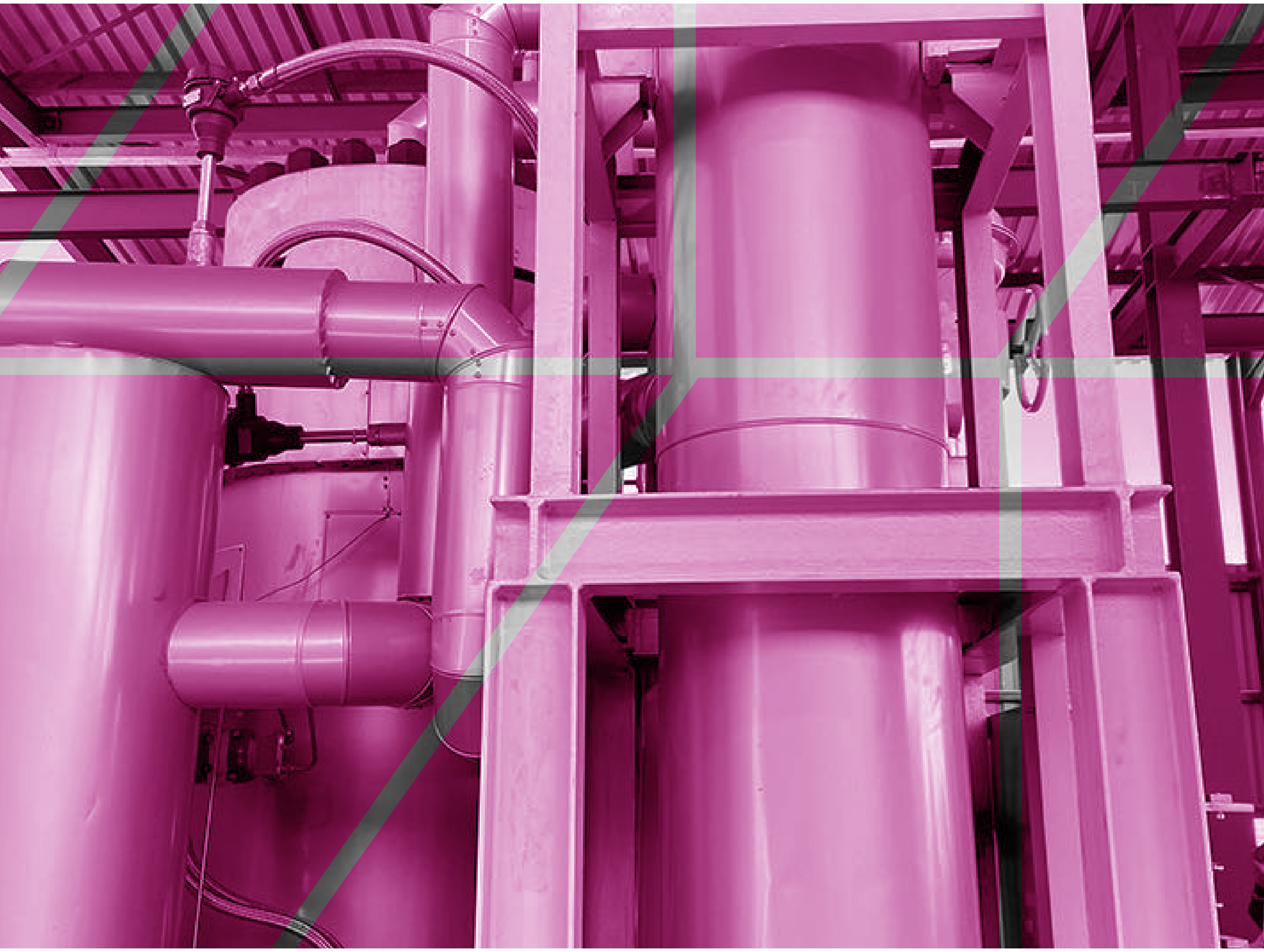
german
cooperation
DEUTSCHE ZUSAMMENARBEIT



# TVET SKILLS FOR RENEWABLE ENERGY AND GREEN HYDROGEN IN NAMIBIA

## Annexure 5: Electrolyser Installation, Operation and Maintenance

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

# IMPRINT

Published by the
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Friedrich-Ebert-Allee 36+40
3113 Bonn, Germany
Phone +49 228 44 60-0
Fax +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
Phone +49 61 96 79-0
Fax +49 61 96 79-17 66

**Namibia**

Promotion of Technical Vocational Education and Training (ProTVET) Project
10 Rand Street, Khomasdal, Windhoek, Namibia
Phone +264 61 222 447
Email jerry.beukes@giz.de
www.giz.de/en/worldwide/323.html

As of 09/2025

Design
Joyce Kondo
Windhoek, Namibia
joycekondojk.wixsite.com/mysite

Photo credits
Ndinelago Tshoombe at WVTC: pages 6, 12, 15, 20 and 23
Panduleni Michael at Daures: cover, pages 7 and 10
Rodney Seibeb at HyIron: page 3a
Samuel John at Cleanergy and HyIron: pages 3b and 22

**Responsible**
Sybil Ferris (GfA), Emil Spieler and Rodney Seibeb (GIZ ProTVET)

**Researchers**
Prof Dr Samuel John and Prof Dr Birgit Scheppat

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ)



german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GFA CONSULTING GROUP

## CONTENTS

# ACRONYMS

| | |
|---|---|
| ATEX | Atmosphere Explosibles |
| DC | Direct Current |
| DI | Deionised Water |
| DVGW | German Technical and Scientific Association for Gas and Water |
| EU | European Union |
| HDF | Hydrogène de France |
| NERA | Namibia Energy Regulatory Authority |
| NTA | Namibia Training Authority |
| NUST | Namibia University of Science and Technology |
| OEM | Original Equipment Manufacturer |
| PEM | Proton Exchange Membrane |
| PLC | Programmable Logic Controller |
| PPE | Personal Protective Equipment |
| RO | Reverse Osmosis |
| SADC | Southern African Development Community |
| SCADA | Supervisory Control and Data Acquisition |
| TÜV SÜD | Technischer Überwachungsverein Süd |
| TVET | Technical and Vocational Education and Training |
| UNAM | University of Namibia |
| VTC | Vocational Training Centre |

# 1

# ANALYTICAL REPORT

## 1.1 Status quo – overview of existing training measures and training providers

Namibia's National Renewable Energy Policy of 2017 [1] prioritises the transition to renewable energy (RE), while the Green Hydrogen and Derivatives strategy of 2022 emphasises the utilisation of green hydrogen ($GH_2$), with electrolysers playing a pivotal role in this shift. Section 1.1 provides an overview of the current landscape regarding the deployment of electrolysers in Namibia and assesses the existing training measures and institutional training capacities that are essential for equipping the workforce with the necessary skills.

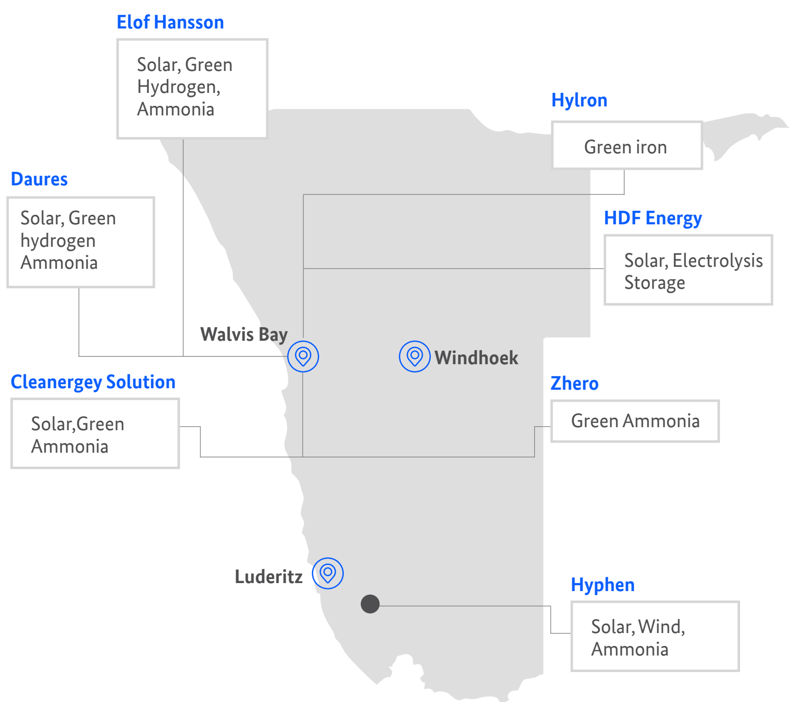
### Current Deployment of Electrolysers in Namibia

The current situation regarding skills in the installation, maintenance, and operation of electrolysers is all but non-existent in Namibia due it being an emerging sector. There are several projects at different stages of development in Namibia.

Electrolyser installation, maintenance, and operation skills are currently needed in the country, as several projects are moving from planning phases to development and operation. Some key pilot projects include HyIron Oshivela, Cleanergy Solutions Namibia, the Daures Green Hydrogen Village, and potential installations under the Hyphen Hydrogen Energy project. Some of these projects are progressing toward the procurement and deployment of electrolysers.

