



TVET SKILLS FOR RENEWABLE ENERGY AND GREEN HYDROGEN IN NAMIBIA

Annexure 7: Plumbing and Pipefitting

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The opinions and recommendations expressed do not necessarily reflect the positions of the commissioning institution or the implementing agency.



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ACRONYMS

Ar/Ti purge	High-purity Argon shielding gas with titanium oxygen-gettering coupons/sensors used when welding ultra-clean stainless pipe.
ASME	American Society of Mechanical Engineers (e.g. ASME B31.12 hydrogen-piping code).
ATEX	French acronym for “Atmosphères Explosibles”; European directive for equipment used in explosive atmospheres.
AWS	American Welding Society (AWS D18 hygienic-tubing weld standard).
BINDT / PCN	British Institute of Non-Destructive Testing / “Personnel Certification in NDT” scheme that issues PCN Level 2, 3 etc. cards.
CHIETA	Chemical Industries Education and Training Authority (South Africa).
CPD	Continuing Professional Development.
EPC	Engineering, Procurement and Construction (prime contractor type).
EWSETA	Energy and Water Sector Education and Training Authority (South Africa).
GH ₂	Green (renewable), Hydrogen.
GTAW	Gas Tungsten Arc Welding (TIG).
HAZ	Heat-Affected Zone (in/near a weld).
Hyphen	Hyphen Hydrogen Energy, Namibia’s flagship H ₂ project developer.
IIW	International Institute of Welding.
ISO	International Organisation for Standardisation (e.g., ISO 9606 welder qualification).
KPI	Key Performance Indicator
MoM / MoMs	Minutes of Meeting(s).
MTR	Material Test Report (mill certificate for piping materials).
NACE	Formerly National Association of Corrosion Engineers; publishes MR0175 and TM0284 hydrogen-damage standards.
NAMCOL	Namibia College of Open Learning.
NDT	Non-Destructive Testing (umbrella for PT, RT, UT, etc.).
NIMT	Namibia Institute of Mining and Technology.
NQA	Namibia Qualifications Authority.
NQF	National Qualifications Framework.
NSI	Namibian Standards Institution.
NTA	Namibia Training Authority.
NUST	Namibia University of Science and Technology.
NWIS	National Welding Inspection Services (hydro-/ pressure-test training outfit).
OHS	Occupational Health and Safety.
PED	European Pressure Equipment Directive.
PT / UT / RT	Dye-Penetrant Testing / Ultrasonic Testing / Radiographic Testing (NDT methods).
QCTO	Quality Council for Trades and Occupations (South Africa).
RINA	RINA Consulting (engineering and certification company).
RPL	Recognition of Prior Learning.

SAIW	Southern African Institute of Welding.
SDP	Skills Development Provider (QCTO-accredited training centre).
SETAs	Sector Education and Training Authorities (South Africa).
SN	“Sniffer” (mass-spectrometer hydrogen leak detector).
ToT	Training of Trainers (capacity-building secondment).
TWI	The Welding Institute (UK).
VTC	Vocational Training Centre (government or community training college).

1

ANALYTICAL REPORT

1.1 Status quo, overview of existing training measures and training providers

Namibia's vocational education system already provides a structured pathway for plumbing and pipefitting, primarily through the National Vocational Certificate (NVC) in Plumbing and Pipefitting (Levels 1–4) under the Namibia Training Authority (NTA). Training is competency-based and delivered by public Vocational Training Centres (VTCs), private providers, and community-based institutions.

Organisations such as Valombola Vocational Training Centre (VVTC), Namibia College of Open Learning (NAMCOL), Community Skills Development Centres (COSDECs), and the Katutura Youth Enterprise Centre (KAYEC) serve different learner groups across the regions and offer a combination of classroom teaching and practical training.

However, workshop infrastructure and trainer capacity vary considerably, with many centres facing difficulties in providing adequate hands-on exposure to modern systems.

The capacity of training providers is further limited by several systemic challenges:

- ▶ **Workshop infrastructure constraints:** While many institutions provide hands-on training, specialised plumbing laboratories and access to advanced piping systems remain limited. This restricts trainee exposure to industry-relevant systems such as multi-storey layouts, pressurised installations, and modern pumping technologies, which are particularly important for evolving infrastructure and renewable energy (RE) projects.
- ▶ **Trainer capacity challenges:** Attracting and retaining trainers with recent field experience remains difficult. Many current trainers bring valuable civil plumbing expertise but have limited exposure to emerging areas such as solar thermal integration, advanced pressure regulation, or automated control systems. Efforts to address this gap through upskilling initiatives and industry engagement are ongoing.

- ▶ **Evolving curriculum needs:** While core plumbing competencies are well covered, most programmes do not yet incorporate newer topics such as water-efficient technologies, greywater reuse, or hydrogen-ready infrastructure. With Namibia's growing green hydrogen (GH₂) sector, the demand for future-oriented training content is clear, and curriculum updates are currently being considered or implemented in several institutions.

- ▶ **Delivery scale and coordination:** Training is often delivered in small cohorts (15–25 trainees per level), with workshops and resources shared across multiple trades. Community-based centres play a vital role in improving access and equity, although their capacity to offer fully accredited qualifications varies. Strengthening alignment between providers and emerging sector needs remains a key opportunity.

Overall, while Namibia has an established plumbing training framework and delivery institutions, significant adaptation is needed to meet the demands of the GH₂ value chain.

Priorities include curriculum reform, trainer upskilling, upgraded laboratories, modern training equipment, and stronger partnerships between training centres and industry.

Table 1: Overview of training providers in Plumbing and Pipefitting (excerpt)

Registered provider (NTA/NQA)	Current water-related qualification(s)	Nominal cohort size*	Comments on delivery capacity
Valombola Vocational Training Centre (Ongwediva/Oshakati)	National Voc Cert, Civil and Building Services Engineering (Plumbing), Levels 1-3	3×20	Public VTC with dual-system workshops; good geographic access for north-central regions.
NAMCOL (Otjiwarongo, Windhoek, Ongwediva, Rundu)	National Voc Cert, Plumbing and Pipefitting, Levels 1-3	3×20 per campus	Blended distance+block release; theory well covered, but practical exposure depends on local host employers.
Mapac Technical Training Institute (Oshakati)	National Voc Cert, Plumbing and Pipefitting, Levels 1-3	3×25	Private TP; capacity slightly higher than average but relies on rented workshop space.
Other Training Providers (Namvoc, National Youth Service, etc.)	Plumbing (L1-3), offerings registered, each 20 seats Registered	Scattered rural coverage; equipment often shared with carpentry and bricklaying trades.	

*Cohort sizes taken from NTA registration records.

Brief appraisal of provider capacity and observed gaps:

Strengths: Namibia has a nationwide plumbing training pipeline, with more than ten training providers (TPs) across all regions offering NQF Level 1–3 programmes. These contribute to a basic workforce for installation and maintenance.

Critical gaps: Namibia must address priority areas such as water-efficient fixtures, greywater reuse, and hydrogen-ready installations, in line with the emerging GH₂ value chain. Most state-owned VTCs can accommodate only 20–25 trainees per level and typically share workshops with other building trades, limiting practical exposure to industry-scale piping, pumps, and control systems.

Implications for the forthcoming gap- and benchmarking study:

The Terms of Reference (ToR) for the Water, Plumbing / Plant Operation and Desalination assignment under ProTVET III explicitly require benchmarking against international standards and recommendations for accelerated short-course solutions to close the GH₂ skills gap.

The original hypothesis behind this assignment was that plumbing and pipefitting unit standards need to be revised to incorporate high-efficiency fittings. This includes hydrogen-compatible piping and greywater systems, as well as Continuous Professional Development (CPD) and upskilling for current artisans, enabling their integration into the GH₂ value chain.

