



TVET SKILLS FOR RENEWABLE ENERGY AND GREEN HYDROGEN IN NAMIBIA

Consolidated Report: Skills Gaps and Recommendations
across 11 Occupational Areas

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This report is a collective achievement. We hope it serves as a practical resource for guiding strategic investments in skills development for the energy transition and green industrialisation of Namibia.



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ACRONYMS

ASME	American Society of Mechanical Engineers
ATEX	ATEX (Atmosphere Explosive) Directive
AWS	American Welding Society
BMZ	German Federal Ministry for Economic Cooperation and Development
CBET	Competency-Based Education and Training
CPD	Continuous Professional Development
DENA	German Energy Agency
DIN	German Institute for Standardisation
DVGW	German Technical and Scientific Association for Gas and Water
EWSETA	Energy and Water Sector Education and Training Authority
EPC	Engineering, Procurement, and Construction
EU	European Union
EQF	European Qualifications Framework
GDP	Gross Domestic Product
GH ₂	Green Hydrogen
GW	Gigawatt
GWO	Global Wind Organisation
H ₂	Hydrogen
HE	Higher Education
HMI	Human Machine Interface
HPPII	Harambee Prosperity Plan II
IEC	International Electrotechnical Commission
IIW	International Institute of Welding
ISA	International Society of Automation
ISC	Industry Skills Committee
ISO	International Organisation for Standardisation
IW / IWT / IWE	International Welder / Welding Technologist / Welding Engineer
IWTC	International Welding Training Centre
MEIYSAC	Ministry of Education, Innovation, Youth, Sport, Arts and Culture (Namibia)
NamPower	Namibia State-Owned Power Corporation
NamWater	Namibia State-Owned Water Corporation
NDP	National Development Plans
NEBOSH	National Examination Board in Occupational Safety and Health (UK)
NFPA	National Fire Protection Association (USA) Non-Governmental Organisation
NGO	Non-Governmental Organisation
NIMT	Namibian Institute of Mining and Technology
NIW	National Institute of Welding
NQA	Namibia Qualifications Authority
NQF	National Qualifications Framework
NSI	Namibia Standards Institution
NTA	Namibia Training Authority
NUST	Namibia University of Science and Technology
OEM	Original Equipment Manufacturer
OHS	Occupational Health and Safety
PED	Pressure Equipment Directive
PEM	Proton Exchange Membrane (Electrolyser type)
PLC	Programmable Logic Controller
PPTP	Public-Private Training Partnership
PtX	Power-to-X
PV	Photovoltaic
QCTO	Quality Council for Trade and Occupations (South Africa)
RE	Renewable Energy
RITC	Raysonics Inspection Testing and Certification
RO	Reverse Osmosis
RPL	Recognition of Prior Learning
SADC	Southern African Development Community
SDG	Sustainable Development Goals

SAESI	South African Emergency Services Institute
SAQA	South African Qualifications Authority
SARETEC	South African Renewable Energy Technology Centre
SCADA	Supervisory Control and Data Acquisition
SDGs	Sustainable Development Goals
SIL	Safety Integrity Level
SIDS	Small Island Developing States
TōT	Training-of-Trainer
TP	Training Provider
TÜV	Technical Inspection Association, Germany
TVET	Technical and Vocational Education and Training
UAE	United Arab Emirates
UNAM	University of Namibia
VDE	Association for Electrical, Electronic and Information Technologies, Germany)
VTC	Vocational Training Centre
VTP	Vocational Training Providers
WIL	Work-Integrated Learning
WSS	Water Supply and Sanitation
ZDH	German Confederation of Skilled Crafts

EXECUTIVE SUMMARY

This consolidated report presents a high-level synthesis of the occupational studies undertaken to assess skill gaps and training needs in Namibia's emerging green hydrogen (GH₂) and renewable energy (RE) sectors.

It was developed in close collaboration between the **Namibia Training Authority (NTA)** and the **Promotion of Technical and Vocational Education and Training (ProTVET III) Project**, implemented by the **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH** on behalf of the **German Federal Ministry for Economic Cooperation and Development (BMZ)**.

The report responds to the urgent demand for a skilled workforce to drive Namibia's ambitious green industrialisation agenda.

Recognising that the success of Namibia's GH₂ strategy depends on a technically skilled, safety-conscious, and internationally certified workforce, the report consolidates the spectrum of findings across key occupational areas including Electrical Engineering; Solar Equipment Installation and Maintenance; Wind Turbine Installation and Maintenance; Instrumentation and Control; Electrolyser Installation, Operation and Maintenance; Water Treatment and Desalination; Plumbing and Pipefitting; Welding; Heavy Haulage; Occupational Health and Safety; and Firefighting. Each of these occupational studies is available as a stand-alone Annex, offering sector-specific recommendations, international benchmarking, and curricula evaluations. For detailed technical analyses and proposed training interventions by occupation, readers are referred to the annexes.

The report identifies training gaps across critical domains of the GH₂ value chain. While Namibia has a strong Technical and Vocational Education and Training (TVET) system with existing qualifications at foundational levels, delivery systems are not yet equipped to meet the specialised safety, digital, and process demands of hydrogen production and RE deployment. Hydrogen-specific content is absent, training equipment is often outdated, and many trainers lack exposure to emerging technologies and international standards.

Through extensive stakeholder consultations and international benchmarking in the eleven occupational areas, the report finds that Namibia must take targeted action to align its TVET system with global safety standards and occupation-specific technical competencies. Across all occupational areas, hydrogen-specific content is largely absent. Cross-cutting gaps were, for example, identified in hydrogen safety, digital diagnostics and Supervisory Control and Data Acquisition (SCADA)/Programmable Logic Controller (PLC) systems. These transferable competencies should be embedded across multiple occupations to enable mobility and flexibility within the sector.

Strategic recommendations are anchored to five pillars:

- ▶ Modular short courses targeting immediate skill needs in selected occupations.
- ▶ Curricula review and trainer upskilling, including integrating hydrogen-specific modules and competencies into existing qualifications and scaling training-of-trainer (ToT) initiatives.
- ▶ Policy and certification alignment with international standards (e.g., TÜV, NFPA, GWO, IIW), ensuring compliance, workforce mobility, and investor confidence.
- ▶ Industry engagement through public-private training partnerships, co-development of training content, and structured work-integrated learning (WIL) opportunities.
- ▶ Investment in simulation infrastructure in training delivery, especially in high-cost occupation and regions with hydrogen projects underway.

This consolidated report is intended to serve as a practical resource for strategic planning and decision-making by policymakers, regulators, training institutions, donors, and the private sector.

By identifying key gaps and proposing targeted measures, it offers a foundation for aligning Namibia's TVET system with the technical requirements of the GH₂ and RE sectors. Effective implementation of the outlined recommendations will be essential to ensure that training provisions keep pace with evolving industry needs and support the development of a competent national workforce.

1

INTRODUCTION AND BACKGROUND

Green Hydrogen and Power-to-X: A Global Context

Green Hydrogen (GH₂) and Power-to-X (PtX) technologies are gaining international significance as countries accelerate efforts toward climate neutrality. GH₂, produced via electrolysis using renewable electricity, is a critical enabler for decarbonising emissions-intensive sectors. These include steelmaking, fertiliser production, long-distance transport, and shipping, all of which are areas where direct electrification is not technically or economically feasible.

Its role is reinforced by the potential of PtX derivatives like green ammonia and green methanol, which act as energy carriers and feedstocks for global industries. Green ammonia, for instance, is expected to replace fossil-based “grey” ammonia in fertiliser production and emerge as a low-carbon shipping fuel. Likewise, green methanol is poised to be a cleaner alternative in aviation and petrochemicals. The versatility and tradability of these derivatives make them integral to a future global hydrogen economy.

Motivated by net-zero targets, over 30 countries — including Namibia, members of the European Union, the United States, China, and India — have adopted national hydrogen strategies and are investing heavily in hydrogen hubs, infrastructure, and electrolyser technology. Global demand for clean hydrogen is projected to increase nearly fivefold by 2050, representing up to 22% of global final energy demand under netzero scenarios.

Major economies are advancing bilateral partnerships and certification systems to facilitate the trade and uptake of GH₂ across borders.

Investment momentum is growing while implementation challenges remain, particularly around infrastructure, regulation, and commercial take-off. In 2024, globally over 20 Gigawatt (GW) of electrolyser capacity had reached final investment decision, up from just 1 GW in 2023. This signals a decisive shift from planning to deployment, even though several projects still need to navigate regulatory and financing hurdles.

In this evolving landscape, countries with exceptional renewable resources and access to international markets are particularly well positioned to supply cost-competitive GH₂ and its derivatives. The early movers, like Namibia, can benefit from growing demand, strategic partnerships, and long-term export opportunities.

However, capturing this potential requires infrastructure and investment, the rapid development of human capital, and technical expertise to support the emerging value chains.

Namibia's Green Hydrogen Ambitions and Opportunities

Namibia has identified the production of GH₂ as a strategic pillar of its economic transformation. The government adopted a Green Hydrogen and Derivatives Strategy in 2022 that outlines an ambitious roadmap for positioning Namibia as a global hydrogen producer. The strategy leverages the country's exceptional solar and wind resources to develop three regional “hydrogen valleys” in the northern, central, and southern regions, intended to concentrate infrastructure, production, and export capabilities.