These initiatives signal a clear transition from feasibility to implementation along Namibia's $GH_2$ journey. Other non-pilot projects include the Hydrogène de France (HDF), which is still in the inception stages. Other non-pilot projects are also under consideration as the nation aims to expand its capabilities in $GH_2$ production. Figure 1 shows some key projects and their locations in Namibia. The focus of this study is on identifying the skills required in the installation and maintenance of electrolysers, which remains a critical need in the region.

**Figure 1: Key Green Hydrogen Projects in Namibia**



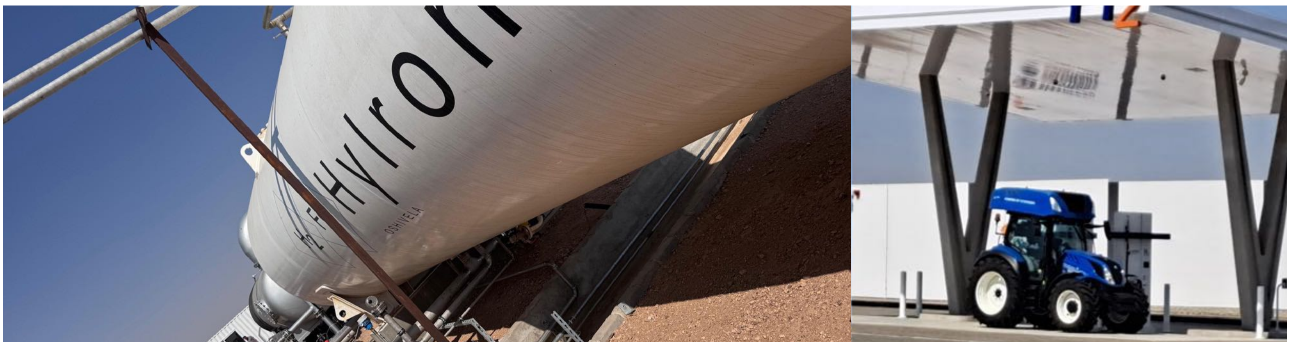

| Project | Phase of Development (mid 2025) |
|---|---|
| Hyphen | Feasibility |
| Elof Hansson | Development |
| HDF | Development/planning phase |
| Hylron | Phase 1- Production in 2024/5 |
| Zhero | Development/planning phase |
| Cleanergy Solotions | Pilot/Phase 1- Production in 2024/5 |
| Daures Hydrogen Village | Pilot/Phase 1- Production in 2024/5 |

While electrolyser hardware begins to arrive, local technical capacity needed to install, operate, and maintain these systems is severely lacking. Table 1 summarises the key $GH_2$ projects currently underway, or planned, in Namibia and outlines their scale and current development status:

**Table 1: Summary of Key Hydrogen Projects and Current Status in Namibia**

| Project Name | Size | Current Status (mid 2025) |
|---|---|---|
| **Hyphen Hydrogen Energy** | Targeting 2 MTPA of green ammonia by 2030 (from 3 MPTA of green hydrogen equivalent). Renewable capacity: 7.5 GW, electrolyser capacity: 3 GW. Investment: > US$10 billion. [2] | Advancing with front-end engineering design. Construction of phase one planned to start by end of 2026, with commissioning by end of 2028. [2] Feasibility and Implementation Agreement signed. [2] |
| **Cleanergy Solutions Namibia (Refuelling Station)** | 5 MW PEM electrolyser for refuelling station. Larger green hydrogen and ammonia factory planned [4]. | Construction of the refuelling station commenced in late September 2024, aiming for operation by mid-2025. Demonstration plant completed in 2024, operation to commence in 2025. |
| **HyIron Oshivela Plant** | 12 MW electrolyser. Targeting 15,000 tonnes of Direct Reduced Iron (DRI) in phase 1, scaling to 2 million t/y by 2028. | Commenced green hydrogen production in March 2025, scaling up to full capacity. Work on phases 2 and 3 expected to commence in 2025. |
| **Daures Green Hydrogen Village** | Pilot phase: 18 tonnes of green hydrogen, 100 tonnes of green ammonia. Planned expansion: > 180,000 t/y hydrogen, 1 million t/y ammonia. | Pilot project completed, with launch expected in the fourth quarter of 2025. Preparing for design studies for the larger facility. |
| **Hydrogène de France (HDF) Energy** | 70 MW electrolyser. Aiming to reach 3.5 GW electrolyser by 2030.<br>85 MW solar PV plant.<br>Green hydrogen production unit - Integrated with battery storage and fuel cells for stable power supply. | Feasibility studies completed.<br>Land secured.<br>Investors secure final investment with decision pending. |
| **Zhero/Envision Energy Plant** | 500,000 t/y of green ammonia from 2029. | Construction set to commence in 2025, completion by 2028, production from 2029. |

**Figure 2: HyIron (left) and Cleanergy (Right)**



**GREEN HYDRON PLANTS IN NAMIBIA**

## Current Training Measures

At present, no institution in Namibia offers a dedicated vocational or technical qualification tailored to electrolyser systems. While the Namibia University of Science and Technology (NUST) and the University of Namibia (UNAM) are building research capacity through green hydrogen institutes and postgraduate programmes for upskilling relevant qualification holders, these are primarily academic and not vocationally hands-on.

NUST plans to offer an integrated bachelor's degree programme in Renewable Energy, with focus on solar systems. While these moves are noble, they fail to address the technical skills required for electrolyser installation, maintenance, and operation at the technician level. It is worth noting that the Namibia Training Authority (NTA) has embarked on a massive skills gap analysis in the $GH_2$ sector. The current report explores the skills gaps in the electrolyser technician in particular.

Although the Namibia Training Authority (NTA) has no qualifications that directly address hydrogen or electrolysers, they do provide partial foundational knowledge for the installation, maintenance, and operation of electrolysers. Table 2 presents the relevant base qualifications for electrolyser technicians and their justification.

### Table 2: Relevant NTA Qualifications for Electrolyser Technicians

| Programme Title | Level | Relevance to Electrolyser Work | Justification |
|---|---|---|---|
| **National Vocational Certificate in Electrical Engineering – Electrical General** | 2–4 | Electrical Installation and Basic Operation. | Covers electrical safety, wiring, circuit installation, and maintenance fundamentals. |
| **National Vocational Certificate in Electrical Engineering – Electrical Energy** | 5 | System Commissioning and Troubleshooting. | Includes advanced power systems, load analysis, and commissioning practices. |
| **National Vocational Certificate in Electrical Engineering – Instrumentation and Control** | 2–4 | Instrumentation Basics. | Teaches how to install, calibrate, and maintain instruments (sensors, control loops). |
| **National Vocational Certificate in Electrical Engineering – Instrumentation and Control** | 5 | Automation and Monitoring. | Covers PLCs, SCADA, industrial communication, and system-level integration. |
| **National Vocational Certificate in Metal Fabrication (Pipefitting and boiler maker)** | 4 | Pipefitting, mechanical assembly and pressure systems. | Piping for water, hydrogen, and oxygen. |

**While the listed qualifications provide foundational technical skills, none of them currently address the following:**

- Hydrogen-specific safety
- Electrolyser stack operation or design
- Gas system commissioning or maintenance
- Integration of renewable energy into electrolysis systems

Conversely, some key industry stakeholders are planning to offer in-house training tailored to their needs. A selection of these efforts is presented in Table 3. They also provide real-world environments for skills development, internships, and industrial placement.

### Table 3: Industry Stakeholders Training Efforts

| Stakeholder | Role |
|---|---|
| **Hyphen Hydrogen Energy** | Large-scale project holding potential for thousands of construction and operational jobs. A future anchor for hydrogen-related technician training. |
| **Cleanergy Solutions Namibia (O&L and CMB.TECH)** | Offers on-site training at its hydrogen refuelling and ammonia terminal facilities; a pioneer in hands-on electrolyser training. |
| **Daures Green Hydrogen Village** | Acting as a demonstration and training hub, especially in ammonia production and small-scale electrolyser maintenance. |
| **HDF Energy Namibia** | Focuses on integrating hydrogen production with power generation and fuel cells—relevant for dual training in energy systems. |
| **Oshivela Green Hydrogen and Iron Project** | Offers training potential in hydrogen integration with iron ore reduction processes, creating a demand for advanced electrolyser operation skills. |

Currently, the suppliers of electrolysers offer training for the regular maintenance and operation of electrolysers installed throughout Namibia.

However, relying too heavily on these suppliers for breakdown maintenance poses a significant risk, high costs, and may lead to prolonged shutdowns that are not sustainable in the long term. It is essential to develop a robust training program for Namibian technicians in order to remedy these issues.

Operational efficiency and reduced downtime can be ensured by empowering TVET trainees with skills necessary to perform all types of maintenance and repairs on both Alkaline and Proton Exchange Membrane (PEM) electrolysers (also known as Polymer Electrolyte Membrane). Investing in local expertise is not only a practical solution but also vital for the long-term sustainability of Namibia's green hydrogen industry.

Currently, there are no dedicated electrolyser training providers within the Southern African Development Community (SADC) region. However, several initiatives and international programmes are available to support skills development in electrolyser installation, maintenance, and operation. This is discussed in detail in Section 1.4.

