International PtX Hub

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ENHANCING EMPLOYABILITY

Skills Needs and Gap Analysis in Namibia's PtX Sector and Recommendations for a Skills Development Programme

IMPRINT

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Windhoek, August 2023

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NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Executive Summary

Background, Objectives and Scope

The Namibian government's Hydrogen Strategy aims to develop a supportive ecosystem for the green hydrogen and Power-to-X (PtX) sectors, fostering innovation and entrepreneurship. The PtX industry presents an excellent opportunity to establish the country as a regional leader in sustainable energy production and to generate diverse job opportunities along the PtX value chain.

Skills development is key to equip Namibians with the necessary knowledge, expertise, and skills to participate in the PtX industry, ultimately enhancing employability.

This study explores the skills requirements in the PtX industry, identifies skills gaps and other education-related barriers in Namibia, and proposes actions to enhance the employability of Namibians.

Jobs and Skills Demands along the PtX Value Chain

In the PtX industry, job opportunities span across the entire value chain, encompassing renewable hydrogen production, hydrogen handling, storage, transport, and end-use applications, including further processing to other chemicals and steel. Professionals in overarching fields of work, such as in government or agencies responsible for health and safety, will also need to understand PtX-specific concepts.

As the PtX industries in Namibia begin to evolve, the next ten years will be dominated by large projects where renewable power, industrial plants and hydrogen transport and storage infrastructure need to be built up. The phases of these projects can all be broadly seen as planning & design, manufacturing, transportation, construction & installation, and operation & maintenance. All of these phases require specific expertise and skills.

Professionals with an academic background in the renewables-based PtX industry are needed for their technology-specific in-depth knowledge and expertise. They typically hold advanced degrees in relevant fields such as chemical engineering, electrical and power systems engineering, industrial engineering, mechanical engineering, civil engineering or materials science. These professionals play critical roles in renewable power and PtX system project planning and design, implementation and plant operation, and process design, but also in research and development, and in policy and regulation formulation.

On the other hand, professionals undergoing Technical and Vocational Education and Training (TVET) or similar programmes are set to play a crucial role in the practical implementation and operation of the renewables-driven hydrogen and PtX systems. They possess specialised technical skills, enabling them to perform hands-on tasks related to renewable power generation, the production of hydrogen and its derivatives, equipment maintenance, system monitoring, safety compliance, and logistical operations. These professionals may include technicians, operators, maintenance personnel, and skilled artisans.

Professionals in the renewable hydrogen and PtX industry require a solid understanding of the specific features of the novel technologies involved and their interplay, safety protocols, quality control measures, and environmental standards. Knowledge of relevant technologies, such as those employed in renewable energies (especially wind and photovoltaics), electrolysis, fuel cells, gas processing, and industrial processes, is essential. Additionally, professionals in these roles must regularly update their knowledge and skills to keep up with the continuously evolving hydrogen and PtX industry. Green Hydrogen and PtX-related Education Gaps in Namibia

Based on the skills required by a green hydrogen and PtX industry workforce, the study examined the existing education and training opportunities in Namibia and identified hydrogen- and PtX-related educational gaps.

In **academic education**, the qualification programmes offered by the University of Namibia (UNAM) and Namibia University of Science and Technology (NUST), in areas relevant to the PtX industry, were examined. Both UNAM and NUST offer programmes in engineering and non-engineering disciplines, renewable energy and science courses. In both universities, the specific modules on PtX were found to be limited.

UNAM, however, is already developing a new school/faculty of Alternative and Renewable Energy in partnership with German universities, and a green hydrogen and synthetic fuels stream is being introduced as part of the Master of Science in Renewable Energy programme. UNAM is also developing the Master of Science in Renewable Energy Engineering programme, focusing on technologies such as solar photovoltaics and wind.

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NUST offers the Master of Sustainable Energy Systems programme, and plans to collaborate with students on how to develop a renewable power project. It also offers the Master of Environmental Engineering which incorporates renewable energy and energy efficiency in its syllabus. It also offers the research-based Master in Natural and Applied Sciences with a focus on green hydrogen production, storage and application.

Additionally, collaborations between higher education institutions, industry, and research organisations such as the Namibia Energy Institute (NEI) and the Namibia Green Hydrogen Research Institute (NGHRI) have the potential to enhance PtX-related skills and knowledge.

However, the higher education sector faces barriers to offering PtX-industry relevant content. These include a shortage of lecturers with PtX industry expertise, inadequate laboratory equipment, challenges in finding work-integrated learning (WIL) placements for students, minimal registration of engineering professionals with the Engineering Council of Namibia (ECN), and a lack of coordination between institutions.

The analysis of the TVET sector in Namibia covering green hydrogen and PtX-related skills shows that Namibia Qualifications Authority (NQA)-accredited and Namibia Training Authority (NTA)-registered TVET offers relevant to the PtX industry exist. These include vocational training in air conditioning and refrigeration, general electrical training, electronics, plumbing and pipe fitting, and solar equipment installation and maintenance.

However, although these training offers provide professionals with a certain skills foundation, the programmes need further enhancement to provide the workforce with the specific knowledge and skills the green PtX industry needs. First, curricula need to be updated and complemented to meet industry needs, training of trainers must be enhanced, and investments in updated modern training equipment is needed. Other important barriers are a lack of industry participation in apprenticeship programmes and difficulties in finding job placements for trainees. Tackling these tasks and addressing these barriers in a holistic and practice-relevant manner requires close collaboration between training providers and private sector companies, as well as regulation and mandating of apprenticeship programmes.

Key Insights into Skills Gaps and How to Bridge Them

Overall, the study found the **need to integrate PtX-specific knowledge across various disciplines and provide training opportunities for professionals at different stages of their careers**. Thus, Namibian educational institutions and training programmes should offer specialised courses and further develop existing curricula to meet the specific needs of the green hydrogen and PtX industry.

Higher education and vocational training should contain **practical training opportunities, hands-on experience with relevant equipment, and internships or apprenticeships to bridge the gap between theoretical knowledge and real-world application**.

Existing **engineering** curricula serve as a solid foundation, but they need to be expanded to include courses focused on PtX topics. This applies to engineering disciplines such as energy, electrical, electronics, power systems, process, industrial, mechanical, chemical, and civil engineering.

In addition to engineering, **non-engineering** professionals in fields like finance, law, and environmental management also require PtX-specific knowledge.

Besides the addition of PtX-specific topics, this study recommends enhancing academic programmes by means of the following:

- Provisioning of capacity building for lecturers and students through collaborations with external organisations with PtX-related expertise.
- Establishing stronger relationships between higher education institutions and industry for knowhow transfer and work-integrated learning placements.
- Investing in laboratory infrastructure and equipment.
- Increasing registration and mentorship programmes for engineering professionals.
- Improving coordination among stakeholders.

Artisans should be provided with opportunities to reach higher competency levels. By reaching Levels 4 and 5 of the National Qualifications Framework (NQF), artisans can carry out complex tasks independently and demonstrate mastery in their field. Furthermore, vocational training programmes should also offer relevant elective courses during apprenticeships that focus on renewable energy and PtX topics.

To leverage the opportunities and overcome the barriers in the TVET sector, recommendations include:

- Utilising Industry Skills Committees to develop unit standards aligned with PtX industry needs.
- Establishing a monitoring and verification system to quantify the number of TVET graduates requiring upskilling or reskilling for the PtX industry.

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- Promoting collaborations between training providers and private sector companies for job attachments and skills transfer.
- Conducting proper inventory and investment in training tools and equipment.

In addition to training the next generation of professionals, it is also important to ensure that those who are already in the labour market and have experience are given opportunities for further training. An efficient approach would be to **repurpose existing or newly developed elective renewable PtX courses** at higher education or TVET institutions as training programmes for professionals already working in their respective fields.