These valleys, located in coastal areas, offer favourable conditions for large-scale electrolysis using desalinated water and for the export of GH₂ derivatives via existing and future port infrastructure. The southern corridor, in particular, has been internationally recognised for its outstanding RE potential and land availability, placing Namibia among the most cost-competitive locations for GH₂ production globally.

Namibia has attracted strong international interest, with various large-scale projects and investment proposals under development. National strategies envision large-scale export of derivatives (ammonia/methanol) and significant job creation (Namibia's Sixth National Development Plan (NDP6), target: 30,000 green jobs by 2030), positioning GH₂ as a transformation catalyst contingent on rapid skills expansion.

This would contribute substantially to Gross Domestic Product (GDP) (NDP6 projects that hydrogen and related value chains could contribute up to 16% of Namibia's GDP by 2050), growth and industrial development, positioning hydrogen as a key driver of structural economic change. On this basis, Namibia's private sector in the RE and GH₂ space is rapidly evolving, driven by significant foreign investment, public-private partnerships, and a strong policy push toward sustainable energy. Key players include independent power producers, emerging GH₂ developers, and local enterprises positioning themselves across the value chain—from production to infrastructure development.

There is also significant potential for job creation across the value chain, including construction, operations, logistics, and supporting services. To this end, NDP6 calls for green industrial hubs supported by targeted skills and infrastructure development. The government has prioritised local participation and skills development in all strategic planning processes and is actively engaging with investors to ensure that employment, training, and procurement benefits are retained domestically.

NDP6 outlines the need for aligning TVET offerings with GH₂ projects, including through partnerships between public institutions and private investors. Beyond economic development, Namibia's GH₂ ambitions align closely with its energy and climate goals.

By expanding RE capacity, the country aims to reduce its dependency on imported electricity and thereby enhance national energy security. At the same time, GH₂ is expected to contribute to Namibia's climate commitments, including its nationally determined contributions under the Paris Agreement and its broader vision for a just and inclusive green transition. NDP6 affirms this alignment, positioning GH₂ as central to both mitigation and green industrialisation efforts.

Building on these ambitions, Namibia has also taken steps to coordinate skills development systematically. Based on the recommendations of the 2023 study **“Enhancing Employability: Skills Needs and Gap Analysis in Namibia's PtX Sector and Recommendations for Skills Development”** the government established the “National Task Force on Education, Training and Research for Green Hydrogen and its Derivatives”. This body provides oversight and coordination for developing and implementing the national Skills Development Strategy and Plan (SDSP) in the sector.

In parallel, targeted awareness and capacity-building activities have begun by several actors in the TVET sector. For example, in close collaboration with the Namibia Training Authority (NTA), the GIZ ProTVET project has conducted six regional training sessions to sensitise and capacitate key TVET stakeholders on GH₂ and Power-to-X (PtX), laying an essential foundation for scaling up vocational training in this emerging sector.

TVET Skills Gaps and the Rationale for Workforce Development

Namibia's GH₂ ambitions depend on the availability of a skilled workforce across a wide range of technical occupations. While the foundational skills required in the GH₂ and PtX value chains, such as electricians, welders, mechanical fitters, and plant operators, exist in Namibia, they are generally available in insufficient numbers and/or often lack the specific competencies required for complex new industries like the hydrogen sector. Upskilling and expanding this workforce are therefore essential.

The national TVET system presents both challenges and opportunities. State-owned Vocational Training Centres (VTCs) play a foundational role but mostly offer training only up to Level 3 of the National Qualifications Framework (NQF). Although qualifications up to Level 5 in areas such as Solar Installation, Welding, Instrumentation, and Plumbing are registered, the implementation at scale is limited due to shortages of qualified trainers and modern equipment.

Nonetheless, these registered qualifications and modular unit standards provide a solid basis for expansion. Trainer availability remains a bottleneck, especially in emerging technical fields. Some institutions, such as the Namibian Institute of Mining and Technology (NIMT) and Namibia University of Science and Technology (NUST), are engaged in international upskilling and training-of-trainer exchanges. Hydrogen-focused training initiatives are emerging through projects like Cleanergy Solutions Namibia's H₂ Academy and the Daures GH₂ Village. However, many trainers lack current industry knowledge and exposure, and facilities remain under-equipped for hands-on training in automation, RE, and high-pressure systems. WIL is inconsistently implemented but shows promising pilots and growing employer interest.

NDP6 calls for expanding WIL, hydrogen-specific curricula, and closer employer involvement in co-designing training content. Without targeted interventions, graduates risk entering the labour market lacking sufficient workplace readiness.

To address these challenges, there is a growing consensus for the importance of short-cycle, modular training programs (micro-credentials) that can flexibly respond to immediate industry needs. Such courses, focusing for example on hydrogen safety, electrolyser maintenance, or high-pressure welding, can equip unemployed youth, artisans-in-training, graduated artisans and technicians with specific skills for employment in the GH₂ sector.

Internationally benchmarked training modules already exist and can be adapted or locally franchised to fast-track capacity building. This approach also supports certification in high-skill areas, such as coded welding, where Namibia currently lacks domestic testing facilities.

Short- course models allow for competence-based, scalable training that can be delivered in partnership with industry, including through practical attachments at ongoing hydrogen projects.

They represent a critical step toward reducing reliance on foreign expertise to ensure that Namibians are well-prepared for emergent employment opportunities. NDP6 supports this flexible training approach and underscores the need for modular, just-in-time skills development, tailored to GH₂ and related sectors.

Alignment with National Development Goals and Just Transition

Namibia's GH₂ agenda is closely integrated into its national development vision, prioritising inclusive growth, youth employment, and long-term economic transformation. The Harambee Prosperity Plan II (HPPII) first identified GH₂ as a new engine for growth, a commitment that was further detailed in the 2022 Green Hydrogen and Derivatives Strategy.

Together, these frameworks align with Vision 2030 and National Development Plans, positioning GH₂ as a catalyst for sustainable industrialisation and diversification. NDP6 positions the sector as not only a driver of export revenue, but as a cornerstone of a new, low-carbon economy. Skills development is central to this ambition. The National TVET Policy (2021) calls for a demand-driven, accessible, and high-quality training system.

Current reforms, such as expanding higher-level qualifications, implementing work-integrated learning, and strengthening collaboration between vocational institutions and industry, are essential for equipping Namibians with the necessary competencies for emerging sectors like GH₂ and RE.

These reforms are directly embedded in NDP6, which commits to transforming VTCs into TVET colleges, expanding access to NQF Levels 4–6, and piloting regional Centres of Excellence, also focused on hydrogen and renewables.

This also aligns with Sustainable Development Goal (SDG) 7 (Clean Energy) and SDG 13 (Climate Action). Although Namibia contributes minimally to global emissions, a just transition lens is applied throughout, with the government emphasising that shifting to a green economy must generate broad-based social benefits. Building skills locally ensures that Namibians are included in new industry opportunities.

This is particularly important in light of persistent youth unemployment, underemployment and inequality. Hydrogen-related employment that spans construction, logistics, and maintenance offers potential for engaging both skilled and semi-skilled workers nationwide.

To promote inclusion and local participation, the government introduced measures such as local procurement targets for hydrogen projects, expanded community-based training, and, as of 2026, free tertiary education. These initiatives aim to ensure that technical fields become accessible to a broader range of Namibians, including women and persons with disabilities. NDP6 integrates these objectives and mandates that gender-responsive and disability-inclusive skill programmes accompany GH₂ investments.

GH₂ also supports the broader goals of green industrialisation and regional integration. Domestic production can enable additional value for fertilisers, clean steel, and critical minerals processing, while surplus renewable energy and green fuels may serve regional markets.

In this way, hydrogen-related skills development becomes a foundation, not only for national resilience and economic opportunity, but for regional cooperation and climate-aligned growth. NDP6 highlights this regional potential, noting Namibia's strategic role as a Southern African hub for clean energy exports and hydrogen-base industrial inputs.



2

ELEVEN IN-DEPTH STUDIES

Rationale

Namibia's ambition to become a global actor in RE and GH₂ hinges on the availability of a skilled workforce. However, there is a significant mismatch between current training provision and the skills needed in emerging sectors. Traditional TVET programmes do not yet reflect the rapidly evolving technological requirements of these green industries.

The gap analyses in eleven occupational areas were initiated to ensure that future training is responsive to the real needs of the labour market. The occupations were selected according to strategic relevance across the GH₂ value chain, expected demand in current and planned RE projects, and feedback from public and private stakeholders.

By identifying and addressing existing training gaps, Namibia can reinforce its youth employment prospects, align educational offerings with market demand, and support its broader socio-economic and climate goals.

Purpose and Scope

The purpose of the annexed studies was to assess existing vocational training programmes across key occupational areas and determine their readiness to meet the skill demands of Namibia's growing RE and GH₂ sectors. Specifically, the gap analyses aimed to:

- I. Identify critical skills gaps between current training and actual industry needs.
- II. Benchmark national training content and standards against international best practices and industry standards.
- III. Engage relevant stakeholders, industry, training institutions, and regulators, to validate findings on the ground and ensure relevance.
- IV. Recommend feasible short courses, curriculum adaptations and potential partners to bridge identified gaps.

Each annex focuses on one specific occupational area and explores both formal training pathways (e.g. NTA-endorsed qualifications) and non-formal or emerging training needs (e.g. hydrogen firefighting protocols, solar net-metering skills, or turbine safety certifications).