## 1.2 Stakeholder Mapping and Gap Analysis

Several stakeholders are involved in the electrolyser installation, maintenance, and operation training in Namibia. Table 4 captures the key stakeholders, their roles, and their interests.

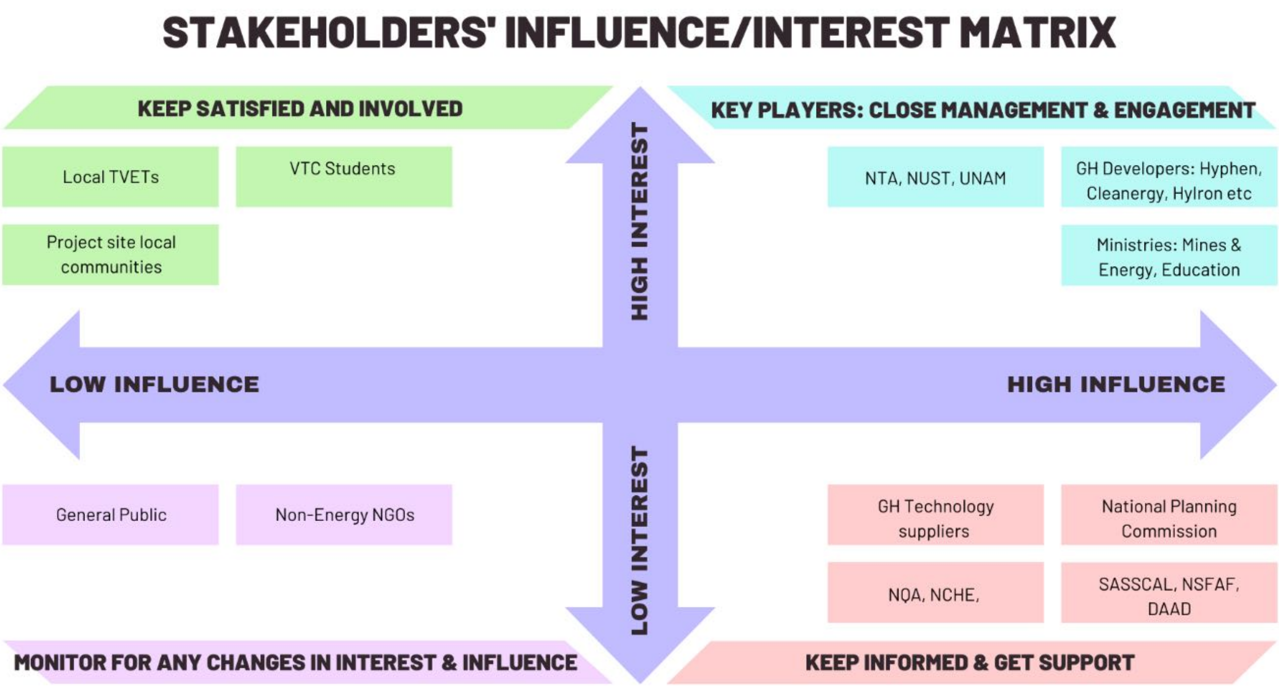
**Table 4: Key Stakeholders and Roles**

| Stakeholder Group | Key Stakeholders | Role/Interest in Electrolyser Installation Operation and Maintenance |
|---|---|---|
| **Government** | - Ministry of Education, Innovation, Youth, Sport, Arts and Culture (MEIYSAC)<br>- National Planning Commission (NPC)<br>- National Training Authority (NTA)<br>- National hydrogen strategy | - Policy and regulation<br>- National hydrogen strategy<br>- Skills development investment and oversight |
| **Regulatory Authorities** | - Namibia Energy Regulatory Authority (NERA)<br>- Namibia Standards Institution (NSI) | - Licensing and compliance<br>- Safety standards (e.g. ATEX, ISO) |
| **Academic and TVET Institutions** | - Namibia University of Science and Technology (NUST) University of Namibia (UNAM)<br>- VTCs (Eenhana, Nakayale, Windhoek, etc.) | - Curriculum development<br>- Training delivery (TVET and university)<br>- R&D and applied innovation |
| **Industry and Project Developers** | - Hyphen Hydrogen Energy<br>- Cleanergy Solutions Namibia (O&L and CMB Tech)<br>- Daures Green Hydrogen Village<br>- HDF<br>- HyIron<br>- Namport (infrastructure support)<br>- NamPower | - Electrolyser design and supply<br>- Tech transfer and maintenance support<br>- Training for technicians and engineers |
| **Technology Providers** | - Siemens Energy<br>- ITM Power<br>- H-TEC Systems<br>- Enapter<br>- Plug Power | - Technical assistance and funding<br>- Workforce development programs<br>- International best practice and standards support |

| Stakeholder Group | Key Stakeholders | Role/Interest in Electrolyser Installation Operation and Maintenance |
|---|---|---|
| **International Development Partners** | - GIZ (H2-Diplo, PtX Hub)<br>- SASSCAL<br>- European Investment Bank (EIB)<br>- KfW<br>- UNDP<br>- EU | - Technical assistance and funding<br>- Workforce development programs<br>- International best practice and standards support |
| **Private Sector Contractors and SMEs** | - Electrical and mechanical contractors<br>- EPC (Engineering, Procurement, Construction) firms<br>- Water treatment companies | - Execution of installation and maintenance<br>- Skilled labour employment<br>- Supply chain integration |
| **Communities and Civil Society** | - Local communities near hydrogen hubs (e.g. Lüderitz, Walvis Bay)<br>- Youth associations<br>- NGOs (environmental and social) | - Employment and skills development<br>- Social license to operate<br>- Environmental advocacy |
| **Professional and Certification Bodies** | - Engineering Council of Namibia<br>- Namibia Training Authority (NTA)<br>- Namibia Qualifications Authority (NQA) | - Certification and qualification alignment<br>- Support for skills funding<br>- Professional recognition |

The interest and influence matrix of the key stakeholders is represented in Figure 3, after which a brief explanation further clarifies the impact of necessary engagement with the stakeholders.

**Figure 3: Stakeholders' Influence/Interest Matrix**



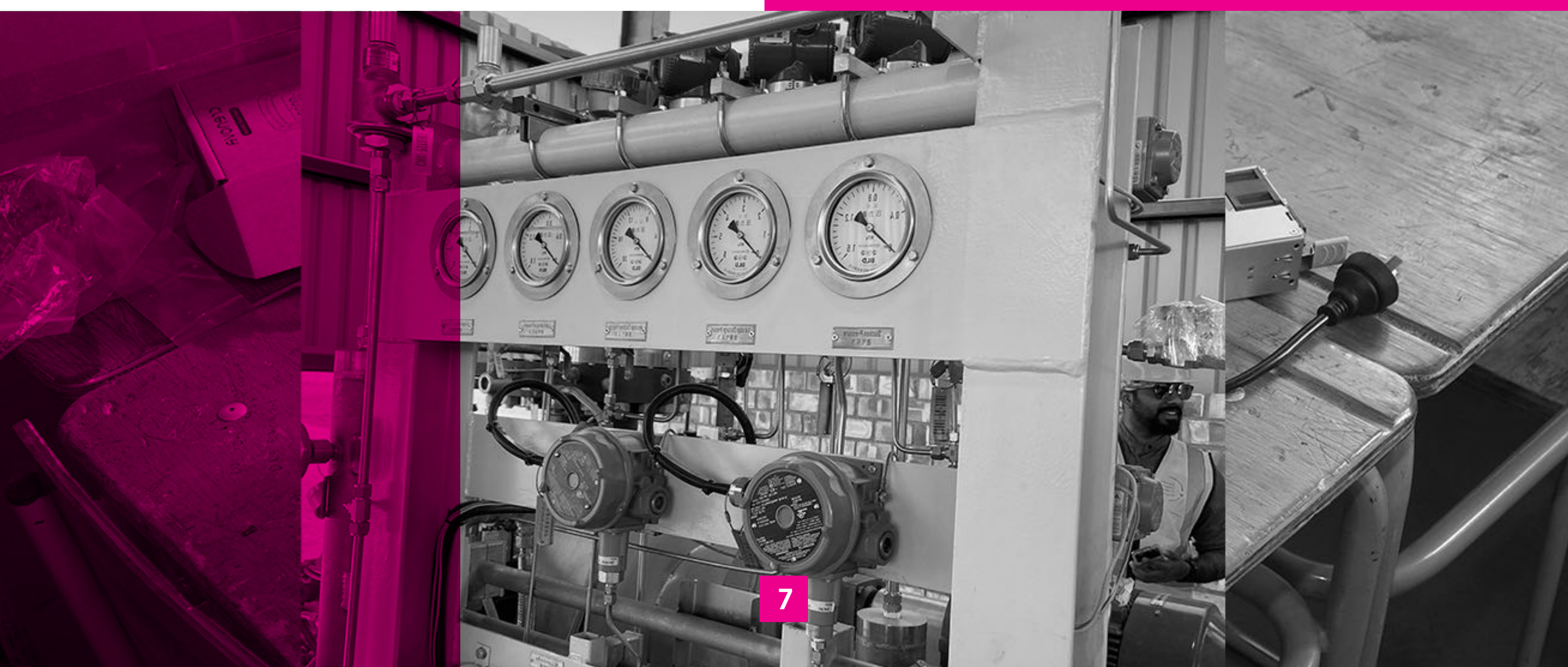

**Explanation of the Grid:**

- **Key Players (High Influence/High Interest):** These stakeholders are crucial. They have the power to significantly impact the electrolyser sector and are deeply invested in its success. Requires close management and engagement.