After careful consideration and curriculum analysis, it has become apparent that:

- ▶ Plumbers are most valuable for the building-services components of hydrogen projects.
- ▶ Upskilled welders (e.g. Welding Level 4 plus a hydrogen top-up) are indispensable for shop fabrication, site tie-ins, pressure testing, and repair work.

Project phase from planning and design through to construction and, finally, operations

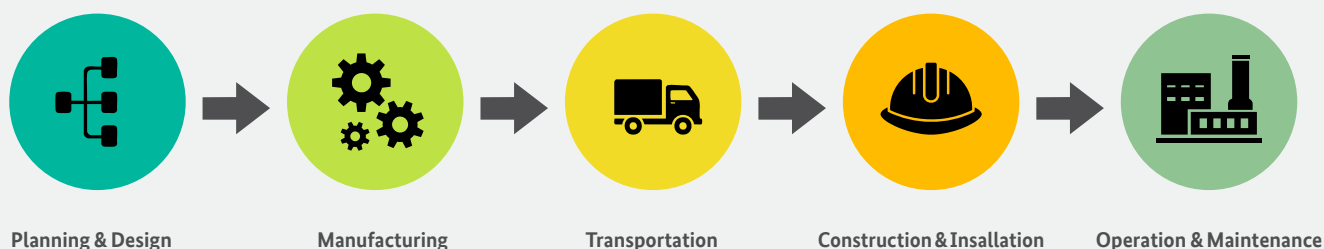


Figure 1: Green Hydrogen Value Chain (Source: Skills Needs and Gap Analysis in Namibia's PtX Sector and Recommendations, PtX Hub)

1.2 Stakeholder mapping and analysis in the RE and Hydrogen sector in Plumbing and Pipefitting

In Namibia, the emerging GH₂ sector involves a range of stakeholders linked to plumbing and pipefitting occupations. Private sector actors include project developers such as Hyphen Hydrogen Energy, HDF Energy, Daures Green Hydrogen Village, and Cleanergy Solutions Namibia, all of whom require extensive water, gas, and hydrogen piping systems. Utility and infrastructure entities like NamWater (water supply) and NamPower (energy) also play a role, as GH₂ projects depend on substantial water inputs that may need to be integrated with power systems.

The Namibian government's Green Hydrogen Programme (NGH₂P) coordinates policy and standards with respective line Ministries. It works with bodies such as the Namibian Standards Institution (NSI) and German DIN to adopt hydrogen-ready codes. Regulators and training authorities are equally crucial: the Namibia Training Authority (NTA) and Namibia Qualifications Authority (NQA) oversee technical and vocational qualifications (e.g. NVCs in Plumbing and Pipefitting, Level 4) and guide curriculum updates.

Technical universities and training institutions (NUST, UNAM, and VTCs), together with development partners such as GIZ's ProTVET project, contribute through research, training, and capacity building. Finally, industry associations and contractors in plumbing and building services (e.g. construction companies and plumbing firms) have a stake in ensuring that their workforce can manage new technologies such as solar water heaters and hydrogen fuel lines.

Feedback from Namibia's Power-to-X (PtX) industry stakeholders has highlighted gaps in advanced piping skills for hydrogen and related systems. The current Plumbing and Pipefitting qualifications in Namibia remain focused on conventional domestic plumbing, such as water supply and sanitation.

GH₂ projects, however, require plumbers and pipefitters with additional competencies: handling high-pressure gases, working with new materials (hydrogen-compatible pipes and seals), and following stricter safety protocols for flammable hydrogen gas.

Industry leaders anticipate a need for skills in reading and interpreting complex piping diagrams, pressure testing, and knowledge of standards for gases (similar to those used in industrial pipefitting). There is also demand for expertise in smart monitoring systems (leak detection, sensor-integrated plumbing) and renewable energy (RE) integration, such as solar water heaters and heat pumps in plumbing systems.

A recent skills assessment report, the Namibia PtX skill needs assessment, recommended upgrading the existing Plumbing and Pipefitting qualification (Levels 3–4) to include industrial pipefitting knowledge and hydrogen safety.

In summary, stakeholders require plumbers who can work on hybrid systems—for example, installing solar thermal systems, connecting electrolyzers to pipelines, or maintaining water recycling in hydrogen plants — combining traditional plumbing skills with new technical expertise in RE and GH₂.

These needs align with broader findings that Namibia must upgrade its qualifications for the hydrogen economy, including the addition of modules on hydrogen, ammonia, and high-pressure systems to relevant vocational programmes.

1.3 International Benchmarking in relation to Plumbing and Pipefitting

Globally, plumbing and pipefitting occupations are typically governed by national certification frameworks and standards bodies. Many countries have official vocational qualifications for plumbers, often issued by government or industry training authorities, which define the core skills and certification requirements:

Namibia

The National Vocational Certificate (NVC) in Plumbing and Pipefitting (Level 4) is issued under the National Qualifications Framework (NQF). It covers domestic water supply, basic sanitation, pumps, and related areas. However, its focus remains largely on conventional plumbing and building services, with no modules currently addressing hydrogen or high-pressure gas systems.

Germany

Germany's plumbing and heating trade certifications are overseen by the Chambers of Crafts (Handwerkskammer) and follow DIN standards. A common qualification is the Anlagenmechaniker für Sanitär-, Heizungs- und Klimatechnik (Plant Mechanic for Sanitary, Heating, and Air Conditioning Systems) for journeymen, and the Installateur- und Heizungsbauermeister (Master Plumber/Heating Technician) for advanced certification.

German training strongly emphasises safety, material standards, and pressure regulations. Plumbers are extensively trained in gas piping for natural gas, heating systems (including modern condensing boilers), and advanced water technology. The core areas therefore include domestic and commercial water supply, wastewater, heating (radiators and boilers), and gas installations, all in compliance with rigorous DIN/EN standards.

A strength of the German system is its comprehensiveness and quality control: apprentices must demonstrate mastery in installing systems according to strict codes (e.g. DVGW standards for gas and water) and undergo a dual training system that is internationally respected.

In terms of renewable energy (RE) and GH₂, Germany's existing plumbing qualifications already incorporate energy-efficient technologies such as solar thermal panels and heat pump integration, alongside general gas safety principles applicable to hydrogen. Notably, many German boilers and piping systems are now marketed as "H₂-ready" (hydrogen-ready) for future conversion.

Thus, the German qualification is well-suited for a hydrogen upgrade, requiring only specific updates once hydrogen use in buildings becomes regulated. The current gap is the lack of explicit hydrogen content, as national regulations for hydrogen pipelines in buildings are still under development.

Gulf Region (KSA/UAE)

In the Gulf, vocational training is often overseen by bodies such as Saudi Arabia's Technical and Vocational Training Corporation (TVTC) and equivalent authorities in other GCC states. Plumbing training in this region is typically linked to large-scale water infrastructure. For example, programmes in Saudi Arabia often focus on desalination plant operations, industrial piping, and high-capacity pump systems, given the reliance on desalinated water.

The core content for a Desalination and Plumbing Technician includes pipeline maintenance, brine and treated water handling, and industrial safety standards. Strengths of the Gulf model include extensive experience with large-scale infrastructure and water recycling technologies. Trainees are taught to manage and conserve water in extreme climates and may also be familiar with advanced control systems used in desalination.

However, GH₂ is a new field. While Gulf countries such as the UAE and Saudi Arabia are investing heavily in hydrogen projects, hydrogen-specific plumbing content—such as hydrogen pipeline materials or leak detection for H₂—has not yet been integrated into standard plumbing curricula. This represents a gap, as hydrogen safety protocols differ from those for water or even natural gas. There are some emerging short courses (for example, Qatar and the UAE have organised seminars on hydrogen safety), but formal integration into plumbing qualifications remains underdeveloped.

