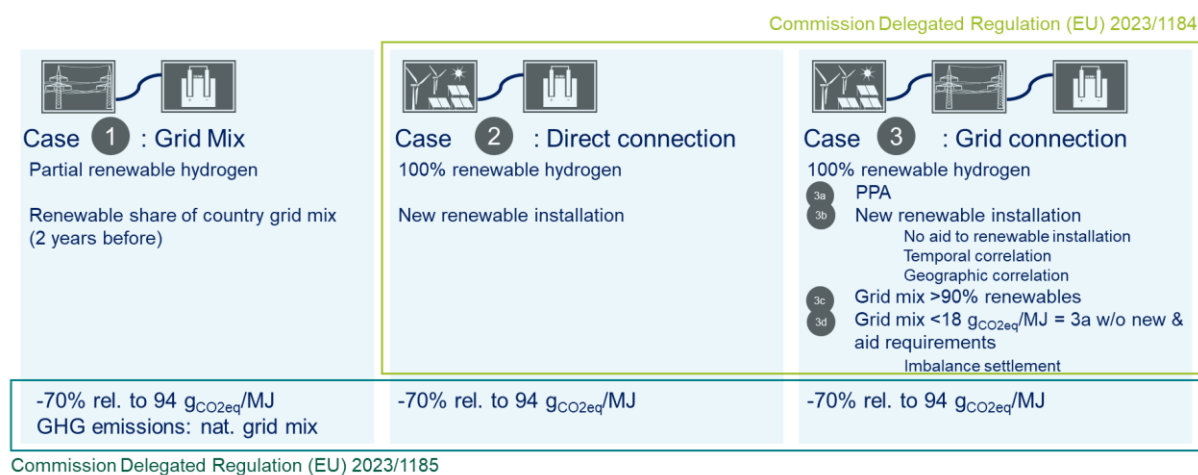


Figure 7: Electricity Supply Cases for Europe; own source.

Case 1 is the supply of the national grid mix to the electrolyser. The renewable share of the grid mix determines the renewable share of the hydrogen/ RFNBO produced. The greenhouse gas balance is the average resulting from the grid mix.

Case 2 is a direct electrical connection of the renewable power plant(s) to the electrolyser. No electricity is supplied via the public grid.

Case 3 and the sub-cases are related to electricity supply via the public grid:

- Based on a Power Purchase Agreement (PPA) between the electricity producer and the hydrogen/ RFNBO producer; four criteria are to be met for electricity to be recognized as renewable (see below for more details).
- If the grid mix has a renewable electricity share above 90%, all hydrogen/ RFNBO produced from it is recognised as 100% renewable (some detailed conditions must be fulfilled).
- If the greenhouse gas emissions intensity of the grid mix is below 18 g_{CO2}/MJ_{elec}tricity, the conditions to be met are limited to temporal and geographic correlation (see below for more details).

- d) If the hydrogen/ RFNBO is produced during periods of imbalance settlement in the public grid, the resulting hydrogen/ RFNBO is recognized as renewable.

Four conditions are to be met by renewable electricity:

1. **Additionality:** Renewable power plants are new, i.e. they were put into operation not more than 36 months before the electrolyser; some grandfathering provisions apply if the electrolyser comes into operation before 2028.
2. **No support:** Renewable power plants must not have received any public support (neither CAPEX nor OPEX support); some grandfathering provisions apply if the electrolyser is put into operation before 2028.
3. **Temporal correlation:** Electricity generation and electricity consumption for hydrogen production must take place at the same hour. The requirement is reduced to a monthly correlation until the end of 2029 (no grandfathering). Electricity storage to decouple generation and consumption is permitted both at the location of the renewable power plant and at the location of the electrolyser. Alternatively, day-ahead prices (in markets where such price-building exists) below EUR 20/MWh are sufficient to fulfil this requirement.
4. **Geographical correlation:** The renewable power plants and the electrolyser must be located in the same “bidding zone”, or on interconnected bidding zones of off-shore bidding zones under certain conditions.

RED II requires certification of RFNBOs as proof that the product complies with the RED II requirements. Certification according to RED II is carried out by so-called “Voluntary Schemes”⁴⁶. These must be recognised by the European Commission for the certification of biofuels or RFNBOs (or both) under RED II. While a number of Voluntary Schemes have been recognised for certification of biofuels under RED II, the recognition of Voluntary Schemes for RFNBOs is currently ongoing for the schemes that have applied.

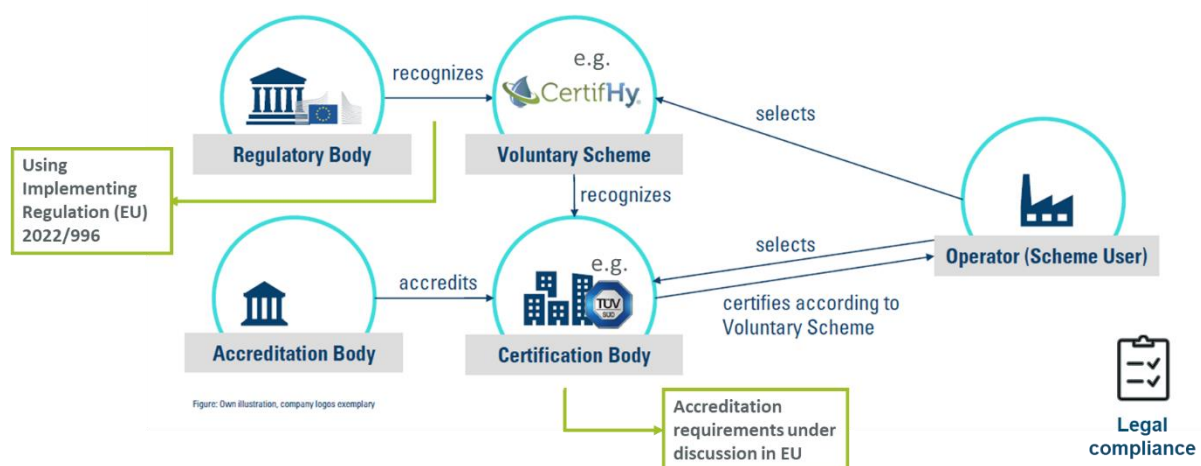


Figure 8: Requirements for recognition and participation in “Voluntary Schemes”; own source.

⁴⁶ Note: While “voluntary schemes” use the term voluntary in the name, they are set up to provide certification for compliance with legal requirements.

To date, five schemes have applied for recognition as RFNBOs; the first three have received a positive technical assessment and are awaiting the formal recognition decision:

1. CertifHy EU RFNBO.
2. ISCC⁴⁷ EU RFNBO.
3. REDcert.
4. KZR INiG System.
5. CCEE Hydrogen and Derivatives Certification System.

It is expected that other voluntary schemes recognised for biofuels will submit an application for recognition of RFNBOs by the European Commission. Economic operators producing, processing or handling RFNBOs are free to choose a recognised voluntary scheme for the certification process.

The actual auditing of economic operators as part of the certification process is carried out by independent third-party certification bodies. Each Voluntary Scheme recognises Certification Bodies under its scheme based on professional qualification criteria. After choosing a Voluntary Scheme, economic operators select a Certification Body recognised by that scheme to carry out the audits. An initial audit is carried out at the start of operations and then every 12 months to renew the certificate.

Certification focuses on the economic operator, not primarily on the product: It is the economic operator that is certified, not the product quantities. Figure 9 shows the modular approach to certification under RED II. Each operator in the supply chain that either produces, processes, stores or trades in the products must be certified. Product transport is not certified separately but is included in the certification of the downstream operator. The last operator in the supply chain, usually the fuel supplier, must cover both upstream and downstream transport to the final consumer (e.g. a refuelling station) in the certification. The producer at the beginning of the supply chain includes the renewable electricity production in its certification by collecting trustworthy information and data from the renewable electricity producer, from grid operators and/ or public authorities.

Each economic operator delivering product quantities ("consignment") to the next operator in the supply chain must provide so-called "Proofs of Sustainability" (PoS) with each consignment. These Proofs of Sustainability must contain all the relevant sustainability information required by RED II. During the annual audit, the auditors check the PoS issued by the economic operator during the previous 12 months. If major irregularities are found, either corrective action may be required, or certification may be refused.

⁴⁷ International Sustainability & Carbon Certification

Each economic operator is free to choose a certification scheme (and certification body). Voluntary schemes are required by RED II to mutually recognise certificates from other recognised voluntary schemes. This modular approach allows for both linear supply chains (such as the one shown in Figure 9) and complex supply networks with many producers, processors, traders, storage providers and fuel suppliers.

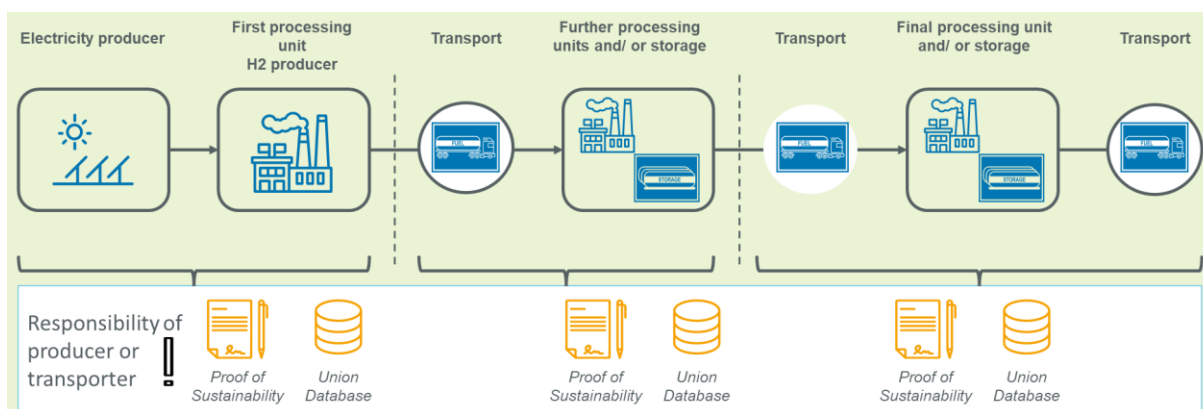


Figure 9: Modular certification approach under RED II, own source

For further details on the EU's regulatory framework for renewable hydrogen and its derivatives, see the *Policy brief on EU requirements for renewable hydrogen and its derivatives* by PtX Hub (available at ptx-hub.org). This publication provides an in-depth overview of RED II and RED III requirements and additional insights on certification processes and standards.

4.3.2 Australia

Hydrogen is strategically defined as an export commodity but is also widely used domestically.

As early as 2019, Australia had identified hydrogen as a major opportunity for its economy, particularly in the context of global energy trade. Since then, many projects have been announced and the project pipeline remains one of the largest in the world, with Australian companies such as Fortescue among the most active players.

Australia has specifically identified the export of hydrogen and ammonia (and to a lesser extent methanol) as a major opportunity, with some 35 derivative projects currently at various stages of development. A key element in supporting the export of hydrogen and derivatives are bilateral energy partnerships with eight countries, including Germany, Japan and Korea, but also the United States, the United Kingdom, the Netherlands, Singapore and India. One prominent example for direct cooperation is the co-development of a LH₂-route between eastern Australia and Japan, gaining experience on future export pathways.

The country could offer some of the lowest levelized costs for hydrogen production by 2050, partly because of its huge renewable energy potential. This allows the country to be relatively competitive on the global market, despite its rather remote location.

In addition to measures such as gas law reviews, research and pilot programmes, transparency programmes and more, Australia aims to support the development of its hydrogen economy by developing its own certification scheme. This includes the development of associated requirements to be administered by the Clean Energy Regulator (CER), a division of the Department of Climate Change. This process began in 2020 and has since included several rounds of stakeholder consultation. The Guarantee of Origin (GO) scheme aims to support future domestic and international trade by informing customers of emissions and other relevant attributes. Australia has been very active in the IPHE working groups and has had a significant influence on the development of methodologies for determining the carbon emissions of both hydrogen and its derivatives.

The scope⁴⁸ “Well-to-Delivery gate”⁴⁹ currently discussed is somewhat unique compared to other schemes and standards. It aims to provide information on the emission intensity of hydrogen (in $\text{kgCO}_2\text{eq/kgH}_2$) from the well (including upstream emissions).

- Up to the delivery gate for domestic users (in the specific case of injection in the NG pipeline this would however be only until injection point).
- And up to the last Australian port for hydrogen exports.

By additionally defining a sub-boundary at the production gate, the scheme aims to enable compatibility with reporting obligations from other schemes or standards worldwide. It is therefore seeking to comply with the requirements of CBAM⁵⁰, for example, so that information on GHG emissions from the Australian GO scheme can be used to meet CBAM's GHG reporting requirements.

Although not explicitly stated, the geographical scope appears to be limited to Australia, making it less likely that international production facilities will be able to participate in the scheme.

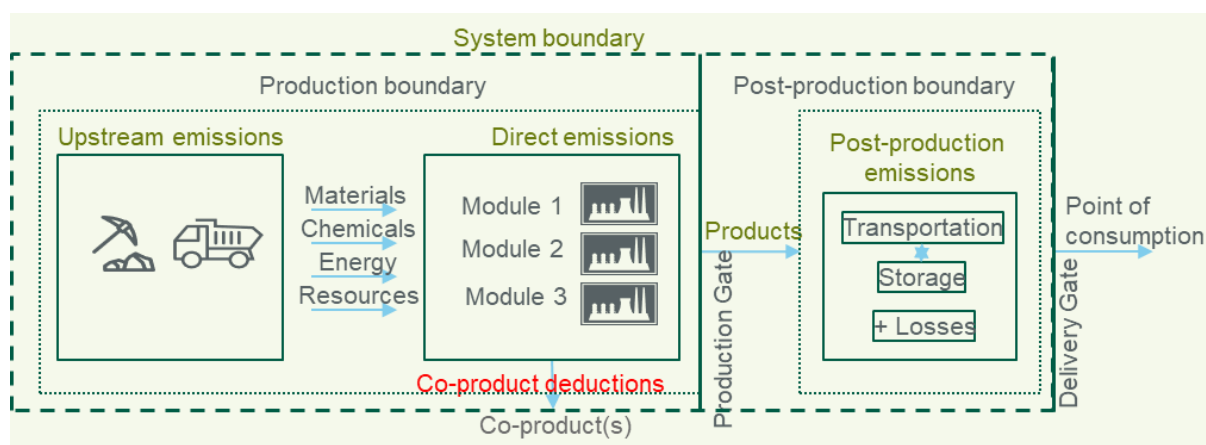


Figure 10: Scope of carbon footprint assessment for Australian GO scheme, own source.

⁴⁸ The scope of a carbon footprint calculation defines the elements of the life-cycle that are covered in the calculation.