The findings can form the technical basis for the full development and implementation of short courses and potential curricula review efforts supported through different actors in the Namibian TVET sector.

Methodology: Data Collection Methods and Stakeholder Engagement

A consistent mixed-methods approach was applied across all eleven occupational areas, with most reports compiled by a joint team of one Namibian and one international expert to ensure international expertise is utilised in conjunction with Namibian context-specific knowledge. The methodology comprised the following:

- I. **Desk Review:** Analysis of existing training standards/curricula, qualification frameworks, regulations, and available literature.
- II. **International Benchmarking:** Identification and review of comparable training standards across several countries per occupation, especially for renewables and hydrogen-specific skills.
- III. **Stakeholder Consultations:** Semi-structured interviews and/or questionnaires with TVET providers, universities, industry partners and private sector, regulators and standards organisations.
- IV. **Institutional Capacity Assessment:** Review of training infrastructure, trainer qualifications, and availability of up-to-date training materials and equipment.
- V. **Gap Analysis Framework:** Comparison of Namibian training offers and delivery against occupational tasks expected in industry, identifying missing or outdated competencies, equipment, and certifications.

Limitations of the Studies

While each study aimed for rigour and inclusivity, several limitations were noted:

- ▶ **Data Focus:** The studies do not aim to provide quantitative, up-to-date statistics on employment and workforce demand; instead, they focus on qualitative data regarding skills gaps in current training provision. However, concurrent studies by other actors, concentrating more on quantitative labour-market demand for GH₂, should be read as complementary to this skills gap analysis.
- ▶ **Benchmarking Gaps:** Access to detailed and standardised occupational benchmarks from comparator countries was at times fragmented, resulting in limited comparability across contexts. Globally, GH₂ and PtX related occupations often still lack universally agreed technical and occupational standards, complicating international benchmarking and curriculum alignment in some cases.
- ▶ **Technical Competencies of Interviewees:** In certain cases, both training institutions and industry stakeholders, quite understandably, had limited technical expertise in highly specialised areas of the GH₂ value chain, which may have influenced their ability to fully assess training needs.
- ▶ **Fast-Evolving Industry Landscape:** The GH₂ and RE sectors are advancing rapidly, with technologies and occupational standards changing faster than most training systems can adapt to.
- ▶ **Fragmented Implementation Environment:** The presence of multiple donors, development partners, private actors, and at times blurred lines between TVET and Higher Education (HE), who are simultaneously working in the sector, creates a complex landscape, increasing the risk of overlaps and/or uncoordinated interventions.
- ▶ **Follow-Up and Continuity Risks:** Stakeholders expressed concern that previous studies and recommendations have occasionally failed to translate into actionable reforms or funded implementation, highlighting the need for strong institutional ownership and coordination.

Despite these limitations, the gap analyses provide an essential foundation for evidence-based planning of short courses and longer-term TVET reforms tailored to Namibia's green transition.



3

OVERVIEW OF THE OCCUPATIONAL FOCUS AREAS

Occupational Area	Description
Electrical Engineering Annex 1	Electrical Engineering is a critical enabling occupation across all RE and GH ₂ projects, particularly in installation, operations, maintenance, and safety of systems like solar PV, electrolyzers, and wind turbines. The occupation forms the backbone for the electrification of GH ₂ processes and possible grid integration.
Solar Equipment Installation and Maintenance Annex 2	This occupation is essential to GH ₂ production via a direct link to the GH ₂ value chain. Energy generated by solar PV systems powers electrolyzers and other GH ₂ infrastructure. Skills for installation, fault detection, and maintenance are vital for uninterrupted energy-efficient systems.
Wind Turbine Installation and Maintenance Annex 3	After solar, wind energy is the second key input for Namibia's GH ₂ production zones. Wind Turbine Technicians, responsible for the installation, operation, and maintenance of turbines and associated infrastructure, are therefore indispensable to the GH ₂ ecosystem.
Instrumentation and Control Annex 4	This occupational area is essential for monitoring and managing automated processes in RE and GH ₂ facilities, including electrolyzers and energy storage systems.
Electrolyser Installation, Operation and Maintenance Annex 5	Electrolyser systems are central to Namibia's GH ₂ production, application and export ambitions, yet the local capacity to install, operate, and maintain them barely exists.
Desalination and Water Treatment Annex 6	Water is a critical input for GH ₂ production, particularly in arid regions where electrolyzers require large volumes of purified water. Desalination and advanced water treatment are therefore essential to the GH ₂ value chain.
Plumbing and Pipefitting Annex 7	Hydrogen-ready pipefitting requires high-pressure competencies, hydrogen-compatible materials, and advanced welding techniques, far beyond the current Plumbing and Pipefitting curriculum.
Welding Annex 8	GH ₂ projects around the world are creating new demand for skilled welders and welding technicians. Building electrolyzers, pipelines, storage tanks, and other hydrogen infrastructure requires high-quality welding to prevent leaks and embrittlement. In fact, welding is "indispensable for the transition to climate neutrality", from assembling wind farms to manufacturing the facilities for GH ₂ production, storage, and transport.
Heavy Haulage Annex 9	Heavy Haulage involves transporting large equipment and fuel inputs/outputs across RE and GH ₂ project sites, including large components like wind turbine blades or electrolyzers. Safe and efficient logistics are critical for project rollout and sustainability.
Occupational Health and Safety (OHS) Annex 10	OHS is fundamental to managing risks in hydrogen and RE projects, where high-pressure gases, explosive atmospheres, and chemical exposure are common.
Firefighting Annex 11	Firefighting, particularly hydrogen-specific safety, is critical in RE and GH ₂ facilities due to high-risk materials such as hydrogen and ammonia. It underpins emergency preparedness, hazard control, and compliance with international standards (e.g., NFPA).

4

INTERNATIONAL BENCHMARKING

The international benchmarking analyses across the Annexed reports offer a comprehensive view of how Namibia's TVET sector compares to international standards within the RE and GH₂ value chains. This synthesis distils several key insights gained from each study, structured around shared themes, while recognising the nuances within separate occupational areas.

Overview of Benchmarking Methodology

The benchmarking across the eleven occupational reports followed a mixed-method approach combining curricula analysis, standards mapping, and stakeholder engagement. The primary objective was to compare Namibia's current TVET offerings with international best practices relevant to RE and GH₂ value chains.

Each report customised the benchmarking according to occupational contexts, although several shared methodological pillars emerged from the process:

Desk-based research: All reports reviewed publicly available curricula, qualification standards, and vtraining outlines from recognised international training institutions. Key sources included training authorities in Germany (e.g. DIHK, TÜV, VDE), South Africa (e.g. SAQA, QCTO), EU frameworks (EQF), and global industry bodies (e.g. NFPA, GWO, ASME, IEC).

Comparative curricula and qualification analyses: Benchmarking matrices or summaries were used in most reports (e.g. Solar, Instrumentation, Welding, Plumbing, Electrical, Firefighting) to compare:

- ▶ Course duration, entry/exit levels, and assessment methods.
- ▶ Key competencies, occupational standards, and international certification pathways.
- ▶ Learning modes (theory/practice split), simulation tools, and integration with work-based learning.

Use of international standards: For Namibia's emerging GH₂ industry, aligning training with international standards is essential to ensure safety, quality, and global market compatibility. Standards like IEC, ISO, ASME, and NFPA provide the technical foundation for working with hazardous materials, high-pressure systems, and RE infrastructure, building trust for investors and enabling workforce mobility across borders.

- ▶ NFPA (Firefighting, OHS), ISO 45001 (OHS), IEC/SANS (Electrical, Solar, Instrumentation).
- ▶ GWO (Wind), ASME/IIW/ISO (Welding and Pipefitting), TÜV/DVGW (Electrolyser).
- ▶ EU Directive 2003/59/EC, VDI 2700, DIN EN 12195 (Heavy Haulage logistics).

Industry and training partner interviews: All reports incorporated interviews and consultations with institutional and private sector actors, including NIMT, NamPower, NamWater, SARETEC, DENA Education, TÜV Rheinland, Festo Didactic, Hyphen, and international trainers. These uncovered many gaps in practical training and delivery feasibility.

Certification system and regulatory comparisons: Reports examined country-specific licensing systems and international certification bodies, such as IFSAC (Firefighting), DVGW (Electrolyser), IIW (Welding), TÜV (Instrumentation and Electrolyser), while mapping their relevance to the Namibian context.

Addressing limitations: Several reports (Solar, Plumbing, Heavy Haulage) note challenges in data comparability due to fragmented standards, inaccessible occupational descriptors, or rapidly evolving technologies. Nonetheless, the consultants triangulated available sources to present well-aligned benchmarking results.

Integration with local context: Where appropriate, benchmarking findings were aligned with Namibian unit standards (e.g. for Transport and Logistics, Electrical occupations), and regional references (South Africa, Tanzania, Kenya, etc.) were used to assess the feasibility of regional integration.

This approach allowed each report to deliver tailored, internationally informed recommendations for short courses, upskilling modules, and certification pathways, ensuring alignment with global standards while remaining rooted to Namibia's training infrastructure and labour market realities.

Key Countries/Regions Analysed

Across the Annexed reports, selective countries and regions were benchmarked based on relevance to specific occupational areas, regulatory leadership, and applicability to Namibia's GH₂ and RE ambitions.