Kenya

Kenya's vocational training, overseen by the Technical and Vocational Education and Training Authority (TVETA), offers programmes such as the Diploma in Plumbing and Water Engineering. This reflects Kenya's needs in both urban and off-grid contexts. The curriculum covers rural water supply, urban plumbing, wastewater management, and integrates renewable energy (RE) aspects such as solar water heating and rainwater harvesting, driven by a national push for sustainable water use.

A strength of Kenya's programme is its focus on the water-energy nexus. For example, plumbers are trained to install solar-powered water pumps for boreholes and solar thermal heaters — skills that are highly relevant in remote areas without grid power. Training also emphasises resource conservation, which is particularly important in regions affected by water scarcity.

However, Kenya's current standards do not yet include hydrogen technologies; there is no content on handling pressurised gases such as hydrogen. The absence of high-pressure pipefitting content means that additional training would be required for Kenyan plumbers to work on hydrogen fuel systems or industrial gas lines. Kenya is still in the early stages of exploring a GH₂ economy, and aligning plumbing skills with GH₂ requirements — such as material selection for hydrogen and prevention of embrittlement — represents a future opportunity.

Zambia

In Zambia, the traditional trade qualification was the Craft Certificate in Plumbing and Sheet Metal, issued by TEVETA (Technical Education, Vocational and Entrepreneurship Training Authority). This course combined plumbing skills with sheet metal work, such as the fabrication of gutters, flashing, and ducting. The core focus was on practical plumbing installations (water supply and drainage) and basic metal fabrication.

A strength of the Zambian training system is its hands-on approach: trainees gain extensive practice in pipe joining, bending, and metalwork, making them versatile in both plumbing and light fabrication tasks. Recently, TEVETA has been rebranding and updating programmes—for example, renaming Plumbing and Sheet Metal to Plumbing and Pipefitting Technology—to modernise the skill set.

Despite these updates, content gaps remain. There is currently no coverage of renewable energy (RE) plumbing (e.g. solar water heaters) or hydrogen. Safety training mainly addresses basic occupational safety, but does not extend to gas hazards or pressure systems beyond normal water pressure. The major gap for RE and GH₂ lies in the absence of high-pressure gas piping knowledge and sustainability-related topics.

Updating Zambia's curriculum to include solar water pump systems or biogas digesters would be beneficial, alongside introducing hydrogen pipeline safety concepts as the country explores new energy avenues.

Uganda

Uganda's plumbing training is comparatively broad under the National Certificate in Plumbing (NCPL), administered by bodies such as the Directorate of Industrial Training (DIT) and the Uganda Business and Technical Examinations Board (UBTEB), with curricula developed by the National Curriculum Development Centre (NCDC). Note: DIT and UBTEB are likely to be merged in the near future.

The NCPL curriculum is modular and competence-based, covering domestic water supply, sanitary installations, and industrial plumbing systems, as well as the basics of other trades. Uniquely, Ugandan plumbing trainees are also introduced to elements of air conditioning, refrigeration, and sheet-metal work as part of their programme.

They take modules on entrepreneurship and computer applications to broaden their skillset. This produces graduates who are not only competent in household plumbing but also able to contribute to larger building projects—for example, understanding how plumbing integrates with Heating, Ventilation, and Air Conditioning (HVAC) systems and industrial processes.

The strength of Uganda's programme lies in its comprehensiveness: NCPL holders gain exposure to practical projects and even some electrical and mechanical concepts, making them highly adaptable. However, when benchmarked for GH₂ readiness, Uganda's curriculum still lacks content on hydrogen or modern renewable technologies.

There are no specific modules on hydrogen gas safety, fuel cell systems, or high-pressure gas pipe standards. Given Uganda's interest in expanding its energy sector, incorporating at least foundational knowledge of hydrogen and other emerging technologies (such as smart water systems) would be necessary to close this gap.

Japan

In Japan, plumbing is part of the national vocational trade skills system, with national trade tests and licenses. Plumbers in Japan can obtain certification as Class 2 or Class 1 plumbing technicians, administered under the Ministry of Health, Labour and Welfare's skills evaluation framework. The core focus of Japan's plumbing training is on high-quality building services, water supply (with strict standards for earthquake resilience), sanitary drainage, and integration with home gas appliances (as many homes use gas for hot water).

A hallmark of Japanese plumbing is the emphasis on advanced technology and efficiency; for example, plumbers are familiar with on-demand gas water heaters and early fuel-cell cogeneration units such as ENE-FARM systems.

Training programmes often cover condensing boilers and modern heating systems, some of which are already designed to handle blends of hydrogen and natural gas. The strengths of Japan's system include rigorous practical training, often conducted in partnership with industry, and a culture of precision, meeting standards comparable to JIS.

Hydrogen-specific training is not yet part of formal plumber education, but Japan's government and industry are actively pursuing a "hydrogen society." While dedicated hydrogen pipeline work is carried out by specialists, the plumbing industry is expected to adapt as hydrogen mixing in gas grids and fuel-cell installations expands. Currently, no

explicit hydrogen module exists in the national plumber certification, which represents a gap. However, given the high standards for gas safety, existing Class 1 qualified plumbers are likely to be able to upskill quickly for hydrogen appliances.

Japan's certifying bodies, such as the Japan Vocational Ability Development Association (JAVADA), have not yet announced a hydrogen-specific plumber license. It is anticipated, however, that as hydrogen-ready appliances (e.g. hydrogen fuel boilers) become commercially available, the curriculum will evolve. In summary, Japan's plumbing training is technically advanced and safety-focused, but the transition to GH₂ usage will require additional specialised training—likely delivered through manufacturer certification courses for new hydrogen equipment. Certifying bodies to watch include the Ministry of Economy, Trade and Industry (for any regulation on hydrogen in buildings) and existing gas associations, which may drive new qualifications.

Israel

In Israel, the plumbing trade has a unique certification structure that exists in law but is only loosely enforced. The Ministry of Labor (formerly the Ministry of Industry, Trade and Labor) defines five levels of professional plumber certification. These range from a basic level, authorised for simple home plumbing “from the sewer to the faucet,” up to higher levels involving gas heating systems and eventually a master plumber/contractor level. In practice, many plumbers work based on experience or apprenticeship without formally completing all levels of certification.

The core training focuses on water supply, sewage, and residential plumbing, but by the second certification level, plumbers are expected to handle “Yunkers” gas-fired heating systems (tankless gas water heaters). A major factor in Israel is the mandate for solar water heaters in new buildings: since 1980, Israeli law has required solar thermal collectors on most new dwellings. This means that plumbing training and practice in Israel routinely include solar hot water system installation and maintenance—a renewable energy (RE) component that in many countries is offered only as an add-on.

The strengths of Israel's plumbing industry are its adaptability (plumbers often learn multiple skills on the job) and the integration of solar technology by default. Israeli plumbers are also accustomed to working with water-saving devices due to the country's water scarcity.

For hydrogen readiness, Israel remains at an early stage. The national focus in RE is currently more on solar PV and energy storage. There is no mention of hydrogen in plumbing curricula or certification. While one of the higher plumbing certification levels includes gas works, which could theoretically encompass hydrogen in future, the gap is that no hydrogen-specific training or standards currently exist. Any hydrogen-related work—for example, installing a fuel cell or hydrogen boiler—would likely require special manufacturer training or oversight by engineers. In the coming years, if Israel pursues power-to-X fuels or fuel-cell vehicles, vocational training may introduce relevant modules, but at present the plumbing trade is not directly aligned with hydrogen technologies.