- **Manage Closely (High Influence/Low Interest):** These indirectly interested stakeholders can influence the sector. To ensure their continued support it is necessary to keep them informed, as their influence can be critical.

- **Keep Satisfied (Low Influence/High Interest):** These stakeholders hold a keen interest in the sector's outcomes but with limited powers to directly influence it. Efforts should be made to keep them satisfied and involved.

- **Monitor (Low Influence/Low Interest):** These stakeholders have the least influence and interest. Although requiring minimal attention, they should nonetheless still be monitored for any changes of interest or influence levels.



## 1.3 International Benchmarking

Since Namibia does not currently offer training in electrolyser installation, maintenance and operations, this section outlines the certification requirements. This will assist the next phase of the project, during which the training programmes will be developed. Installing, operating, and maintaining electrolysers involves different skills and certifications. Table 5 summarises the Key Core Competency Areas for Certification.

**Table 5: Key Core Competency Areas for Certification**

| Area of Competency | Description |
|---|---|
| **Hydrogen Safety and Hazard Control** | Understanding of ATEX zones, gas detection, LEL/UEL limits, PPE, and ESD. |
| **Pressure Vessels for storage and transporting hydrogen** | Verifies that hydrogen tanks and components can safely handle stresses like embrittlement, leakage, and high pressure. |
| **Electrical and DC System Installation** | Competency in DC cabling, grounding, explosion-proof wiring systems. |
| **Electrolyser Operation (PEM/Alkaline)** | Stack operation, voltage/current management, diagnostics. |
| **Instrumentation and Control (SCADA/PLC)** | Programming and interfacing SCADA /PLC with H□ production systems. |
| **Maintenance and Troubleshooting** | Replacing membranes, valves, stack parts; leak detection. |
| **Water Treatment System Operation** | Handling RO and DI systems, ensuring ultrapure water for electrolysis. |
| **Emergency Response and Risk Management** | Hydrogen-specific firefighting, emergency shutdown, evacuation procedures. |

### European Certifications and Training

The following European bodies provide certifications that could be considered for training in Namibian.

#### TÜV SÜD / TÜV Rheinland

Both TÜV SÜD (Technischer- Überwachungsverein Süd) and TÜV Rheinland are leading German certification, testing, and inspection organisations with global operations. They play key roles in hydrogen technology, particularly in safety, certification, and training for hydrogen production, storage, and distribution.

**Key Roles in Hydrogen Technology:**

Certification and Standards Compliance

- The certification of electrolysers, fuel cells, hydrogen storage systems, and refuelling stations according to international standards (e.g., ISO 22734, IEC 62282).
- Assess the safety, performance, and durability of hydrogen systems.
- Providing CE marking, ATEX (explosion safety), and pressure equipment directives (PED) compliance.

Training and Qualification Programs

- Offering specialised training for hydrogen system installation, operation, and maintenance (O&M).
- Programs covering safety protocols, risk assessments, and best practices for handling hydrogen.

Benchmarking and Consulting

- Support technology benchmarking for hydrogen projects.
- Providing advice on regulatory compliance, efficiency optimisation, and safety management.

TÜV SÜD provides certification, safety consulting, and technical advisory services to Hyphen Hydrogen Energy in Namibia. This project is one of Africa's largest $GH_2$ and ammonia initiatives, aiming to achieve 3 gigawatts (GWs) of electrolyser capacity by 2030. Their relevant Namibian experiences qualify them as a suitable partner for benchmarking the training of electrolyser technicians in the region.

**Website:** www.tuvsud.com | www.tuv.com

#### EU H2Skills / H2EU+Store

- **Scope:** European upskilling programme for hydrogen workforce ( 2023–2027).
- **Certifications:** Expected to offer technician-level certifications aligned with ECVET.
- **Website:** www.h2skills.eu

The European Union has launched initiatives such as EU H2Skills and H2EU+Store to advance hydrogen technology expertise and infrastructure. EU H2Skills focuses on workforce training and standardisation for installing, operating, and maintaining electrolysers and fuel cells, ensuring that professionals are equipped with the necessary skills. Meanwhile, H2EU+Store concentrates on large-scale hydrogen storage and transport, emphasising safety and certification frameworks.

The two programs share common goals: developing standardised training curricula for hydrogen professionals, ensuring safety and compliance with EU regulations like ISO and IECEx, and support for upskilling efforts in emerging hydrogen economies beyond Europe.

Within the realm of certification and training, these initiatives provide guidelines aligned with EU standards for electrolysers and hydrogen fuel, to aid in establishing competency frameworks for hydrogen technicians. They also offer modular training programs that cover crucial areas such as electrolyser installation and safety, hydrogen storage and handling, along with maintenance and troubleshooting — all focused on practical skills for operators engaged in renewable hydrogen projects.

These programs present promising opportunities for Namibia's hydrogen sector. Their strengths include alignment with EU standards, which is advantageous if Namibia intends to export green hydrogen to Europe. The structured training approaches can be adapted locally, and their safety-first methodology is particularly important for Namibia's developing hydrogen industry.

### DVGW (German Technical and Scientific Association for Gas and Water)

- **Scope:** Publication of standards (e.g. G 265-2) for hydrogen installation and grid compatibility.
- **Certification Types:** Installer certification, hydrogen network readiness, safety compliance.

DVGW offers specialised training programs aimed at educating technicians and engineers on hydrogen safety, the operation and maintenance of electrolysers, and blending hydrogen into existing gas grids. They also certify professionals to ensure compliance with German and EU standards.

The extensive expertise of DVGW makes it a valuable benchmark for Namibia's electrolyser programs, especially given its strict safety standards and detailed guidelines specific to electrolysis systems, like the G 485. Furthermore, their EU-aligned certifications could facilitate Namibia's hydrogen export ambitions to European markets.

**Website:** www.dvgw.de

### Summary

In summary, these three organisations hold varied strengths and limitations for the Namibian context. Table 6 provides an overview.

**Table 6: Comparison with Other Standards (TÜV, EU H2Skills)**

| Aspect | DVGW | TÜV SÜD/Rheinland | EU H2Skills |
|---|---|---|---|
| **Focus** | Gas/$H_2$ infrastructure | Global $H_2$ certification | EU workforce training |
| **Key Standard** | DVGW G 485 (Electrolysers) | ISO 22734, IECEx | Modular skills framework |
| **African Relevance** | Limited (but adaptable) | Strong (Namibia projects) | EU-focused |

## African and Asian Examples

It is worthwhile to explore the early stages of training in electrolyser systems, gaining momentum across the African and Asian continents. The following examples provide a benchmark reference for Namibia.

**South Africa – Hydrogen South Africa (HySA) Program** (https://www.hysasystems.com)

The Hydrogen South Africa (HySA) Programme is a national flagship initiative by South Africa's Department of Science and Innovation (DSI) to leverage the country's significant platinum group metal (PGM) resources to develop an indigenous knowledge-based economy centred on hydrogen and fuel cell technologies.

- **Training Focus:** Covers hydrogen production (including electrolysis), storage, and fuel cell technology.
- **Partners:** Universities (e.g., University of the Western Cape), government, and industry.
- **Benchmarking Value:** HySA provides technical training and research collaboration opportunities that Namibia could adapt. This is similar to NUST's initiative of a learning factory concept to be established at the Lüderitz campus.

**Morocco – Institut de Recherche en Énergie Solaire et Énergies Nouvelles (IRESEN)** (https://iresen.org)
IRESEN operates across the entire value chain of green innovation, through financial support and human and technical assistance for researchers, doctoral students, entrepreneurs (startups, SMEs and manufacturers) throughout the project development process, through to the marketing of innovative products, processes and services. A potentially good benchmark to enable collaboration between NTA and NUST in skills development across the $GH_2$ value chain.

- **Training Focus:** $GH_2$ production, electrolyser systems, and renewable energy integration.
- **Partners:** German development agencies (GIZ), industry, and universities.
- **Benchmarking Value:** Morocco is a leader in African green hydrogen; Namibia could model its vocational programs after IRESEN's hands-on training.

**Egypt – Regional Centre for Renewable Energy and Energy Efficiency (RCREEE)** (www.rcreee.org)

RCREEE is an inter-governmental organisation promoting renewable energy and energy efficiency in pan-Arab countries. As the technical arm of the Arab League's Energy Department and AMCE, it collaborates with governments, international partners, and the private sector to advance clean energy policies, develop technologies, encourage investments, and build capacity, boosting the region's share in modern energy solutions.

- **Training Focus:** Hydrogen technologies, including electrolyser operation and safety.
- **Partners:** International organisations (UNIDO, EU) and African governments.
- **Benchmarking Value:** RCREEE offers regional vocational training that Namibia could join or replicate.

**India – National Institute of Solar Energy (NISE) and Skill Council for Green Jobs (SCGJ)** (https://www.nise.res.in)

NISE is an autonomous institute under the Ministry of New and Renewable Energy (MNRE), India, focused on research, testing, certification, and development of solar products. It supports MNRE's goal to make India self-reliant in renewable energy and to address challenges during the National Solar Mission (NSM). NISE has contributed to the solar sector by developing new technologies and standards, and it aims to further accelerate renewable energy growth in collaboration with the Indian government.