⁴⁹ Previously discussed versions even considered “Well-to-User”, which turned out to be too ambitious.

⁵⁰ Carbon Border Adjustment Mechanism

At present, the scheme only covers hydrogen and its direct derivatives ammonia and methanol, but regular annual updates are planned to extend the scheme to green steel or similar products in the future.

The applied chain of custody⁵¹ is mass-balancing for hydrogen and the derivatives but allows book and claim for the supplied renewable energy (via a separate certificate called “REGO”). This is less stringent than the European Union requirements, but as described below, the system has indicated that it may include location and time requirements in future updates. Please see the more detailed description of the electricity feed-in requirements in the following section.

Australia has a relatively large economy that provides significant amounts of domestic hydrogen applications. This justifies to some extent the Australian Government's efforts to develop a national scheme. However, Australia is struggling to bring the scheme into line with global requirements, particularly those set by the European Union. This may make the export market smaller than necessary, or at least create additional bureaucratic burdens for Australia's renewable hydrogen producers. The process of developing the national scheme, which required several rounds of stakeholder input, demonstrates the importance of working very transparently and through many public consultation processes to slowly inform the public while still being able to adapt to any obstacles.

Australia has had considerable experience with other certification schemes, also under the same regulator now responsible for the Hydrogen GO scheme, which still took more than 4 years to complete. Therefore, the pursuit of a national certification scheme in Namibia will require significant effort, which may not be useful to those projects in Namibia that export to the European Union and potentially other markets.

4.3.3 Kenya

Ammonia (based on H₂) to replace imported fertilisers and decarbonise agricultural sector.

Due to a large domestic application potential of hydrogen in the fertilizer industry, Kenya has reasonable interest to define domestic requirements for hydrogen. Very recently (May 2024)⁵², Kenya published such requirements via its Energy and Petroleum Regulatory Authority:

- Sustainability threshold requirements, including land use, water use, and grid-connected electricity (at least 80% renewable and below 64.8 gCO₂/kWh)
- A CO₂-threshold for ammonia is defined: 0.3 kgCO_{2e}/kgNH₃
- Additionality and temporal correlation (echoing REDII)

⁵¹ See also: <https://ptx-hub.org/de/publication/hydrogen-certification-101/>

⁵² <https://www.epra.go.ke/kenyas-guidelines-on-green-hydrogen-and-its-derivatives/>

4.3.4 Others (MENA and India)

UAE: Hydrogen mostly to diversify energy exports

The United Arab Emirates have also announced ambitions to provide hydrogen to markets such as Europe, Korea and Japan as part of its National Hydrogen strategy⁵³ (published in 2023). While the focus (in contrast to Namibia and other jurisdictions) is on low-carbon hydrogen, the UAE clearly recognises the importance of certification schemes to provide evidence of the greenhouse gas emissions associated with hydrogen production. Together with other Arab countries such as Egypt, Oman and Morocco, the UAE signed the COP 28 summit's declaration of intent on mutual recognition of certification schemes.

The National Hydrogen Strategy outlines an indicative timeline for the establishment of a system of guarantee of origin for hydrogen:

2023-2025	Engagement with key export markets and international entities to establish the required Guarantees-of-Origin that satisfy cross-jurisdictional requirements
2026-2028	An internationally recognized Guarantee-of-Origin certification scheme and tracking system implemented
2029-2031	Review the certification scheme and re-assess

India aims to export and apply H2 domestically

India has also taken steps towards a local definition of 'green hydrogen' in August 2023⁵⁴, and has also mandated the Ministry of New and Renewable Energy to develop a methodology for reporting, monitoring and verification, as well as certification in accordance with the requirements:

- Basis should be use of renewable energy “according to applicable regulations”
- Emissions not higher than $2 \text{ kg}_{\text{CO}_2\text{eq}}/\text{kg}_{\text{H}_2} \sim 16.7 \text{ g}_{\text{CO}_2\text{eq}}/\text{MJ}_{\text{H}_2} \rightarrow$ comparatively low threshold

4.3.5 Chile

Hydrogen with high export focus, with opportunity to enhance local industrialisation

In Chile, as part of the Latin America and Caribbean (LAC) region, hydrogen standards are either under development or non-existent. Against this background, CertHILAC is being introduced, a certification system that is not designed for regulatory compliance,

⁵³ <https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/national-hydrogen-strategy>

⁵⁴ <https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/aug/doc2023819241201.pdf>

but to help producers improve the marketability of their products. CertHILAC is a voluntary scheme and is aimed specifically at producers who wish to differentiate their products in the marketplace through clean or low-carbon hydrogen certification. It is also aimed at consumers who are interested in products that meet these environmental standards.

Looking ahead, CertHILAC is positioning itself as a future cornerstone for future regulatory frameworks by providing a basic model that countries in the region could adapt to regulate the production and consumption of clean and/or low-carbon hydrogen. This approach underlines the potential of the certification scheme to influence and shape future legal norms.

It is important to note that different energy sources are considered in the standard as long as the hydrogen is renewable or "low carbon". However, two different categories are distinguished: Certification for the Latin American and Caribbean region and for the EU market, where stricter standards must be met.

The first category, developed for the Latin American and Caribbean region, uses a flexible approach that considers a variety of energy sources or production technologies through detailed documentation of key product characteristics. A requirement for this category is compliance with greenhouse gas (GHG) emission thresholds. The aim is to standardise the system with ammonia certification schemes that are still under development (in the US and globally). The approach to measuring GHG emissions is based on international practice, in particular the methodology used by the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), which uses various ISO standards.

The second category is tailored to the European market and aims to adapt to the provisions for Renewable Fuels of Non-Biological Origin (RFNBOs) under the European Union's Renewable Energy Directive Recast (RED II). Compliance with the requirements of RED II must be verified against the following criteria: Additionality, Geographical Correlation and Temporal Correlation. Other attributes, which are common to all certification schemes worldwide, must also be met: Information on primary energy sources and energy production facilities, information on H₂ production facilities, intensity and scope of greenhouse gases. According to RED II, the quantification of GHG emissions for this certification category must extend to the point of final use (or "well-to-wheel").

For manufacturers targeting the European market, certification by a scheme recognized by the European Commission is essential. This requirement underlines the importance of international compatibility and recognition in the design of CertHILAC and facilitates the entry of hydrogen and its derivatives produced in Latin America and the Caribbean into the European market under recognised standards.

CertHILAC plans to integrate different technologies and energy sources: The system covers a range of energy sources and production technologies, focusing on both clean and low-carbon hydrogen. Both renewable energy and grid electricity will be considered as energy sources for the operation of the electrolysis. In addition, natural gas

and coal are considered as energy sources to produce "low carbon" hydrogen by pyrolysis, SMR or gasification - in combination with CCS technologies. Biomass is also being considered for renewable hydrogen production through gasification or biomass reforming. However, hydrogen produced from fossil sources without carbon capture is not included in CertHILAC. One reason for including different technologies is the focus on environmental and social sustainability, including positive social impacts and sustainable water use.

The certification scheme does not include a specific label. This decision is based on feedback from representatives of different countries in the region. It recognises that different projects may use different technologies and inputs to produce hydrogen. The primary objective of the certification scheme is to provide information rather than to recommend a particular type of technology or input for hydrogen production.

A key piece of information provided is the accounting of emissions. A distinction is made between a "well-to-gate" approach for certification in the LAC region and a "well-to-wheel" approach for export to EU markets.

The proposal for the Chain of Custody system is to start with the introduction of a mass balance system, as this system allows the mixing of certified and non-certified products, if there is continuous tracking and monitoring of the quantities of certified products throughout the supply chain to the final consumer. This method also anticipates and complies with European Union export requirements, eliminating the need for an independent certificate trading platform, as would be the case with a book and claim system. This effectively reduces the logistical and administrative burden. However, market developments should be monitored on an ongoing basis. There is also the possibility of moving to a book-and-claim system in the longer term if this proves more advantageous for the LAC region.

Key attributes for certification include energy sources, social impact and sustainable water use. For energy sources, hydrogen and its derivatives must be produced using renewable energy sources or fossil fuels combined with CCS in order to be certified.

The system is generally designed to meet the requirements of the target markets, allowing for flexible system implementation. A key element in ensuring this flexibility is the avoidance of labels: The proposed system avoids using labels to categorise products, instead focusing on reporting key characteristics such as carbon intensity and production technologies. "This responds to lessons learned from operational systems like CertifHy, which use colours or qualifiers ("yellow hydrogen") potentially obscuring diverse emission intensities. Such terminology has proven impractical in serving as a foundation for making contracting or financing decisions, dissuading potential investors." In general, a distinction is made between the certification methodology for the LAC region and certification for the EU market.

4.4 Summary and take aways of international examples

	Strategic focus	Green or renewable H2 Requirements (incl. standards or other)	Certification Scheme running
EU	Domestic and imports	yes	yes
Australia	Exports and domestic	yes	(yes)
Kenya	Domestic	yes	no
UAE	Exports	no	No - planned
India	Exports and domestic	yes	No - planned
Chile	yes	No	No - planned

The cases presented above show that schemes are particularly important in regions that need to import hydrogen (or derivatives). Countries that also want to establish a domestic market need to at least define what "green" or "renewable" hydrogen is, and usually aim to establish a certification scheme that serves this domestic market. Importantly, it is not yet possible for any existing "foreign" scheme to provide the required proof (due to lack of mutual recognition (see comments on COP28 declaration), which underlines the importance for each jurisdiction to clearly differentiate whether the strategic focus is on exports (foreign certification schemes apply) or whether the domestic market is relevant.

5. Current Status in Namibia, Comparison and Gap Analysis

5.1 Technical Standards

Namibian standards development process

The NSI, through the Standards Development and Coordination (SDC) Department, facilitates, prepares and develops Namibian Technical Standards (NAMS) in accordance with the International Code of Good Practice as specified in Annex 3 of the World Trade Organisation Agreements and the International Organisation for Standardisation Directives.

The development of technical standards in Namibia follows a similar approach to most other countries that follow ISO and IEC standards and goes through a number of stages.

1. Proposal/request stage – the request or proposal for a new standard can come from a number of different sources including the private sector or a public sector organisation.
2. Preparatory stage
3. Committee stage – if a relevant Technical Committee exists, the proposed standard will be referred to it. Alternatively, a new Technical Committee (usually modelled on ISO committees) may be formed. The TC will discuss and decide whether an International Standard can be adopted or whether a new standard needs to be developed.
4. Public Enquiry stage
5. Ratification stage
6. Publication stage – The new technical standard is published by NSI in the Namibian Standards Catalogue

Namibia has a long history of cooperation with the South African National Standards Institute (SABS) and in many cases South African Standards (SANS) have been used as best practice.

International development of technical standards for hydrogen

Significant progress has been made internationally in the development of technical standards for hydrogen, as discussed in sections 3.4 to 3.6.5 of this report. Several countries have published national hydrogen standards. At national level, China, Germany and Japan are the most advanced in terms of the number of national standards developed.

Table 26 Comparison of number of hydrogen standards in different territories⁵⁵

Organisation	Number of Standards
International standards	133

⁵⁵ Source: <https://h2tools.org/>, SABS and DIN webstores

Organisation	Number of Standards
International Organisation for Standardization (ISO)	53
International Electrotechnical Commission (IEC)	41
International Electrochemical Commission	39
National Standards	
China - Fuel Cell Standards	63
China - Hydrogen Standards	15
Germany Hydrogen and Fuel Cell Standards	41
Japanese Standards Association	37
South African National Standards (SANS)	21
Taiwan Fuel Cell Standards	21
Korean Standards Association	17
Standards Australia	14

The list above highlights the level of activity in different regions in the development and adoption of hydrogen-specific standards. While the number of standards in a given country may indicate the extent of that country's focus on hydrogen technologies, it does not directly confirm the completeness or robustness of its standards framework. Completeness would require an assessment of whether all critical aspects of hydrogen production, storage, transport and end-use applications are covered, while robustness would require an assessment of how well these standards are aligned with safety, efficiency and environmental objectives.

For example, countries with a higher number of standards, such as China, Germany, and Japan, may be closer to establishing a comprehensive hydrogen framework by addressing multiple facets of the hydrogen value chain. Conversely, countries with fewer standards, such as South Africa or Australia, may focus on core elements or rely on international standards to fill gaps, particularly in areas where new or highly specific standards have not yet been developed.

The overall aim in each country is to avoid 'duplication of effort' by developing entirely new standards, instead focusing on international standards where applicable. While there is considerable overlap in the standards that countries tend to adopt or adapt, there are also clear differences. For example, Australia has adopted ISO 22734:2019 for hydrogen generators using water electrolysis (for industrial, commercial and residential applications) with some modifications, resulting in AS 22734:2020. Several other countries do not have national standards for hydrogen production as a harmonised standard.

Namibian status quo

The NSI has 277 published standards and 14 withdrawn standards according to the NSI Namibian Standards Catalogue 2024.⁵⁶ However, Namibia has not yet developed or adopted hydrogen-specific standards. The reasons for developing national standards include Namibian regulations. This means that regulations prescribing the use of standards require national standards and that the industry should have access to hydrogen standards in local currency. The prioritisation of national standards should therefore be informed by the planned regulation of the hydrogen industry and follow the good practice of prioritising the adoption of international standards. The priority needs identified based on stakeholder engagement will be for safety-related standards to ensure clarity of regulatory guidance and to provide confidence to financiers in this area.

The areas where there are related standards which may be applicable for the GH2 and the PtX industry are in the field of transportation of dangerous goods and where Namibia has adopted SANS standards. These are listed in Table 27:

Table 27 Namibian standards relevant to hydrogen

Standard	Standard Number	Publication Date	Gazette Number
The identification and classification of dangerous goods for transport by road and rail modes	NAMS/SANS 10228:2018	26/08/2018	6737
The identification and classification of dangerous goods for transport by road and rail modes	NAMS/SANS 10228:2018	26/08/2018	6737
Transport of dangerous goods - Packaging and large packaging for road and rail transport Part 1: Packaging	NAMS/SANS 10229-1:2018	26/08/2018	6737
Transport of dangerous goods - Packaging and large packaging for road and rail transport Part 2: Large Packaging	NAMS/SANS 10229-2:2018	26/08/2018	6737
Transport of dangerous goods - Operational requirements for road vehicles	NAMS/SANS 10231:2018	26/08/2018	6737
Transport of dangerous goods - Emergency information systems Part 1: Emergency information system for road transport	NAMS/SANS 10232-1:2019	14/03/2019	6868
Transport of dangerous goods - Emergency information systems Part 3: Emergency response guides	NAMS/SANS 10232-3:2019	14/03/2019	6868
Transport of dangerous goods - Intermediate bulk containers for road and rail transport	NAMS/SANS 10233:2018	26/08/2018	6737
Transport of dangerous goods - Design, construction, testing, approval, and maintenance of road vehicles and portable tanks	NAMS/SANS 1518:2018	26/08/2018	6737

⁵⁶ <https://www.nsi.com.na/wp-content/uploads/2023/03/Download-Namibian-Standards-Catalogue.pdf>

Namibian Technical Committees

The NSI has well established experience in the management of Technical Committees and has established 16 Technical Committees (TCs), with 8 sub-committees, to assist with the preparation, adoption, and publication of standards in accordance with the World Trade Organisation requirements.