Netherlands

The Netherlands has a well-developed vocational education system (MBO – Secondary Vocational Education) for the construction and installation sector. Plumbers (and broader installation technicians) typically obtain an MBO diploma in Installation Technology (EQF Levels 2–4) under the guidance of organisations such as the Cooperation Organisation for Vocational Education and Training (SBB). Dutch plumbing qualifications cover water distribution, sanitary installations, heating systems, and gas piping for buildings.

Historically, the Netherlands had an extensive natural gas grid, so plumbers were trained in gas safety and central heating installation. The current focus is shifting toward national climate goals, with a strong push for energy-efficient and sustainable installations, including heat pumps, solar thermal, and district heating. Optional modules or certificates already exist for specialisations such as solar panel installation and EV charger installation, demonstrating how the trade is incorporating new technologies.

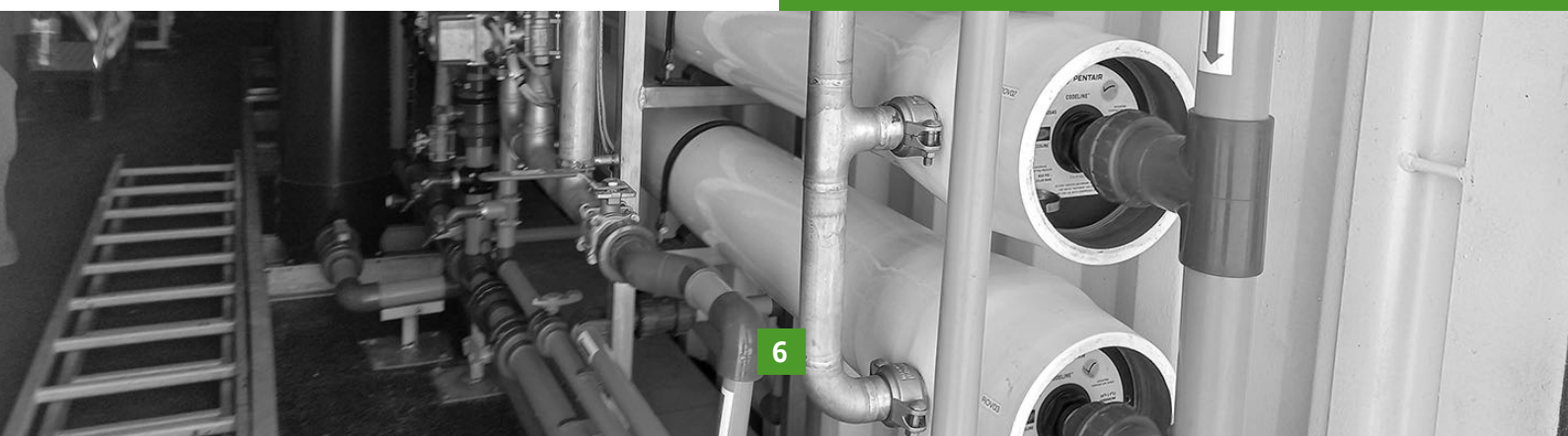
One strength of the Dutch system is its responsiveness to the energy transition. For example, the SBB sector committee has identified emerging skill needs such as hydrogen conversion, domotics (smart home sensors), and climate adaptation measures. Dutch training programmes are updated on a five-year cycle to integrate topics such as hydrogen fuel conversion and climate-neutral building wherever relevant. In fact, the Netherlands is piloting hydrogen-blended gas in some communities, and boiler manufacturers such as Remeha (a Dutch company) have developed hydrogen-ready boilers.

The gaps for RE and GH₂ are gradually closing, although a mainstream qualification specifically for a “hydrogen plumber” is not yet in place. The existing qualifications include broad competencies that can be further built upon. A remaining gap is the lack of uniform inclusion of hydrogen knowledge: at present it may be optional or only briefly referenced as “future technology.” Not all plumbers will receive hydrogen training unless it becomes a standard module or a widely chosen elective.

Currently, the focus is on moving away from gas toward electric heat pumps to meet climate targets. Paradoxically, while the Dutch plumbing sector is preparing for a future with less domestic gas use (for decarbonisation), the national strategy simultaneously promotes the development of a hydrogen economy for industry and heavy transport.

For plumbers, this means the immediate priority is on installing heat pumps and low-carbon heating systems, while hydrogen awareness is being introduced conceptually—for example, through school materials that highlight hydrogen conversion as an emerging trend.

In summary, the Netherlands' plumbing training is modern and modular, strong on sustainability, and partially prepared for hydrogen. Continuous curriculum adaptation will be required to fully integrate hydrogen safety and handling as infrastructure develops.



Morocco

Morocco's vocational training system, led by the Office de la Formation Professionnelle et de la Promotion du Travail (OFPPT) and specialised institutes such as the Institut de Formation aux Métiers des Énergies Renouvelables et de l'Efficacité Énergétique (IFMEREE), offers solid foundational programmes in plumbing, welding, and industrial piping, but is only partially aligned with the advanced requirements of the green hydrogen industry.

Current training emphasises traditional skills such as oxy-fuel welding, copper piping, and safety protocols, yet does not include hydrogen-specific competencies such as high-pressure handling, material embrittlement prevention, and ATEX-compliant safety.

Recognising this, the government and institutions are actively reforming curricula, launching train-the-trainer initiatives, and partnering with international bodies such as the Netherlands, the UK, and GIZ to develop hydrogen-ready programmes. While workforce readiness is improving, Morocco still faces shortfalls in both the number and specialisation of skilled workers. Its success will depend on how quickly new content can be scaled across the vocational system.

South Africa: New Green Hydrogen Vocational Qualifications

In South Africa, the plumbing trade is governed by the Quality Council for Trades and Occupations (QCTO). The current qualification is the Occupational Certificate: Plumber (NQF Level 4), which replaced the earlier unit standards-based certificate.

It includes competencies in hot- and cold-water systems and drainage, and, importantly, electives for solar water heating and gas piping installation. South African standards such as SANS 10254 and SANS 1352 ensure that plumbers are trained in solar geyser installation and safe gas connections. The Plumbing Industry Registration Board (PIRB) further registers licensed plumbers.

Notably, the South African curriculum integrates energy-efficient plumbing (e.g. solar geysers) and gas installations as optional components, which could be adapted for hydrogen, although hydrogen is not yet explicitly included in the training. South Africa has, however, introduced a separate Occupational Certificate for Flammable Gas Installers, which covers hydrogen and other gases in a more specialised way.

It is noteworthy that South Africa recently introduced its first green hydrogen vocational qualifications, approved in 2025 by the QCTO. Three new National Qualifications Framework (NQF) Level 4 skills programmes were created under the auspices of the Chemical Industries Education and Training Authority (CHIETA). The QCTO-approved programmes, each accredited as a nationally recognised qualification, include:

- ▶ Green Hydrogen Production (NQF Level 4, 29 credits, QCTO)
- ▶ Green Hydrogen Storage and Transfer (NQF Level 4, 28 credits, QCTO)
- ▶ Green Hydrogen Technology (NQF Level 4, 29 credits, QCTO)

Each programme is designed to prepare learners for technical roles across the green hydrogen value chain, from hydrogen production (e.g. via electrolyzers) to safe storage and transfer, as well as the operation of hydrogen technologies such as fuel cells and related systems.

The issuing authority for these qualifications is the QCTO, as the regulator approving the curriculum, with CHIETA serving as the development partner and Quality Assurance Partner. These pioneering hydrogen-

focused vocational qualifications mark a milestone in aligning skills development with South Africa's emerging hydrogen economy.