Compliance managers, installations inspectors, and professionals in management roles also require specialised training in PtX-related topics. Such offerings are currently limited in Namibia, but the gap can be addressed through specific continuing education courses. Furthermore, it is important to integrate PtX-specific compliance and management topics into foundational vocational training and offer tailored elective courses and continuing education programmes.

Recommendations for a PtX Skills Development Programme in Namibia: Action items and timeline

Based on the findings of the study, the following **actions** for a Namibian PtX Development Programme are recommended:

1 Establishing a National PtX Skills Task Force

- Form a National PtX Skills Task Force comprising government, industry, academia, and training providers, and align it with the existing Namibia Private Sector Green Hydrogen Task Force.
- This Task Force is to develop a strategic programme and action plan to address PtX skill gaps.

2 Developing Industry-Driven Curricula and Training Programmes

- Design and implement curricula and programmes in collaboration with PtX industry and educational institutions for both higher education and vocational training pathways.
- Include practical, hands-on training and internships to gain real-world experience.
- Regularly review and update curricula to meet evolving industry needs.

3 Up- and re-skilling through Continued Professional Development

- Offer green PtX-related specialised and accredited professional training courses for the existing workforce.

4 Enhancing Apprenticeship Programmes

- Invite green PtX-related industries (including the renewable power sector) to participate in apprenticeship programmes.
- Set minimum standards for apprenticeships (e.g., mentor qualifications and training duration) to ensure satisfying apprenticeship outcomes.

5 Upskilling Academic and Vocational Training Staff

- Conduct PtX-related workshops and seminars for teaching staff.
- Facilitate industry internships for teaching staff and collaboration with PtX experts.
- Establish a Train-the-Trainer platform for theoretical and practical knowledge sharing.

6 Supporting the Bridging of the Gap Between TVET Level 4 and Level 6

- Establish the proposed Faculty of TVET at NUST to bridge the gap between NQF Levels 3 or 4 and Level 6.
- Design undergraduate and postgraduate programmes for trainers to qualify them to train up to NQF level 6 in vocational training centres.

7 Enhancing Research and Development Initiatives

- Promote collaboration between universities, research institutions, and industry partners.
- Provide funding support for green PtX research projects.
- Encourage knowledge sharing and technology transfer through partnerships and networking platforms.

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8 Establishing Centers of Excellence

- Create specialised training centers with state-of-the-art infrastructure, equipment, and resources for hands-on training and research activities.
- Collaborate with international partners for knowledge exchange.

9 Promoting Registration of Engineering Professionals with the ECN

- Initiate and formalise "graduate in training" programmes in collaboration between training institutions and the PtX industry.
- Implement mentorship programmes for professional development.

10 Promoting Gender-Inclusive Career Pathways

- Launch awareness campaigns and showcase career opportunities for women.
- Develop training programmes encouraging women's participation (including flexible training and work arrangements) and mentorship initiatives for women in green PtX fields.
- Encourage women's representation in leadership roles.

11 Engaging Stakeholders

- Develop a comprehensive plan for stakeholder engagement to ensure smooth planning and implementation of the action plan, and consider the use of public-private partnership (PPP) arrangements.
- Form task forces and working groups.
- Foster collaboration, communication, and knowledge sharing between stakeholders, including private sector entities, international organisations, and development agencies, in an environment of continuous learning and improvement.

12 Tapping Financing Opportunities for the PtX Skills Development Programme

- Explore government programmes and international development finance institutions and programmes supporting the introduction of green PtX-related technologies and skills development.
- Establish public-private partnerships to attract funding and explore opportunities in carbon markets to generate revenues.
- Seek grants and partnerships with philanthropic organisations.

13 Fostering Public-Private Partnerships (with Project Developers)

- Establish a PPP framework, create a favorable investment climate, and engage private sector entities.
- Jointly invest in PtX-related infrastructure, technology and knowhow transfer.
- Develop quality assurance mechanisms for training programmes.
- Foster continuous learning and collaboration in the PPP model.

14 Supporting Entrepreneurship

- Create incubation and acceleration programmes for aspiring PtX entrepreneurs.
- Facilitate partnerships between universities and industry stakeholders to support entrepreneurs in accessing new technologies.
- Develop financing mechanisms tailored to entrepreneurs' needs in the PtX ecosystem.
- Foster international entrepreneurial communities and networking.

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Milestones and Timeline

Short-Term Milestones (1-3 years)

- Establish partnerships to design and implement training programmes and short courses.
- Upgrade existing Solar Equipment Installation and Maintenance Course.
- Upgrade pipe fitter/plumber qualification.
- Develop and launch vocational training programmes providing basic skills training in PtX-related areas.
- Initiate on-the-job training, internships, and apprenticeships for trainers, trainees, and students.
- Establish the proposed Faculty of TVET at NUST.
- Implement monitoring and evaluation framework.

Medium-Term Milestones (4-10 years)

- Expand PtX-related training programmes and collaborations in the growing PtX sector.
- Establish a Hydrogen/PtX Centre of Excellence or Research Institute.
- Develop partnerships with international organisations, experts and training providers to leverage global PtX-related expertise.
- Scale up TVET programmes, incl. the offer of internship and apprenticeships opportunities.
- Continuously evaluate and update the programme.
- Develop advanced degree programmes and postgraduate courses that incorporate newest PtX and related.

Long-Term Milestones (11-30 years)

- Strengthen PtX research and development within Namibia.
- Foster entrepreneurship and innovation.
- Establish knowledge-sharing platforms.
- Continuously evaluate and update the PtX Skills Development Programme.
- Regularly assess and update long-term targets and milestones.

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LIST OF ABBREVIATIONS

CBET	Competence-based Education and Training
ECB	Electricity Control Board
ECN	Engineering Council of Namibia
EIF	Environments Investment Fund of Namibia
EU	European Union
GIZ	Deutsche Gesellschaft für International Zusammenarbeit GmbH
ICT	Information and Communication Technology
ILO	International Labour Organisation
LA	Local Authority
MHETI	Ministry of Higher Education Technology and Innovation
MLIREC	Ministry of Labour Industrial Relations and Employment Creation
MME	Ministry of Mines and Energy
NamGHA	Namibia Green Hydrogen Association
NamPower	Namibia Power Cooperation
NCRST	National Commission on Research Science and Technology
NDC	Nationally Determined Contributions
NEI	Namibia Energy Institute
NGHRI	Namibia Green Hydrogen Research Institute
NIMT	Namibia Institute of Mining and Technology
NIPDB	Namibia Investment Promotion and Development Board
NIT	National Institute of Technology
NPC	National Planning Commission of Namibia
NQA	Namibia Qualifications Authority
NQF	National Qualifications Framework
NTA	Namibia Training Authority
NUST	Namibia University of Science and Technology
PHEI	Private Higher Educational Institution
PtX	Power-to-X
REAiON	Renewable Energy Association Industry of Namibia
REDs	Regional Electricity Distributors
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land
TVET	Technical Vocation Education and Training
TP	Training Providers
UNAM	University of Namibia
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VTCs	Vocational Training Centres
WIL	Work Integrated Learning

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1

Job Potential from the Green Hydrogen and PtX Economy in Namibia

INTRODUCTION

Namibia's future hydrogen and PtX economy offers the potential for socioeconomic development. Due to the countries' favourable conditions for renewable energy production, it can leverage new business opportunities with Power-to-X and become one of the frontrunners in emerging Power-to-X markets. Power-to-X creates the potential for Namibia to industrialise and therefore accelerate its economic development, become less dependent on fossil fuel imports and address the topic of poverty reduction. The purpose of this study is to examine the skills requirements and gaps in Namibia's PtX sector and suggest measures to improve the job prospects of Namibians. By addressing these factors, the study aims to assist the education sector and industry stakeholders in developing effective programmes for workforce development.