- TC 1: Technical Committee on Renewable Energy
- TC 2: Technical Committee on ISO 9000:2005 Quality Management Systems (QMS)
- TC 3: Technical Committee on ISO 22000: 2005 Food Safety Management System (FSMS)
- TC 4: Technical Committee on National Electrotechnical Commission (NaEC)
- TC 5: Technical Committee on ISO 14000:2004 Environmental Management System (EMS)
- TC 6: Technical Committee on Construction, Cement and Concrete Technologies
- TC 7: Technical Committee on Halaal Products
- TC 8: Technical Committee on Occupational Health and Safety Management
- TC 9: Technical Committee on Metrology
- TC 10: Roads Construction, Vehicle and Road Safety
- TC 11: Technical Committee on Hospitality Infrastructure and Tourism
- TC 12: Technical Committee on Design of dry sanitation facilities and systems in rural areas and informal Settlements
- Subcommittee 1: Sub Committee for the Development and Adoption of Namibian Standards on the Requirement for Above fuel Storage Tanks
- Sub Committee 2: Sub Committee on Meat and Agricultural Products

Gaps and areas for prioritisation

Globally, the main reason for the existence of technical standards is arguably to reduce potential risks and possible accidents in the workplace (low impact - low probability) through comprehensive and detailed safety assessments. The implementation of safety is crucial to both the worker and the business of a company. Hydrogen has unique characteristics that can lead to a potential safety risk, i.e. with appropriate risk mitigation measures, proper safety assessment, use of detection equipment, good maintenance schedule, reasonable life cycle assessment, adequate ventilation, etc. Therefore, safety and available safety standards should be a top priority when developing or introducing hydrogen technologies in Namibia - a standard that is ensured if Namibia follows internationally recognised and harmonised health and safety standards.

Namibia has defined the export of hydrogen to global markets as a strategic focus, which could mean that potential end uses such as road vehicles, power supply or process heat may be given lower priority, with a greater focus on infrastructure issues and hydrogen production. This affects specific standards and areas of the hydrogen value chain that are internationally available but not adopted in Namibia, namely:

- Green hydrogen production (electrolysis)
- Hydrogen transportation (pipelines, trucks, rail – partially covered by “transport of dangerous goods”)

- Hydrogen Storage Systems
- Hydrogen infrastructure (e.g. ports)

The identification and prioritisation of standards needs is usually done through input from industry stakeholders in national TCs that should be established for hydrogen technologies, e.g. in a TC 197 on hydrogen technologies. In sections 3.5 and 3.6, an initial assessment has been made of the relevance of some of the key technical standards to Namibia's hydrogen sector, including non-hydrogen specific standards and hydrogen standards along the value chain. This can form the basis for decisions on which technical committees are most urgently needed and as an initial priority list for these committees.

Industry input is critical and will inform which standards need to be prioritised and moved from recommended standards (guidelines) to harmonised standards. In addition, cross-links with other industry sectors can be identified where safety related standards are concerned. In Namibia, national cooperation with other industry sectors such as fisheries, oil and gas as well as mining can be beneficial. Even if hydrogen related standards are not referenced in regulations and mandatory or health and safety standards, it is common practice for national standards bodies to provide an accessible list of applicable standards in this sector. This provides project developers with guidance on which standards represent best practice worldwide.

While the above-mentioned approach focuses on the procedural aspects of technical discussions in the form of a TC197, the gap in technical standards needs to be addressed and prioritised in such a way. With reference to Table 12, Namibian standards relevant for hydrogen, it is clear that there are gaps that should be addressed urgently.

The main gaps that should be addressed with a higher priority at national level are the following two considerations, as they are of crucial importance for the establishment of safety and can strongly contribute to a potential safety risk:

Pressure Equipment

In the hydrogen economy and throughout the value chain, pressure equipment is ubiquitous and plays a significant role in contributing to a potential safety risk by handling and storing hydrogen at pressures up to 700 bar. The Pressure Equipment Specification allows a manufacturer to enter the market with a pressure equipment (e.g. electrolyser, hydrogen refuelling station, hydrogen pipeline or hydrogen storage system are defined as such) and refers to requirements for the manufacturer and the operator. It also specifies visual inspections and pressure tests prior to commissioning for equipment with pressures > 0.5 kPa. On the manufacturing side, a pressure equipment standard (in combination with a regulation) refers to hazard categories, conformity assessment, installation and inspection, while separate standards in coexistence focus on in-service activities to be applied.

Major Hazard Installation

Considerations for Major Hazard Installations describe the safe handling of dangerous substances. Hazardous substances are generally defined as substances or mixtures used or present in the workplace which, if not properly controlled, can cause damage to people, the environment and property because of loss of containment, fire or explosion. Hydrogen is therefore a hazardous substance. Hydrogen itself is a stable mole-

cule, but as a flammable gas it can contribute to the formation of an explosive atmosphere when combined with oxygen and an ignition source such as a spark, fire, electrical discharge or even a hot surface. The lower explosion limit of such an explosive atmosphere is 4 vol% hydrogen, while the upper explosion limit is around 75 vol% hydrogen in the atmosphere. These discussions on standards should include "essential components" and their design, installation and operation. In addition, the standards should address explosion protection (e.g. prevention measures), explosive atmospheres (e.g. zone classification), conformity assessment and principles for risk assessment defining equipment for potentially explosive atmospheres.

It is important to stress that the prioritisation should not be limited to these two aspects. Hydrogen technologies deal not only with hydrogen-specific safety issues, but also with interdisciplinary issues such as pressure equipment and explosion protection mentioned above, but also material evaluation, fire codes, general construction or low and high voltage.

In this evolving hydrogen economy, the establishment of new safety regulations, technical standards, and sustainability criteria will play an important role. Some of these (safety-related) criteria have already been addressed in neighbouring South Africa. Over decades, South Africa has had similar gaps and discussions on processes and technical considerations that are now being transferred to the emerging (green) hydrogen economy. In terms of the emerging hydrogen economy, South Africa has a long history of hydrogen production, particularly using the Fischer-Tropsch process to produce grey hydrogen. This experience has led to the development of a sophisticated regulatory framework dealing with hydrogen as a flammable gas, chemical agent or hazardous substance. In addition, various North American or ISO/IEC standards have been adopted over the past decades. This incorporation process is based on technical and formal discussions in South Africa over the last 10 to 15 years to ensure global trade in accordance with the WTO and in particular with the main trading partners EU, UK, USA and Asia.

In the context of SADC cooperation, the incorporation of standards used in the region can save time and ensure that Namibia does not have to go through the same technical and formal discussions as, for example, South Africa. In this context, it can be an important role for the NSI to make recommendations to the Namibian regulator on appropriate health and safety standards.

5.2 Sustainability Certification

Strategic documents in Namibia are aligned that "green hydrogen" comes from renewable electricity sources, but beyond that no specific requirements are defined within the country. Having further defined the export of hydrogen as strategic focus it becomes clear that the requirements (or specifications) are defined by the respective importers. Here the strategy as well as our stakeholder interactions underlined a focus on Europe, with options to Japan/Korea.

Projects in Namibia are currently focused on off-grid operations, thus being able to provide "top quality of green hydrogen" and on avoiding interactions with potentially

‘polluting’ electricity mixes from the grid, which despite having a share of ~21 % renewables in final energy consumption⁵⁷, relies up to 60-70 %⁵⁸ on electricity imports from the SAPP (Southern Africa Power Pool which relies to about 60% on coal⁵⁹). In the long term, this strategy of off-grid operation may make it possible to oversize the corresponding renewable energy production, which can then be fed into the grid and thus contribute to the decarbonisation of the overall grid (although this is not an immediate focus at present).

The hydrogen strategy does emphasise the pride Namibia takes in being “a global leader in conservation and nature-based rural development”, thus bringing up the two additional important points to be covered by a green hydrogen definition and corresponding certification, namely:

1. Environmental: potential harms of brine disposal (sea water desalination) and water scarcity are important, as well as;
2. Socio-economic aspects: Participation, job creation and an overall just transition towards an industrialised Namibia are to be supported.

In terms of certification as such, NSI and UEA have extensive experience in product certification, e.g. food products such as fish. In addition, quality management systems can be certified (ISO 9001) and there are plans to cover ISO 45001 - Occupational Health and Safety Management Systems and ISO 14001 - Environmental Management Systems. While accreditation for management systems has already been achieved through SADCAS, NSI is aiming for accreditation for product certification in the near future.

Adjacent (sustainability) certification markets

Electricity market

The certification of renewable electricity is linked to hydrogen certification, as renewable hydrogen is produced from renewable electricity. However, issuing certificates for renewable electricity is not enough to certify hydrogen according to EU requirements. The potential expertise in electricity certification could make hydrogen certification a natural next step.

However, certification of the electricity market in the Namibia is not common practice. The international organisation I-REC considers Namibia to be part of its region and has appointed the default issuer (GCC) to cover the market⁶⁰. Issuance is based on data as available from NamPower's metering systems, but verification is only possible through aggregated public records on NamPower's website.

⁵⁷ <https://www.iea.org/countries/namibia/renewables>

⁵⁸ https://www.nampower.com.na/public/docs/annual-reports/NamPower_Integrated_Annual_Report_2023.pdf

⁵⁹ <https://www.sapp.co.zw/sites/default/files/Full%20Report%20SAPP.pdf>

⁶⁰ https://www.trackingstandard.org/wp-content/uploads/Public_I-REC-Country-Assessment-Namibia-v.2.0.pdf

For independent power producers (including small-scale renewable energy producers such as households), the certification requirements are simple to non-existent to ensure easy market access. In the Power Purchase Agreements to secure eligibility for specific feed-in tariffs (“REFIT”) is available on NamPower’s website.⁶¹ The only obligation for the electricity seller is to ensure that the electricity comes only from the device in question. How exactly this is ensured is not defined in detail in the documents. Trust is created by licensing under the Electricity Control Board (ECB) to become “eligible seller”.⁶²

According to the EU definition that must be met for the certification of hydrogen and hydrogen derivatives for export to the EU, PPAs for renewable energy are electricity supply contracts between a producer of renewable electricity and an electricity consumer, which can be facilitated by an intermediary. The contract must clearly specify which renewable power plant(s) produce(s) the electricity that is sold to the hydrogen producer. The hydrogen producer can then prove that the electricity consumed for hydrogen production fulfils the sustainability requirements (additionality, temporal and geographical correlation). As long as this is complied with and the electricity producer has reliable measurements of the electricity generated at hourly level, e.g. by the grid operator measuring the electricity fed into the grid, hydrogen certification in accordance with EU requirements is possible.

In some cases, information on GHG reduction itself is provided by non-public GHG emission calculations (without information on the exact methodology) by third party consultants (e.g. UNIQUE Forestry and Land Use GmbH). Relevant data collection is carried out under the M&E system of the National Planning Commission.

It is worth noting that Namibia has successfully established a specific standard for biomass under the FSC scheme, with input from local stakeholders.⁶³ Existing renewable power plants have been certified to the Verra VCS standard (see section on carbon markets below).

Carbon market

Like the market for electricity certificates, carbon markets in principle offer the opportunity to benefit from existing expertise in relation to the applicable methods for greenhouse gas emissions and the existing structures for tracking certificates. This also provides an opportunity for H2 producers to generate additional revenue (e.g. in the context of emissions trading schemes).

Carbon emissions are tracked in Namibia via a so-called Monitoring and Evaluation (M&E) system implemented via the National Planning Commission⁶⁴ (which is also sitting in the NGHP). The focus is on the general collection of data relevant to the calculation of the country's GHG emissions. Such data are held by the national statistical office or in private databases. However, at this stage, the data is mostly dispersed. As

⁶¹ <https://www.nampower.com.na/refit>

⁶² <https://www.ecb.org.na/licensing/>

⁶³ <https://www.n-big.org/wp-content/uploads/2024/05/FSC-STD-NAM-V1-0-EN-The-FSC-National-Forest-Stewardship-Standard-for-the-Republic-of-Namibia.pdf>

⁶⁴ <https://www.npc.gov.na/wp-content/uploads/2022/08/Directorate-Monitoring-Evaluation-M-E-Charter.pdf>

a result, there is currently no central institution with an interest in tracking GHG (and therefore carbon) emissions. Carbon markets in Namibia are generally served by private actors, such as the Aera Group, which uses the international Vera VCS standard⁶⁵, but does not rely on resources/institutions etc. from within Namibia.

Gaps and areas for improvement

The activities mentioned above (related to the electricity or carbon market) do not rely heavily on Namibian resources or have limited transferability to the sustainability certification of green hydrogen. This means that if Namibia decides in favour of sustainability certification for hydrogen, it has the opportunity, but also the burden, to create completely new structures.

Hydrogen sustainability certification depends to a large extent on proper certification of the origin of the (renewable) electricity used. Some elements to contractually establish the supply of renewable electricity can therefore serve as a basic structure (i.e. licensing and PPAs). However, guarantees of origin, auditing, verification, etc. will require the establishment of clear responsibilities. As a standardisation body, government advisor and testing and product certification body, the NSI already covers some responsibilities through its existing mandate (i.e. accredited to ISO 17065). A detailed discussion of its roles can be found in Chapter 5.4. Within the established roles, the first priority is to reach consensus on the objectives to be achieved through certification. These should be focused on exports in the short term to allow time for the NSI to engage internationally and build capacity before defining green hydrogen requirements for a potentially developing domestic market in the medium to long term.

5.3 Relevant Local Stakeholders and their Roles in the context of both quality infrastructure and sustainability certification

Quality Infrastructure is, by definition, “a system comprising both public and private organisations, together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the quality, safety and environmental soundness of goods, services and processes”⁶⁶. It is therefore important to consider all the stakeholders who will play a role in the development or adoption of technical standards and sustainability certification to support the development of a quality infrastructure for the Namibian green hydrogen industry.

The following table summarises the main stakeholders (other than NSI, which is discussed in more detail in section 5.4) and their role in the development, adoption, implementation and use of hydrogen technical standards (safety, quality, infrastructure) and product renewal certification.