- **Training Focus:** $GH_2$ production, electrolyser maintenance, and solar integration.
- **Partners:** Ministry of New and Renewable Energy (MNRE), private sector.
- **Benchmarking Value:** India has scalable vocational training models that Namibia could customise.

**China – China Hydrogen Alliance (CHA) and Vocational Training Institutes** (https://www.ceic.com)

The China Hydrogen Alliance (CHA) is a key industry group focused on developing China's hydrogen energy sector, promoting research, and setting technical standards. It fosters cooperation and strategic planning through its analyses and roadmaps, predicting strong growth in hydrogen demand and a shift to cleaner energy. With specific vocational training links still limited, CHA's support for capacity building suggests involvement in developing a skilled workforce for China's hydrogen industry.

- **Training Focus:** Large-scale electrolyser deployment, PEM/alkaline electrolysis, and safety protocols.
- **Partners:** Government, Sinopec, and academic institutions.
- **Benchmarking Value:** China leads in electrolyser manufacture; Namibia could adopt necessary best practices in maintenance training.

**Japan – Fukushima Hydrogen Energy Research Field (FH2R) and Technical Colleges**

- **Training Focus:** Advanced electrolyser operation, hydrogen safety, and system integration.
- **Partners:** NEDO, Toshiba, and Toyota.
- **Benchmarking Value:** Japan's high standard in technical training could guide Namibia's vocational programs.

### Summary

The African and Asian organisations are government-run bodies that consolidate research from universities, vocational centres, and industry stakeholders. Since most Vocational Training Centres (VTCs) are not easily accessible online, these organisations will provide direct links to suitable VTCs for partnership opportunities with the Namibia Training Authority (NTA).

Furthermore, these models will improve the dual training system and encourage the establishment of technology centres or learning factories. These facilities will enable practical interactions among vocational experts, researchers, innovators, and industry players throughout the entire green hydrogen value chain.

## 1.4 Skills Gap Analysis in the Field of Electrolyser Installation, Operation and Maintenance

### Industry Stakeholders' Key Skills Requirement

The following skills align with key industry stakeholders' requirements for the various projects listed in **Table 1**. Some skills are not at the TVET level, as some operations require higher engineering skills. This is further explained in **Section 1.5.**

**Electrical and Power Systems**

- Installation and maintenance of high-voltage DC systems from solar/wind sources
- Integration of renewable energy with electrolyser systems
- Electrical protection systems and grounding
- Power electronics (inverters, transformers)

**Electrolyser Operation and Maintenance (PEM / Alkaline)**

- Electrolyser stack installation and commissioning
- Performance diagnostics (voltage, current, temperature monitoring)
- System calibration and control (SCADA/PLC interfaces)
- Hydrogen yield monitoring and optimisation
- Troubleshooting low-pressure and purity issues

**Instrumentation and Control (I&C)**

- Calibration of flow, pressure, temperature, and conductivity sensors
- Maintenance of automated control systems (e.g. PLCs, HMIs)
- Alarm response and system health checks

**Mechanical Maintenance**

- Assembly and preventive maintenance of pumps, valves, and compressors
- Leak detection systems for hydrogen
- Piping system inspection and cleaning (stainless steel, composite piping)

**Water Treatment and Recycling**

- Operation of reverse osmosis (RO) and deionisation (DI) units
- Monitoring water quality (TDS, pH, conductivity)
- Closed-loop water reuse for sustainable operation

**Hydrogen Safety and Risk Management**

- Understanding ATEX zones and gas classification standards
- Use of hydrogen detectors and alarms
- Emergency shutdown and fire suppression protocols
- Personal protective equipment (PPE) and evacuation procedures

**Process Integration Skills**

- Integration of hydrogen production with downstream uses (e.g., ammonia synthesis, DRI iron production)
- Control of flow rates and synchronisation with industrial furnaces
- Process control logic across multi-unit operations

## Gaps in the National Vocational Qualifications

Current National Vocational Qualifications have elements that are relevant to Electrolyser installation, operation, and maintenance. However, the gaps are non-trivial. Table 7 presents a summary of some of the gaps.

**Table 7: Areas of Skills Gap and Observation**

| Area | Skills Gap | Observations |
|---|---|---|
| **Electrolyser-Specific Technical Training** | Major gap | No formal qualification or certifications exist in PEM/alkaline electrolyser operation or maintenance. |
| **Instrumentation and Control (Hydrogen Context)** | Partial gap | Some training in general I&C exists but lacks hydrogen-specific applications (SCADA for electrolyser systems). |
| **Hydrogen Safety Protocols** | Major gap | No widespread training for ATEX compliance or hydrogen safety. Few emergency response capabilities for hydrogen incidents. |
| **Water Treatment for Electrolysis** | Partial gap | Basic water treatment is covered in NVC in Water Supply and Sanitation qualification but not tailored to ultrapure water and closed-loop reuse in electrolysis. |
| **Hydrogen Integration with Industry (e.g., Iron/Ammonia)** | Emerging gap | Currently no qualification to support the integration of hydrogen with iron reduction or ammonia production. |
| **Workplace-Based Learning (WBL) Opportunities** | Severe gap | Few or no structured internships/apprenticeships at hydrogen project sites in Namibia. |

Two key national qualifications [5] are essential for the installation, operation, and maintenance of electrolysers.

1. National Vocational Certificate in Electrical Engineering (Electrical General) Levels 2 to 5
2. National Vocational Certificate in Electrical Engineering (Instrumentation and Control) Levels 2 to 5

By analysing these qualifications, significant skills gaps have been identified that need to be addressed for electrolyser technicians. For a detailed overview of these gaps, please refer to **Tables 8 and 9**, which provide a comprehensive gap analysis derived from the current training offerings.
Understanding and bridging these gaps is crucial for enhancing the skills of electrolyser technicians. Hence, this will be the basis for the proposed short courses enumerated in **Section 2**. These short courses will ultimately lead to improved operational efficiency and safer practices in the field.

**Table 8: Curriculum Gap Analysis Electrical General**

| Electrolyser Skill Area | Existing Related Content | Gap Identified | Recommendation |
|---|---|---|---|
| **1. Electrical Installation for Electrolysers** | Basic installation principles (general) at Levels 3-5 | No mention of DC systems for electrolysis, hydrogen-specific cabling, or control panels | Short course on "Electrical Installation for Hydrogen Systems" |
| **2. System Commissioning** | "Test and commission installations" (Level 5) | No mention of electrolyser commissioning, gas-tightness, purging protocols | Short course on "Commissioning of Electrolyser Units" |
| **3. Maintenance of Electrolysers** | "Conduct planned and unplanned maintenance" (Level 4) | Does not cover membrane cleaning, gas sensor calibration, or stack servicing | Short course on "Maintenance of Electrolyser Systems" |
| **4. Hydrogen and Gas Safety** | No coverage | No gas hazard awareness, explosion-proof equipment, or H2 detection | Short course on "Hydrogen Safety and Hazard for GH2 Production" |
| **5. Electrolyser Operation** | General operation principles in electrical context only | Missing operational control logic, diagnostics, and performance tuning | Short course on "Operational Management of Electrolysers" |
| **6. Renewable Integration with Electrolysers** | General metering and power systems coverage | Missing integration of variable renewable energy sources (solar/ wind) | Short course on "Integrating Electrolysers with Renewables" |

**Table 9: Curriculum Gap Analysis Electrical (Instrumentation and Control)**

| Electrolyser Skill Area | Existing Related Content | Gap Identified | Recommended Short Course |
|---|---|---|---|
| **1. Sensor and Instrument Integration** | Sensor installation, calibration, loop checking, signal types (Levels 3–4) | No application to gas-specific sensors (e.g., $H_2$ detectors, dew point, pressure) | "Instrumentation for Hydrogen and Electrolysis Systems" |
| **2. Control Systems (PLC/SCADA)** | PLC programming, SCADA systems, process automation (Levels 4–5) | No electrolyser-specific logic, stack control, ramp-up/down cycles | "PLC and SCADA Programming for Electrolyser Control" |
| **3. Electrolyser System Operation** | General process operation principles, DCS systems (Levels 4–5) | No training on electrolyser stacks, efficiency optimisation, operational safety | "Electrolyser Operation and Performance Management" |
| **4. Maintenance Procedures** | Routine and predictive maintenance, diagnostics, loop tuning (Levels 4–5) | No stack replacement, membrane servicing, gas system troubleshooting | "Maintenance of Electrolyser Units" |
| **5. Process Safety and Gas Hazards** | Basic industrial safety and security systems (Level 4), general workplace safety (Level 2) | Lacks hydrogen-specific safety, LEL monitoring, ATEX zones, emergency response | "Hydrogen Safety and Hazard Mitigation for Technicians" |
| **6. Data Logging and Remote Monitoring** | Data acquisition, SCADA, communication protocols (Level 5) | No focus on hydrogen system telemetry, fault logs, cloud monitoring | "Data Acquisition and Remote Monitoring in Hydrogen Systems" |
| **7. Integration with Renewables** | None explicitly covered | Lacks skills for power-electronics interfacing with VRE (solar, wind) | "Integration of Electrolysers with Renewable Energy Sources" |
| **8. Water and Gas Quality Instrumentation** | Analytical instrumentation (Level 4) | No detail on electrolyser input water quality monitoring (conductivity, pH, TOC) | "Water and Gas Quality Monitoring for Electrolysis Systems" |

# 2

# RECOMMENDATIONS FOR TRAINING MEASURES IN ELECTROLYSER INSTALLATION, OPERATION AND MAINTENANCE

## 2.1 Brief Description of Recommended Short Courses

Training for the installation, operation, and maintenance of electrolysers is all but non-existent in Namibia and is still at early stages in Europe. Therefore, we recommend focusing on upskilling graduates from Vocational Training Centres (VTCs) who have studied Electrical General, Instrumentation and Control. Table 10 lists the proposed short courses, their objectives, and the corresponding training levels. However, Namibia University of Science and Technology (NUST), with NQF Level 6 (Diploma) or Level 7 (B Tech) in Electrical or Mechanical Engineering, could also have the short courses listed in Table 10 incorporated with a module on pedagogy.