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1.1 Overall Context

The advancement of Namibia's hydrogen and PtX economy presents an avenue for the country's socioeconomic development and industrialisation. Namibia's high unemployment rate, particularly among the age group of 15-24 years (*World Bank Open Data*, n.d.), stands as a significant challenge to the country. However, there is renewed potential for alleviating unemployment through the emerging green hydrogen and Power-to-X (PtX) sectors.

PtX technologies, which involve converting renewable energy sources into storable and usable forms such as hydrogen, synthetic fuels, and chemicals, have the potential to contribute to driving sustainable growth, and reduce greenhouse gas emissions.

By investing in education, research, and development, Namibia can create a supportive ecosystem that fosters innovation and entrepreneurship in the green hydrogen and PtX sectors.

The Namibian government's Hydrogen Strategy (Namibia, Ministry of Mines and Energy, 2022) recognises the integral role of skills development. By investing in education, research, and development, Namibia can create a supportive ecosystem that fosters innovation and entrepreneurship in the green hydrogen and PtX sectors. This not only holds the potential to generate new employment opportunities, but also enables the country to become a regional leader in sustainable energy production and exportation.

Furthermore, the expansion of the green hydrogen and PtX sectors can also spur the growth of ancillary industries and supply chains, creating a multiplier effect driving job creation across various sectors of the economy. This inclusive approach to economic development has the power to uplift communities, reduce poverty, and foster a more sustainable and equitable future for Namibia.

1.2 Aim and Scope

This study aims to explore the skills needs and gaps in Namibia's PtX sector and propose actions to enhance the employability of Namibians. By addressing these key factors, the study seeks to support the educational sector and industry stakeholders in formulating effective initiatives for workforce development.

The findings of this study shed light on the specific skills required by the PtX sector, including technical, scientific, and managerial capabilities. Moreover, it identifies the gaps and barriers that currently impede Namibians from accessing employment opportunities within the PtX sector, such as limited access to education and training, inadequate infrastructure, and underdeveloped support systems.

The study proposes recommendations to bridge the identified skills gaps, fostering the employability of Namibians in the country's growing hydrogen and PtX economy. These recommendations will encompass areas such as curriculum development, technical vocational training programmes and capacity-building initiatives that promote inclusivity, and equitable access to employment opportunities.

Empowering Namibians with the skills required to participate in the hydrogen and PtX industry will not only enhance employability, but also create pathways for social and economic advancement, gender-inclusivity, entrepreneurship and innovation.

By addressing the skills needs and gaps in Namibia's PtX sector, this study seeks to contribute to the sustainable socioeconomic development of the country. Empowering Namibians with the skills required to participate in the hydrogen and PtX industry will not only enhance employability, but also create pathways for social and economic advancement, gender-inclusivity, entrepreneurship, and innovation.

Overall, this study aims to provide valuable insights, and actionable recommendations that can inform policy formulation, investment decisions, and education and training strategies; ultimately driving the growth of Namibia's hydrogen and PtX economy, while enhancing local acceptance of green hydrogen and PtX investments by highlighting the social and economic benefits for the Namibian people.

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Outside the scope of this study:

- A quantitative analysis of numbers of jobs needed is not provided as there are no concrete figures available yet (some indicative workforce demand estimations have been provided in Section 2).
- Jobs and skills in synthetic fuel production (including carbon sourcing) are not considered at this stage since the future of this is too unclear at this time.
- Jobs and skills in potential future manufacturing industries are not considered at this stage. However, when the planned green iron and steel production projects are developed, this is expected to open up many new opportunities for the manufacturing industry.
- Jobs and skills in indirect and induced jobs are discussed briefly, but not elaborated on to the same extent as direct jobs.

1.3 Methodology

This study included stakeholder mapping, skills needs assessment, and gaps analysis, in order to provide crucial information and insights that serve as the foundation for constructing an effective skills development programme.

In a first step, key stakeholders were identified and mapped. By conducting **stakeholder mapping**, the assessment identified and analysed the various organisations, and entities that play a role in Namibia's PtX industry. Understanding the stakeholders and their respective interests, roles, and capabilities is essential for realising the collaborative efforts and partnerships required for successful skills development.

The **skills needs assessment** involved interviewing Namibia's PtX private sector companies (see Annex 1 for the developed private sector company interview guideline, and Annex 3 for a list of stakeholders interviewed). Since they are still in the early planning stages of their PtX activities, and have not yet developed a full picture of their jobs and skills needs, the expected skills needs were determined largely through a review of international literature.

The **gap analysis** examined the existing educational ecosystem in Namibia, in relation to the identified skills needs (see Annex 2 for the developed education sector interview guideline). It highlighted the disparities between the current skill levels and the desired skill requirements for the PtX industry. This analysis helps identify the pathways where skills development interventions are most urgently needed.

The results and findings serve as **the basis for elaborating a skills development programme** for Namibia's green hydrogen and PtX industry.

Stakeholder Mapping

The **key stakeholders** for this study were private sector companies for the skills needs assessment, and educational institutions for the education gap analysis. Interviews were conducted with the following parties:

Private Sector

- Hyphen Hydrogen Energy
- Hydrogène de France (HDF Energy)
- Cleanergy Solutions Namibia
- Daures Green Hydrogen Village
- HyIron – Green Technologies (Pty) Ltd

Education Sector

- Namibia University of Science and Technology (NUST) – Faculty of Engineering and Built Environment
- University of Namibia (UNAM)
- Namibia Training Authority (NTA)
- Namibia Qualifications Authority (NQA)
- UNAM – School of Engineering and Built Environment - José Eduardo dos Santos Campus
- UNAM – Faculty of Agriculture, Engineering & Natural Sciences
- UNAM – Namibia Green Hydrogen Research Institute (NGHRI)
- GIZ - Promotion of Technical Vocational Education and Training (ProTVET) project
- Community Skills Development Foundation

Government Ministry

- Ministry of Labour, Industrial Relations and Employment Creation
- Ministry of Higher Education, Technology and Innovation

For further information on these stakeholders, and for a visualisation of the stakeholder map, please refer to Annex 4.

1.4 Planned Training Initiatives of Private Sector PtX Projects in Namibia

Namibia has a vision to establish three green hydrogen valleys, with a range of PtX projects currently being planned. The planned timelines up to 2030 for the construction phases of these projects are depicted in Figure 1. More detail on each of these projects is provided in Table 1 below. This table includes the numbers of jobs as currently estimated by the projects, the type of project, and each project's planned training initiatives. At the time of writing there are no projects confirmed in the Northern Valley.