⁶⁵ <https://aera-group.fr/project/first-ever-grid-connected-wind-farm-in-namibia/> and <https://aera-group.fr/project/contribute-to-green-electricity-transition-in-namibia/>

⁶⁶ International Network on Quality Infrastructure (InetQI)

Table 28 Stakeholders in Namibia relevant in the context of technical standards and sustainability certification

Institution	Mandate	Role
Ministry of Industrialization and Trade (MIT)	The main objectives of the Ministry are to develop and to diversify the Namibian economy towards an efficient and competitive level. The mandate of the Ministry is divided into four main programme areas as outlined below: International Trade Development which is administered by the Directorate: International Trade in the Department of Trade and Commerce. Industrial and Enterprise Development which is the responsibility of the Directorate: Industrial Development. Investment Promotion and Facilitation which is the function of the Namibia Investment Centre. The centre which has been established in terms of the Foreign Investment Act (Act No. 24 of 1993 as amended). The Centre serves as the Namibia's official investment promotion and facilitation agency and the first point of call for investors. The development of a vibrant and competitive domestic economy and market conditions function of the Ministry is administered by the Directorate: Commerce in the Department of Trade and Commerce⁶⁷	MIT is a key Government Ministry with direct input into the hydrogen industry policy and regulatory framework and the subsequent development of standards & certification as it is responsible for the NSI through the Namibian Standards Council. It can influence the development of hydrogen standards and certification in order to develop and to diversify the Namibian economy towards an efficient and competitive level.
Ministry of Mines and Energy (MME)	The Strategic Mandate of the Ministry of Mines and Energy was constitutionally established to take custody of the diverse geological, mineral and energy resources, and to ensure their contribution to the country's socioeconomic development. Its Mission is to formulate policies and legislations that effectively regulate activities in mining and energy sectors; generate knowledge and information on resources and provide services to stimulate investment for sustainable economic development and benefit to all Namibians.⁶⁸	MME is a key Government Ministry with direct input into the hydrogen industry policy and regulatory framework due to its mandate regarding the energy sector. It can influence the development of hydrogen standards and certification in order to effectively regulate activities the energy sector and stimulate investment for sustainable economic development.
Ministry Of Works & Transport (MWT)	The Ministry of Works and Transport is responsible for sectoral policy and regulation and has a mandate to ensure infrastructure development and maintenance on transport and state asset management through operational excellence and prudent management of resources.	MWT is a key Government Ministry with direct input into the hydrogen industry policy and regulatory framework particularly with respect to the mobility and infrastructure sectors. It can influence the development of hydrogen

⁶⁷ Ministry of Industrialisation and Trade Website www.mit.gov.na

⁶⁸ Ministry of Mines and Energy Website www.mme.gov.na

	Its Mission is to ensure and regulate the provision of safe, effective and efficient infrastructure and services which are responsive to the socio-economic needs of the public. ⁶⁹	standards and certification in the mobility sector and in order to provide safe, effective and efficient infrastructure.
Ministry of Environment, Forestry and Tourism (MEFT)	The mandate of the Ministry is derived from the Constitutional provision. Chapter 11: Principles of State Policy Article 95: Promotion of the Welfare of the People The state shall actively promote and maintain the welfare of the people by adopting, inter alia, policies aimed at the following: <i>“Maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future; in particular, the Government shall provide measures against the dumping or recycling of foreign nuclear and toxic waste on Namibian territory”</i>. The mission of the Ministry of Environment, Forestry and Tourism is to promote biodiversity conservation in the Namibian environment through the sustainable utilization of natural resources and tourism development for the maximum social and economic benefit of its citizens.⁷⁰	MEFT is a key Government Ministry which can influence the environmental aspects of the hydrogen industry policy and regulatory framework and therefore development of hydrogen standards and certification.
Ministry of Finance and Public Enterprises (MFPE)	The Ministry of Finance and Public Enterprises is responsible for central government finances, including coordination of the national budget, financial markets, consumer legislation and tax policy, the ministry plays an important role in positioning Namibia's Public Enterprises to play a significant role in the country's developmental agenda. Its mission is to ensure prudent public finance management and setting the direction of Namibia's economic and fiscal policy for sustainable, inclusive economic growth and development.”⁷¹	The MFPE will have an interest in how the hydrogen industry policy and regulatory framework and therefore development of hydrogen standards and certification may have an impact on central government finances.
National Investment Promotion and Development Board (NIPDB)	NIPDB was registered as a non-profit association as per Section 21 of the Companies Act no. 28 of 2004 on 27 November 2020. The Agency started its operations on 01 April 2021 and will have been operational for two years at the commencement of this strategy. The Namibia Investment Promotion and Facilitation Bill will mandate NIPDB's activities once it is enacted as law. The Ministry of Industrialisation and Trade (MIT) is the custodian of the Bill,	The NIPDB can influence the development of the green hydrogen industry policy and regulatory framework and therefore development of hydrogen standards and certification as it is mandated to develop institutional mechanisms and assume the lead coordinating role across all levers for MSME development nationally.

⁶⁹ Ministry of Works and Transport Website www.mwt.gov.na

⁷⁰ Ministry of Environment and Tourism Website www.meft.gov.na

⁷¹ Ministry of Finance and Public Enterprises Website www.mfpe.gov.na

	which is currently undergoing stakeholder consultations.⁷² The NIPDB is mandated to implement the government's economic diversification strategy with a specific focus on investment promotion and MSME development activities. The Agency maintains a dual reporting structure to both the Presidency and the Ministry of Finance and Public Enterprises (MFPE)⁷³.	Given its role to identify and find solutions to general and sectoral constraints and create a conducive investment climate and provide aftercare services to current investors, it will be a key stakeholder in the development of investor friendly technical standards and certifications schemes. It has already identified green hydrogen and renewable energy as Namibian sectors which are abundantly filled with development opportunities awaiting investment.⁷⁴
National Planning Commission (NPC)	The Mandate of the National Planning Commission is "To plan and spearhead the course of national development." <i>The NPC Mandate is derived from the Article 129 of the Constitution of the Republic of Namibia and the National Planning Commission Act 2013 (Act 2 of 2013)⁷⁵.</i>	The NPC can influence development of the hydrogen industry policy and regulatory framework and therefore development of hydrogen standards and certification as it formulates short-term, medium-term and long-term national development plans in consultation with regional councils and develops monitoring and evaluation mechanisms to ensure effective implementation of the national development plans.
Namibia Green Hydrogen Programme (NGHP)	The Namibian Green Hydrogen Programme is run through the Ministry of Mines and Energy and led by the Green Hydrogen Commissioner.	The NGHP is a very key roleplayer in all aspects of the development of the Green Hydrogen industry. It has crafted a green industrialisation blueprint in collaboration with the Ministry of Industrialisation and Trade. It can influence development of hydrogen industry policy and regulatory framework and therefore development of hydrogen standards and certification. It has already identified technical standards and sustainability certification as key enablers of the industry and will have an interest in the development thereof.

⁷² NIPDB Strategic Plan 2023 to 2028

⁷³ NIPDB Annual Report 2023

⁷⁴ NIPDB Sector Profile Green Hydrogen

⁷⁵ <https://www.npc.gov.na/about/>

Nampower	NamPower is the national state-owned power utility. Its core mandate is the provision of bulk electricity supply to all sectors of the economy and the population, particularly in areas where Regional Electricity Distributors (REDs) have not yet been established or where municipalities are not able to provide distribution services. According to the Electricity Act 4 of 2007, NamPower's mandate covers the entire electricity value chain, encompassing generation, transmission, distribution, supply, and trading. This includes facilitating electricity imports and exports, enabling it to fulfil its role within the dynamic regulatory and market environment⁷⁶.	Production of renewable power for green hydrogen production is a critical consideration of the business as their core business is the generation, transmission and energy trading, which takes place within the Southern African Power Pool (SAPP). Nampower will have an interest in the development of appropriate technical standards and sustainability certification schemes given its strong interface with the green hydrogen industry.
ECB	The Electricity Control Board (ECB) is a statutory regulatory authority established in 2000 under the Electricity Act 2 of 2000; which has subsequently been repealed by the Electricity Act, 4 of 2007; the latter Act having expanded the ECB mandate and core responsibilities. The core mandate of the ECB is: „To exercise control over the electricity supply industry (ESI) with the main responsibility of regulating electricity generation, transmission, distribution, supply, import and export in Namibia⁷⁷.“	Production of renewable power for green hydrogen production is a critical consideration of the ECB as the core mandate is to exercise control over the ESI. The ECB will therefore have an interest development of appropriate technical standards and sustainability certification schemes, particularly as they interface with the ESI regulatory framework. It has been an active member of the scoping of a legal framework for clean hydrogen.
Namport	Namport's mandate is to -Manage and exercise control over port operations, lighthouses and other navigational aids in Namibia and its territorial waters. - Provide port facilities and services⁷⁸	Namport will play an enabling role in the export of green hydrogen and PtX products which is a key element of the Namibian Green Hydrogen strategy. They will therefore be a key stakeholder regarding technical standards required for the ports and shipping sectors. They will also play a role in the supply chain aspects of green hydrogen certification.
Transnamib	Transnamib's Mandate⁷⁹ is: To provide and promote, either by itself or through any subsidiary company, transport ser-	Transnamib provides and promotes, transport services (rail and road transport) in Namibia or elsewhere by managing, developing and utilizing the resources and assets

⁷⁶ Nampower Integrated Annual Report 2023

⁷⁷ ECB Annual Report 2023

⁷⁸ Namport Integrated Annual Report 2023

⁷⁹ <https://www.transnamib.com.na/>

	vices in Namibia or elsewhere by managing, developing and utilising the resources and assets at its disposal. To manage and develop, either by itself or through any subsidiary company, immovable property, including such property as may be transferred to it by virtue of section 14(1)(a) of the National Transport Services Holding Company Act, 1998 (Act No. 28 of 1998); and To conduct, either by itself or through any subsidiary company, and with the consent of the shareholder minister, any other business, on a commercial basis.”	at its disposal. They will be key in the transport of green hydrogen and PtX products and should therefore have a vested interest in technical standards required for the safe transport and handling of hydrogen and PtX products both within Namibian and the across border into the SADC region.
Namibia Green Hydrogen Research Institute (NGHRI) / University of Namibia (UNAM)	The Namibia Green Hydrogen Research Institute serves as a national research and capacity building hub under the University of Namibia with the aim to conduct local research and development and provide innovative solutions as well as upskill and reskill Namibians and develop local businesses across the value chain of Green Hydrogen⁸⁰.	The NGHRI’s mission is to unlock the potential of the green economy, as envisaged by the Namibia Harambee Prosperity Plan II, through policy formulation and development of a Hydrogen Energy value chain that facilitates the transition to green energy, through innovation in the science of advanced materials and engineering. It can therefore play a role conducting research regarding the adoption of technical standards to Namibian conditions.
National Commission on Research, Science and Technology (NCRST)	The NCRST’s mission is “To enable a thriving and sustainable national research, science, technology, and innovation ecosystem⁸¹”.	The NCRST can play a role conducting research regarding the adoption of technical standards to Namibian conditions.
Project Developers and Private Sector	The aim of project developers will be to develop sustainable and feasible green hydrogen projects that can reach financial close.	Project Developers and Private Sector will have a keen interest in all technical standards, particularly those that are compulsory, as they will influence the design and feasibility of projects. They will require certainty of the technical standards landscape at the earliest opportunity. They will also have a keen interest in understanding and adhering to the certification schemes applicable in their target markets.

⁸⁰ <https://www.unam.edu.na/nghri>

⁸¹ <https://www.ncrst.na>

5.4 National Standards Body Functions and Capabilities

The Namibian Standards Institution (NSI) is the National Standards Body (NSB) responsible for coordinating all trade-related standardisation activities in Namibia. It also implements other components of Namibia's national quality infrastructure (QI) by acting as the National Metrology Institute (NMI), the Legal Metrology Authority (LMA), and the Certification Body (CB). The NSI provides various quality assurance services, including testing, inspection, and certification of selected products and services.

The NSI was established in 2007 under the Standards Act (Act No. 18 of 2005) and became operational in January 2008. The establishment of the NSI marked a significant shift towards a more integrated and systematic approach to quality infrastructure in Namibia, aligning the country's standards and quality assurance practices with international standards to enhance competitiveness in global markets...

The Namibian Standards Council (NSC) is the governance structure in charge of the management and performance of the Namibian Standards Institution (NSI) in accordance with the Namibian Standards Act, 2005 (Act No.18 of 2005). It is tasked with leading the institutional and legal modernisation of the National Quality Infrastructure and Technical Regulations Framework in Namibia.

Main Functions and Capabilities of NSI

The Namibian Standards Institution (NSI) plays a crucial role in the development and enforcement of standards and quality assurance in Namibia. It is responsible for implementing the National Quality Policy, which sets the framework for all quality assurance and standardisation activities in the country. This policy ensures that standards represent best practice within industries, covering products, processes, and management systems.

The NSI is involved in the development, adoption, and promotion of Namibian Standards (NAMS) and other relevant standards. This process involves participation in the preparation, adoption, and publication of standards through Technical Committees. To help industries to meet national and international requirements, the NSI provides training on various standards. This training, delivered through courses and workshops, improves the understanding and implementation of standards across different sectors.

In addition to standards development and training, NSI provides certification services to ensure that products and services meet established standards. These services include market surveillance, registration and approval procedures for various certification schemes, helping companies to meet regulatory requirements and improve their market competitiveness.

NSI operates a Testing Centre in Walvis Bay, providing comprehensive testing services to both government and private entities. The Testing Centre carries out microbiological and chemical analyses on products such as fish and fishery products, dairy products, potable water, and environmental samples. This facility is accredited by the South African National Accreditation System (SANAS) to ISO/IEC 17025 standards, ensuring high competency in testing and calibration.

Inspection services are another key function of the NSI, verifying compliance with standards and regulatory requirements. The Inspection Centre offers product sampling, market surveillance and compliance monitoring in various industries, particularly for fish and fishery products, canned fish, and canned meat products.

As the National Metrology Institute and the National Legal Metrology Authority, the NSI maintains and develops national measurement standards. The Metrology Department ensures accuracy and traceability for scientific, industrial, and legal metrology applications, supporting various industries, regulatory authorities, and the health sector.

NSI is also responsible for enforcing and administering the Trade Metrology Act, 1973 (Act No. 77 of 1973), ensuring legal compliance in trade measurements. In addition, the NSI actively participates in regional and international standardisation and conformity assessment forums, aligning Namibian standards with international best practices and facilitating global trade and cooperation.

The functions of the NSI in the context of Namibia's national quality infrastructure are detailed in Table 29.