In addition to the above NQF Level 4 programmes, an earlier Hydrogen Fuel Cell System Practitioner skills programme was introduced in 2023 by the Energy and Water Sector Education and Training Authority (EWSETA).

This programme is accredited at NQF Level 5 (39 credits) and was formally approved by the QCTO in early 2023. It is sometimes referred to as the Hydrogen Fuel Cell System Technician course and is aimed at training practitioners to install, operate, and maintain hydrogen fuel cell systems. The EWSETA-led course (NQF Level 5) complements the CHIETA NQF Level 4 programmes by focusing on fuel cell technology, a key application of hydrogen, and is similarly offered via QCTO-accredited providers.

Curriculum Content and Focus Areas: These hydrogen-focused curricula cover a broad range of technical competencies with a strong emphasis on gas handling, safety standards, and integration with renewable energy systems. For the NQF Level 4 Green Hydrogen programmes (Production, Storage and Transfer, Technology), the curriculum content was developed in close collaboration with industry to meet real-world needs. Key learning areas and module topics include:

- ▶ **Hydrogen production processes:** operating and maintaining hydrogen production equipment (e.g. water electrolyzers), understanding renewable energy inputs such as solar and wind power for green hydrogen generation, and process monitoring.

Storage, transfer, and pressure systems: safe handling of hydrogen gas and its storage mediums (compressed gas, cryogenic liquid, or chemical carriers), including pressure vessel operation, pipefitting and gas piping standards, leak detection, and transport logistics. Given hydrogen's flammability and small molecule size, the programmes stress rigorous safety procedures for high-pressure systems and pipelines. Hydrogen safety and regulatory compliance training is central, ensuring that trainees learn to apply industry standards to mitigate explosion risks during storage and fuel transfer. For example, the Green Hydrogen Storage and Transfer course specifically addresses safe cylinder and tank handling, compression, fuelling protocols, and emergency response.

- ▶ **Hydrogen technology and integration:** learners study the operation of hydrogen technologies such as fuel cells and related control systems. The Green Hydrogen Technology programme imparts skills to manage on-site hydrogen technologies (e.g. electrolyser systems and fuel cells), including electrical and instrumentation basics for integrating hydrogen systems with existing energy infrastructure. Coverage also includes hydrogen's role in the broader energy system—for example, using hydrogen produced from renewables for power generation, transport fuel, or industrial processes—linking to sustainable energy goals.

- ▶ **Environmental and efficiency considerations:** trainees are taught to monitor environmental impacts and performance of hydrogen systems. This includes understanding the carbon emissions reduction potential of green hydrogen and ensuring compliance with environmental regulations during hydrogen production and use.

- ▶ **Safety and standards:** all programmes include dedicated modules on hydrogen safety, occupational health and safety (OHS), and regulatory frameworks. These cover hydrogen-specific fire and explosion risks, first aid and firefighting techniques for hydrogen incidents, handling of high-pressure flammable gases, and relevant South African standards and codes for gas systems.

For instance, the Hydrogen Fuel Cell Practitioner curriculum contains a knowledge module on “Health and Safety regarding Hydrogen Fuel Cell Systems,” along with practical modules on firefighting and first aid. Similarly, the NQF Level 4 courses ensure that graduates “understand safety, regulatory, and industry standards” applicable to hydrogen operations.

- **Technical coordination and logistics:** beyond hands-on technical skills, the curricula prepare learners to coordinate technical activities and logistics in hydrogen projects. This may include overseeing the delivery of hydrogen cylinders, scheduling maintenance, monitoring supply chains and the transport of hydrogen (by road or pipeline), and ensuring compliance with safety certifications.
- **Unit Standards and Modules:** although these new programmes are structured as occupational qualifications (with integrated knowledge, practical, and work modules rather than legacy unit standards), they contain modules that mirror key unit standards within related fields.

For example, the Hydrogen Fuel Cell Practitioner (NQF Level 5) course includes knowledge modules on basic electrical science and hydrogen technology, practical modules on electrical wiring for system installation, site inspection and system commissioning, and work-experience modules for on-site hydrogen system operation and maintenance.

Similarly, the Green Hydrogen Production and Storage curricula cover the foundational chemistry of hydrogen, principles of renewable energy-driven electrolysis, gas compression technology, and routine maintenance tasks for hydrogen equipment.

Notably, many of these skills intersect with traditional trades such as plumbing and pipefitting, welding, electrical, and gas installation. The inclusion of pipefitting and pressure system content reflects industry feedback that “we need pipefitters who are adequately trained for hydrogen projects.”

The Department of Higher Education and Training (DHET) and Council for Scientific and Industrial Research (CSIR) Identification of Skills Needed for the [Hydrogen Economy report \(Apr 2024\)](#) notes that existing artisan programmes “address some, but not all, of the skills needed for the hydrogen economy.

For example, welding is offered and required in the hydrogen value chain,” and that hydrogen curricula must be added to legacy trade courses. The competency tables from the same report emphasise welding in a hydrogen environment, piping-system design, valves and seals, and roles such as “gas fitter” and “fitter-and-turner” for distribution pipelines and compression stations.

Hydrogen facilities blend high-pressure piping, leak-free welding, electrical integration and gas-safety plumbing in a single asset:

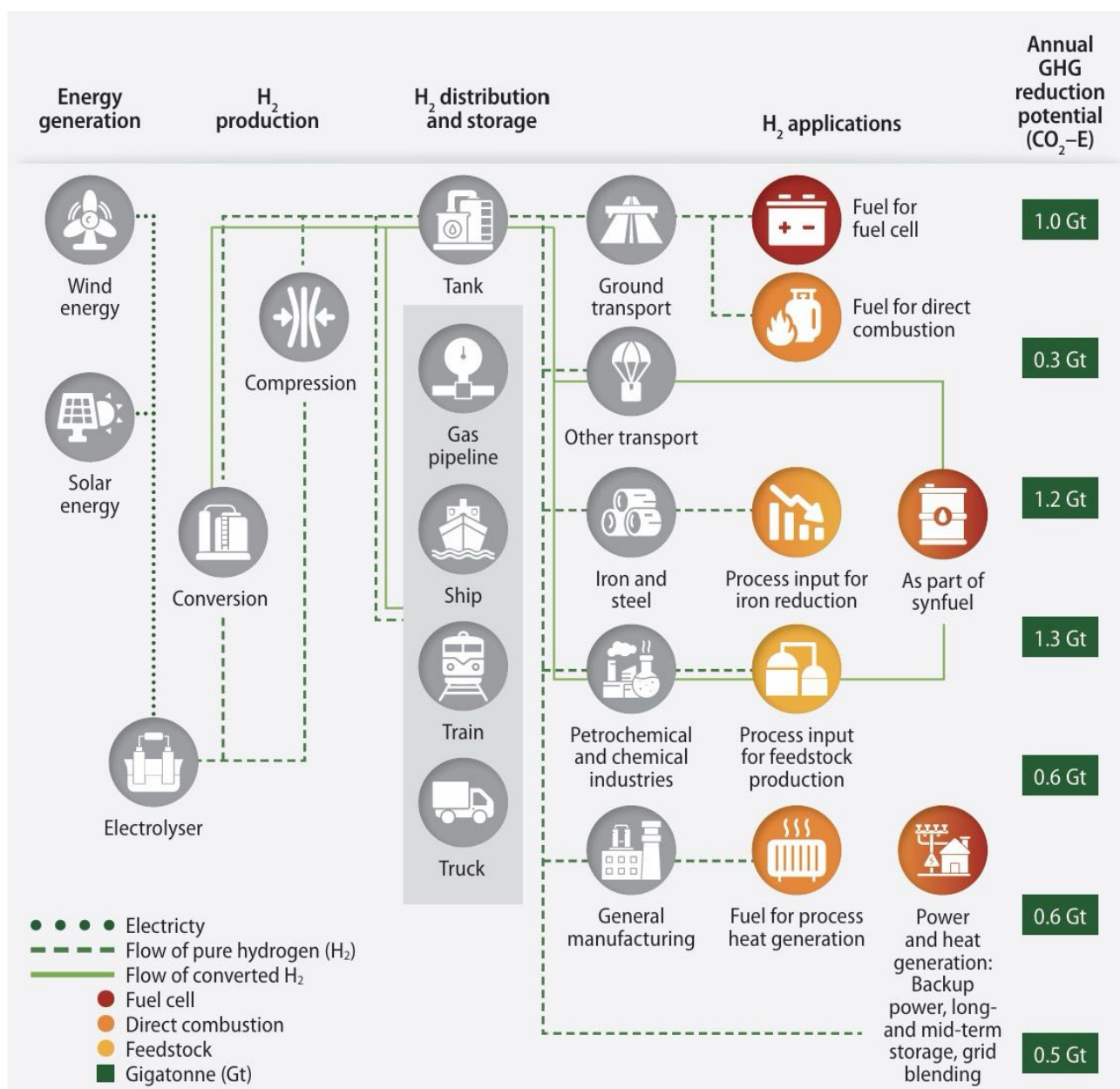
Table 2: Qualification overlap for GH2 between trades