Planned PtX projects in Namibia's three green hydrogen valleys and their approximate construction timelines

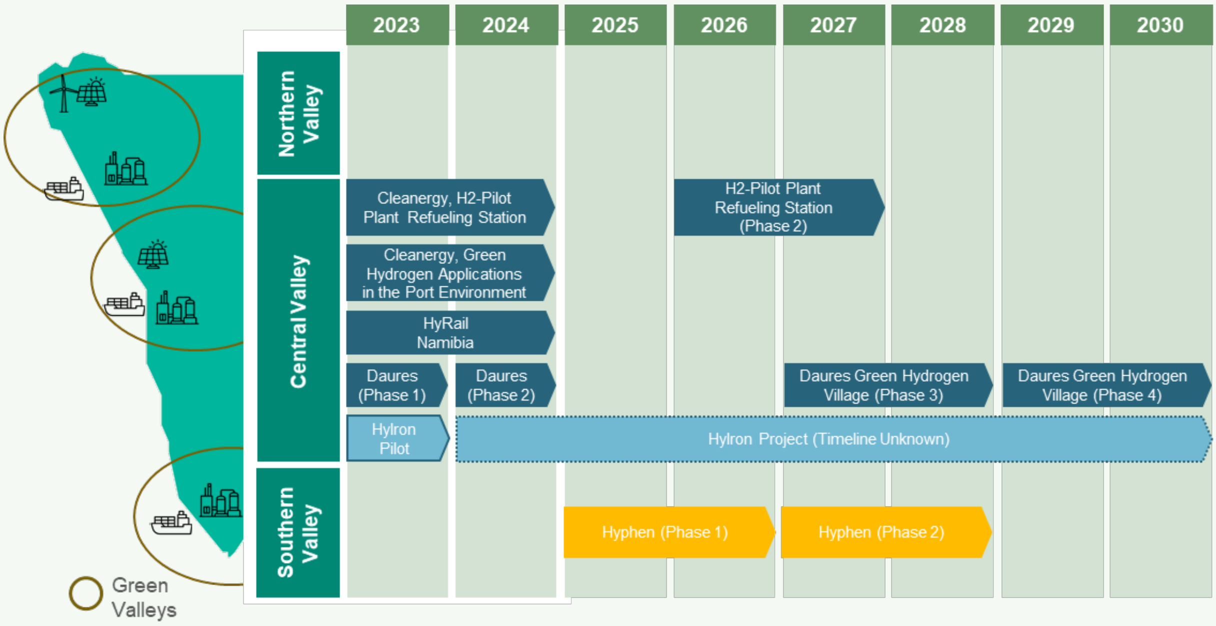

Figure 1

All the PtX private sector companies consulted indicated that they are, or will be, conducting studies internally to assess their PtX jobs and skills demands. To date, this information is not yet available. However, they highlighted that the highest demand is for design engineers, maintenance engineers and graduates from energy fields. Furthermore, they indicated that a significant number of refrigeration experts will be needed for the ammonia industry. Engineers including mining, mechanical and civil engineers are needed during planning and construction phases, while during hydrogen and ammonia production a significant number of chemical engineers, electrical engineers, physicists, environmental engineers and chemists are needed. Professionals in non-technical fields such as regulation, marketing, and management will also require some PtX-specific skills.

The private sector highlighted the following planned training initiatives in the PtX sector:

- **Hyphen Hydrogen Energy (Hyphen)** indicated that they intend to implement a training programme similar to the South African Renewable Energy Technology Centre (SARETEC), an institution affiliated to the Cape Peninsula University of Technology in South Africa, especially in the area of wind power. Furthermore, Hyphen highlighted that in terms of practical knowledge, they are planning to develop apprenticeship and internship programs.

- **Hydrogène de France (HDF)** plan to have a training centre where theoretical and practical training will take place for direct skills transfer and reskilling. Engineers who are interested in upskilling their knowledge in the PtX industry will be able to utilize the centre from all over Namibia and get linked to the experts (local or from outside Namibia) that will work on the project.
- **Cleanergy Solutions Namibia** highlighted that they partnered with University of Namibia (UNAM) and the Federal Institute for Materials Research and Testing (BAM) in Germany to establish a research institute at UNAM. The objectives of the institute will be to carry out their materials testing, to upskill the capacities of laboratories in Namibia through UNAM (whereby BAM will provide laboratory equipment), and for UNAM Master's and PhD students to be assisted with their research through BAM. Furthermore, they are also planning to collaborate with the Namibia Institute of Mining and Technology (NIMT) at their Arandis Campus to see how they can upskill NIMT students. This will assist students in acquiring skills in green ammonia and renewable energy (photovoltaics and wind). They will achieve this by collaborating with their partners from Belgium to help NIMT to introduce hydrogen content in their curriculum.
- **HyIron** has a dual vocational training approach which aims to establish a strong connection between industry and the educational sector. HyIron, through the Kambaku College in cooperation with Merj GmbH in Germany, has in the last 4 years developed the Mainporter Vocational Online College. This online college aims to support 1) apprentices through online resources and online access to trainers and other apprentices, 2) practical trainers, mentors and trade organisations with online training support and other resources, and 3) theoretical trainers who are trade experts and provide guidance to apprentices and practical trainers.

  In HyIron's initial project phases, apprentices will receive practical training in Germany from technology partners with strong expertise in the field of PtX.

Most projects are planning to sign a Memorandum of Understanding (MOU) with NIMT. Trainers and trainees from NIMT will go to the project sites to receive training to acquire the skills needed in the PtX industry. Additionally, the companies will assist NIMT to introduce curricula that align with the PtX industry. Furthermore, most projects are collaborating with UNAM on research and capacity building.

Table 1: Brief description of planned PtX projects. All the below information is publicly available from project websites and press releases.

Name of the Project	Project activities	Estimated number of jobs	PtX end use	Planned training initiatives	Timeline
Daures Green Hydrogen Village	In 4 phases up to 600 MW wind, 400 MW PV, 420 MW electrolyser, hydrogen, ammonia	Pilot phase one will provide 20 to 30 jobs	Chemical industry (fertilisers and cleaning detergents); Potential for industrial level	Internship programmes	Phase 1: 2022-23 Phase 2: 2023–24 Phase 3: 2026–28 Phase 4: 2029-30
H2-Diesel Dual Fuel Locomotive (CMB.Tech, UNAM, Hyphen, TransNamib, NGHRI) Walvis Bay to Kranzberg corridor (Central Region)	50 locomotive fleet conversion to green hydrogen & diesel dual fuel	Pilot phase: 10 – 15 direct jobs Roll-out phase: 36 direct jobs, 160 indirect jobs	Fleet of green hydrogen & diesel dual fuel locomotives	Research collaboration	2022 - 2023
Green Hydrogen Applications in the Port Environment (Cleanergy, NamPort, UNAM) Walvis Bay Port (Central Region)	Hydrogen for heavy-duty port equipment	Not indicated	Heavy duty fuel cell vehicles (tugboats and heavy-duty port equipment), and green H2 for bunkering vessels and refuelling equipment	Research collaboration	Not indicated
Cleanenergy H2-Pilot Plant / Refueling Station Walvis Bay (Central Region)	5 MW PV 5 MW electrolyser Hydrogen refuelling station	25-50 for the pilot plant, and greater than 1000 for the commercial plant and related industry	H2 refuelling station for heavy duty fuel cell vehicles in mining sector and ports	On-site training and research institute	2022 – 2026/7
Hyphen (Southern Corridor Development Initiative) Tsau/Khaeb National Park (Southern Region)	7 GW wind + PV 3 GW electrolyser 350k tonnes/year H2 production 2 million tonnes/year ammonia production	15,000 new jobs during construction, 3000 permanent jobs during operation. 90% of jobs to be filled by Namibians, 20% of which will be youth	Ammonia for export. Industrial and agricultural chemicals. Target of 30% local procurement of goods and services during construction & operation	Training programme, apprenticeship and internship programmes	Construction Phase 1: 2025-26, Phase 2: 2027-28, Operation: 40 years
Hydrogène de France (HDF) Energy	85 MW solar park with battery storage, electrolyser, hydrogen storage, fuel cells	Around 250 direct jobs during construction and around 30-40 jobs during operation	Power-to-Power (production and storage of green hydrogen, conversion back to electricity via fuel cells)	On-site training centre	Planning & construction: 2022-2024 Commercial operation: 2024+

HyIron (pilot plant in Lingen, Germany)	Green H2 as a reducing agent for green iron and steel production. First stage: 20 MW green power, 15000 tonnes iron/year; Final stage: 1GW green power, 1 million tonnes iron/year	Not indicated	Iron and steel production	Apprenticeship, practical Train-the-Trainer training for trainers, training abroad	Pilot plant in Germany due to open in August 2023

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2

Conducting a Skills Needs Assessment of the Future Namibian Power-to-X Economy

SKILLS NEEDS ASSESSMENT

This skills needs assessment aims to identify jobs and skills along the PtX value chain that Namibia needs for a market transformation using PtX. These tie in with the analysis of the educational system to allow skills gaps to be identified, and recommendations to be made on how these may be filled. The findings from this assessment will serve as a crucial starting point for designing effective strategies to enhance the employability of the Namibian workforce and support the development of a skilled workforce in the PtX economy.