They may subsequently become trainers for the VTC graduates and thereby create a multiplier effect for the training of electrolyser installation, operation and maintenance in Namibia.

**Table 10: Proposed Short Courses, their Aims and Levels**

| Module | Short Course Title | Aim of Training | Proposed NQF Level |
|---|---|---|---|
| 1 | Hydrogen Fundamentals and Electrolyser Technologies | Introduce trainees to the hydrogen value chain, electrolysis principles, and electrolyser types (PEM/Alkaline). | Level 3 |
| 2 | Electrical Installation for Electrolyser Systems | Equip electrical technicians with skills to install and connect hydrogen-specific DC systems safely. | Level 4 |
| 3 | SCADA, PLC and Control for Electrolysers | Train technicians to operate and interface with electrolyser control systems (PLC, SCADA, HMI). | Level 5 |
| 4 | Electrolyser Stack Operation and Performance Monitoring | Enable safe stack operation, monitoring of key parameters, and operational optimisation. | Level 4–5 |
| 5 | Maintenance of PEM and Alkaline Electrolysers | Provide knowledge and practical skills to perform routine and preventive maintenance on electrolyser systems. | Level 4 |
| 6 | Water Treatment for Electrolysis Operations | Build competence in managing water purification systems (RO, DI) and ensuring water quality. | Level 4 |
| 7 | Hydrogen Safety and Emergency Response | Ensure safe work practices in hydrogen environments, including ATEX zones and gas detection. | Level 3–4 |
| 8 | Integration of Electrolysers with Renewable Energy Systems | Prepare technicians to manage power variability and interface electrolysers with solar/wind systems. | Level 5 |

The eight short courses are mandatory in order to become a qualified professional in the installation, operation, and maintenance of electrolysers. However, the necessity of certain courses may vary according to the technician's specific job description. For instance, if a candidate's role is limited to operation and maintenance, Module 2 may be deemed unnecessary.

## 2.2 Recommended Upskilling Training Measures Related to the Short Courses

A detailed analysis of the NTA-registered programs [6] highlights the key areas related to the installation, operation, and maintenance of electrolysers as follows:

- National Vocational Certificate in Electrical Engineering – Electrical General (NQF Levels 2-4)
- National Vocational Certificate in Electrical Engineering – Electrical Energy (NQF Level 5)
- National Vocational Certificate in Electrical Engineering – Instrumentation and Control (NQF Levels 2-4)
- National Vocational Certificate in Electrical Engineering – Instrumentation and Control (NQF Level 5)

Details for the justification for these qualifications are presented in Table 2. It is worth noting that most Vocational Training Centres (VTCs) within the country only offer qualifications up to NQF Levels 1 to 3. Therefore, the few VTCs capable of delivering training up to Level 5 should be targeted to pilot the recommended upskilling program.

Furthermore, the recommended short courses could be expanded to become a full qualification at NQF Level 5, with the admission requirement being holders of Level 4 qualifications in the aforementioned qualifications.

As elaborated in Section 2.5, the proposed delivery method will be based upon Germany's dual studies format, yet adapted to the Namibian context. This dual approach could enhance the practical skills of trainees and improve their employability by integrating classroom learning with hands-on experience in the industry. This enhances their preparation for future career opportunities in the field.

## 2.3 Short Courses: Brief Outline of Competencies Required

As outlined in Table 8, eight short courses are recommended for the upskilling of holders of an electrical general or energy qualification, as well as holders of instrumentation and control level 3, to become electrolyser operators at level 4/5. The details of these short courses, includes duration, learning outcomes, and expected competencies, which are all provided in this section.

Table 8: Short Course Recommendations

| | | | |
|---|---|---|---|
| **Title of Short-Course 1** | **Hydrogen Fundamentals and Electrolyser Technologies** | | |
| **Objective** | Provides a foundational understanding of hydrogen production, electrolysis technologies, and applications. | NQF Level 3 | |
| **Target Group** | All technician-level trainees | Duration | 5 days |
| **Comprehensive outcome** | Trainees will understand hydrogen value chains and distinguish between major electrolyser technologies (PEM, Alkaline, SOEC). | | |
| **Learning outcomes** | • Explain the hydrogen value chain and green hydrogen context.<br>• Describe the working principles of PEM and Alkaline electrolysers.<br>• Compare different electrolysis technologies and their applications. | | |
| **Topics** | 1. Hydrogen production pathways<br>2. Electrolyser components and chemistry<br>3. PEM vs Alkaline systems<br>4. Industrial hydrogen use cases | | |
| **Practical Session(s)** | Demonstration of electrolyser systems; visual comparison of PEM vs Alkaline units | | |
| **Competencies Gained** | • Understanding the role of hydrogen in the global energy transition.<br>• Learn how electrolyser technologies (PEM, Alkaline, SOEC) work.<br>• Compare applications and performance characteristics of different electrolyser types. | | |
| **Title of Short-Course 2** | **Electrical Installation for Electrolyser Systems** | | |
| **Objective** | Prepare technicians for safe and effective DC power system installation and hydrogen-specific wiring. | NQF Level 4 | |
| **Target Group** | Electrical General Graduates | Duration | 5 days |
| **Comprehensive outcome** | Trainees will perform safe electrical installation of DC systems and hydrogen-rated components. | | |
| **Learning outcomes** | • Identify DC components and protection systems.<br>• Apply ATEX requirements for wiring in hazardous zones.<br>• Perform panel wiring and component mounting for electrolysers. | | |
| **Topics** | 1. DC systems, grounding, and protection<br>2. Cable routing for explosive atmospheres<br>3. Panel installation and termination<br>4. ATEX-compliant practices | | |
| **Practical Sessions** | Hands-on panel installation, cable routing, and termination for hydrogen systems. | | |
| **Competencies Gained** | • Perform safe installation of DC electrical systems specific to electrolyser units.<br>• Interpret and apply ATEX requirements for wiring in explosive atmospheres.<br>• Install and test hydrogen-rated panels, breakers, and protection devices. | | |

| | | | |
|---|---|---|---|
| **Title of Short-Course 3** | **SCADA, PLC and Control for Electrolysers** | | |
| **Objective** | Enable technicians to interact with control systems managing electrolyser stacks. | NQF Level | |
| **Target Group** | Instrumentation Graduates | Duration | 10 days |
| **Comprehensive outcome** | Trainees will configure and operate SCADA and PLC systems for electrolyser monitoring and control. | | |
| **Learning outcomes** | • Explain PLC functions in electrolyser systems.<br>• Configure SCADA displays and alarm logic.<br>• Operate and troubleshoot basic electrolyser control systems. | | |
| **Topics** | 1. PLC logic for stack management<br>2. SCADA alarms, HMI interaction<br>3. Electrolyser ramp-up/down programming<br>4. Remote monitoring and data logging | | |
| **Practical Sessions** | Simulated PLC/SCADA setup; fault insertion and resolution using HMI tools. | | |
| **Competencies Gained** | • Configure PLCs and SCADA systems for electrolyser operation and monitoring.<br>• Interpret control logic, alarms, and process automation workflows.<br>• Troubleshoot and maintain digital control interfaces (HMI, alarms, signals). | | |
| **Title of Short-Course 4** | **Electrolyser Stack Operation and Performance Monitoring** | | |
| **Objective** | Train technicians to operate stacks safely and optimize performance. | NQF Level 5 | |
| **Target Group** | Mixed (Electrical + I&C graduates) | Duration | 10 days |
| **Comprehensive outcome** | Trainees will start, monitor and stop electrolyser stacks and optimise key performance parameters. | | |
| **Learning outcomes** | • Start up and shut down electrolyser stacks safely.<br>• Monitor current, voltage, and temperature.<br>• Diagnose and address common operating faults. | | |
| **Topics** | 1. Stack startup and shutdown<br>2. Monitoring current, voltage, temperature<br>3. Troubleshooting common faults<br>4. Efficiency and yield optimisation | | |
| **Practical Sessions** | Live stack operation in demo lab or simulator; diagnostic exercises. | | |
| **Competencies Gained** | • Start up and shut down electrolyser stacks following OEM procedures.<br>• Monitor key operating parameters (current, voltage, temperature).<br>• Identify and resolve basic performance issues affecting hydrogen yield. | | |