Traditional trade	“Hydrogen twist”	Overlap opportunities
Plumbing / pipefitting	Select H ₂ -compatible alloys, flange seals, pressure-test to 1.5× operating pressure	Shared modules on pipe layout, threading and torque control with welders
Welding / boiler making	Master low-heat-input techniques to curb hydrogen embrittlement; qualify to ASME IX / ISO 15614 for H ₂	Joint practical with pipefitters on orbital welding of seamless stainless lines
Electrical	Grounding, intrinsic-safety wiring, HVDC cabling for electrolyzers	Crosstrain with plumbers on conduit routing and penetration sealing
Gas installation	Odourless-gas detection, ventilation rates, EX-rated valves	Common safety-case studies with welders on purge and leak-testing



By coteaching fundamentals (materials, pressure codes, leak detection), and then letting each trade specialise, TVET colleges can shorten training times while producing multi-skilled crews. The result is a workforce that can:

- pull a stainless-steel spool, prep and weld it,
- thread EX-rated sensors, and
- commission the line to SANS 10019 hydrogen-safety standards.



Source: Ludwig et al. (2021)

Figure 2: Elaborated GH₂ value chain for South Africa qualifications

Trainees gain practical skills in assembling and maintaining hydrogen piping and storage installations in line with hydrogen-specific standards (e.g. using appropriate materials to avoid hydrogen embrittlement and applying proper sealing techniques for high-pressure hydrogen).

Hydrogen safety is a recurring theme across all modules, given that hydrogen gas is flammable and requires special precautions (e.g.

ventilation, leak detection sensors, and avoidance of open flames) when equipment is being installed or serviced.

To support RE integration, the curricula place hydrogen in context: learners understand how GH₂ is produced via solar or wind power and how it enables energy storage and decarbonisation.

This systems approach ensures that, for example, a trainee in the Production programme learns not only how to operate an electrolyser but also how its output can be used in fuel cells or transported as a clean fuel. In summary, the content is multidisciplinary, blending elements of chemical process operation, electrical and mechanical maintenance, gas safety, and environmental management to create a well-rounded hydrogen technician or artisan.

Rollout Status and Training Delivery: The three CHIETA-developed NQF Level 4 programmes received QCTO approval on 30 April 2025, meaning they are now ready for implementation. As of mid-2025, Skills Development Providers (SDPs) can apply to QCTO/CHIETA for accreditation to deliver these courses. CHIETA has indicated that, with the curricula now finalised, training is expected to commence as soon as providers are accredited and equipped—likely in late 2025 or 2026.

Understandably, no trainees have graduated from the new NQF Level 4 courses yet, but CHIETA is actively recruiting public TVET colleges and private training centres to begin implementation. The authority has also launched an awareness roadshow to promote the programmes nationwide and ensure that institutions across various provinces participate. This includes building institutional training capacity by providing laboratories, hydrogen demonstration equipment, and related resources.

Institutions either offering or planning to offer: While specific colleges are still in the process of accreditation, there are clear indications of which institutions will be involved:

- **Technical and Vocational Education and Training (TVET), Colleges:** At least seven TVET colleges were indirectly involved through a “train-the-trainer” initiative for hydrogen fuel cells (detailed below), and more are expected to follow. CHIETA has not yet designated which TVET college will host the Green Hydrogen Centre of Specialisation, but one college will be selected to anchor the Centre in partnership with a university.

The participating TVETs in early pilot projects included Flavius Mareka TVET, Gert Sibande TVET, Goldfields TVET, Motheo TVET, Maluti TVET, Nkangala TVET, and Tshwane North TVET. Each of these seven colleges sent faculty for hydrogen training and are expected to be among the first to roll out the new hydrogen courses to trainees, leveraging their upskilled lecturers.

- **Universities and Universities of Technology:** The University of Pretoria has already played a key role by delivering the pilot fuel cell course for TVET lecturers, drawing on its expertise in engineering and chemistry. The University of Johannesburg (UJ) is poised to be another hub: UJ hosts a Research Chair in Green Hydrogen and was specifically noted as a candidate to co-host the Hydrogen Centre of Specialisation.

This suggests UJ may integrate the vocational programmes into extended courses or work-integrated learning for technicians. Other universities with hydrogen initiatives—such as North-West University (home to a HySA hydrogen centre) and Stellenbosch University (hydrogen research)—could also collaborate to provide facilities, though CHIETA explicitly named UJ. Universities of Technology, such as Tshwane University of Technology or Cape Peninsula University of Technology (via its SARETEC centre), may also offer specialist short courses or act as assessment sites, given their practical training focus.

- **Specialised Training Centres:** The South African Renewable Energy Technology Centre (SARETEC) in Cape Town is a likely partner for renewable energy and hydrogen training. SARETEC, based at the Cape Peninsula University of Technology (CPUT), already has

infrastructure for technician training in wind and solar; this could extend to electrolyser or fuel cell technician training, possibly in partnership with CHIETA or EWSETA. In addition, CHIETA’s Smart Skills Centres (mobile or rural training hubs equipped with simulators and digital labs) may be used to deliver parts of the curriculum in remote areas, ensuring wider access.

- **Private Providers and Industry Academies:** Some industry partners may train their own staff or communities. For example, Sasol’s training facilities may incorporate the CHIETA curriculum to prepare plant operators for future GH₂ plants.

Companies such as Afrox and Air Products (industrial gas companies) could also become accredited providers to train gas-handling technicians in hydrogen, given their involvement in developing the production practitioner course. Private technical training companies specialising in gas or renewable energy installation are also likely to seek accreditation to offer the hydrogen skills programmes to the public.

Pilot Deliveries and Current Initiatives: Although the CHIETA programmes were only recently approved, the EWSETA-led Hydrogen Fuel Cell System Practitioner (NQF Level 5) programme has already seen pilot implementation. In 2024–2025, a major “train-the-trainer” pilot course was delivered to a cohort of 30 TVET college lecturers from across the country.

The intensive six-week training concluded in April 2025 and was run by the University of Pretoria with support from the [RES4Africa Foundation and industry experts](#).

The 30 lecturers, from the seven previously listed colleges, were recognised in Pretoria upon completing the Hydrogen Fuel Cell Training Programme, which combined classroom theory with hands-on laboratory work covering hydrogen fuel cell safety, setup, and maintenance.