Table 29 Namibia's Quality Infrastructure

QI Function	Responsible Institution	Status
Development of National Standards	Namibian Standards Institution (NSI)	NSI develops, adopts, and promotes Namibian Standards (NAMS) and other relevant standards through Technical Committees.
Certification	Namibian Standards Institution (NSI)	NSI offers certification services to ensure products and services meet established standards. This includes market surveillance and approval procedures.
Testing	Namibian Standards Institution (NSI)	NSI operates a Testing Centre in Walvis Bay, providing microbiological and chemical analyses on various products, accredited by SANAS to ISO/IEC 17025 standards.
Inspection	Namibian Standards Institution (NSI)	NSI performs inspection services, including product sampling, market surveillance, and monitoring compliance in various industries.
Metrology	Namibian Standards Institution (NSI)	NSI acts as the National Metrology Institute and the National Legal Metrology Authority, maintaining and developing national measurement standards.
Enforcement of Trade Metrology Act	Namibian Standards Institution (NSI)	NSI enforces and administers the Trade Metrology Act, 1973, ensuring legal compliance in trade measurements.
Accreditation	SADC Accreditation Service (SADCAS)	Namibia, as part of SADC, uses SADCAS for accreditation services. SADCAS is a multi-economy accreditation body that serves multiple SADC member states.

Status of QI for Hydrogen in Namibia

Namibia is in the process of developing its quality infrastructure for the green hydrogen sector. The NSI has not yet established specific standards or quality assurance

measures dedicated for hydrogen, but there are ongoing initiatives and progress in related areas:

1. Namibian Green Hydrogen Research Institute (NGHRI):

- **Function:** Established under the University of Namibia (UNAM), the NGHRI focuses on research, development, and innovation in green hydrogen technologies. It serves as a hub for scientific research, experimental stations, and collaboration with private and public sectors.
- **Capabilities:** The NGHRI provides state-of-the-art infrastructure, fully equipped laboratories, and training centres to support the development of the green hydrogen industry in Namibia.

2. Namibia's Green Hydrogen Strategy:

- **Objective:** Launched at COP27, the strategy outlines Namibia's commitment to reduce emissions to net zero by 2050 and positioning the country as a major global producer and exporter of hydrogen. The strategy includes plans for pilot projects, the development of a comprehensive regulatory framework and the establishment of a shared user infrastructure to reduce development costs and risks.

3. Collaborations and Partnerships:

- **International Support:** Namibia is working with international partners, including Germany, to develop its green hydrogen capabilities. These partnerships provide technical assistance, funding and knowledge transfer to ensure the successful implementation of green hydrogen projects.

4. Regulatory and Policy Framework:

- **Synthetic Fuels Act:** This forthcoming legislation aims to create an enabling environment for green hydrogen production, ensuring compatibility with international standards for green fuel, certification, health, safety, and environmental protection.

Additionally, Namibia collaborates with international partners, including Germany. Important partnerships include cooperation with the Bundesanstalt für Materialforschung und -prüfung (BAM), the Deutsches Institut für Normung (DIN), and the Physikalisch-Technische Bundesanstalt (PTB)⁸². BAM, for instance, is involved in a project with the Namibia Green Hydrogen Institute to research and develop a hydrogen pilot plant near Walvis Bay⁸³. This project aims to gain scientific insights for upscaling green hydrogen technologies and ensure high safety standards for the hydrogen economy in both Namibia and Germany.

DIN is also collaborating with Namibia to develop standards for green hydrogen technologies, ensuring that Namibia's standards align with international best practice.

⁸² <https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2024/03/20240320-pioneering-collaboration-on-hydrogen-and-ptx.html>

⁸³ <https://energycapitalpower.com/germany-namibia-research-green-hydrogen/>

PTB supports the development of measurement techniques and standards for the production, storage and use of hydrogen, which are crucial for ensuring the accuracy and reliability of hydrogen technologies.

Comparison with international practice and Gap Analysis

The following table provides a detailed comparison of Namibia's green hydrogen quality infrastructure (QI) against international practices. This analysis highlights the current status of Namibia's QI elements, contrasts them with leading examples from other countries, and identifies gaps and opportunities for improvement.

Table 30 Comparison Table for Namibia's Quality Infrastructure for Green Hydrogen

QI Requirements for Green Hydrogen	International Status	International Examples	Namibian Status	Gaps and Opportunities
1. Metrology				
Accurate measurement standards for hydrogen (pressure, temperature, flow); traceability to international references (BIPM)	Standards traceable to international references (BIPM)	Germany: PTB – Metrology infrastructure for high-pressure gas and liquified hydrogen. PTB's Hydrogen Strategy - Metrology and Safety Technology for Hydrogen Applications⁸⁴ UK: NPL – Hydrogen purity measurement, online hydrogen quality sensors, Primary Reference Mixtures (PRMs)⁸⁵ Enagás' Hyloop+ project for hydrogen flow metrology⁸⁶ NMISA (National Metrology Institute of South Africa)	General metrology services (NSI)	Develop metrology services demanded by the hydrogen industry in Namibia. Collaborate with international bodies for best practices and technology transfer. Namibia is already working with PTB (Physikalisch-Technische Bundesanstalt, Germany) on hydrogen metrology and could also explore partnerships with institutions like NPL (National Physical Laboratory, UK), NIST (National Institute of Standards and Technology, USA), and KRISS (Korea Research Institute of Standards and Science, South Korea) to further enhance its hydrogen quality infrastructure.
Standardisation				

⁸⁴ PTB's Hydrogen Strategy https://www.ptb.de/cms/fileadmin/internet/forschung_entwicklung/Innovationscluster_der_PTBI/Innovationscluster_Energie/Hydrogenstrategy_PTBI_2024_eng.pdf

⁸⁵ Hydrogen Measurement Service Hub <https://empir.npl.co.uk/hydrogenhub/laboratory/npl/>

⁸⁶ Enagás' Hyloop+ <https://www.enagas.es/en/press-room/news-room/press-releases/hyloop-aragon-government-visit/>

QI Requirements for Green Hydrogen	International Status	International Examples	Namibian Status	Gaps and Opportunities
New standards needed for hydrogen distribution, storage, transfer to end users, liquid hydrogen, and derivatives like synthetic fuels; requirements for higher hydrogen concentrations	ISO TC 197: Hydrogen technologies; IEC TC 105: Fuel cell technologies; ISO/TS 19870: Safety considerations for hydrogen systems	Germany: DIN Hydrogen Standardisation Roadmap; UNIDO Global Programme for Hydrogen Standards; GH2 Green Hydrogen Standard	Existing experience in national standards adoption and development Hydrogen related standardisation is at an initial stage (NSI)	Adoption, adaptation and development of hydrogen-specific standards. Increase regional and international participation
Testing				
Hydrogen-specific testing capabilities; accredited labs for high-pressure and purity testing		Germany: BAM Conducts hydrogen-related testing, including safety tests for hydrogen storage and transport. UK: National Physical Laboratory (NPL) – Offers hydrogen quality testing services;	General testing services (NSI) Accredited by SAD-CAS, traceable to international standards	Establish need for hydrogen-specific testing facilities by industry by NSI laboratories accredited to ISO 17025 by SAD-CAS. Collaborate with international bodies such as BAM and NPL for best practices and technology transfer
Certification and Inspection				
Certification schemes for production, storage, and transportation processes; regular inspection and compliance verification	Certification and inspection services provided by international bodies like TÜV; compliant with ISO 17020/21 (NoBo, System certifications according to ISO 9001, ISO 14001 standards, etc.)	Germany: TÜV – Provides certification and inspection services for hydrogen components, systems, and infrastructure	Accredited by SAD-CAS, traceable to international standards; ISO 9001, ISO 14001 No hydrogen-specific certification and inspection (NSI)	Develop certification schemes specific to hydrogen; improve inspection protocols; seek international recognised accreditation (by SADCAS, SANAS, ...) according to ISO 17020/21/24/25/65. For technical aspects this would mainly concern activities around pressure equipment and major hazard installations on a higher prioritization, but also should consider hydrogen specific standards for hydrogen storage (e.g. ISO 19880-1), hydrogen production (e.g. ISO 22734) or hydrogen transportation (e.g. ISO 14687).
Regulation				

QI Requirements for Green Hydrogen	International Status	International Examples	Namibian Status	Gaps and Opportunities
Comprehensive policies supporting hydrogen production and use; regulatory oversight	National Hydrogen Strategies New laws and regulations as well as amendments to existing laws and regulations	South Africa: GAS AMENDMENT BILL expanded the definition of gas to include hydrogen.	Mechanism exists to declare national standards compulsory under various existing laws. New regulation planned (NSI, Ministry of Mines and Energy)	Formulate comprehensive hydrogen policies; establish robust regulatory framework The most important regulations are required are those that guarantee safety along the green hydrogen value chain in order to protect the customer and prevent possible negative environmental effects. ⁸⁷ Ensure investor certainty regarding future regulatory framework

Analysis and Recommendations

Namibia is at an early stage in developing its quality infrastructure for green hydrogen. While basic elements are in place, significant gaps remain in terms of alignment with international standards and practices. Key observations and recommendations are presented below:

Metrology: Namibia's metrology services, while functional for general purposes, lack the specificity required for hydrogen applications. The development of metrology services that meet the specific needs of the hydrogen industry and collaboration with international bodies can bridge this gap. This initial analysis and recommendation should be taken forward through international cooperation and partnerships. such as the International Organisation of Legal Metrology.

Standardisation: Namibia has made progress in standardisation but needs to adopt and adapt more comprehensive hydrogen-specific standards. Active participation in international committees such as ISO TC 197 and IEC TC 105 will be crucial.

Testing: There is a clear need to establish hydrogen-specific testing facilities in Namibia. The current general testing services do not meet the high pressure and purity requirements for hydrogen. Benchmarking with facilities such as Germany's BAM and the UK's NPL can help to establish the necessary infrastructure and capabilities. Collaboration with international bodies will be essential for best practice and technology transfer. This initial analysis and recommendation should be taken forward through international collaboration with partners currently being established.

Certification and Inspection (non-sustainability related certification): Certification and inspection services in Namibia are currently limited and not specific to hydrogen. The comprehensive services provided by, for example, the TÜV organisations in Germany can serve as a model. TÜV operates under national accreditations such as ISO 17020, ISO 17025 or ISO 17065 and acts as an independent third party for certification requirements. These certifications are a trusted seal of approval, guaranteeing that a product, service or process has been thoroughly tested for safety, quality

⁸⁷ The Quality Infrastructure System for Green Hydrogen - Creating the Basis for the Development of the Emerging Sector https://www.ferdinand.es/wp-content/uploads/2024/02/QI_for_Green_H2.pdf

and sustainability. The four-eye principle will be particularly important in the context of safety-critical components and systems, which is the case for hydrogen applications. These tests include compliance with international, regional and national regulations or standards. The development of certification and testing protocols tailored to hydrogen and the pursuit of international accreditation, in combination with applied / mandatory standards and applicable regulations, will be critical steps forward. This initial analysis and recommendation should be further pursued through international collaboration with partners currently being established.

Regulation: The development of a robust regulatory framework is essential to provide clarity and certainty to investors and stakeholders in the hydrogen sector. The formulation of a comprehensive hydrogen policy and the establishment of a clear regulatory framework will be key to supporting the growth of the hydrogen economy in Namibia. This initial analysis and recommendation should be taken forward by the relevant ministries and regulators in Namibia to address specific regulations such as a pressure equipment regulation, major hazard installation regulation or general construction regulation.

Structure and organisation: Analysis of international examples shows that the NSI has multiple functions, including standards development, accreditation, metrology and certification - functions that are often performed by separate institutions in other countries. While this structure may be appropriate for Namibia's current circumstances, particularly given its size and the need to manage resources efficiently across different sectors, it is important to consider the potential changes that may arise in the future

6. Findings and Preliminary Recommendations

The study used a detailed desktop study to collect and analyse existing international and Namibian standards and certification schemes relevant to the hydrogen industry, as described in previous chapters. However, it was critical to gather input from key public and private sector stakeholders in the Namibian GH2 ecosystem to contextualise the findings for Namibia. This chapter outlines the key topics that emerged from the structured stakeholder interviews, key findings regarding the potential role of the NSI in hydrogen standards and sustainability certification, and recommendations for the definition of standards and norms beneficial to the Namibian hydrogen economy.

6.1 Stakeholder Engagement Themes

As outlined in Section 1.4, a diverse array of public and private sector stakeholders participated in structured interviews and a review workshop held between April and July 2024 (refer to Appendices B and C). From these engagements, several key issues emerged:

Industry Focus

- The industry is mainly export-oriented, and the first markets targeted are the EU, Japan and Korea. However, there are also projects that focus solely on the domestic market. Renewstable Swakopmund. Consequently, it is essential to ensure that products comply with the sustainability certification requirements of export markets, while also placing emphasis on the certification of domestic products.
- The industry is presently concentrating on establishing facilities to produce end products like green hydrogen and ammonia. However, there is a public sector drive to localise the production of manufacturing equipment such as electrolyzers, storage tanks and wind turbines in the long term. Therefore, the development and adoption of standards should prioritize the production, transport, and handling of these end products, followed by the local production of the necessary manufacturing equipment.
- There are currently several smaller pilot projects to test “proofs of concept” with the aim of developing larger facilities at a later stage. Therefore, there is a need to expedite the development/adoption of standards that can be used within the pilot projects as these projects have shorter timeframes.

Private Sector Compliance and Collaboration

There was a strong plea from the private sector, as well as from a number of public sector actors, that standards should enhance market development and industrialisation, not prohibit it. They urged that the focus should be on safety-critical standards.

- Most project developers currently rely on international standards, primarily ISO and IEC, along with ASME and API; however, there are no specific Namibian standards in place. This absence is not necessarily a concern for developers, as the bankability of their projects frequently hinges on adherence to internationally recognized standards.

- However, they are looking for guidance equipment that doesn't currently meet general international standards, e.g. Chinese equipment standards for electrolyzers.
- There is a consensus that adopting or adapting international standards to better suit local conditions—such as humid desert environments—could be beneficial. This approach may necessitate particularly stringent specifications to prevent costly replacements resulting from corrosive conditions.
- There is a pressing need to enhance the visibility and accessibility of applicable standards. Many stakeholders were unaware of how to access the NSI Standards Catalogue, and some expressed that the fragmentation of standards poses challenges for projects. It is essential to clarify which standards are recommended and which are mandatory.
- Another need identified by the industry is the necessity for increased awareness, training, and dialogue regarding the sustainability certification aspects of their projects and the requirements of key export markets. This need is particularly pronounced among smaller, less experienced project developers who may lack access to the project development tools and established standards and specifications of global parent companies.

Regional Collaboration

- Stakeholders recognize significant value in regional interactions, such as SADCAS. The private sector has expressed a desire for increased regional cooperation to leverage synergies with local projects and enhance the ability to market products within the region.
- The need to harmonize standards regionally is especially critical in the transport sector, as end products are likely to be transported to neighbouring SADC countries by road and rail. Currently, many transport standards are derived from SANS standards.