South Africa remains the most frequently cited reference across most occupational areas. Its geographic and institutional proximity, shared qualification structure, and recent hydrogen-related curriculum reforms make it a vital reference. For example, South Africa's Quality Council for Trades and Occupations (QCTO) has approved new hydrogen-related qualifications (NQF Level 4–5), covering hydrogen production, storage, and safety. The firefighting report references the South African Emergency Services Institute (SAESI), while the plumbing and instrumentation annexes highlight the region's growing focus on pressurised systems and hydrogen-related piping standards.

Tanzania, Uganda, Zambia, Kenya, Egypt, and Morocco are referenced in the plumbing, OHS and solar Annexes as regional references. These countries offer insights into solar integration, water– energy linkages, and hybrid trade qualifications. Tanzania's multi-level TVET model and integration of solar competencies into national training frameworks are especially relevant.

European Union frameworks were extensively used for the wind turbine technician and electrolyser reports, particularly the European Qualifications Framework (EQF) and Global Wind Organisation (GWO) standards. Additionally, EU-funded initiatives such as H₂ Skills and H2EU+Store were referenced as best-practice models for building hydrogen technician capacity.

Germany is extensively referenced under wind energy, plumbing, welding, and electrolyser training. The German dual system's integration of theory, practice, and safety standards serves as a benchmark, particularly for complex hydrogen and renewable applications. DIN standards, TÜV SÜD and TÜV Rheinland certification systems, and trade qualifications such as the "Anlagenmechaniker" and International Welding Engineer (IWE) feature prominently. These institutions and standards support compliance with ISO 3834 (welding), ISO 22734 (electrolysers), and other international norms essential to GH₂.

As part of its national hydrogen strategy, the **Netherlands** is investing heavily in human capital development for hydrogen technologies. It is referenced particularly in the plumbing, welding, and electrolyser reports, with its GroenvermogenNL ("Make Hydrogen Work") programme serving as a model of coordinated hydrogen-skills development through regional hubs. Dutch training already includes hydrogen safety in pipelines, heating, and appliances, with dedicated short courses offered in English.

The United States is highly regarded for safety benchmarking. The NFPA (e.g., NFPA 2, NFPA 472, and NFPA 1001) is the cornerstone of the firefighting report and referenced in OHS benchmarking. These standards define global best practices for hydrogen hazard management and emergency response.

Japan is a leader in hydrogen technology and has special training centres that focus on the safe handling, storage and use of hydrogen. The Japan Hydrogen and Fuel Cell Demonstration Project also offers training courses for technical personnel.

China is referenced in the Electrolyser and Welding annexes. It is the world's largest hydrogen producer (still mostly grey) and is investing in green hydrogen for transport and industry. Training is mainly industry- and state-led, rather than part of a national TVET framework. For welding, China uses established qualification systems aligned with ISO

9606 and ASME IX, given its strong export orientation. Hydrogen-specific content is gradually being added, especially in materials science courses, with emphasis on challenges such as pipeline transport and hydrogen embrittlement.

The Gulf Region (e.g., UAE, Saudi Arabia) is cited within the plumbing Annex as an example of training systems aligned with large-scale water and energy infrastructure. However, hydrogen-specific training is still emerging.

International standards bodies such as the Global Wind Organisation (GWO), the International Institute of Welding (IIW), and ISO were central in the benchmarking for most annexes. Standards that require alignment include NFPA 2, ISO 45001, IEC 60079, ISO/TS 19880-1, ISO 9606, ASME BPVC IX, and welding certifications such as IW, IWT, and IWE.

The countries and regions analysed were selected according to technical relevance, regulatory maturity, and roles in advancing hydrogen-compatible occupational standards. The diversity of references ensures that the benchmarking was simultaneously relevant to the global context while regionally grounded.

Lessons Learnt: Best Practices and Innovations

The international benchmarking exercises conducted across the eleven occupational areas revealed a number of best practices and innovations to inform the transformation of Namibia's TVET system within the context of RE and GH₂.

A recurring theme was the use of modular and stackable qualification pathways, which allow trainees to incrementally accumulate competencies and return to training whenever deemed necessary. This approach enables lifelong learning and provides flexible career progression between artisan to technician and technologist levels, ensuring that training systems remain adaptable to rapidly changing technologies.

It is of equal importance to integrate hydrogen-specific technical and safety standards into vocational education. International providers have already embedded content on hydrogen firefighting, electrolyser operation, welding standards for high-pressure systems, and hazardous gas handling into their curricula. These programmes are benchmarked against internationally recognised certification bodies such as NFPA, IIW, TÜV, ASME and GWO. By contrast, Namibia's current qualifications remain generalised, with hydrogen-related competencies not yet reflected in training programmes.

Innovative training delivery methods featured prominently. In countries with mature systems, simulation technologies and digital learning tools are being deployed where access to real infrastructure is limited or prohibitively expensive. High-fidelity simulators for wind turbine maintenance, SCADA operations, leak detection and emergency response, allow trainees to develop critical skills within a safe and controlled learning environment. Such tools enhance training quality while reducing dependency on live installations, which is especially relevant for Namibia as its hydrogen economy still scales up, and work integrated learning is limited.

The benchmarking further highlighted the importance of Work- Integrated Learning (WIL), Recognition of Prior Learning (RPL) and flexible accreditation pathways.

Many Namibian workers own extensive hands-on experience in occupations such as Welding, Plumbing and Heavy Haulage but lack formal certification. International best practice shows that robust RPL frameworks, when well aligned with international standards, can integrate these workers into the formal system and accelerate workforce readiness.

Namibia's existing RPL system provides a foundation but requires more visibility, streamlined processes, and stronger links to international recognition in order to serve this purpose effectively.

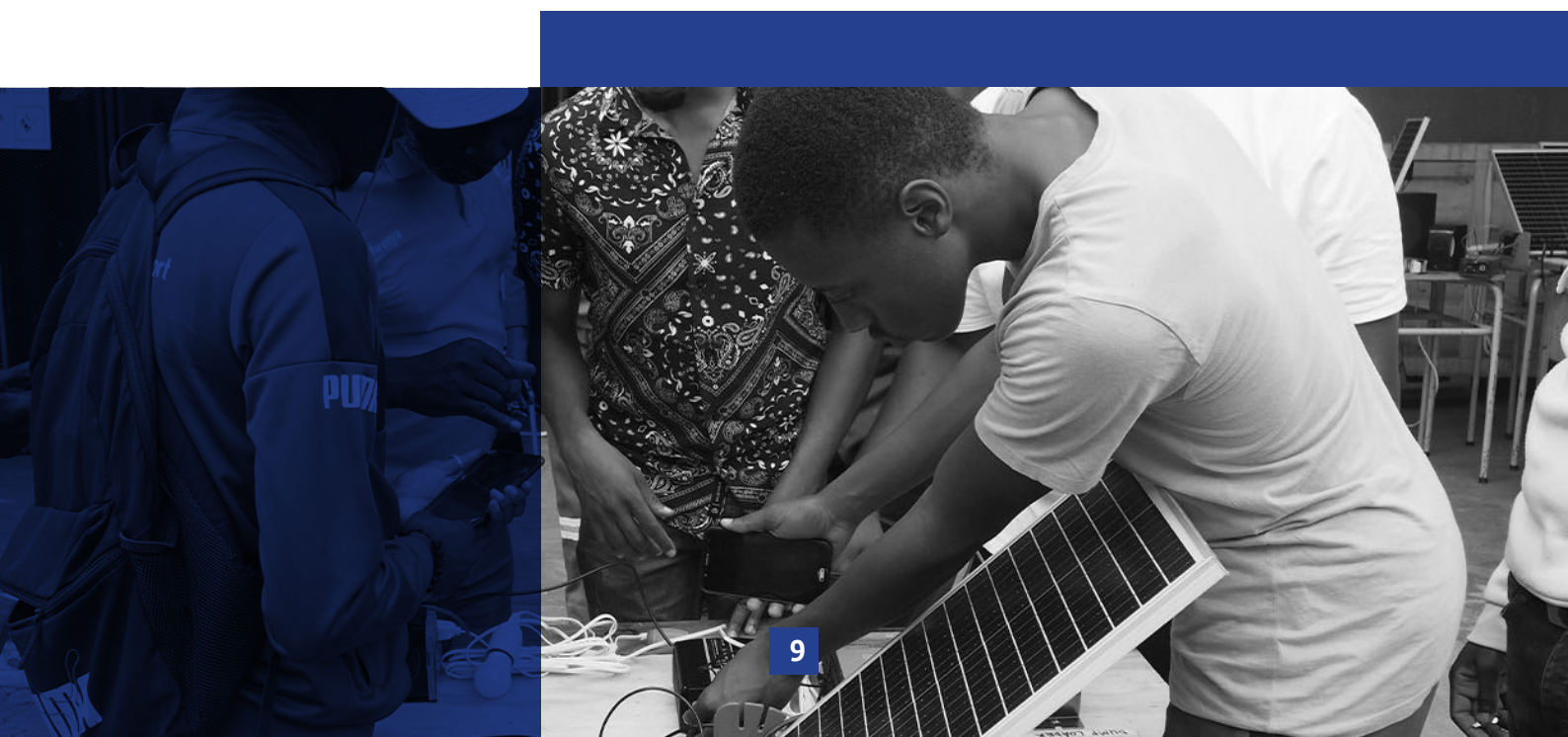
The value of close industry involvement in training design and delivery was repeatedly evidenced. In leading international systems, employers play an active role in shaping curricula, co-developing short courses, and making modern technologies available for training purposes. This ensures that qualifications remain relevant and directly linked to workplace requirements. Such collaboration is also a proven way to strengthen work-integrated learning, whether through apprenticeships, internships, or structured simulation-based practice.