The aim was to build capacity within TVET institutions so that lecturers could return to their colleges and deliver hydrogen training to trainees, either as part of engineering courses or as a separate skills programme. This suggests that some colleges may begin offering the Hydrogen Fuel Cell Practitioner programme (NQF Level 5) to trainees as early as late 2025, using their newly qualified trainers.

The success of this pilot is notable: it was delivered through an international partnership involving the RES4Africa Foundation, Sasol Foundation, and Enel Foundation, under a platform called the Re-Skilling Lab. These partnerships provided equipment, curriculum input, and sponsorship for the training.

The course was run collaboratively between the University of Pretoria’s engineering department and industry specialists (including experts from CSIR, Bambili Energy, RINA Consulting, and Hydrogen de France). This multi-stakeholder delivery model may be replicated for the CHIETA NQF Level 4 programmes—for example, initial classes could be run as pilot projects with strong industry involvement to ensure quality before scaling up.

CHIETA has indicated that Skills Development Providers can begin offering the NQF Level 4 programmes as soon as they are accredited, with CHIETA ready to provide “strategic guidance and support.” Over the next one to two years, several training centres are expected to launch these hydrogen courses. We can also anticipate learnerships or apprenticeships being registered alongside these qualifications—for example, companies may take on learners in hydrogen technician apprenticeships, combining on-the-job training with classroom instruction based on the QCTO curriculum.

As of mid-2025, the Green Hydrogen Production, Storage and Technology programmes are approved (curricula finalised) and moving into the piloting and accreditation phase. The Hydrogen Fuel Cell Practitioner programme is slightly ahead, having been piloted with instructors and now ready for broader learner delivery.

By 2026, the first cohorts of artisans and technicians are expected to graduate from these hydrogen programmes, ready to be employed in GH₂ projects.

1.4 Gap analysis in the field of Plumbing and Pipefitting

What a GH₂ pipefitter actually needs: Industrial hydrogen pipelines and on-plant tubing typically operate at pressures of 100 bar or higher, with 99.97% purity, and are located within ATEX Zone 1 or Zone 2 classified areas. Core competence blocks therefore include:

Table 3: Green Hydrogen Pipe-fitter Competency Family (proposed)

Competence family	Typical elements	Why it matters for H ₂
Metallurgy and materials	micro-structure of low-alloy and austenitic steels, Ni-alloys, hydrogen embrittlement, gasket compatibility	Prevent brittle fracture and leaks
Pressure-class welding and fabrication	TIG/GTAW (incl. orbital), high-integrity SMAW, purge and back-gas control, pipe joint lay-out and fit-up, NDT interpretation	Maintain purity, strength and traceability
Process-safety and codes	ASME B31.12, IEC 60079, leak-testing with inert gases, venting and purging, hazardous-area work permits	Minimise ignition risk
Instrumentation and leak detection	Swagelok / double-ferrule fittings, H ₂ sensors, pressure transducers, digital SCADA hooks	Early fault detection
Commissioning and O&M	drying, inerting, pressure ramp-up, periodic inspection	Long-term reliability

The following qualifications were examined:

Table 4: Overview of examined qualifications

Qualification No.	Trade Name	Level
Q0753	National Vocational Certificate in Metallurgy (Foundation)	Level 1
Q0754	National Vocational Certificate in Metallurgy (Operator Attendant)	Level 2
Q0755	National Vocational Certificate in Metallurgy (Junior Operator)	Level 3
Q0756	National Vocational Certificate in Metallurgy (Operator)	Level 3
Q0757	National Vocational Certificate in Metallurgy (Hydrometallurgical Processing, Senior Operator)	Level 4
Q0758	National Vocational Certificate in Metallurgy (Mineral Processing, Senior Operator)	Level 4
Q0036	National Vocational Certificate in Metal Fabrication	Level 2
Q0037	National Vocational Certificate in Metal Fabrication (Boiler-making)	Level 3
Q0038	National Vocational Certificate in Metal Fabrication (Welding)	Level 3
Q0039	National Vocational Certificate in Metal Fabrication (Boiler-making)	Level 4
Q0972	National Vocational Certificate in Metal Fabrication (Welding)	Level 4

Qualification No.	Trade Name	Level
Q0044	National Vocational Certificate in Civil and Building Services Engineering (Plumbing)	Level 1
Q0045	National Vocational Certificate in Civil and Building Services Engineering (Plumbing)	Level 2
Q0046	National Vocational Certificate in Civil and Building Services Engineering (Plumbing)	Level 3
Q0047	National Vocational Certificate in Civil and Building Services Engineering (Plumbing)	Level 4

After careful examination of each qualification, it was concluded that welding—rather than plumbing—provides a better fit as the base qualification for H₂ piping. Additions are then required to cover all aspects of the GH₂ pipefitter competency framework (process safety, instrumentation, leak detection, etc.; see Table 3).

Table 5: Alignment of TVET pathways with H₂ piping

Pathway	Alignment with H ₂ piping	Evidenced unit standards
Metal Fabrication – Welding L4	Advanced TIG & SMAW on stainless-steel pipe, all positions, the closest match to H₂ process piping	- No explicit high-pressure testing, NDT, or H₂ embrittlement - Limited ATEX / process-safety content
Metal Fabrication – Boiler making L4	Fabrication of pipe joints (contour markers, centre-finders), and erection of steel structures	- Focus is lay-out rather than pressure-class welding - Lacks purge, leak-test and hazardous-area skills
Metal Fabrication L3 (feed-in year)	TIG on stainless steel (down-hand), and MIG on mild-steel	Position-limited welding; purity, digital weld documentation absent
Plumbing L3	Some gas-supply installation (low-pressure LPG), insulation and sheathing of pipework	Domestic scale (<10 bar), no high-pressure alloys, no welding to code
Plumbing L4	Water-firefighting, irrigation, effluent pumps etc., strong in trench support and small-bore plastic pipe	Entirely civil/utility focus; no pressure-class metallic pipe; zero hazardous-gas competence

Key take-away

The Welding/Boiler-maker route already embeds pressure-vessel metallurgy, coded welding, and pipe-joint geometry, whereas plumbing curricula are aimed at domestic water and low-pressure gas. Welding therefore provides the stronger backbone for a hydrogen pipe qualification.

Reasons why plumbing should not serve as the primary base:

- Domestic plumbing stops at approximately 6–10 bar and mostly involves PVC/PEX or copper.

- Welding, purge control, and alloy selection—critical for H₂—are electives or absent.
- The gas-supply unit in Plumbing Level 3 is limited to introductory LPG piping, not process hydrogen.
- Upskilling plumbers to H₂ standards would require nearly the entire welding skill set plus metallurgy, effectively duplicating the welding pathway.