Inter-Governmental and Regulatory aspects

- The need for more information and guidance on sustainability certification of GH2 for export markets and CBAM legislation was expressed by some government departments.
- Concerns were also raised about Namibia's capacity to develop the GH2 industry and ensure compliance with standards. It was felt that capacity development is required in this area.
- There appears to be several inter-Ministerial task teams looking at global regulations, codes and standards. This work should be coordinated.
- The Transport Policy 2018 makes no reference to GH2, and this gap needs to be addressed. The NSI also needs to be involved in the drafting of the Downstream Gas Bill and the Synthetic Fuels Bill.

Role of NSI

- It is vital that industry has direct input into the development and prioritisation of standards, and the NSI can play a key role in this, for example by forming a National Mirror Committee (NMC) that includes key industry players.

- Stakeholders felt that NSI should be the custodian of industrial standards and focus on
 - Enhancing Industrialisation and Trade
 - Public consultation
 - National standardisation policies and strategy
- There is a need for public awareness of the socio-economic benefits of standards.
- NSI's profile needs to be enhanced with private sector. Many have not worked with them nor aware of everything they offer.

6.2 NSI's role in the GH2 Industry

The NSI has the potential to play a crucial role within the GH2 ecosystem, with mandates that encompass various levels of interaction and collaboration. These roles are vital for supporting the development, standardization, and certification of green hydrogen technologies, thereby ensuring Namibia's active participation in the global green hydrogen market.

Table 31 below summarises the key findings of this scoping study on the potential roles of the NSI in hydrogen standards and sustainability certification.

Table 31 Summary of findings in terms of NSI's role in hydrogen standards and sustainability certification

Role	Example (EU)	NSI's Potential Role	Prerequisites
Standardisation Body	National Standardization Bodies of 33 European countries under the European Standardisation Organisations CEN, CENELEC and ETSI	Nationally adopt international standards; Manage national TC; Contribute actively to the development of new standards (e.g., ISO 19870)	Become Participating Member of ISO/TC 197/SC 1
Advisor to the Government	EU JRC	Support government in defining regulatory framework related to standardisation (incl. referencing of standards) and certification.	Capacity building and build-up
Testing & Product Certification Body	Third-Party (e.g., TÜV SÜD, Bureau Veritas, DNV, SGS)	Consider becoming Certification Body for hydrogen	Accreditation according to ISO 17065 (in relevant scope); capacity building; recognition by Voluntary Scheme(s). The IAF requirements for impartiality and freedom of conflict of interests are to be considered (acc. to WTO and TBT together with ISO 17029 – mutual recognition agreement regarding impartiality). Two Divisions are needed to be organisationally independent and these Divisions can report to the same board that is non-executive (similar to South Africa with SABS / SANS).
Accreditation Body	National accreditation bodies in EU (e.g., DAKKS in Germany)	Not applicable: role already for SADCAS	not applicable

Role	Example (EU)	NSI's Potential Role	Prerequisites
Legislator / Regulator	Council of the EU, EU Parliament, EU Commission	not applicable: roles already defined (i.e. ECB)	Not applicable
Certification Scheme Holder	e.g., CertifHy, REDcert, ISCC.	Scheme holder of national/regional scheme or providing know-how personnel to regional scheme	Political decision and new mandate
Certificate Issuing Body	Carried out by certification bodies for RFNBO; separate function for Guarantees of Origin	If a national or regional (SADC) scheme was developed (similar to Guarantees of Origin), NSI could be Issuing Body (compare Instituto Argentino de Normalización y Certificación (IRAM) proposed for CertHiLAC)	Establishment of National or Regional certification scheme
Verification Body (Auditors)	N/A for RFNBO (EU RED) but for EU CBAM	Applicable for Namibian producers of CBAM products to be exported to EU (tbc)	New mandate; accreditation according to ISO 17029
Labelling Partner	N/A	Labelling of e.g. "ultra-low-carbon green hydrogen"; relevant under national/regional scheme	New mandate
Provide LCA Calculations to H2 Producers	Private consultants	Service provider to producers (conflict with certification/verification body)	New mandate
Advisors/Consultants to Economic Operators	Private or institutional	Knowledge owner for Namibia (conflict with certification/verification body)	Capacity building
UDB Service Provider to H2 Producers	Producer/traders schemes service providers	Specifically, to few Namibian projects as a service	Capacity building (EU Market only); IT infrastructure (new mandate?!)
Trade Platform Operator	Only relevant for B&C	N/A	N/A
Single Source of National Information/Data	N/A (various sources)	Support all project developers in Namibia for getting EU RFNBO certification; certification requires "reliable data from official sources"	New mandate

6.3 Recommendations

The analysis of the current status, gaps, and opportunities concerning technical standards for green hydrogen and sustainability certification in Namibia, as well as the role of Namibia's NSI in developing the quality infrastructure for hydrogen, has led to several key recommendations

a. Establishing NSI's Role in the GH2 Value Chain

The emerging hydrogen sector in Namibia requires a well-defined and robust quality infrastructure, with NSI at its core. It is recommended that NSI takes the lead in developing a H2-focused extension to the National Quality Policy⁸⁸, in collaboration with all relevant stakeholders of the hydrogen industry in Namibia. This extension should be developed in close collaboration with the Green Hydrogen Council, MME, MIT and ECB to ensure alignment with national targets and international standards.

To effectively fulfil the relevant roles within this strategic approach, the NSI should consider undertaking a comprehensive review of its current organisational structure, capabilities and services, using Table 31 as a guide. This review will align the NSI's activities with the needs of Namibia's green hydrogen and green industrialisation strategies. The functions of the NSI should be well defined and segregated to ensure that there is no conflict between standards development and conformity assessment training; this will ensure impartiality and compliance with international best practice in close coordination with the regional accreditor, i.e. Southern African Development Community Accreditation Service (SADCAS). It is recommended that this matter be kept under constant review and that close communication with SADCAS be maintained. Internationally, it is well established to differentiate between:

- a. Conformity Assessment Division for laboratory and certification services, compliant with ILAC/IAF recognition and ISO 17021/25 SADCAS accreditations.
- b. Standards Development Division for standards governed under National Standards Acts and separate from regulatory activities.
- c. National Regulators for Compulsory Specifications Division for safety regulations related to health and environment, independent from the standards and conformity assessment activities.

Capacity building is also needed to equip the NSI with the skills and knowledge to meet the needs of the hydrogen sector. This should include the development of tailored training programmes in collaboration with national organisations such as UNAM and international partners, such as DIN and PTB. Continuous improvement mechanisms need to be established to regularly refine and update NSI's services.

Finally, it is essential that the NSI formalises its approach to stakeholder engagement and ensures active collaboration with national and international partners. This includes

⁸⁸ PTB's Hydrogen Strategy could serve as an example of such a strategic extension https://www.ptb.de/cms/fileadmin/Internet/forschung_entwicklung/Innovationscluster_der_PTBI/Innovationscluster_Energie/Hydrogenstrategie_PTBI_2024_eng.pdf

strengthening regional partnerships through SADC and aligning with global standards. By following these recommendations, the NSI will be well positioned to lead Namibia's hydrogen quality infrastructure and support the country's ambitions in the global hydrogen economy.

b. ISO/TC 197

The development of a comprehensive standards framework for Namibia's emerging hydrogen industry requires the establishment of a dedicated Technical Committee (TC) at national level. This committee, specifically focused on hydrogen technologies and all other relevant green hydrogen value chain standards, is essential to enable industry engagement and participation in the standards development process.

To effectively represent Namibia's interests in the global hydrogen sector, the NSI should become a participating member of ISO/TC 197 and contribute to the development of international standards. In addition, the TC will need to guide the prioritisation of standards, with a particular focus on safety and user interface interactions, to ensure that the Namibian hydrogen industry is aligned with global best practices. Establishing these standards at the national level will require a unified approach to management and coordination, with the NSI overseeing the entire process and ensuring that the resulting standards meet national, regional and international requirements.

NSI has already established 16 Technical Committees (TCs), with 8 sub-committees, to assist with the preparation, adoption, and publication of standards in accordance with the World Trade Organization (WTO) requirements. It emphasises the principles of good standardisation practice at the national level, which includes the national adoption or implementation of international and regional standards. It is recommended that TC 197 be established at the national level to discuss the technical practicality of international standards in relation to Namibia's interests, as well as to facilitate international trade and promote wider acceptance.

c. Regional Collaboration

To secure Namibia's position in the global green hydrogen market, NSI will need to work closely with regional standardisation and conformity bodies (e.g. SADC), in order to align national standards with regional standards and practices. This will enable regional trade and ensure that the region can collectively achieve the highest quality of green hydrogen, particularly for premium markets in the EU. Industry input to TC 197 is critical and will inform what standards are needed in the sector.

Regional collaboration improves the understanding of actors in the hydrogen economy by fostering a broader dialogue among stakeholders and creating a robust trading zone within the region, built on a shared technical foundation. This collaboration enables countries to pool their resources and share insights, facilitating knowledge exchange and accelerating progress along the learning curve in various technical domains.

In addition to regional collaboration, the NSI must actively participate in global discussions at the ISO level and through platforms such as the International Partnership for

Hydrogen and Fuel Cells in the Economy (IPHE). These engagements should be strategically coordinated to reflect a unified regional perspective, thereby enhancing Namibia's influence in the global hydrogen standards arena. Through Namibia's TC 197, the NSI and other stakeholders can align their activities with those of regional and international bodies. This includes incorporating additional sustainability and social considerations into hydrogen certification processes, as well as ensuring that regional certification schemes meet the requirements of international target markets. Furthermore, international case studies and reference materials from other regions should be validated or confirmed by NSI TC 197 and adapted to suit local circumstances and the practical needs of Namibia's hydrogen ecosystem.

d. Advising the Namibian Government

The successful implementation of a quality infrastructure for hydrogen—encompassing both technical standards and sustainability certification—requires specialized expertise. As the authoritative body on hydrogen standards, the NSI is well-positioned to advise the Namibian government on relevant regulatory, standards, and sustainability certification matters. NSI should provide essential input to ministries and regulators, (e.g. ECB), regarding governance structures and technical decisions, ensuring alignment with both national legislation and international best practices. This role is crucial, as NSI possesses a comprehensive understanding of market needs, insights gained from technical discussions within TC 197, and the capacity to serve as a valuable advisor to the government.

This advisory role would be supported by Technical Committees (TCs) and Advisory Committees, which will serve as forums for discussion and decision making. Through continuous monitoring of the regulatory framework and engagement with regional and global developments, the NSI will be able to provide informed perspectives on both national and international standardisation and conformity assessment.

The NSI has already successfully implemented these practices in other technical areas, and they should now be applied to hydrogen-specific issues to ensure the successful development of the sector in Namibia.

e. Facilitating Private Sector Standards Adoption and Compliance

The successful development and implementation of technical standards and sustainability certification for green hydrogen in Peru will depend heavily on a successful partnership between the NSI and the private sector, particularly GH2 project developers. It is essential that the private sector is involved in the development and adoption of technical standards that affect the project development industry in general, as well as those that are specific to the GH2 and PtX industry.

The NSI has the capability to play a pivotal role within the green hydrogen (GH2) ecosystem as the custodian and knowledge owner of national standards relevant to the industry. Additionally, the NSI can serve as a valuable UDB (Unified Data Base) Ser-

vice Provider for hydrogen producers, acting as a centralized source of national information and data. This dual role positions NSI as a key facilitator in the development and implementation of standards that support the growth of the hydrogen sector.

The NSI has 277 published standards, and 14 withdrawn standards listed in the NSI Namibian Standards Catalogue 2024.⁸⁹ This catalogue and various other publications and related information are available on the NSI website.⁹⁰ However, discussions with stakeholders revealed that many were not aware of the information provided. Informed stakeholders pointed out that they need more context on the positioning of the standards within the legal and regulatory framework. It also needs to be clarified which standards are binding. Another wish expressed by industry was for awareness raising, training and discussion on the sustainability certification aspects of their projects and the requirements of key export markets. This need was more pronounced among smaller, less experienced project developers who did not necessarily have access to the project development tools and established standards and specifications of the global parent companies. It is therefore recommended that the NSI adopt a phased approach in its engagement with the private sector, primarily through the establishment and management of TC 197.

- **i) Stakeholder Engagement** – The stakeholder mapping and needs assessment completed for this study should be expanded to thoroughly understand the private sector landscape and its needs. Key private sector stakeholders should form an integral part of the Technical Committees (particularly TC197) and Working Groups.
- **ii) Awareness** Stakeholders should be assessed in terms of their awareness of the current products and services offered by NSI. This should be complemented by a social media marketing campaign, dialogue and possibly awareness workshops to ensure that all key industry stakeholders have a thorough understanding of NSI's valuable products and services.
- **iii) Training** – The next phase should include detailed training on currently published standards, as well as new standards that have been or are being adopted specifically for the GH2 industry, and their context within the legal and regulatory framework. Training should also be provided on sustainability certification requirements for key export markets. This training could be provided by the NSI or by third parties facilitated by the NSI.
- **iv) Development of Practical Tools and Guidelines** – Ultimately, the goal is to develop practical tools and step-by-step guidelines to assist green hydrogen projects in adopting regulations, codes, and standards. In addition, it would be valuable to develop guidelines for green hydrogen projects on sustainability certification procedures to facilitate access to export markets.

These recommendations will be developed and steps to implement them will be included in Part 2 of the study, which will include a roadmap for implementation.

⁸⁹ <https://www.nsi.com.na/wp-content/uploads/2023/03/Download-Namibian-Standards-Catalogue.pdf>

⁹⁰ <https://www.nsi.com.na/>

7 Conclusions

The scoping study analysed the current status, gaps and opportunities related to technical standards for green hydrogen and sustainability certification in Namibia. It also examined the role of the Namibian National Standards Institute (NSI) in developing the quality infrastructure for hydrogen.

Key Findings

The study revealed insights into three main aspects: technical standards for green hydrogen, sustainability certification, and the role of the NSI in Namibia's hydrogen quality infrastructure.

Regarding **technical standards for green hydrogen**, the study showed that the international landscape is well developed, covering different dimensions such as hydrogen production and conditioning, storage and transport, hydrogen fuel cells, fuel quality and purity, and end-use applications. These standards ensure safety, performance and interoperability throughout the hydrogen value chain. There is currently a lack of specific standards for hydrogen technologies in Namibia. This gap should be addressed in close collaboration with industry to enable sector development and provide investor certainty for the large capital-intensive investments required to build Namibia's hydrogen economy.