These technical and institutional innovations are anchored in coherent policy frameworks. Benchmarked countries were found to frequently apply competency-based education and training as a foundation for modern curricula, and their qualifications are bound by occupational standards with continuous updates from employers.

Skills planning is also integrated into national strategies for energy, industrialisation and innovation, with TVET positioned as a driver of economic transformation rather than a separate training function. Strong institutional coordination between regulators, curriculum bodies and quality assurance agencies allows for timely updates and the incorporation of international content. Embedding skills development into national hydrogen and energy strategies ensures that the training meets industrial priorities.

Taken together, these lessons point to a clear direction for Namibia. By embedding modular learning frameworks, integrating hydrogen-specific safety and technical standards, investing in simulation-based training, strengthening recognition of prior learning, and fostering genuine industry partnerships, the country can build a training system that is internationally credible and responsive to its GH₂ ambitions.

When supported by coherent policy frameworks and institutional coordination, these practices provide a proven blueprint for aligning Namibia's TVET system with the needs of a hydrogen-driven and renewables-based economy. Please refer to the individual Annexed reports for detailed sector-specific benchmarking and curriculum matrices.



5

SKILLS MAPPING AND SKILLS GAPS

Skills Landscape and Gaps for the Green Hydrogen Transition

Namibia's current vocational training provision across the eleven occupational areas relevant to the GH₂ value chain presents a mixed picture of established strengths, partial coverage, and complete absences. Some fields already benefit from nationally registered qualifications on the National Qualifications Framework (NQF). Yet, most remain designed for conventional and domestic industries and have not been adapted to the emerging demands of the RE and GH₂ economy.

Electrical Engineering and Solar Equipment Installation and Maintenance (Annexes 1 and 2) are supported by nationally registered qualifications up to NQF Level 5. However, these programmes generally lack components related to grid integration, advanced automation, and the operation of SCADA and PLC systems, which are essential for monitoring and controlling modern RE facilities in line with International Electrotechnical Commission (IEC) standards, which ensure compatibility and safety across global energy systems.

Plumbing and Pipefitting (Annex 7), even though higher qualifications exist (Level 1 to 4), they continue to focus on conventional, domestic water systems without addressing hydrogen-compatible piping or high-pressure gas handling, both of which are critical for transporting hydrogen safely.

Occupational Health and Safety and Firefighting (Annexes 10 and 11) have established frameworks, but their content is not aligned with hydrogen-specific safety requirements. This includes the management of ammonia hazards, hydrogen fire behaviour, and the high-pressure and cryogenic systems used in production and storage. International safety frameworks such as those of the National Fire Protection Association (NFPA) and the International Fire Service Accreditation Congress (IFSAC) set globally recognised protocols for fire prevention, emergency response, and hazard control, which are not embedded in the current Namibian training provision. **Instrumentation and Control** (Annex 4): Although qualifications exist at Level 2 to 5, training provision is offered only up to NQF Level 3, omitting advanced automation and diagnostic competencies. Modern hydrogen and RE plants rely on supervisory control and data acquisition (SCADA) and programmable logic controllers (PLCs) to operate safely and efficiently. These skills are currently absent from training.

Welding qualifications (Annex 8) are available nationally, but delivery infrastructure is outdated, and training is not systematically aligned with internationally accepted industrial quality and safety standards, especially in the case of GH₂ welding. Relevant examples include ISO 9606, which certifies welder competence for specific materials and welding processes; ISO 3834, which covers quality assurance in welding production, and ASME B31.3, which defines global safety requirements for high-pressure piping systems, all directly relevant to hydrogen pipelines and plant infrastructure.

Desalination and Water Treatment (Annex 6), a critical enabler for hydrogen production in arid regions, is not a dedicated qualification. Existing coverage within plumbing and environmental health training requires additional specialist content about reverse osmosis systems, membrane maintenance, and water-energy integration. International benchmarks such as ISO 24510/24511 provide service quality guidelines for water utilities, and the DVGW W1000 series sets technical specifications for water safety and supply; both of which should inform future training provisions.

The three occupational areas, **Electrolyser Operation and Maintenance**, **Wind Turbine Installation Maintenance**, and **Heavy Haulage** for oversized or hazardous loads, are not included within the current formal national qualifications' framework (Annexes 5, 3, and 9). **Electrolyser technicians** require combined mechanical, electrical, and process skills, along with hydrogen safety competencies, to operate and maintain PEM and alkaline systems. German TÜV and DVGW certification schemes provide recognised frameworks for safe and efficient hydrogen production and handling.

Wind Turbine Installation Maintenance must be trained in accordance with the Global Wind Organisation (GWO) standards, which focus on working at heights, mechanical and electrical servicing, and emergency response. **Heavy Haulage** for GH₂ infrastructure requires compliance with Southern African Development Community (SADC) and international permitting protocols to ensure the safe transportation of large, high-value, and potentially hazardous components.

Following the identification of skills gaps across the eleven occupational areas, the reports also mention a number of concrete initiatives that have started to address these shortcomings and strengths of the system. The National Qualifications Framework (NQF), administered by the Namibia Qualifications Authority (NQA), provides a solid basis for introducing modular qualifications and embedding international certification pathways. Institutions such as the Namibian Institute of Mining and Technology (NIMT), the Namibia University of Science and Technology (NUST), and the National Institute of Welding (NIW) are already engaged in training-of-trainer (ToT) initiatives.

Additionally, international skills exchanges and hydrogen-related pilot programmes are underway, including the SASSCAL-led skills exchange initiative, Cleanergy Solutions Namibia's H₂ Academy, and the Daures GH₂ Village. Donor and industry collaboration has supported the development of short courses in instrumentation, the provision of solar training kits, pilot WIL programmes, and stakeholder dialogues on welding standards through certification bodies.

Addressing the identified gaps will, however, require more than isolated initiatives. Systematic updates to existing qualifications with hydrogen-specific modules, the establishment of national pathways for currently uncovered occupations, and the integration of globally recognised safety and technical standards are needed. At the same time, investment in trainer capacity, modern facilities, and the expansion of structured industry partnerships for WIL will be essential. Building upon existing institutional assets and the pilot measures now underway, Namibia can align its workforce capabilities with the technical, safety, and quality demands of the emerging RE and GH₂ sectors.

Table Overview of Existing Qualifications and Identified Skills Gaps

The table below condenses the key findings from all eleven occupational gap analyses reports annexed to this study, presenting existing qualifications, NQF levels, identified skills gaps, recommended short courses, and applicable international standards for each occupational area in the GH₂ and RE value chains. It provides high-level, comprehensive reference, to guide curricula updates, new qualification development, targeted short courses, and alignment with global certification requirements.

No.	Occupational Areas	Existing Relevant Qualifications	NQF Level	Identified Gaps	Recommended Short Courses	Applicable International Standards and Possible Partners
1.	Electrical Engineering	National Vocational Certificate in Electrical Engineering (Electrical General)	2 - 4	Computer Skills / Computer Literacy (Basic understanding, command-line usage)	1. Basic Computer Skills and Office Software	IEC and South African Bureau of Standards (SABS) guidelines
		National Vocational Diploma in Electrical Engineering (Electrical Energy)	5	- Office Software for reporting or calculations in a Spreadsheet - Networking (Setting up network communications, IP addressing, WIFI, Internet, Modbus) - Mid- and High-Voltage Switching (Namibian Electricity Safety Code) - Power Electronics (Basic understanding, inverters, motor controllers) - Diagnosis and Fault Finding (Selecting, carrying out and interpreting measurements; recording and analysing data; recognising, eliminating, and documenting root causes of faults) - Mechanical Principles and Interdisciplinary System Thinking (Knowledge of mechanical principles, even for electricians) - PLC Programming and Monitoring (IEC 61131) (Including diagnosis and fault finding) - Hydrogen (Basic understanding, supply chain, safety and hazards, Special considerations for electrical work) - Batteries and Storage (Basic understanding, battery types, handling) - Working at Heights	2. Networking 3. Data Monitoring, Logging and Analysis 4. Medium and High Voltage Switching and Safety Procedures 5. Hydrogen Systems and Electrical Safety for Electricians and Technicians 6. Power electronics, Inverters, Batteries and Storage short courses / training measures to close the skills need and skills gap in Electrical Engineering 7. Programmable Logic Controller (PLC)- Handling, Diagnosis and Programming 8. Mechatronic/ Interdisciplinary System Thinking (Mechanical Principles for Electricians, System Structures, Diagnostics, Mechanical material processing for electricians)	
2.	Solar Equipment Installation and Maintenance	National Vocational Certificate in Solar Equipment Installation and Maintenance	1 - 4	Monitoring systems (SCADA, IoT-based monitoring, drones)	1. Grid connected photovoltaic systems	IEC and South African Bureau of Standards (SABS) guidelines
		National Vocational Certificate in Solar Equipment Installation and Maintenance (Technician)	5	Troubleshooting inverters, charger controllers, batteries, wiring, and power electronics.	2. Large PV electrical storage systems 3. Solar tracking 4. Hybrid baseload GH ₂ – photovoltaic systems 5. Solar thermal power systems	