| Title of Short-Course 5 | Maintenance of PEM and Alkaline Electrolysers | | |
| --- | --- | --- | --- |
| **Objective** | Equip trainees to conduct scheduled and preventive maintenance. | NQF Level 4 | |
| **Target Group** | Electrical / I&C / mechanical technicians | Duration | 10 days |
| **Comprehensive outcome** | Trainees will carry out scheduled maintenance and address common issues in PEM and Alkaline systems. | | |
| **Learning outcomes** | • Perform stack inspection and membrane checks.<br>• Service pumps, compressors, and valves.<br>• Apply leak detection protocols and replace faulty components. | | |
| **Topics** | 1. Membrane and gasket checks<br>2. Electrolyte management<br>3. Pump, valve, and compressor maintenance<br>4. Leak detection (hydrogen sensors)<br>5. Safe Ventilation and Purging Procedures for Electrolyser Maintenance in Hydrogen Environments | | |
| **Practical Sessions** | Dismantling stack components; leak detection drill; part replacement exercises. | | |
| **Competencies Gained** | • Conduct preventive maintenance and routine checks on electrolyser systems.<br>• Inspect and replace stack components, seals, and membranes.<br>• Use diagnostic tools for troubleshooting electrical and mechanical faults. | | |
| **Title of Short-Course 6** | **Water Treatment for Electrolysis Operations** | | |
| **Objective** | To build competence in water purification techniques essential for high-efficiency hydrogen production. | NQF Level 4 | |
| **Target Group** | Technicians working in electrolyser O&M | Duration | 5 days |
| **Comprehensive outcome** | Trainees will operate and maintain RO and DI water systems for electrolyser use. | | |
| **Learning outcomes** | • Operate reverse osmosis and DI units.<br>• Monitor water quality parameters (TDS, pH, conductivity).<br>• Troubleshoot water system faults. | | |
| **Topics** | 1. Reverse osmosis (RO) system operation<br>2. DI unit maintenance<br>3. Water quality monitoring (TDS, conductivity, pH)<br>4. Closed-loop reuse systems | | |
| **Practical Sessions** | Hands-on RO/DI unit maintenance and water sampling exercises. | | |
| **Competencies Gained** | • Operate and maintain reverse osmosis and deionisation (DI) water systems.<br>• Monitor water quality parameters like TDS, pH, and conductivity.<br>• Diagnose and resolve common water system issues in electrolyser setups. | | |

| | | | |
|---|---|---|---|
| **Title of Short-Course 7** | **Hydrogen Safety and Emergency Response** | | |
| **Objective** | Ensure technicians work safely in explosive hydrogen environments. | NQF Level 4 | |
| **Target Group** | All personnel involved in electrolyser operation | Duration | 5 days |
| **Comprehensive outcome** | Trainees will follow ATEX standards and emergency procedures for hydrogen incidents. | | |
| **Learning outcomes** | • Identify hydrogen hazards and LEL values.<br>• Use PPE and gas detectors correctly.<br>• Respond to hydrogen leaks and fires. | | |
| **Topics** | 1. ATEX zones, gas classification<br>2. Gas detectors and alarms<br>3. PPE, evacuation, fire suppression<br>4. Incident reporting and emergency drills | | |
| **Practical Sessions** | Emergency response drills; ATEX zone hazard walk-through; PPE usage exercise | | |
| **Competencies Gained** | • Apply ATEX and LEL principles in hydrogen environments.<br>• Use gas detection equipment and personal protective equipment (PPE) appropriately.<br>• Effective response to hydrogen leaks, fires, or system failures. | | |
| **Title of Short-Course 8** | **Integration of Electrolysers with Renewable Energy Systems** | | |
| **Objective** | Train technicians for interfacing variable solar/wind power with electrolysers. | NQF Level 5 | |
| **Target Group** | Advanced trainees (Level 5+) | Duration | 5 days |
| **Comprehensive outcome** | Trainees will configure electrolyser systems to operate with solar/wind energy sources. | | |
| **Learning outcomes** | • Explain load-following operation with renewables.<br>• Configure the interface between VRE systems and electrolyser units.<br>• Troubleshooting integration issues (voltage drops, fluctuations). | | |
| **Topics** | 1. Load-following operation<br>2. Buffer systems and DC/DC converters<br>3. Grid and off-grid control logic | | |
| **Practical Sessions** | Simulated power variability exercise; configuration of load-matching logic. | | |
| **Competencies Gained** | • Interface electrolyser systems with variable solar and wind energy sources.<br>• Manage voltage and current variability through load-following strategies.<br>• Troubleshooting integration issues between renewable energy and hydrogen production systems. | | |

The implementation of these short courses or their transformation into a comprehensive one-year qualification may be further developed. This might require a bridging programme to enhance candidate skills prior to them undertaking the electrolyser technician qualification.

## 2.4 Potential Capacity-Building Initiatives Related to the Short Courses

This study shows that, currently, no NTA-recognised VTCs provide the two main qualifications needed to develop skilled technicians in electrolyser installation, operation, and maintenance at Level 4.

Furthermore, the training equipment at VTCs offering Level 3 qualifications is outdated and inadequate for electrolyser applications. These factors create significant challenges for finding a suitable VTC to pilot the essential training.

To overcome this challenge, we propose a collaborative initiative between the most competent VTC, and supportive industry partners such as HyIron or Cleanergy, to create an effective pilot training team. We strongly advocate for implementing a dual training system for this purpose.

Alternatively, these programmes could be hosted between identified VTCs and NUST or UNAM, where modern facilities are readily available. This will address the articulation problem that currently exists between the VTCs and the universities.

Including graduates from electrical, mechanical, and chemical engineering in the upskilling process can enhance training quality and cultivate a robust pool of electrolyser technicians.

This approach promises to generate a critical mass of skilled professionals who can meet the industry's growing demands. As an example, NUST could offer Level 6 Diploma programmes in Electrical Engineering and Mechanical Engineering.

These programmes will include relevant courses like automation, controls, measurements, renewable energy, and power systems. Consequently, diploma students shall easily be fast-tracked to becoming electrolyser technicians, requiring minimal additional training with modern laboratory equipment.

### Infrastructure and Equipment Requirements

For effective electrolyser operation technician upskilling, we recommend the following practical equipment and facilities that a Vocational Training Centre (VTC) would need via effective partnering with industry. The setup is designed for hands-on, technician-level training and tailored to the proposed short courses.

**Table 11: Core Training Facilities**

| Facility | Purpose |
|---|---|
| **Hydrogen Training Lab (Safe Zone)** | Controlled space for hands-on electrolyser operations, stack handling |
| **Electrical Installation Workshop** | For DC system setup, ATEX-compliant wiring, panel installation |
| **SCADA/PLC Simulation Lab** | For programming, troubleshooting, and HMI interface exercises |
| **Water Treatment Mini-Plant** | Training on RO and DI systems for ultrapure water preparation |
| **Hydrogen Safety Training Room** | For ATEX zoning, detector use, PPE drills, and virtual fire simulations |
| **Renewable Energy Simulation Bench** | Simulates solar/wind input variability for integration training |
| **Mechanical Assembly Bay** | Valve, pump, and compressor disassembly, maintenance, and diagnostics |