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2.1 PtX Value Chain

The PtX value chain describes the sequence of processes involved in the production and distribution of both hydrogen and hydrogen derivatives such as ammonia and synthetic fuels up to their end use in a range of PtX applications. Upstream activities are those relating to green hydrogen production and storage, while downstream activities are those relating to the end-use.

PtX value chain

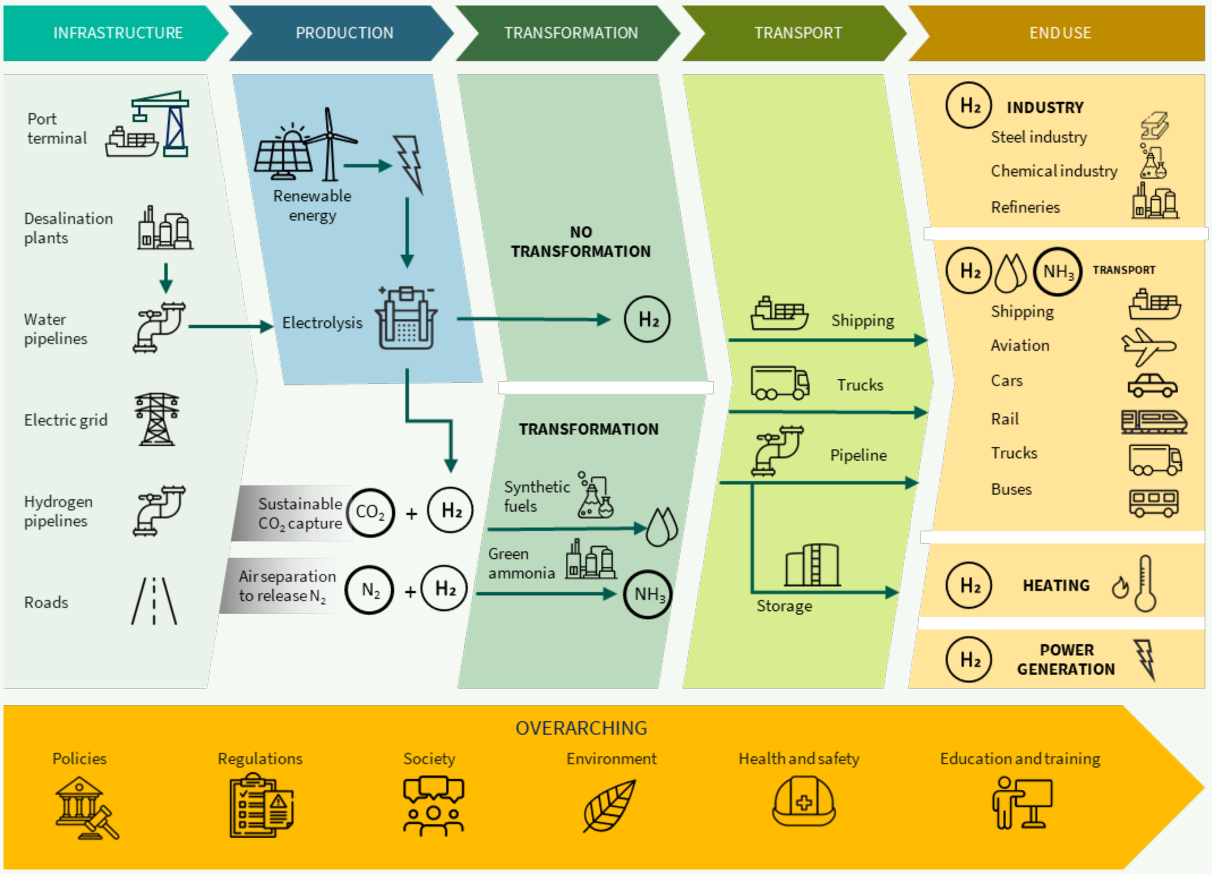

Figure 2: Adapted and modified from IRENA (2020), Green Hydrogen: A guide to policy making, International Renewable Energy Agency, Abu Dhabi

For this study, the PtX value chain has been divided into the following six stages:

1. Infrastructure

This value chain stage considers all the infrastructure that is required to support the PtX value chain. Since the planned renewable energy and green hydrogen production projects eclipse existing energy generating facilities, a massive scale-up of infrastructure will be needed. This will include new desalination plants, new water pipelines, extensions to the electricity grid, new hydrogen pipelines, and new roads. Importantly, deep sea port terminals need to be constructed to receive the large ammonia transportation ships.

It is essential to plan how the new PtX products, processes and systems will be integrated into the existing infrastructure smoothly and effectively.

2. Production

This value chain stage focuses on green hydrogen production via electrolysis using electricity supplied by wind and solar PV parks, and water supplied from new desalination plants via new water pipelines.

3. Transformation

This value chain stage considers the conversion of hydrogen primarily into ammonia through the addition of Nitrogen which is extracted from air in an air separation unit. In the long term, Namibia plans to produce synthetic fuels through the addition of sustainably captured CO_2.

4. Storage and Transportation

This value chain stage looks at the storage of hydrogen and its transportation via pipelines and/or tanker trucks. It also looks at the storage and transportation of hydrogen derivatives, primarily ammonia. An important sector here is the export of ammonia via ammonia tanker ships.

5. End use

In the Namibian context, near-term PtX end-use applications are, for example, ammonia for export, fertiliser, fuel cell heavy duty vehicles (mining trucks and long-haul trucks), fuel cell locomotives, and fuel cell tug boats, as well as green iron production. In the longer term, Namibia plans to produce carbon-based synthetic fuels which, along with green iron and steel production, will unlock further manufacturing opportunities.

6. Overarching

This encompasses aspects which impact on the other groups such as the policy and regulatory landscape, social and environmental considerations, health and safety considerations, and education and training.

2.2 Jobs and Skills Demands along the PtX Value Chain

As the hydrogen and PtX markets in Namibia begin to evolve, the next few years will be dominated by large construction projects where significant numbers of jobs will be created. The phases of these projects can all be broadly seen as planning & design, manufacturing, transportation, construction & installation, operation & maintenance. The decommissioning phase comes at the end of the project's life and, although this is 25+ years into the future, consideration should be given at the start of the project to factors such as component recycling (in particular batteries and PV modules) and disposal of waste. Jobs and skills in manufacturing industries are not considered at this stage.

Project phases from planning and design through to construction and, finally, operation

Figure 3: Illustration by RENAC

Firstly, this section takes a detailed look at key jobs and skills for the following stages of the PtX value chain where **direct** jobs are created (see Figure 2):

- Green hydrogen production (PV, wind, battery storage, electrolysis)
- Green hydrogen compression, storage and transportation
- Green ammonia production
- Hydrogen refuelling stations and fuel cell heavy duty vehicles

Note on direct jobs

Direct jobs are those required in the primary industries and sectors of interest (in this case, green hydrogen and PtX). In this study, all jobs associated directly with green hydrogen production and PtX activities are considered to be direct jobs.