No.	Occupational Areas	Existing Relevant Qualifications	NQF Level	Identified Gaps	Recommended Short Courses	Applicable International Standards and Possible Partners
3	Wind Turbine Installation and Maintenance	None	-	- Wind Turbine Installation and Commissioning - Knowledge in Maintenance and Fault Diagnosis - Occupational Safety and Rescue Techniques for Wind Turbine Technicians - Handling of Specialised Tools and Lifting Equipment	Prio 1: GWO (Global Wind Organisation) Training Modules: Enhanced First Aid Training (EFA), Service Lift Training, Advanced Rescue Training (ART), Basic Safety Training (BST), Basic Technical Training (BTT), Blade Repair Training (BRT), Control of Hazardous Energies Training (CoHE), Crane and Hoist Training, Slinger Signaller Training Prio 2: Generic Wind Turbine Technician Basic Training Modules: Fundamentals of Electrical Engineering in Wind Turbines, Mechanics and Hydraulics in Wind Turbines, Control Systems and Programming in Wind Turbines	Global Wind Organisation (GWO) safety and training standards
4	Instrumentation and Control	National Vocational Certificate in Electrical Engineering (Instrumentation and Control)	2 - 5	- Implementation only to Level 3. - Strong command of technical English and the ability to read and apply technical documentation. - Operating and interpreting data from SCADA systems, programmable logic controllers (PLCs), and - Digital instrumentation platforms, sensor calibration, and automated process diagnostics, safety-integrity levels (SIL)	- Introduction to Instrumentation in GH₂ Systems - Introduction to Programmable Logic Controllers (PLC) - Calibration and testing instrumentation equipment - Installation and Removal of instruments and components as per OEM specifications - Fault finding on instrumentation equipment and systems - Occupational Health and Safety legislation	- Control and automation loop tuning using PLCs and SCADA → aligned with ISA-95 and IEC 62264 - Measurement and calibration of flow, pressure, level ...etc. → aligned with IEC 61298 and 60534 - Functional safety requirements of alarms and fail-safe systems → aligned with IEC 61511 and 61508 - Hazardous area work → aligned with IEC 60079
5	Electrolyser Installation, Operation and Maintenance	National Vocational Certificate in Electrical Engineering – Electrical General National Vocational Certificate in Electrical Engineering – Electrical Energy National Vocational Certificate in Electrical Engineering – Instrumentation and Control National Vocational Certificate in Electrical Engineering – Instrumentation and Control	2 - 4 5 2 - 4 5	- Hydrogen-specific safety - Electrolyser stack operation or design - Gas system commissioning or maintenance - Integration of RE into electrolysis systems	- Hydrogen Safety and Hazard Control - Electrical and DC System Installation - Electrolyser Operation (PEM/Alkaline) - Instrumentation and Control (SCADA/PLC) - Maintenance and Troubleshooting - Water Treatment System Operation - Emergency Response and Risk Management	TÜV SÜD, TÜV Rheinland, and DVGW Standards

No.	Occupational Areas	Existing Relevant Qualifications	NQF Level	Identified Gaps	Recommended Short Courses	Applicable International Standards and Possible Partners
6	Water Treatment/Desalination	National Vocational Certificate in Water Supply and Sanitation	2 - 4	- Reverse osmosis systems, - Membrane operation and maintenance, - Chemical dosing, and - Water quality monitoring	- Fundamentals of RO pressure and safety (lock out, burst disc, pressure decay test) - Cartridge / bag filter change out and pre treatment troubleshooting - Feed water diagnostics for variable salinity (TDS strip, iron, fluoride quick kits; scaling index calc)	WHO water safety guidelines, ISO 24510/24511 service quality frameworks, and DVGW W1000 series technical standards
		National Vocational Certificate in Metallurgy (Foundation)	1 - 4			
		National Vocational Certificate in Metallurgy (Pyrometallurgical Processing – Senior Operator)	4			
7	Plumbing and Pipefitting	National Vocational Certificate in Civil and Building Services Engineering (Plumbing and Pipefitting)	1 - 4	- Hydrogen-compatible materials, - High-pressure pipe welding, and Hydrogen leak testing - Welding of pressurised vessels and Pipelines for hydrogen applications	- Orbital GTAW set-up, purging and weld-log recording - Hydrogen-embrittlement science and alloy-repair techniques - High-pressure hydro / pneumatic testing and H₂-sniffer leak detection	IIW, AWS to qualify a local workforce for EPC contractors, ISO 3834 (for quality assurance in welding) and ISO 9606 or ASME B31.3 (for welder qualification and pipeline safety).
		National Vocational Certificate in Metal Fabrication (Boilermaking and Welding)	2 - 4			
8	Welding	National Vocational Certificate in Metal Fabrication (Boilermaking and Welding)	2 - 4	- Pressure-class fabrication with hydrogen-grade practice - Hydrogen embrittlement awareness and hardness control - Commissioning & leak-testing - Process safety and coordination at shop-floor level - Training of Trainer initiatives aligned to ISO 14732 and ISO 3834-2 - Facilities & SOPs	Short – Medium term interventions: GH₂-related short-course development to complement existing NVCs in welding - Orbital GTAW Set up, Purging & Weld Log Recording. - High Purity Tube Prep, Cleaning & Passivation for H₂ Service - High-Pressure Hydro/ Pneumatic Testing & H₂ Sniffer Leak Detection - Valve & Instrument Hook Up (V&IHU): Double Ferrule Fittings in H₂ Systems Medium – long term interventions: Alignment of NVCs in Welding to International Standards (IIW) - International Welding Practitioner (IWP) - International Welding Specialist (IWS) - International Welding Technologist (IWT) - Mechanised, Orbital and Robot Welding (MORW)	IIW, AWS to qualify a local workforce for EPC contractors, ISO 3834 (for quality assurance in welding) and ISO 9606 or ASME B31.3 (for welder qualification and pipeline safety).
		National Vocational Certificate in Metallurgy	1-4			

No.	Occupational Areas	Existing Relevant Qualifications	NQF Level	Identified Gaps	Recommended Short Courses	Applicable International Standards and Possible Partners
9	Heavy Haulage	National Vocational Certificate in Transport Operations and Logistics (Freight Handling)	2 - 5	- Load securing techniques for different types of heavy loads: - Machine parts and construction machinery: securing with chains, tension belts, stanchions and antislip mats.	- Basics of load securing for commercial heavy goods transport - Advanced Training Course: Fundamentals of Heavy Transport with Specialised Vehicles - Advanced Training Course: Anticipatory Driving and Driving Safety in Heavy Haulage - Advanced Training Course: Operation of Truck-Mounted Loading Cranes	(SADC) protocols and international permitting practices, Intra-European regulations (VDI 2700 Page 1, Securing of loads on road vehicles - Training and contents of training VDI 2700 PAGE 3.1, Securing of loads on road vehicles - Instruction manual for lashings DIN EN 12195, Load securing on road vehicles EU Directive 2003/59/EC UVV DGUV regulation 52, §29 - Operating authorisation for truck-mounted loader crane Learning area 8 - Loading of freight, training of professional drivers in Germany
		National Vocational Certificate in Surface Mining and Quarrying (Heavy Equipment Operations)	2 - 3	- Concrete parts and steel structures: Use of special load securing equipment such as heavy-duty lashing straps and wedges. - Transformers and wind turbines: Special transport racks and modular securing systems. - Calculation of the required lashing forces and friction coefficient. - Use of electronic and mechanical securing systems. - Influence of road conditions on load securing. - Legal requirements and international standards (e.g. EN 12195, VDI guidelines)		
10	Occupational Health and Safety	National Vocational Certificate in Preventative Health (Occupational Health and Safety)	4 - 5	- Lack of hydrogen or Power-to-X (PtX) content - Inadequate exposure to international safety frameworks (ISO, NFPA, IECEx) - No integrated approach to hybrid RE-GH2 infrastructure risks - Limited technical and emergency competencies for GH2 operations	- Hydrogen Safety Fundamentals - Cryogenic Hazard Awareness - Hydrogen Transport and Logistics Safety - Emergency Response and Incident Command - Hydrogen Leak Detection and Containment - Simulation-Based Fire Drills - OHS for Hydrogen Infrastructure	ISO 45001; NFPA 2 (Hydrogen Technologies Code); IEC 60079 and IECEx Certification; ISO/TR 15916 and ISO 19880-1; CompEx Certification (UK); ILO Conventions (C155, R164), NEBOSH, and IOSH; ISO 19880; ISO 22734; ISO 16111; ISO 14687 and DIN EN 17124; ISO/TR 15916; ASME B31.34; CGA H-3-2019
11	Firefighting	National Vocational Certificate in Fire-fighting and Rescue Operations	1 - 4	- Manage hydrogen-specific risks, including: - Explosion hazards, - Ammonia exposure, - High-pressure systems	- First Responder Training for Hydrogen and Chemical Fires - Hydrogen Firefighting and Explosion Management - Fire Risk Assessment and Prevention for Hydrogen Facilities	National Fire Protection Association (NFPA) and the International Fire Service Accreditation Congress (IFSAC); ISO 45001; SAESI; IFSTA

Identification of the most Critical Gaps and possible Priority Areas for Skills Development

Based on the consolidated findings from the eleven annexes, several interlinked and urgent skills gaps emerge as critical for enabling Namibia's transition to a GH₂ economy.