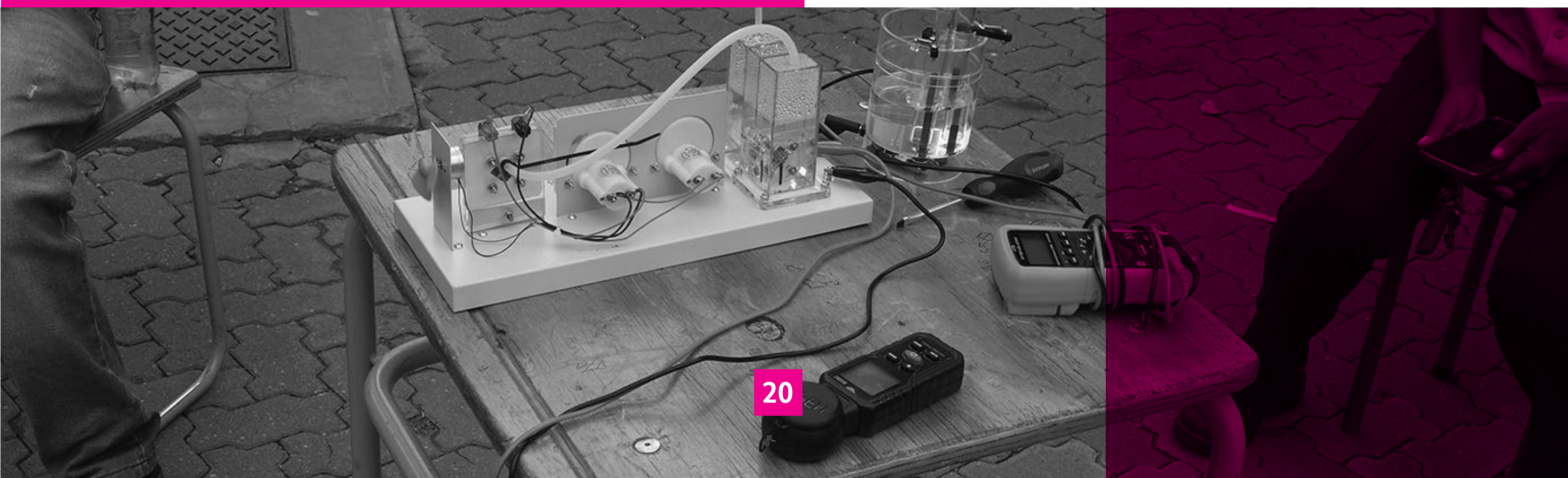


Table 12: Key Practical Equipment and Tools

| Equipment | Training Use |
|---|---|
| **Training Electrolyser Unit (PEM + Alkaline)** | Demonstrates stack operation, control logic, and maintenance procedures |
| **DC Power Supply Units (adjustable)** | Simulates variable voltage input from renewables |
| **Programmable Logic Controllers (PLCs)** | Used to replicate electrolyser control scenarios |
| **SCADA Interface Systems** | HMI setup, real-time monitoring, alarm configuration |
| **Reverse Osmosis (RO) and Deionisation Units** | Operate and maintain ultrapure water systems |
| **Water Quality Meters** | Measure conductivity, TDS, pH |
| **Hydrogen Leak Detectors (portable and fixed)** | Detect leaks during safety drills |
| **Explosion-Proof Lighting and Panels** | Demonstrate ATEX-rated installations |
| **Personal Protective Equipment (PPE)** | Fireproof suits, gloves, gas masks, face shields, ATEX boots |
| **Gas Storage Demonstrators (small-scale)** | Simulate hydrogen production and safe containment |
| **Simulation Software (Hydrogen Plant Models)** | Practice process integration and remote-control logic |
| **Solar/Wind Emulator Kit** | Mimic renewable source behaviour for interfacing exercises |

Table 13: Tools and Consumables

| Item | Purpose |
|---|---|
| **Industrial hand tools (multimeters, wrenches, testers)** | General maintenance and installation tasks |
| **Electrical cabling (DC-rated, ATEX-rated)** | Hands-on installation tasks |
| **Hydrogen-compatible tubing and valves** | Piping and flow system exercises |
| **Replacement parts for stacks/membranes** | Practice assembly and troubleshooting |
| **Safety signage and labels** | Hazard zone simulation |

Table 14: Industry Collaboration Requirements

| Item | Purpose |
|---|---|
| **Access to live industrial hydrogen sites** | For internships, job shadowing, real system exposure |
| **Donation or lease of training-scale electrolysers** | Enable hands-on practical exercises with real equipment |
| **Guest instructors from industry** | Deliver specialised modules (e.g., hydrogen standards, OEM procedures) |
| **OEM documentation and system manuals** | Teach troubleshooting and operation aligned with real equipment |

## 2.5 Recommendations for Potential Partnerships

As outlined in Section 2.4, we have identified two key local partners for a pilot dual-study system: Cleanergy and Oshivela HyIron. Both are small companies with electrolyser capacities of 5 MW and 12 MW, respectively, who have expressed their strong interest in pursuing this partnership.

To formalise this collaboration, several agreements are required, that cover confidentiality, OEM practices, amongst other terms. However, unlocking Namibia's green hydrogen potential depends on establishing these strategic partnerships, and we believe that these collaborations will be supported and encouraged.

**Figure 4: Electrolysers at Oshivela HyIron**

**6 MW x 2 Electrolysers in Oshivela Hylron**

Also two excellent German candidate companies for a partnership in Namibia, given their interest in providing their technology in the country.

Companies having Equipment and Projects with Possible Links to Namibia

**Bilfinger**

- Engaged in large-scale green hydrogen systems (in partnership with Green Hydrogen Systems).
- As an engineering service provider, Bilfinger is well-positioned to supply and/or support equipment installations in Namibia.

**Siemens Energy**

- Delivering large-scale electrolyser systems, including stacks and power electronics (e.g., Emden 280 MW plant).
- Could supply key components like stacks and electrification modules with vocational training relevance.

Alternatively, further German institutions and companies, which are already involved in dual study programs in Germany, and also interested in developing Namibia's green hydrogen industry, could be approached to pilot this arrangement.

Establishing partnerships with these organisations will help Original Equipment Manufacturers (OEMs) develop a skilled workforce for their equipment, to ensure reliable after-sales maintenance and long-term success.

### Proposed German Dual-Study and Training Partners in Hydrogen

**Maximator Hydrogen GmbH**

- Dual-study partnership with Nordhausen University of Applied Sciences to train students in hydrogen tech through combined academic and practical workplace learning [5].
- Specialising in $H_2$ infrastructure solutions, including refuelling stations, compressors, and system integration.

**Fraunhofer IWU**

- Implementing practical microgrid projects with hydrogen production and fuel cell use in Walvis Bay (Namibia) [6].
- Providing applied research and training, thus making for a potential partner for vocational training content and localised capacity building.

**BAM (Federal Institute for Materials Research and Testing)**

- Supporting doctoral tracks and short courses in Namibia on hydrogen safety, lab capacity, and standardisation infrastructure [7].
- Covering hydrogen materials safety—a critical area for VTC practical labs and certification.

**DECHEMA (Society for Chemical Engineering and Biotechnology)**

- Leading the GH2 Namibia programme, supporting technical training, water management, and hydrogen technology research [8]

# 3 CONCLUSION AND RECOMMENDATIONS

## Conclusion

Key conclusions indicate that Namibia currently faces a significant skills gap in electrolyser technology, as there's no dedicated vocational qualification for its installation, operation, nor maintenance.

Although some foundational electrical and instrumentation training exists through NQF-registered qualifications, these fail to cover hydrogen-specific safety or technologies.

The rising demand from major hydrogen projects, such as HyIron and Cleanergy, underscores an urgent need for local technicians, with reliance on OEMs for maintenance deemed unsustainable while retarding local empowerment. Furthermore, there are no regional training providers offering structured electrolyser training.

European certification standards like TÜV SÜD and DVGW could serve as helpful benchmarks. A dual training model, that combines classroom learning with hands-on industrial training—commonly practiced in Germany—is highly regarded and particularly suitable for Namibia's context.

## Key Recommendations

Key recommendations focus on establishing a comprehensive training framework. This includes implementing eight mandatory short courses at the technician level (NQF levels 3–5) that cover fundamental and advanced topics such as hydrogen technology, electrical installation, safety, and renewable integration, aligned with international certification standards. Promoting a dual training approach involves partnerships with vocational training centres and industry players to facilitate work-based learning and enhance employment prospects.

A critical mass of future trainers for the VTCs can simultaneously emerge. Infrastructure upgrades at vocational training centres are essential, requiring investments in specialised labs, simulators, electrolyser demo units, and safety equipment. Strengthening formal industry partnerships is also critical, involving collaborations with companies like HyIron, Cleanergy, Siemens, and TÜV SÜD who can provide real-world training opportunities and ensure curriculum validation. Fast-tracking upskilling efforts at institutions like NUST and UNAM via utilising engineering graduates as trainers are recommended to build local training capacity.

Finally, we recommend the development of a national electrolyser technician qualification, through evolving the current short courses into a formal NQF Level 5 credential with clear pathways from existing vocational programs.

# 4 LITERATURE AND DOCUMENTS


[1] S. Shefeni, “Renewable Policy and Practice: A Look at Namibia,” Institute for Public Policy Research (IPPR), Windhoek, 2024.

[2] Namibia Green Hydrogen Programme, “Green Hydrogen Projects,” 2024. [Online]. Available: https://gh2namibia.com. [Accessed May 2025].

[3] Hyphen, “The Hyphen Project,” [Online]. Available: https://hyphenafrica.com/the-hyphen-project/. [Accessed 1 May 2025].

[4] Media Centre, [Online]. Available: https://namgha.org/media. [Accessed May 2025].

[5] The Ohlthaver and List Group and CMB.TECH launch Namibia's first green hydrogen production plant, [Online]. Available: https://www.ol.na/the-ohlthaver-list-ol-group-and-cmb-tech-launch-namibias-first-green-hydrogen-production-plant/. [Accessed 1 May 2025].

[6] N. Q. A. (NQA), “Regulations Setting-Up the National Qualifications Framework for Namibia,” Ministry of Education, Windhoek, 2006.

[7] Namibia Training Authority, “Qualifications and Unit Standards Portal,” [Online]. Available: https://unitstandards.nta.com.na. [Accessed January 2025].

[8] M. Kurras, “Maximator Hydrogen,” 19 December 2023. [Online]. Available: https://www.maximator-hydrogen.de/en/newsroom. [Accessed 25 June 2025].

[9] U. Beyer, “Fraunhofer IWU,” 14 July 2023. [Online]. Available: https://www.iwu.fraunhofer.de/en/press. [Accessed 25 June 2025].

[10] BAM, “Bundesanstalt für Materialforschung und Prüfung (BAM),” 28 October 2022. [Online]. Available: https://www.bam.de/Content/EN/Press-Releases. [Accessed 25 June 2025].

[11] S. Möhl, DECHEMA, 13 April 2023. [Online]. Available: https://dechema.de/en/About+DECHEMA/Press/. [Accessed 25 June 2025].

[12] GIZ, “Enhancing Employability: Skills Needs and Gap Analysis in Namibia’s PtX Sector and Recommendations for a Skills Development Programme,” Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Bonn and Eschborn, Germany, 2023.