The jobs and skills have been mapped against the respective project phase. These jobs and skills maps provide an overview of the types of jobs and skills that will be required. More detail is provided in Annex 6 in sample job profiles for key jobs in PV and wind.

Secondly, this section looks more broadly at **indirect** jobs and skills in sectors on which the PtX sector depends, namely in infrastructure and in the overarching areas such as regulatory, policy, societal, environmental, education and training.

Note on indirect jobs

Indirect jobs are those found in the sectors and industries that supply equipment or services to the primary industries. (It is often not clear cut whether a job falls into the direct or indirect category.) Therefore, all jobs enabling green hydrogen production and PtX activities are considered to be indirect jobs.

Finally, this section considers **induced** jobs and skills demands for example in new housing construction, in the service sector and in support jobs:

Note on induced jobs

All jobs arising through the presence of workers and the salaries that they spend are considered to be **induced jobs**.

2.2.1 Jobs and Skills Demand in Green Hydrogen Production (PV, Wind, Battery Storage, Electrolysis)

Photovoltaics (PV)

Namibia currently has around 163 MW of installed **PV capacity** (USAID, n.d.) and as such has accrued some significant experience in planning, installing and operating PV plants. Nevertheless, since 3+ GW of PV are planned to be constructed in the next years, there will be a clear increase in demand for qualified PV professionals. Job profiles describing knowledge and skills required for key PV jobs are provided in Annex 7.

IRENA's 2017 publication "Renewable Energy Benefits: Leveraging Local Capacity for Solar PV" (IRENA, 2017b) estimates the workforce demand for a 50 MW utility-scale PV plant. These figures are presented in Table 2 below. **Once the installation is completed, the same workforce can move onto the next installation. This is important: in workforce demand estimates due care must be taken not to count the same workforce twice.**

Table 2: Estimated workforce demand for a 50 MW utility-scale PV plant

Project Phase	Workforce Demand [Person-days for 50 MW]	Workforce Demand (assuming a 5-day working week) [Person-years for 50 MW]	Employment Factor [job-years/MW]
Planning & Design	2120	8	0,16
Transportation	3475	13	0,27
Construction & Installation	39380	151	3,03
Operation & Maintenance	13560	52	1,04

Note on size of workforce required

The figures presented here can give an idea of workforce size. It must, however, be emphasised that there is high potential variability in these figures due to aspects such as project size, market status, and level of experience in the workforce. The private sector companies currently planning PtX projects will be able to provide more precise figures relating directly to their situation when they have completed their in-house skills demand assessments.

Wind

Currently there are around 7 MW of installed wind capacity (USAID, n.d.). So far, therefore, there is only limited experience in Namibia in wind farm planning, installation and operation. With 4+ GW of wind farms being planned, there is also demand here for qualified wind professionals. Job profiles describing knowledge and skills required for key wind jobs are provided in Annex 7.

Typically, wind turbine manufacturers provide in-house training to the personnel who will be constructing and operating the wind plants. However, the South African Renewable Energy Technology Centre (SARATEC) in Cape Town, for example, offers a SAQA accredited NQF Level 5 Wind Turbine Service Technicians qualification with NQF Level 4 electrical, mechanical or mechatronics engineering qualifications as prerequisites.

IRENA's 2017 publication "Renewable Energy Benefits: Leveraging Local Capacity for Onshore Wind" (IRENA, 2017a) estimates the workforce demand for a 50 MW utility-scale onshore wind plant. These figures are presented in Table 3 below.

Table 3: Estimated workforce demand for a 50 MW utility-scale onshore wind plant

Project Phase	Workforce Demand [Person-days for 50 MW]	Workforce Demand (assuming a 5-day working week) [Person-years for 50 MW]	Employment Factor [job-years/MW]
Planning & Design	2580	10	0,20
Transportation	875	3	0,07
Construction & Installation	34480	133	2,65
Operation & Maintenance	2665	10	0,21

Batteries

The extent to which the planned green hydrogen production projects will incorporate **battery energy storage systems** has largely not yet been defined. Batteries will, however, play an important role in the energy mix for energy storage as well as for providing grid services (maintaining stable grid voltage and frequency). Therefore, there will be a demand also here for a workforce with expertise in sizing, selecting, installing and maintaining battery systems.

Electrolysers

There is 3+ GW of **electrolyser capacity** planned to be installed in the next years. In terms of space, this is equivalent to over 110,000 m^2 of area or around 15 football fields. If, in the long term, electrolyser demand picks up to beyond 3-4 GW per year, then electrolyser balance of plant and assembly facilities could be localised in Namibia, creating 5,000 jobs in 2035-40 (Namibia, Ministry of Mines and Energy, 2022). Up until that point, it is assumed that job creation is restricted to installing the electrolyser plant at the production site. Key jobs and associated skills are provided in the skills map below.

Note on terminology

Note that some "jobs" such as "electrical engineer" would more accurately be called "professions". For example, "electrical engineer" has been listed as a job to make it clearer what qualification and base skillset a person would need to have to fulfil the required function. In actual fact, someone with the profession "electrical engineer" would have the appropriate base qualification to perform many of the required jobs, such as "PV system design engineer", "lead engineer during construction", "operations engineer".

Table 4: Jobs and skills for green hydrogen production (including PV, wind, battery, electrolyser plants) mapped along the project phases

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform planning, approvals and compliance processes **Project developers, planners, regulators**	*Receive, process, hold, release incoming goods at ports* **Port authority personnel, shipping agents**	*Perform detailed engineering design and procurement of PV, wind, battery, electrolyser plant* **Electrical, mechanical, civil, industrial, process and other engineers**	*Monitor and operate PV and battery plant* **Electrical engineers**
Ensure compliance with environmental and social standards **Environmental experts, natural resource managers**	*Organise transport of components, equipment and materials to construction site* **Logistics personnel**	*Prepare ground, lay foundations* **Civil engineers, earthmoving plant operators, concreters**	*Monitor and operate wind plant* **Mechanical and electrical engineers**
Perform preliminary design of PV, wind, battery, electrolyser plant **Electrical, mechanical, civil, industrial, process and other engineers**	*Transport components, equipment and materials to construction site* **Truck drivers**	*Oversee overall PV, wind, battery, electrolyser plant construction and installation* **Lead engineering manager**	*Monitor and operate battery plant* **Electrical and electronic engineers**
Perform preliminary design of hydrogen compression and storage system **Industrial, process, mechanical engineers**		*Supervise construction site* **Construction managers**	*Monitor and operate electrolyser plant* **Mechanical, industrial, process, instrumentation or other engineer**
Perform grid assessment and develop grid connection agreement **Power, grid connection, electrical engineers working for electricity utility**		*Move components, equipment, material around site* **Crane, hoist and lift operators**	*Perform engineering maintenance of PV, wind, battery, electrolyser plant* **Electricians, mechanics, pipe fitters, instrumentation technicians and other technicians**
Negotiate and make contracts **Lawyers, legal experts**		*Install and commission all electrical, control and monitoring works for PV, wind, battery, electrolyser plant* **Electrical and electronics engineers, electricians, electrical technicians, labourers**	*Perform plant inspections at intervals* **Engineering inspectors**

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Develop financial plan and make financial arrangements **Financial expert**		*Install and commission all mechanical and pipe works for PV, wind, battery, electrolyser plant* **Mechanics, mechanical technicians, pipe fitters, instrumentation technicians, labourers**	*Perform non-technical routine maintenance of PV plant and general* **PV module cleaners and grounds people**
		Approve all installations with regard to quality, performance, safety **Inspectors, health & safety officers**	*Keep site secure* **Security personnel**

2.2.2 Jobs and Skills Demand in Green Hydrogen Compression, Storage and Transportation

Hydrogen can be transported either via pipeline or via specialised tanker truck. In pipeline transportation, **hydrogen is compressed** to pressures of 100-900 bar (as opposed to 30-100 bar for natural gas) and injected into dedicated pipelines, where it flows under pressure to distribution points or end-users. Tanker truck transportation involves either compressing hydrogen to 200-900 bar or liquefying it by reducing the temperature to below -253°C at the production site, loading it onto trucks equipped with storage systems, and transporting it to the desired destinations. The **storage tanks** – at the production sites, on the tanker trucks, and at the refuelling stations – as well as the compressors, pipework, hoses, and all other valves and fittings must be capable of withstanding these temperatures and pressures, and must have appropriate safety devices in place to allow safe release of hydrogen under failure conditions.