These gaps span both technical specialisations and cross-cutting competencies, affecting high-risk operations, digital systems integration, and large-scale energy infrastructure deployment. Addressing these gaps is essential for ensuring a safe, effective, and internationally aligned workforce.

The most pressing skills deficits include:

- I. **Hydrogen Safety and Risk Management:** An absence of hydrogen-specific safety training across occupational profiles poses significant health and operational risks. This must be addressed through cross-sectoral short courses aligned with NFPA and TÜV SÜD standards.
- II. **Electrolyser Operations and Maintenance:** No formal training or certification exists for operating electrolyser systems, which are central to GH₂ production. Required skills include gas handling, pressure regulation, diagnostics, and familiarity with hydrogen purity standards.
- III. **Desalination and Water Treatment for Hydrogen Production:** There is no dedicated training provision for membrane operation, chemical dosing, or reverse osmosis systems, despite their necessary roles in providing processed water for electrolyzers. Practical skills in water-energy integration, quality monitoring, and maintenance of industrial water systems must be prioritised.
- IV. **Instrumentation and Process Control:** Although critical across multiple energy systems, these skills are absent in existing curricula. PLCs, SCADA, sensor calibration, and automated process diagnostics are essential for hydrogen, wind, and solar operations.
- V. **Welding for Hydrogen Infrastructure:** Current programmes lack the specialisation levels in welding of pressurised vessels and pipelines for hydrogen applications requiring compliance with stringent international codes (e.g., ISO 9606, ASME IX) to ensure structural integrity, safety and efficiency of key components.
- VI. **Wind Turbine Maintenance and Safety:** Namibia lacks a national qualification or certified training in wind turbine operation and maintenance, despite growing demand. Skills include tower climbing, blade inspection, and condition monitoring.
- VII. **Heavy Haulage and Hydrogen-Sensitive Logistics:** Current training programmes fail to address transporting hydrogen-related equipment requiring advanced logistics planning, abnormal load securing, and safety protocols for hazardous materials. Training gaps also exist in escort vehicle coordination and integration with cross-border logistics standards.

Cross-Occupational Skills Gaps and Systemic Challenges in Training Delivery

In parallel to the technical and occupation-specific needs, the analyses of all eleven occupational areas uncovered a set of transferable competencies that are consistently required across different segments of the GH₂ value chain. These cross-occupational skills form the backbone of a versatile and mobile workforce to adapt to emerging technologies, interdisciplinary work environments, and cross-functional tasks.

However, Namibia's TVET system's ability to deliver these competencies is constrained by a range of systemic challenges. These challenges include outdated training content, insufficient exposure of trainers to GH₂ and RE technologies, and the lack of a national framework for short courses linked to certification.

Together, these cross-cutting skills gaps and institutional limitations create a dual barrier to effective workforce development for Namibia's GH₂ ambitions.

Cross-Occupational Skills Gaps

These are the competencies and behaviours required in multiple occupational areas. Their relevance spans the entire value chain, from project development and construction to operation and maintenance.

- ▶ **Hydrogen and Renewable Energy Literacy:** All trainees/artisans, technicians, technologists and practitioners need a basic understanding of the hydrogen economy, energy transition concepts, and Namibia's national vision for sustainability. This foundational knowledge is currently missing from most existing curricula.
- ▶ **Safety and Emergency Response Protocols:** From firefighting to safe handling of high-pressure hydrogen, emergency awareness and response capacity must be built into every level of training, using standardised frameworks.
- ▶ **Digital Competence and Diagnostic Tools:** Workers must be able to engage with SCADA, mobile diagnostics, and remote monitoring systems, particularly for instrumentation, electrolyser maintenance, and water treatment operations. Digital fluency is compulsory and core to operational safety and efficiency.
- ▶ **Preventive Maintenance and Troubleshooting:** Regardless of whether trainees are working on solar PV, haulage systems, wind turbines, or electrolyzers, core maintenance and fault detection skills are increasingly required.
- ▶ **Workplace Readiness and Soft Skills:** Communication, teamwork, intercultural fluency, adaptability, and customer orientation are vital in international project environments. Soft skills determine whether technical skills can be applied effectively in the workplace.

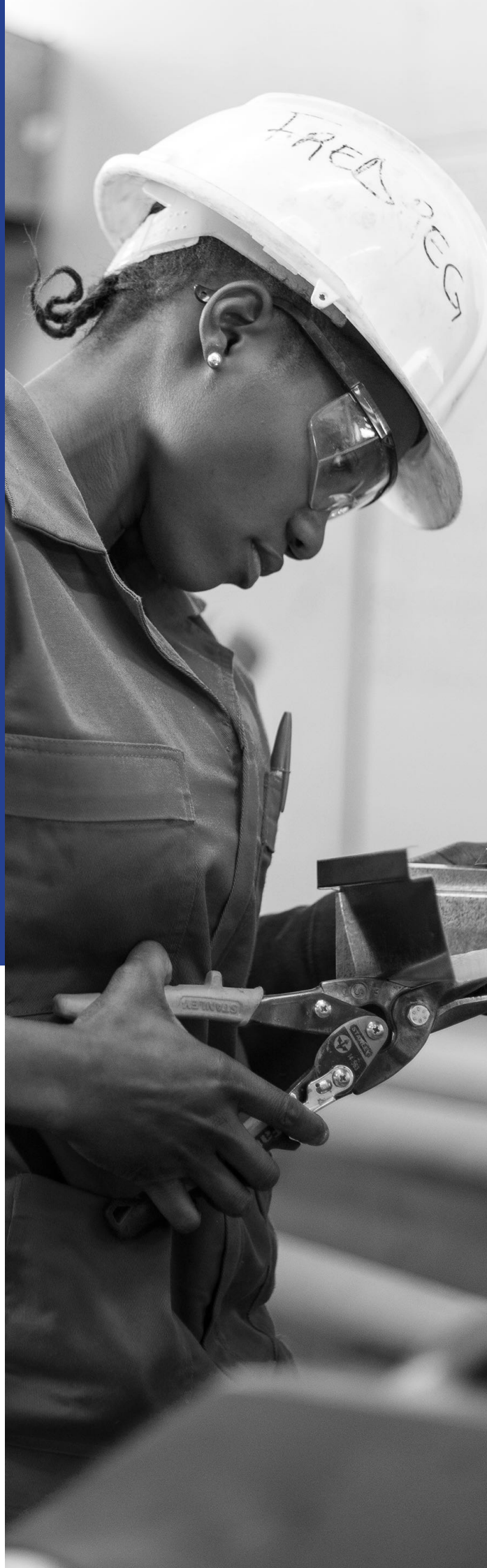
Systemic Challenges in Skills Delivery

Despite the recognition of these cross-cutting skills, Namibia's training system is not yet able to deliver these at scale nor with sufficient quality.

The following systemic gaps were repeatedly observed across all eleven occupational-specific reports:

- ▶ **Trainer Capacity and Exposure:** Many trainers lack experience with modern technologies or have not engaged in industry placements. This leads to outdated training and low relevance to the actual needs of employers of training content.
- ▶ **Outdated Infrastructure and Training Equipment:** Training centres often rely on equipment far behind industry standards. This limits trainees' ability to engage with the kind of systems they will encounter in the workplace, especially in areas like Instrumentation, Welding, and Solar.
- ▶ **Fragmented Short Course Framework:** There is currently no institutional framework or coordination mechanism to standardise short course design, accreditation, delivery, assessment and recognition across various regions and providers. As a result, these interventions tend to be isolated, often conducted outside the formal scope of the NQF.
- ▶ **Gaps in Certification and Accreditation:** Namibia lacks nationally recognised hydrogen-related certifications and is not yet aligned with international frameworks such as IIW (welding), TÜV (hydrogen safety), or NEBOSH (OHS). This limits the quality and mobility of graduates.
- ▶ **Missing Industry Partnerships and Work-Integrated Learning:** Few structured pathways exist for trainees to gain practical experience in GH₂ projects. Stakeholder engagements highlighted the need for industrial attachments, internships, dual training models, and co-development of curricula with employers.
- ▶ **Underuse of Simulation and Digital Learning Tools:** Simulation-based training remains underutilised, particularly important for hazardous or capital-intensive systems. Institutions lack the digital infrastructure and content required to deliver training at scale using blended or remote methods.
- ▶ **Uptake of Recognition of Prior Learning (RPL):** While Namibia has established a formal RPL process for its TVET system through the NTA, its visibility, efficiency, and uptake remain limited. Many Namibians, particularly in occupations like Welding, Plumbing, and Heavy Machine Operations, possess valuable hands-on experience but face challenges in accessing and navigating RPL procedures. Enhancing the reach, clarity, and implementation of RPL systems would allow for a broader workforce inclusion and improved alignment with the demands of the GH₂ sector.

Addressing these cross-cutting skills gaps and systemic challenges is essential for building Namibia's flexible, inclusive, and industry-responsive TVET system. Modular, transferable training standards and system-level reforms must complement and interweave together. Strategic investment in both software (curricula, trainers, partnerships) and hardware (tools, simulators, platforms) will be required to realise the potential of the GH₂ economy, and to ensure that Namibians are equipped to lead it.