In addition, the study examined **sustainability certification** in the green hydrogen sector. Internationally, sustainability certification schemes focus on assessing the environmental impact, carbon footprint and overall sustainability of hydrogen production processes. These certifications ensure that hydrogen production is in line with global environmental and sustainability goals. As the Namibian green hydrogen strategy is primarily focused on exports, helping developers to meet the requirements of export markets - particularly in regions such as Europe, Japan and South Korea - will be key to the success of the strategy.

Finally, the study examined the **role of the NSI** in supporting the hydrogen quality infrastructure in Namibia. Internationally, national standards bodies play a role in research, standardisation and policy support for hydrogen technologies. They contribute to the development of standards, facilitate compliance, and support policy frameworks that encourage innovation and adoption of new technologies. For Namibia, developing the capacity of the NSIs in these areas can provide a basic structure for its hydrogen economy. This includes improving the NSI's ability to conduct research, set standards and support the implementation of policies that promote the development of hydrogen technologies.

The successful development and implementation of technical standards and sustainability certification for green hydrogen in Namibia will rely heavily on regional and international cooperation. Building partnerships with neighbouring countries through SADC and participating in global platforms such as ISO/TC 197 will allow Namibia to access shared knowledge, resources and best practices. In addition, international engagement will keep Namibia abreast of global developments and enable it to adopt standards that meet the needs of the international market.

Next Steps

The findings and recommendations outlined in this report will be further refined and elaborated in collaboration with the NSI and other key stakeholders to ensure relevance and practical applicability. This will lead to the creation of a detailed roadmap with timelines, milestones and responsible parties to ensure successful implementation of standards and sustainability certification.

By addressing these gaps and capitalising on the identified opportunities, Namibia can develop a framework for green hydrogen standards and sustainability certification. This can position Namibia as a leader in the sustainable hydrogen economy and foster regional and international partnerships, thereby increasing the country's competitive advantage in the global hydrogen market.

Appendix A Review Workshop Report

Not for publication

Date 6 June 2024
Time 08h30 to 16h30
Venue Mercure Hotel, Windhoek

Agenda

08h30 – 09h00	Registration	All
09h00– 09h10	Welcome and Introductions	NSI
09h10 – 10h00	The Namibian Standardisation Strategy Namibia's Green Hydrogen Vision and Strategy Technical Standards and certification as enablers of quality infrastructure	NSI Namibia Green Hydrogen Programme GIZ Green Hydrogen Business Alliance
Tea Break		
10h30 – 12h30	Technical Standards – Status and Gap Analysis Certification – Status and Gap Analysis	Presentations by Rebel, LBST, TÜVSÜD followed by discussion
Lunch		
13h30 – 14h00	Preliminary Findings and Draft Recommendations	Rebel, LBST, TÜVSÜD
14h00 – 14h30	Case Study - Chile	Ministry of Energy - Chile
Tea Break		
14h45 – 16h00	Workshop - Preliminary Findings and Draft Recommendations	Rebel, LBST, TÜVSÜD and all attendees
16h00 – 16h30	Wrap up and Closing Remarks	NSI

Workshop Notes

1. Introduction

Dr Eino Mvula - CEO NSI

Dr Mvula welcomed everybody to the Workshop. He outlined the importance of standards in the development of the Namibian Green Hydrogen industry and emphasised the role of standards as an enabler of the Synthetic Fuels Act, which is under development. GIZ were thanked for initiating this project and assisting NSI play its role as a world class organisation.

He emphasised that NSI has all the prerequisites to meet international requirements but that “for us to succeed we need you as an industry”.

2. The Namibian Standardisation Strategy

Mr Jekonia Haufika - GM: Standards Development and Coordination – NSI

Mr Simasiku Matali - Head: Metrology -NSI

Mr Haufika and Mr Matali explained NQI in the global context and outlined the Namibian Standardisation Strategy. “A standard defines minimum requirements of a product or a service”. They also explained the mandate, roles and responsibilities and services of the NSI. It was explained that the NSI aspires to be a leader in the development, adaption and adoption of Green Hydrogen standards and will “draw from international standards”. It needs to create trust/confidence in terms of trading requirements, safety etc. A primary aim is to develop certification services that support the green hydrogen value chain and provide third-party testing” as a service to project developers.

It was announced that NSI will create a TC197 mirror committee and that all relevant stakeholders are invited to contribute.

3. Namibia’s Green Hydrogen Vision and Strategy

Ms Nikol Hearn – Head of Transactions Namibia Green Hydrogen Programme

Ms Hearn gave an overview of the Namibian Green Hydrogen Programme, established under the Goal 3 Develop Complementary Engines of Growth of the Harambee Prosperity Plan II (HPP II). She spoke about the Namibian Green Hydrogen Strategy which was launched in November 2022 with an aspiration of producing 22 million tonnes of GH by 2050 through the rollout of three valleys - northern, central and southern.

She indicated that Namibia has joined the African Green Hydrogen Alliance and that the development of standards and certification is a critical enabler of the development of the industry.

4. Technical Standards and certification as enablers of quality infrastructure

Ms Munolwiso Ipangelwa – Project Manager: Green Hydrogen Business Alliance – GIZ

Ms Ipangelwa gave context on where the project originated. She indicated that the World Bank workshop on the GH regulatory landscape had identified gaps which included certification and standards. A Green industrialisation workshop has also been hosted and same/similar people were present.

5. Technical Standards and Certification – Status and Gap Analysis

Mr Laurens Cloete – Rebel, Mr Thomas Frohn – TÜVSÜD, Ms Jennifer Zeiss – Rebel, Mr Matthias Altmann – LBST, Dr Leo Diehl – LBST

The Consulting team gave an overview of the current status of technical standards and certification globally and in Namibia and outlined the gap analysis. This was followed by key findings and recommendations. This led to discussion amongst the workshop participants on a number of key themes.

- Speed is of the essence. The discussion of these topics amongst Namibian role players is overdue as Namibia needs to meet the window of opportunity. A concern was raised that in the electricity industry (where a regulatory framework already exists), it can take up to 5 years to get a standard adapted and then put into regulation. NSI indicated that they are trying to improve the process and composition of Technical Committees (TCs) to improve the time.
- The biggest gap regarding standards relates to safety standards and industry is seeking guidance. There is a risk that plants will be designed and commissioned prior to an important standard being developed which could result in them being in contravention.
- They also seek guidance regarding voluntary standards, particularly for equipment that is being imported from countries such as China (e.g. electrolyzers)
- There is a consideration to set up a national Accreditation Body within the next three years.
- It was asked whether NSI (through SADCAS) could be the certification body as SADCAS is linked to IAF and thus mutual recognition around the world should be possible. It was indicated that this is not clear at this stage as this is under discussion at the European Commission specifically for certification bodies in the context of RFNBO certification and is thus an open issue.
- It was clarified that CBAM (which requires a verification body) includes Hydrogen and ammonia and is therefore applicable to this industry.
- The aspiration to produce green hydrogen to the highest purity was questioned as the Namibia grid mix has imported coal-based power. It was suggested that, if possible, Namibia should aim for it as an opportunity – particularly by new South Korean definitions. The price premium for renewable hydrogen in Germany is also high.
- There was also a request to extend the process to other stakeholders and it was explained that there is still sufficient time for information to be gathered from additional stakeholders.
- There was overall support for the creation of a mirror TC 197 Committee in Namibia involving industry as well as the public sector.
-

6. Closing Remarks

Ms Paloma Ellitson GM: Testing and Inspection - NSI

Ms Ellitson thanked all participants for attending the important workshop. She acknowledged that speed is important and announced that NSI is ready to drive the process by determining.

- Which standards are to be prioritised?
- Which conformity assessments need to be implemented?

Appendix B Summary of Stakeholder Engagements

Interviews conducted for the study are tabulated below:

Name of Organisation	Date of Interview
Ministry of Industrialisation and Trade (MIT)	10 May 2024
Ministry of Mines and Energy (MME)	12 April 2024
Namibia Green Hydrogen Programme (NGHP)	23 April 2024
Ministry of Works and Transport (MWT)	15 July 2024
Namibia Investment Promotion and Development Board (NIPDB)	19 April 2024
Namibia Green Hydrogen Research Institute (NGHRI)	15 April 2024
Daures Green Hydrogen	25 April 2024
Hyphen Hydrogen Energy	12 April 2024
ZHero	30 April 2024
HDF Energy	17 April 2024
Namport	27 May 2024
Nampower	16 July 2024
Electricity Control Board (ECB)	24 April 2024
Transnamib	6 May 2024
Deutsches Institut für Normung (DIN) and Physikalisch-Technische Bundesanstalt (PTB)	15 February 2024 10 July 2024 23 July 2024 7 August 2024 27 September 2024

Appendix C Capacity development

Summary of Training Provided to NSI on 5 June 2024

Training on Certification by Matthias Altmann and Dr. Leo Diehl from LBST

The training session on certification, delivered by Matthias Altmann and Dr. Leo Diehl from Ludwig-Bölkow-Systemtechnik GmbH (LBST), focused on sustainability certification for hydrogen and its derivatives. The presenters highlighted the importance of sustainability certification in ensuring compliance with international standards such as the EU's Renewable Energy Directive (RED II). They discussed various certification schemes like CertifHy, which offer reliability and market value for green hydrogen by demonstrating its sustainability attributes. The session covered the certification process, key elements, and the need for robust, transparent, and harmonised certification standards to meet regulatory requirements and support market acceptance. The audience was also introduced to different international certification standards and schemes and the procedures involved in achieving certification, providing a comprehensive understanding of the sustainability certification landscape for hydrogen.

Training on Safety and Technical Standards by Thomas Frohn from TÜV SÜD

Thomas Frohn from TÜV SÜD presented on safety and technical standards for hydrogen technologies. His session began with an introduction to the unique properties of hydrogen and the potential hazards associated with its use. He elaborated on safe handling practices, emphasising the need for appropriate safety measures across the hydrogen value chain. The training included detailed discussions on technical aspects such as hydrogen storage, transportation, and utilisation, as well as the materials and equipment suitable for hydrogen applications. Frohn also highlighted various safety concepts and standards that are critical for ensuring the safe deployment and operation of hydrogen technologies. This comprehensive session aimed to equip NSI staff with the necessary knowledge to understand and implement technical standards and safety measures in Namibia's emerging hydrogen sector.

Appendix D Pressure Equipment Standards

Table 32 United States Pressure Equipment Related Standards

Standard	Description
ASME Section I	Rules for construction of power boilers
ASME Section III	Rules for construction of nuclear facility components (divisions 1,2 and 3)
ASME Section IV	Rules for construction of heating boilers
ASME Section VI	Recommended rules for the care and operation of heating boilers
ASME Section VII	Recommended guidelines for the care of power boilers
ASME Section VIII	Rules for construction of pressure vessels (divisions 1, 2 and 3)
ASME Section X	Fibre-reinforced plastic pressure vessels
ASME Section XI	Rules for in-service inspection of nuclear power plant components
ASME B31	ASME Code for pressure piping: 831.1 -Power piping 831.2 -Fuel gas piping 831.3 -Process piping 831.4 - Pipeline transportation systems for liquid hydrocarbons and other liquids 831.5 -Refrigeration piping and heat transfer components 831.8 - Gas transmission and distribution piping systems B31.8S - Managing system integrity of gas pipelines. 831.9 - Building services piping 831.11 - Slurry transportation piping systems
ASME RTP-1	Reinforced thermoset plastic corrosion resistant equipment
ASME PCC-2	Repair of pressure equipment and piping
ASME PCC-3	Inspection planning using risk-based methods
ASME PVHO-1	Safety standard for pressure vessels for human occupancy
ASTM D 2774	Standard practice for underground installation of thermoplastic pressure piping
ASTM D 2996	Standard specification for filament-wound "fiberglass" pipe (glass-fibre-reinforced thermosetting resin)
ASTM D 3299	Standard specification for filament-wound glass-fiber-reinforced thermoset resin corrosion-
ASTM D 4097	Standard specification for contact-moulded glass-fiber-reinforced thermoset resin corrosion-resistant tanks
API	American Petroleum Institute. Standard specifications for pressure equipment (as applicable)
The Association of American Railroads Section C, Part III	Specifications for tank cars, M 1002
ANSI/ISA 84.00.01	Functional safety - Safety instrumented systems for the process industry sector
ANSI NB-23	National board inspection code
ANSI Z223.1	National fuel gas code
AWWA	American water works association, as applicable
DOT 3T	Seamless steel cylinder with a minimum water capacity of 1000 pounds and a minimum service pressure of 1800 psig.
DOT4L	Welded insulated cylinders.
TEMA rules	Tubular exchanger manufacturers association, Inc.
UL 1316	Standard for safety for glass-fiber-reinforced plastic underground storage tanks for petroleum products, alcohols and alcohol-gasoline mixtures

Table 33 Australian Pressure Equipment Related Standards

Standard	Description
AS 2634	Chemical plant equipment made from glass-fibre reinforced plastics (GRP) based on thermosetting resins

Table 34 British Pressure Equipment Related Standards

Standard	Description
BS 1113	Design and manufacture of water-tube steam generating plant (including super
BS 4994	Specification of the design and construction of vessels and tanks in reinforced
BS5169	Fusion welded steel air receivers
BS 6464	Specification for reinforced plastics pipes, fittings and joints for process plants
BS 7159	Code of practice for design and construction of glass-reinforced plastics (GRP) pip-
RD 5500	Specification for unfired fusion welded pressure vessels

Table 35 European Pressure Equipment Related Standards

Standard	Description
2010/35/EU	Council Directive 2010/35/EU 16 June 2010 on transportable pressure equipment
EN 286-1	Simple unfired pressure vessels designed to contain air or nitrogen - Part 1: Pressure vessels for general purposes
EN 303-1	Heating Boilers - Part 1: Heating boilers with forced draught burners - Terminology, general requirements, testing and marking
EN 303-2	Heating Boilers - Part 2: Heating boilers with forced draught burners - Special requirements for boilers with atomizing oil burners
EN 12493	LPG equipment and accessories - Welded steel tanks for liquefied petroleum gas (LPG) - Road tankers design and manufacture
EN 12952 (All parts)	Water-tube boilers and auxiliary Installations
EN 12953 (All parts)	Shell boilers
EN 13121 (All parts)	GRP tanks and vessels for use above ground
EN 13923	Filament-wound FRP pressure vessels - Materials, design, manufacturing and testing
EN 13445	Unfired pressure vessels
EN 13458-1	Cryogenic vessels - Static vacuum insulated vessels - Part 1: Fundamental requirements
EN 13458-2	Cryogenic vessels — Static vacuum-insulated vessels - Part 2: Design, fabrication, inspection and testing
EN 13480 (All parts)	Piping
EN 13530-1	Cryogenic vessels - Large transportable vacuum insulated vessels - Part 1: Fundamental requirements
EN 13530-2	Cryogenic vessels - Large transportable vacuum insulated vessels - Part 2: Design, fabrication, inspection and testing

EN 14398-2	Cryogenic vessels - Large transportable non-vacuum insulated vessels - Part 2: Design, fabrication, inspection and testing
EN 14025	Tanks for the transport of dangerous goods - Metallic pressure tanks - Design and construction
EN 14931	Pressure vessels for human occupancy (PVHO) - Multi-place pressure chambers for hyperbaric therapy - Performance, safety requirements and testing
EN 14359	Gas Loaded accumulators for fluid power applications
EN 50052	Cast aluminium alloy enclosures for gas-filled high-voltage switchgear and control
CWA 15740	Risk-based inspection and maintenance procedures for industry (RI MAP)
IEC 61508	Functional Safety of electrical/electronic/programmable electronic safety-related systems - General requirements
IEC 61511 (All parts)	Functional safety - Safety instrumented systems for the process industry sector
NOTE In addition to the above-mentioned health and safety standards any standard which results in pressure equipment being CE or Pi marked is deemed approved.	