Safety hazards, and measures to avoid and mitigate them are:

- Hydrogen is a highly flammable gas. Safety measures must be in place to prevent and control hydrogen fires and explosions.
- Due to hydrogen's low molecular weight, it is difficult to contain, and hydrogen leaks are difficult to detect. Effective leak detection and mitigation systems must be in place.
- Hydrogen can cause embrittlement in some metals, which can cause these materials to fail over time. Materials must be selected that are compatible with hydrogen, proper materials testing and standards must be followed for all hydrogen-related infrastructure and equipment, and highly trained personnel must be able to detect cracks and potential failures.

Standards relating to hydrogen and fuel cell safety exist from ISO (International Organisation for Standardisation), NFPA (National Fire Protection Association), IEC (International Electrotechnical Commission), and SAE (formerly Society of Automotive Engineers), amongst others.

Due to all of these factors, highly capable and skilled professionals are required to design the hydrogen systems, to install them, to operate them, to maintain them, and to inspect them. All personnel working with hydrogen must be highly knowledgeable and well-trained in hydrogen safety aspects. Engineers, pipe fitters, gas inspectors and other safety and quality control personnel must be well-versed in hydrogen standards, and must be highly trained in their respective fields of expertise. Some internationally recognised training providers such as TÜV Süd already offer courses on hydrogen safety.

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Table 5: Jobs and skills for green hydrogen compression, storage and transportation mapped along the project phases

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform planning, approvals and compliance processes **Project developers, planners, regulators**	*Receive, process, hold, release incoming goods at ports* **Port authority personnel, shipping agents**	*Perform detailed engineering design and procurement of hydrogen compression and storage facilities, and hydrogen pipelines* **Mechanical, civil, industrial, process and other engineers**	*Monitor and operate PV and battery plant* **Electrical engineers**
Ensure compliance with safety and environmental regulations, permitting and other standards **Regulators, inspectors**	*Organise transport of components, equipment and materials to construction site* **Logistics personnel**	*Install and commission all hydrogen compression and storage units and associated pipework and instrumentation* **Mechanical engineers, pipe fitters, pipe fitter's assistants, metal workers, instrumentation technicians, labourers**	*Monitor and operate hydrogen compression and storage facilities, and hydrogen pipelines* **Mechanical, industrial, instrumentation or other engineers**
Perform preliminary design of hydrogen compression and storage facilities, and hydrogen pipelines **Mechanical, civil, industrial, process and other engineers**	*Transport components, equipment and materials to construction site* **Truck drivers**	*Install and commission hydrogen pipeline and associated pipework, instrumentation, etc.* **Mechanical engineers, pipe fitters, pipe fitter's assistants, metal workers, instrumentation technicians, labourers, earthmoving plant operators, crane and hoist operators**	*Perform engineering maintenance on facility and hydrogen pipelines* **Mechanical engineers, pipe fitters, pipe fitter's assistants, metal workers, instrumentation technicians**
Perform preliminary design of hydrogen compression and storage system **Industrial, process, mechanical engineers**		*Approve all installations with regard to quality, performance, safety* **Inspectors, health & safety officers**	*Monitor and operate electrolyser plant* **Mechanical, industrial, process, instrumentation or another engineer**
			Perform facility and pipeline inspection at intervals **Instrumentation technicians, engineering inspectors**
			Perform plant inspections at intervals **Engineering inspectors**

2.2.3 Jobs and Skills Demand in Green Ammonia Production

Green ammonia is typically produced via the Haber-Bosch process. In this process, Nitrogen is first extracted from the air in an air separation unit. Nitrogen and Hydrogen then react over a catalyst at high pressures and temperatures to form ammonia. Apart from the air separator and the reactor, the other main components making up the green ammonia production plant are compressors (to increase the pressure of the gases), heat exchangers (to remove excess heat from the reaction), separation units (to separate the ammonia gas from any unreacted hydrogen or nitrogen), condensers (to cool and condense any unreacted gases or by-products), storage tanks (to store the produced ammonia), and utilities (such as cooling water systems, power supply systems, instrument and control systems). Industrial process engineers design the plant, and industrial piping engineers design the process piping, while industrial pipe fitters do the main installation work.

Table 6: Jobs and skills for green ammonia production mapped along the project phases

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform planning, approvals and compliance processes **Project developers, planners, regulators**	*Receive, process, hold, release incoming goods at ports* **Port authority personnel, shipping agents**	*Perform detailed engineering design and procurement of green ammonia production facility* **Chemical, mechanical, civil, industrial, process and other engineers**	*Monitor and operate green ammonia production facility* **Industrial, process or other engineer**
Ensure compliance with safety and environmental regulations, permitting and other standards **Regulators, inspectors**	*Organise transport of components, equipment and materials to construction site* **Logistics personnel**	*Prepare ground, lay foundations* **Civil engineers, earthmoving plant operators, concreters**	*Perform engineering maintenance on facility and hydrogen pipelines* **Mechanical, process, chemical engineers, pipe fitters, pipe fitter's assistants, instrumentation technicians**
Perform preliminary design of green ammonia production facility **Mechanical, civil, industrial, process and other engineers**	*Transport components, equipment and materials to construction site* **Truck drivers**	*Oversee green ammonia plant construction and installation, supervise construction site* **Lead engineering manager, construction manager**	*Perform facility and pipeline inspection at intervals* **Mechanical, process, chemical engineers, pipe fitters, instrumentation technicians, engineering inspectors**
		Construct, install and commission green ammonia production facility **Chemical, mechanical engineers, pipe fitters, pipe fitter's assistants, metal workers, instrumentation technicians, labourers, crane and hoist operators**	

		Approve all installations with regard to quality, performance, safety **Inspectors, health & safety officers**	

2.2.4 Jobs and Skills Demand in Hydrogen Refuelling Stations and Fuel Cell Electric Vehicles

One of the main sectors where Namibia sees economic potential for its domestic PtX market is **hydrogen fuel cell vehicles for long haul trucks and on-site mining trucks**. Various international players are currently developing and producing large hydrogen fuel cell mining trucks, amongst them Anglo American in South Africa in collaboration with ENGIE, and the Chinese Engine major, Weichai (SYSTEMIQ, 2022). Fuel cell long haul trucks typically store hydrogen on-board at pressures of either 350 bar or 700 bar. For 350 bar storage, the long-haul trucks have a range of around 500 km between refuelling. With 700 bar storage this can double to around 1000 km between refuelling (H2 Mobility, 2021). The time to refuel is around 15 minutes. To limit the need for widespread and costly hydrogen refuelling infrastructure, the aim would be to have end-to-end refuelling. These factors mean that, in the short- to medium-term, there will likely only be a small number of refuelling stations planned, built and operated. Nevertheless, since this is a key element in Namibia's planned PtX economy, it is worth analysing the types of jobs and skills that will be required.Table 7 below provides a jobs and skills map for hydrogen refuelling stations. Alongside this, heavy duty vehicle maintenance technicians will require additional training in maintenance of fuel cell vehicles and hydrogen safety, and truck drivers will also require additional training in operating hydrogen fuel cell vehicles as well as hydrogen safety these jobs are circled in Table 7 below.)