Sector-specific Implications

The annexed reports demonstrate that skills gaps in Namibia's TVET system affect not only training provision but also broader socio-economic domains. Addressing these implications is essential to ensure that Namibia's green hydrogen and renewable energy transition is efficient, inclusive, and aligned with national priorities. The table below summarises key sectoral implications drawn from the consolidated findings.

Domain	Implications
Education and Training	Curricula require review to integrate GH ₂ safety, RE systems, and pro-cess automation; urgent modular short courses are needed; trainer upskilling and fit-for-purpose training infrastructure/equipment (e.g., orbital welding, instrumentation labs) are prerequisites; NQA/NTA to standardise new occupational profiles and update assessment.
Energy Sector (Public and Private)	Project developers and operators face local recruitment bottlenecks in specialised roles (electrical, instrumentation & control, hydrogen safety, desalination ops); this increases reliance on external specialists and can delay commissioning; growing need for interdisciplinary skills that blend electrical/mechanical, digital monitoring (SCADA/PLC), and OHS.
Industry and Manufacturing	Potential for Emergence of New Industries: GH ₂ derivatives could stimulate the development of new industries, creating demand for high-integrity fabrication and piping, certified welding, pressure sys-tems, and commissioning/O&M services. Existing firms will need to reskill and upskill to meet these requirements and to leverage oppor-tunities arising from GH ₂ production.
Government and Policy	Require a coordinated skills pipeline across ministries; adopt incen-tives for green-skills training; enable recognition of micro-credentials/stackable modules; align immigration and labour rules for critical-skills bridging while localisation pathways mature; strengthen the labour market information system to track demand.
Economic Development	Targeted skills development can unlock job creation in construction and O&M phases; a clearer skills strategy improves investor confi-dence and supports localisation; design measures to include women, youth, and rural trainees in priority trades; focus also on spillover effects from new emerging industries for local job creation.
Safety, Environment and Climate	Competent workforces are essential for hydrogen safety, environmental compliance, and incident prevention (e.g., hazardous areas, pres-sure systems); skills alignment supports progress on national RE and climate targets.



6

RECOMMENDATIONS

Namibia's aspiration to become a leading exporter and user of GH₂ and RE hinges on the urgent and coordinated development of a skilled workforce. The following recommendations derived from the findings of the eleven in-depth occupational studies are clustered into four strategic priority areas:

Skills Development and Training Strategies

- ▶ **Develop modular, short-term upskilling courses tailored to GH₂ needs:** All Annexes emphasise the urgent need for practical, occupation-specific short courses in their specific areas. Hydrogen safety and firefighting, automation, SCADA/PLC systems, electrolyser maintenance and pressure piping/welding are of utmost importance. Additional priority areas include water quality monitoring, reverse osmosis operation, chemical dosing in water treatment, and digital fault diagnostics in control systems. These should be aligned with international standards (e.g., TÜV, IIW, AWS, DVGW, H2Skills) and fast-tracked through pilot delivery in key regions.
- ▶ **Scale up Training-of-Trainer (ToT) programmes:** A national-level strategy to specifically upskill trainers in instrumentation, firefighting, welding, hydrogen safety, and water-energy systems is essential. International secondments, dual training exposure, and collaboration with regional and international partner institutions (e.g., SARETEC, IIW, VDE Institute, TÜV Süd) should be part of the ToT strategy and, where possible, be linked to international recognition and certification. ToT should also include exposure to industrial-scale SCADA and automated process environments where possible.
- ▶ **Establish and/or improve training centres linked to hydrogen valleys:** Regions hosting GH₂ pilot projects (e.g., Daures, Lüderitz, Walvis Bay) should receive priority for establishing decentralised training centres equipped with simulators, mock-ups, and mobile training units. These centres should offer multiple technical courses, that include electrolysis, welding, instrumentation, logistics, firefighting, and water treatment. They should be designed to support hands-on engagement with hazardous or capital-intensive systems.
- ▶ **Introduce cross-cutting GH₂ competencies across relevant occupations:** Key transferable topics such as hydrogen literacy, basic gas physics, safety, and digital diagnostics should be embedded across multiple occupational areas as transversal modules. Shared content includes SCADA literacy, process risk awareness, chemical handling basics, and environmental sustainability principles.
- ▶ **Develop NQF-aligned pathways beyond Level 4 for priority occupations:** For critical roles like Electrolyser Technicians, Control Technicians, Industrial Welders, Desalination Operators, and Hydrogen-Safety Supervisors, clear pathways to NQF Levels 5 and 6 must be established, with articulation into higher education where appropriate.

Policy and Regulatory Support

- ▶ **Formalise hydrogen-related occupations and qualifications:** New job roles emerging from the GH₂ economy (e.g., Hydrogen Safety Officer, Electrolyser Operator, PtX Systems Technician, Industrial Water Treatment Technician) must be formally recognised by NQA and registered on the NQF.
- ▶ **Develop a national hydrogen safety and skills standard:** aligned to international standards Led by Namibia Standards Institution (NSI) and NTA, Namibia should adopt and localise global hydrogen standards and embed them into vocational training. This will ensure compliance and facilitate workers & international mobility. Standards should reference NFPA, ISO, IIW, GWO, DVGW (including W1000 series for water infrastructure), and other applicable frameworks.
- ▶ **Create incentive structures for training providers and employers:** Regulatory tools such as skills development grants, tax rebates for industrial attachments, internships, and recognition for industry trainers will ignite private sector involvement. This should include employers in water supply, logistics, and plant operations alongside GH₂ developers and OEMs.

Education and Curriculum Alignment

- ▶ **Revise existing national curricula to include GH₂ and RE content:** Most qualifications (e.g., Electrical General, Instrumentation and Control, Metal Fabrication, Plumbing, Water and Environmental Systems) lack hydrogen-related content. Specific modules should be developed on hydrogen safety, gas handling, smart systems integration, high-pressure welding, renewable-electrolyser interfacing, and industrial water treatment linked to hydrogen production.

Industry Partnerships and Stakeholder Engagement

- ▶ **Institutionalise Public-Private Training Partnerships:** Long-term partnerships should be formalised between TVET institutions and GH₂ project developers (e.g., Hyphen, Cleanergy, HyIron), EPC contractors, logistics firms, water utilities, and OEMs. These partnerships can drive joint curriculum development, internship placements, and equipment donations.
- ▶ **Engage regional and international partners for certification and support:** Leverage relationships with SADC training centres, German hydrogen institutes, African and European Centres of Excellence, to support dual certification pathways with access to innovation. This should extend to institutions specialising in industrial water treatment, automation, and hydrogen safety training.
- ▶ **Strengthen Industry Skills Advisory Forum for GH₂ / RE:** Forums such as the Skills Task Force on GH₂ and the Industry Skills Committee (ISC) under the NTA need strengthening to involve key ministries, authorities, project developers, and trade unions in order to guide skills forecasting, standard setting, and annual curricula reviews. Cross- sectoral representation should ensure holistic oversight, including from the water infrastructure, logistics, and safety bodies.



Conclusion

Namibia is at a pivotal junction along its journey toward being amongst global frontrunners in RE and GH₂. This consolidated report combines the findings from eleven in-depth occupational gap analyses to provide an integrated overview of the country's current TVET landscape, the emerging demands of GH₂ value chains, and the reforms required to bridge critical skills gaps. The analyses confirm that while Namibia has a well-functioning and adaptable TVET system, it must now embark upon a strategic transformation to meet the technical, safety, and digital demands of a rapidly evolving industrial environment. This transformation requires targeted investment, alignment with international standards, industry training partnerships and coordinated action across the public and private sectors.

The report and its Annexes present a coherent set of recommendations, ranging from modular short courses and updated curricula to certification alignment and structured stakeholder collaboration that can serve as a roadmap for immediate and long-term capacity building interventions. These measures are essential to prepare avenues of employment in RE and GH₂ value chains for Namibia's workforce, and to ensure that the just transition is inclusive, nationally owned, and economically transformative.

The detailed occupational analyses, international benchmarking, and training gap matrices that underpin these findings are captured in the Annexes. Stakeholders seeking to implement the recommendations or design targeted training interventions are encouraged to consult the individual Annexes, which provide sector-specific insights, curricula gaps, and international best practices. Namibia has both the ambition and the foundational systems to position itself as a skills hub in the GH₂ economy. The exciting and challenging task ahead is translating this potential into practice through decisive reforms, strategic partnerships, and subsequent sustained commitments to building the human capital needed for a just, green, and resilient future.



Annexures

Annexure 1:	Report on Electrical Engineering
Annexure 2:	Report on Solar Equipment Installation and Maintenance
Annexure 3:	Report on Wind Turbine Installation and Maintenance
Annexure 4:	Report on Instrumentation and Control
Annexure 5:	Report on Electrolyser installation, operation and Maintenance
Annexure 6:	Report on Water Treatment and Desalination
Annexure 7:	Report on Plumbing and Pipefitting
Annexure 8:	Report on Welding
Annexure 9:	Report on Heavy Haulage
Annexure 10:	Report on Occupational Health and Safety
Annexure 11:	Report on Firefighting
Annexure 12:	Consolidated Stakeholder-Map

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