Table 36 French Pressure Equipment Related Standards

Standard	Description
RCC-M	Design and construction rules for mechanical components of PWR nuclear standards
CODAP	Code for the construction of unfired pressure vessels

Table 37 German Pressure Equipment Related Standards

Standard	Description
DIN 6647	Cylindrical beverage containers
Technical Rules	Technical rules for steam boilers (TRD), Dampfkv and all sections
AD-2000	Technical rules for pressure vessels (TRB), Druckbehvo and all sections
DVS 2205	Design calculations for containers and apparatus made from thermoplastics
DVS 2210-1	Plastic piping for industrial applications

Table 38 ISO Pressure Equipment Related Standards

Standard	Description
ISO 4126 (All parts)	Safety devices for protection against excessive pressure
ISO 14692 (All Parts)	Petroleum and natural gas industries - Glass-reinforced plastics (GRP) piping
ISO 23251	Petroleum, petrochemical and natural gas industries - Pressure-relieving and depressuring systems

Table 39 South African Pressure Equipment Related Standards

Standard	Description
SANS 347	SANS 347; Categorization and conformity assessment criteria for all pressure equipment
SANS 151	Fixed electric storage water heaters
SANS 10228	Identification and classification of dangerous goods for transport
SANS 10254	Installation, maintenance , replacement and repair of fixed electric storage water heating systems
SANS 10227	SANS 10227: Criteria for the operation of inspection authorities performing inspections. in terms of the Pressure Equipment Regulations
SANS 10019	SANS 10019: Transportable metal containers for compressed gas - Basic design, manufacture, use and maintenance
SANS 1475-1:	SANS 1475 -1: The production of reconditioned fire-fighting equipment - Part 1: Portable and wheeled (mobile) rechargeable fire extinguishers
SANS 10087	The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial and industrial installations:
	Part 1: Liquefied petroleum gas installations involving gas storage containers of individual water capacity not exceeding 500 f and a combined water capacity not exceeding 3 000 t per installation
	Part 2: Installation in mobile units and small non-permanent buildings
	Part 3: Liquefied petroleum gas installations involving storage vessels of individual. water capacity exceeding 500 £
	Part 4: Transportation of LPG in bulk by road
	Part 6: The application of liquefied petroleum and compressed natural gases as engine fuels for internal combustion engines
	Part 7: Storage and filling sites for refillable liquefied petroleum gas (LPG) containers of capacity not exceeding 9 kg
	Part 8: The fuelling of fork-lift trucks and other LP gas operated vehicles
	Part 10: Mobile filling stations for refillable liquefied petroleum gas (LPG) containers of capacity not exceeding 9 kg.
SANS 10147	Refrigeration systems including plants associated with air-conditioning systems
SANS 1539	Appliances operating on liquefied petroleum gas — Portable and mobile appliances — Safety aspects
SANS 1237	Single-stage low-pressure regulators for liquefied petroleum gas (LPG)
SANS 329	Industrial thermal processing equipment - Safety requirements for combustion and fuel-handling systems
SANS 10105-1	The use and control of fire-fighting equipment - Part 1: Portable and wheeled (mobile) fire extinguishers
SANS 1910	Portable refillable fire extinguishers
SANS 1567	Portable rechargeable fire extinguishers - CO2 type extinguishers
SANS 10147	Refrigeration systems including plants associated with air-conditioning systems
SANS 1539	Appliances operating on liquefied petroleum gas — Portable and mobile appliances — Safety aspects

SANS 1237	Single-stage low-pressure regulators for liquefied petroleum gas (LPG)
SANS 1518	Transport of dangerous goods - Design, construction, testing, approval and maintenance of road vehicles and portable tanks
SANS 1668	Fibre-reinforced plastics (FRP) tanks for buried (underground) storage for petroleum products
SANS 1748 (All Parts)	Glass-fibre-reinforced thermosetting plastics (GRP) pipes
SANS 7396-1	Medical gas pipeline systems - Part 1: Pipeline systems for compressed medical gases and vacuum
SANS 10019	Transportable containers for compressed, dissolved and liquefied gases - Basic design, manufacture, use and maintenance
SANS 10252-1	Water supply and drainage to buildings - Part 1: Water supply installations for buildings
SANS 10260 (All parts)	Industrial gas pipelines
SANS 10147	Refrigerating systems including plants associated with air-conditioning systems
SANS 10377-1	Pressure vessels for human occupancy - Part 1: Hyperbaric chambers (therapeutic)

Appendix E Additional Tables

Table 40 Hydrogen and hydrogen related DIN standards

Standard	Description
DIN EN 17124:2022-12	Hydrogen fuel - Product specification and quality assurance for hydrogen refuelling points dispensing gaseous hydrogen - Proton exchange membrane (PEM) fuel cell applications for vehicles; German version EN 17124:2022
DIN EN ISO 17268:2024-06	Gaseous hydrogen land vehicle refuelling connection devices (ISO 17268:2020); German version EN ISO 17268:2020
DIN EN 17339:2020-09	Transportable gas cylinders - Fully wrapped carbon composite cylinders and tubes for hydrogen; German version EN 17339:2020
DIN ISO 21087:2022-03	Gas analysis - Analytical methods for hydrogen fuel - Proton exchange membrane (PEM) fuel cell applications for road vehicles (ISO 21087:2019)
DIN EN 17339:2023-07 - Draft	Transportable gas cylinders - Fully wrapped carbon composite cylinders and tubes for hydrogen; German and English version prEN 17339:2023
DIN EN ISO 19884:2018-04 - Draft	Gaseous hydrogen - Cylinders and tubes for stationary storage (ISO/DIS 19884:2018); German and English version prEN ISO 19884:2018
DIN EN 16726:2019-11	Gas infrastructure - Quality of gas - Group H; German version EN 16726:2015+A1:2018
DIN EN 16942:2021-08	Fuels - Identification of vehicle compatibility - Graphical expression for consumer information; German version EN 16942:2016+A1:2021
DIN EN 16942:2023-10 - Draft	Fuels - Identification of vehicle compatibility - Graphical expression for consumer information; German and English version prEN 16942:2023
DIN EN 16726:2024-03 - Draft	Gas infrastructure - Quality of gas - Group H; German and English version prEN 16726:2023
DIN EN 17649:2023-04	Gas infrastructure - Safety Management System (SMS) and Pipeline Integrity Management System (PIMS) - Functional requirements; German version EN 17649:2022
DIN EN 1594:2024-05	Gas infrastructure - Pipelines for maximum operating pressure over 16 bar - Functional requirements; German version EN 1594:2024
DIN EN 10222-3:2017-06	Steel forgings for pressure purposes - Part 3: Nickel steels with specified low temperature properties; German version EN 10222-3:2017
DIN EN ISO 11623:2023-12	Gas cylinders - Composite cylinders and tubes - Periodic inspection and testing (ISO 11623:2023); German version EN ISO 11623:2023
DIN EN 12732:2022-01	Gas infrastructure - Welding steel pipework - Functional requirements; German version EN 12732:2021
DIN EN 10028-3:2017-10	Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized; German version EN 10028-3:2017
DIN EN 13480-2/A7:2020-06	Metallic industrial piping - Part 2: Materials; German version EN 13480-2:2017/A7:2020
DIN EN 13480-4/A2:2024-06	Metallic industrial piping - Part 4: Fabrication and installation; German version EN 13480-4:2017/A2:2023
DIN EN 16314:2013-09	Gas meters - Additional functionalities; German version EN 16314:2013
DIN EN 15001-2:2023-04	Gas supply systems - Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations - Part 2: Detailed functional requirements for commissioning, operation and maintenance; German version EN 15001-2:2023

Standard	Description
DIN EN 14236:2018-12	Ultrasonic domestic gas meters; German version EN 14236:2018
DIN EN 10028-2:2017-10	Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties; German version EN 10028-2:2017
DIN EN 1918-5:2016-11	Gas infrastructure - Underground gas storage - Part 5: Functional recommendations for surface facilities; German version EN 1918-5:2016
DIN EN 437:2021-07	Test gases - Test pressures - Appliance categories; German version EN 437:2021
DIN EN 1776:2016-05	Gas infrastructure - Gas measuring systems - Functional requirements; German version EN 1776:2015
DIN EN 1775:2007-10	Gas supply - Gas pipework for buildings - Maximum operating pressure less than or equal to 5 bar - Functional recommendations; German version EN 1775:2007
DIN EN 12583:2021-03 - Draft	Gas Infrastructure - Compressor stations - Functional requirements; German and English version prEN 12583:2021
DIN EN 13480-4:2017-12	Metallic industrial piping - Part 4: Fabrication and installation; German version EN 13480-4:2017
DIN EN ISO 15112:2023-03	Natural gas - Energy determination (ISO 15112:2018); German version EN ISO 15112:2018
DIN EN 15001-1:2023-04	Gas Infrastructure - Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations - Part 1: Detailed functional requirements for design, materials, construction, inspection and testing; German version EN 15001-1:2023
DIN EN ISO 80079-36:2016-12	Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements (ISO 80079-36:2016); German version EN ISO 80079-36:2016
DIN EN 15502-2-3:2023-11	Gas-fired central heating boilers - Part 2-3: Specific standard for hybrid units combining a gas-fired boiler and an electrical heat pump in a product; German version EN 15502-2-3:2023
DIN EN 1359:2017-11	Gas meters - Diaphragm gas meters; German version EN 1359:2017
DIN EN 10028-1:2017-10	Flat products made of steels for pressure purposes - Part 1: General requirements; German version EN 10028-1:2017
DIN EN 13480-2:2017-12	Metallic industrial piping - Part 2: Materials; German version EN 13480-2:2017
DIN EN 676:2023-03	Forced draught burners for gaseous fuels; German version EN 676:2020 + AC:2022
DIN EN 13480-8:2017-12	Metallic industrial piping - Part 8: Additional requirements for aluminium and aluminium alloy piping; German version EN 13480-8:2017
DIN EN 15502-2-1:2022-11	Gas-fired central heating boilers - Part 2-1: Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input not exceeding 1000 kW; German version EN 15502-2-1:2022
DIN EN 15502-1:2022-02	Gas-fired heating boilers - Part 1: General requirements and tests; German version EN 15502-1:2021
DIN EN 13480-3:2017-12	Metallic industrial piping - Part 3: Design and calculation; German version EN 13480-3:2017
DIN EN 10025-3:2019-10	Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable

Table 41 Hydrogen and hydrogen related SANS standards

Standard	Description
SANS 23273-3:2010	Fuel cell road vehicles — Safety specifications Part 3: Protection of persons against electric shock
SANS 23828:2010	Fuel cell road vehicles — Energy consumption measurement — Vehicles fuelled with compressed hydrogen
SANS 10260-2:2004	Industrial gas pipelines Part 2: Distribution of hydrogen at consumer sites
SANS 10108:2017	The classification of hazardous locations and the selection of equipment for use in such locations
SANS 60079-29-1:2020	Explosive atmospheres – Gas detectors Part 29-1 Performance requirements of detectors for flammable gases
SANS 60079-29-2:2017	Explosive atmospheres – Gas detectors Part 29-2:2017 Selection, installation, use and maintenance of detectors for flammable gases and oxygen
SANS 6469-1:2010	Electrically propelled road vehicles — Safety specifications Part 1: On-board rechargeable energy storage system (RESS)
SANS 6469-2:2010	Electrically propelled road vehicles — Safety specifications Part 2: Vehicle operational safety means and protection against failures
SANS 23273-1:2010	Fuel cell road vehicles — Safety specifications Part 1: Vehicle functional safety
SANS 23273-2:2010	Fuel cell road vehicles — Safety specifications Part 2: Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen
SANS 62282-3-300:2015 / IEC 62282-3-300:2012	Fuel cell technologies Part 3-100: Stationary Fuel Cell Power Systems - Installation
SANS 62282-4-101:2015 / IEC 62282-4-101:2014	Fuel cell technologies Part 4-101: road vehicles and auxiliary power units (APU) - Safety of electrically powered industrial trucks
SANS 62282-5-100:2023	Fuel cell technologies Part 5-100: Portable Fuel Cell Power Systems - Safety
SANS 62282-6-100:2021	Fuel cell technologies Part 6-100: Micro Fuel Cell Power Systems - Safety
SANS 62282-6-200:2021	Fuel cell technologies Part 6-100: Micro Fuel Cell Power Systems - Performance Test Methods
SANS 62282-6-300:2017	Fuel cell technologies Part 6-100: Micro Fuel Cell Power Systems - Fuel Cartridge Interchangeability
SANS 62282-7-1:2023	Fuel cell technologies Part 7: Single Cell Test Methods for Polymer electrolyte Fuel Cell (PEFC)
SANS 62282-7-2:2023	Fuel cell technologies Part 7-2: Test method - Single Cell and Stack Performance Tests for Solid Oxide Fuel Cells
SANS 62282-3-200:2016 / IEC 62282-3-200:2015	Fuel cell technologies Part 3-100: Stationary Fuel Cell Power Systems - Performance Test Methods
SANS 62282-1:2013	Fuel cell technologies Part 1: Terminology
SANS 62282-2:2014 / IEC 62282-2:2012	Fuel cell technologies Part 2: Fuel Cell Modules
SANS 62282-3-100:2023	Fuel cell technologies Part 3-100: Stationary Fuel Cell Power Systems

Standard	Description
SANS 62282-3-201:2022	Fuel cell technologies Part 3-100: Stationary Fuel Cell Power Systems - Performance Test Methods for small power systems
SANS 60050-485:2023	International Electrotechnical Vocabulary - Fuel cell technologies
SANS 61850-7-420:2012	Communication networks and systems for power utility automation