However, looking at the whole value chain of GH₂ operations, we can conclude:

Table 6: GH₂ value chain and best fit for welders and plumbers/pipefitters

Project phase	Typical activities	Best fit for plumbers	Best fit for H ₂ -qualified welders	Why this allocation makes sense
Planning and Design	Layouts, P&IDs, code selections, constructability reviews.	- Provide utility-service know-how for buildings that will house compressors, control rooms, labs, etc. - Advise on trenching, drainage, potable-water tie-ins.	Review weld-class break logic, material selection, access for orbital GTAW rigs.	Each brings field realism to the design team in their domain (domestic/ utilities vs. high-pressure process).
Manufacturing / Prefab	Fabrication of pipe spools, pressure vessels, instrumentation skids.	(shop work is almost entirely welding / machining).	All-position GTAW/ SMAW on 316 L, Cr-Mo, duplex• Clad overlay, PWHT, NDT coordination.	High-spec fabrication requires coded welding; plumbers rarely work to ASME IX / EN ISO 9606.
Transportation / Logistics	Loading prefabricated spools, containerised skids, tube bundles.	Site-utility chase prep (e.g. sleeves in walls, insertion of protective conduits).	On-site repair of transport damage, re-weld of lifting-lug brackets if needed.	Minimal but occasional welding touch-ups; plumbers mostly prepare the “receiving” infrastructure.
Construction and Installation	Setting skids, inter-connecting pipe, tie-ins to buildings, testing.	- Install low-pressure service lines (demineralised-water, potable water, drains, firewater, nitrogen purge headers) - Fit small-bore Cu/PEX hydrogen-ready lines inside buildings (≤10 bar).	- Weld and test process hydrogen headers (100 – 1 000 bar) - Perform purged orbital welds on stainless instrument impulse lines - Coordinate hydro / pneumatic pressure tests to B31.12.	Site works split naturally: plumbers handle civil/ utility pipe; welders own the pressure-boundary hydrogen system.
Operation and Maintenance	Routine inspections, leak checks, component replacement, minor mods.	- Maintain utility and drain systems• Replace H₂-ready flexible hose assemblies in buildings - Support shutdowns with flushing / draining.	Execute hot-work repairs on H₂ pipe, vessels• Develop weld procedures for retrofits, perform NDT on suspect welds.	Long-term plant integrity for hydrogen still depends on weld quality; plumbers keep ancillary systems reliable.

Therefore, it is recommended to retain plumbers while developing a welding-centred hydrogen piping qualification for critical process lines:

- ▶ Plumbers are most valuable for the building-services components of hydrogen projects: water, drainage, low-pressure hydrogen retrofits in domestic or commercial premises, and the physical accommodation of pipe penetrations and trenches. Their codes (SANS/LPG and local plumbing regulations) and tooling align with these duties.
- ▶ Upskilled welders (i.e. Welding Level 4 plus a hydrogen top-up) are indispensable wherever hydrogen remains under high pressure or must meet ultra-high purity requirements: shop fabrication, site tie-ins, pressure testing, and subsequent repair work.



2

RECOMMENDATIONS FOR NECESSARY TRAINING MEASURES IN PLUMBING AND PIPEFITTING

Based on the analysis, the following is a prioritised list of training measures along with their rationale.

Table 7: Prioritised list of short courses and rationale

Rank	Short course / skill gap	Vocational-level rationale for the priority order	Indicative hours*
1	Orbital GTAW set-up, purging and weld-log recording	Coded hydrogen welds are the single biggest bottleneck flagged by Hyphen (specialised welders at L3–4 is in short supply), and every VTC lacks orbital heads, purge panels and borescopes. A defect here means scrapping or re-picking whole spool pieces, so the safety- and-cost stakes are highest.	40h workshop
2	Hydrogen-embrittlement science and alloy-repair techniques	As soon as high-integrity welds exist, repair teams and inspectors must recognise H-induced cracking and stay within hardness limits. The MoMs list welding and metallurgy upskilling among the “critical GH ₂ trades”, but local labs lack micro-hardness gear: hence this course and its equipment grant.	12h module
3	High-pressure hydro / pneumatic testing and H ₂ -sniffer leak detection	EPC packages specify 1 500 bar tests; leaks after installation cause shutdowns and reputational hits. The risk is serious but follows fabrication and materials.	24h practical

2.1 Short Course 1, Orbital GTAW Set-up, Purging and Weld-Log Recording (Priority 1)

Course overview and competencies

Participants will (i), prepare and align tube/pipe and orbital heads, (ii), establish high-purity Ar/Ti purge procedures for hydrogen service, (iii), operate weld-log software and borescope QA tools, and (iv), interpret weld quality to ISO 5817 / AWS D18.

Recommended providers

Primary: NIMT (host booths), + NUST Engineering Training Centre (ETC), as academic anchor, partnered with Southern African Institute of Welding (SAIW), for IIW-aligned certification and mobile orbital rigs. The partnership answers the “specialised equipment” gap logged at every VTC we visited: none of which own orbital heads or borescopes yet.

Duration and delivery

40h block: 8h theory → 24h booth practice → 8h QA/borescope reporting.
Target group and entry requirements

- ▶ Target: coded welders / boilermakers (NTA Level 3–4), and welding supervisors.

- ▶ **Entry:** ISO 9606 GTAW fillet or pipe ticket (any diameter), ≤ 12 months old; one-day GTAW refresher offered by NIMT the week before.

Capacity-building and partnerships

- ▶ **Infrastructure:** 2 orbital power sources (~€45 k each), purge panel, digital borescope, coupon saw.
- ▶ **ToT:** 2 SAIW instructors seconded to NIMT/NUST for 4 weeks.
- ▶ **Certifying body:** IIW-IAB diploma stamped by SAIW.
- ▶ **Industry link:** Hyphen to supply test coupons and four job-attachment slots.

2.2 Hydrogen Embrittlement Science and Alloy-Repair Techniques (Priority 2)

Course overview and competencies

Participants will (i), explain diffusion-based embrittlement, (ii), perform Vickers hardness tests on weld HAZ, (iii), interpret NACE TM0284 results, and (iv), select qualified repair procedures.

Recommended providers

NUST runs the micro-lab and streams demos; practical “feel and do” sessions rotate through Keetmanshoop VTC and NIMT once mobile hardness kits arrive. However, site audits need to be completed to confirm power, ventilation and coupon-prep space at NUST, Keetmanshoop VTC and NIMT, if fail, then re-scope.

Duration and delivery

12h module: 6h lecture, 3h micro-etch and hardness demo, 3h case-study workshop.

Target group and entry requirements

- ▶ **Target:** Level 4 coded welders, welding inspectors.
- ▶ **Entry:** trade theory in metallurgy or RPL test. A two-hour “steel basics” primer built in.

Capacity-building and partnerships

- ▶ **Infrastructure:** micro-hardness tester and mounting press.
- ▶ **ToT:** 2 NUST lecturers shadow TWI instructor; local hand-over after first cohort.
- ▶ **Certification:** TWI certificate of attendance; optional NACE MR0175 awareness badge.

2.3 High-Pressure Hydro/Pneumatic Testing and H₂-Sniffer Leak Detection (Priority 3)

Course overview and competencies

Learners will (i), rig and execute hydro-tests to 1 500 bar, (ii), conduct pneumatic leak checks with mass-spec H₂ sniffers, (iii), apply Namibian OHS and PED rules, and (iv), document results for hand-over dossiers.

Recommended providers

Lead: Windhoek VTC hosts, equipment and instructors leased from Maximator Test LLC; inspection segment aligned with NWIS/CHTI syllabus.

Spokes (vocational):

- ▶ Keetmanshoop VTC (Green-Hydrogen Centre of Excellence), slated to host heavy-plant yard; could share the hydro-test skid once delivered MoMs.
- ▶ NIMT Arandis, strong welding/fitting trade.

Duration and delivery

24 h: 8h safety and regs → 8h hydro-rig set-up → 8h tracer-gas and sniffer practice.

Target group and entry requirements

- ▶ **Target:** commissioning artisans, NDT Level 2 PT/UT technicians.
- ▶ **Entry:** valid Level 2 PT/UT or enrol in the five-day pre-course fast-track proposed in Windhoek VTC.

Capacity-building and partnerships

- ▶ **Infrastructure:** lease-to-own 1 500 bar skid, two H₂ mass-spec sniffers.
- ▶ **ToT:** Maximator technician stays two intakes.
- ▶ **Certification:** optional PCN Leak-Test Technician endorsement.



3

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