Table 7: Jobs and skills for hydrogen refuelling stations mapped along the project phases

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform planning, approvals and compliance processes **Project developers, planners, regulators**	*Receive, process, hold, release incoming goods at ports* **Port authority personnel, shipping agents**	*Perform detailed engineering design and procurement of refuelling station equipment* **Mechanical, civil engineers**	*Monitor and operate refuelling station and equipment* **Refuelling station operator**
Ensure compliance with safety and environmental regulations, permitting and other standards **Regulators, inspectors**	*Organise transport of components, equipment and materials to construction site* **Logistics personnel**	*Prepare ground, lay foundations* **Civil engineers, earthmoving plant operators, concreters**	*Perform engineering maintenance on refuelling station* **Mechanical engineer, pipe fitter**

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform preliminary design of refuelling station **Mechanical, civil engineers**	*Transport components, equipment and materials to construction site* **Truck drivers**	*Oversee green ammonia plant construction and installation* **Construction manager**	*Perform refuelling station inspection at intervals* **Mechanical engineer, pipe fitter, instrumentation technician, engineering inspector**
	Operate heavy duty fuel cell vehicles effectively and safely **Truck drivers**	*Construct, install and commission refuelling station and equipment* **Mechanical engineer, pipe fitter, pipe fitter's assistants, instrumentation technician, labourers, crane and hoist operators**	*Perform maintenance on heavy duty fuel cell vehicles* **Heavy duty vehicle maintenance technician**
		Approve all installations with regard to quality, performance, safety **Inspectors, health & safety officers**	

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2.2.5 Jobs and Skills Demand in Infrastructure

Although a detailed analysis of the indirect jobs and skills demands in the infrastructure projects that will support the PtX sector is outside the scope of this study, this section aims to give some preliminary insights into the activities and jobs involved. It will look at deep-water ports, desalination plants, power transmission lines, water pipelines and roads.

Deep-Water Ports

As part of Namibia's vision for three green valleys, it is planned that the existing ports at Walvis Bay (Central) and Luderitz (South) will be expanded, while a new port will be built in the Northern Valley. NamPort, the Port of Rotterdam and Hyphen are currently working on a master plan for the development of an enhanced deep-water port at Luderitz. This will include storage and production facilities for hydrogen derivatives, marine export and logistics facilities, and secondary and tertiary services (Namibia, Ministry of Mines and Energy, 2022).

A deep-water port is a fixed or floating manmade structure that is deep enough to accommodate the largest ships when fully laden. The Port of Rotterdam, for example, has a water depth of 20 m. The main components making up a deep sea port are the turning basin (this is a large, open water area within the port complex where ships and anchor and manoeuvre), the approach channel (a navigable waterway through which ships enter the turning basin), the breakwaters (structures built offshore to shelter the turning basin and access channel from waves, currents and sedimentation), berths (docking facilities where ships can moor to load or unload cargo), and quay walls (reinforced structures located alongside the berths that provide a platform for cargo handling equipment such as cranes and conveyer systems).

Many vessels, machines and equipment are required to build the various structures making up a deep water port: dredger vessels, pile drivers, crane ships, tugboats, excavators and earthmoving equipment, concrete mixers and pump trucks, jack-up barges, diving support vessels, and so on.

Jobs and Skills in Constructing Deep-Water Ports

Civil, marine and mechanical engineers will design the port and supervise construction activities. Highly skilled vessel and equipment operators will perform major construction activities, while highly skilled technicians and artisans such as welders and metal workers as well as regular construction workers will perform installation work, in part underwater.

Desalination Plants

Namibia's planned coastal desalination plants will employ the reverse osmosis process which removes salt and other impurities from seawater by passing it through a series of semi-permeable membranes. Desalination plants comprise modular units that are pre-fabricated off-site and then assembled on-site. Modular units are connected by pipework comprising piping, valves and fittings.

Jobs and Skills in Constructing Desalination Plants

Industrial process engineers (typically mechanical engineering background) design the plant, and industrial piping engineers (also mechanical engineers) design the process piping, while industrial pipe fitters do the installation. High voltage electricians are responsible for the electrical design and installation. A construction supervisor with experience in industry plant construction will supervise the production, erection and commissioning of the desalination plant.

Power Transmission Lines

Namibia sees great potential in expanding its electricity transmission grid both within its borders and into neighbouring countries. This grid would transport mainly green electricity from wind and sun, and so the grid should be built up in such a way as to remain stable even with high shares of fluctuating renewables.

Jobs and Skills in Installing Power Transmission Lines

Grid expansion planners, power transmission engineers, grid connection engineers, as well as transmission system operators will require knowledge and skills in designing, installing and operating such smart grids. When it comes to upgrading existing transmission infrastructure, and constructing new transmission lines and substations, this team of highly knowledgeable electrical engineers will be supported by highly skilled electricians, electrical technicians,

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earthmoving plant and machinery operators, and general construction workers.

Water Supply Network
A water supply network comprising water treatment works, pumping stations, water pipelines, valves and hydrants, and end user service connections will be needed not only to transport water from the desalination plants to the electrolyser plants, but also to supply water to local communities.

Jobs and Skills in Constructing a Water Supply Network

Civil and mechanical engineers will be required to design the structures and network as well as to supervise construction activities. Civil engineering technicians, concreters, pipe fitters, plumbers, earthmoving plant and machine operators, and general construction workers will be required during construction.

Roads
With the huge increase in construction traffic over the next 10 years, as well as the resulting increase in movement of people to get to and from places of work, Namibia's roads will require rehabilitation and extension.

Jobs and Skills in Constructing Roads

Namibia's already well-established road construction sector will require an increased workforce including civil engineers, surveyors, road designers, project and construction managers, earthmoving plant and machine operators, asphalt and concrete experts, and general construction workers.

2.2.6 Jobs and Skills Demand in Overarching Areas

This section looks at potential skills demands in the regulatory sector as well as in environmental and social fields. Considering jobs and skills demand in these overarching sectors ensures a comprehensive understanding of the PtX industry's impact and potential, allowing policymakers, industry stakeholders, and educational institutions to align workforce development initiatives with the broader goals of regulatory compliance, environmental sustainability, and social responsibility in Namibia.

Regulatory Sector
Namibia is planning to introduce policies, legislation and regulations to ensure the right enabling environment for the green hydrogen and PtX economies. The Synthetic Fuels Act will be brought into force which legislates for aspects such as land access, permitting processes, and electricity grid fees. Namibia also plans to establish a new body – the Implementation Authority Office (IAO) – which will oversee and facilitate all processes associated with identifying, planning, auctioning, procuring, permitting and financing hydrogen and associated infrastructure projects. It intends to provide a comprehensive information service to support embarking hydrogen and PtX project developers.

Policy makers and regulators will play a crucial role in shaping and overseeing the development of the emerging green hydrogen and PtX economies. To effectively regulate and support these sectors, regulators should have in-depth knowledge and skills in:

- green hydrogen and PtX technologies
- environmental and climate science to comprehend the potential benefits and impacts of green hydrogen and PtX in decarbonising the energy, transport and industry sectors
- regulatory incentives, support mechanisms, carbon pricing, emissions standards, and renewable energy targets
- economics and financing of green hydrogen and PtX projects to evaluate financing options, pricing models, and cost effectiveness
- market dynamics, competitive forces, and potential business models within the green hydrogen and PtX sectors
- technical standards and safety regulations specific to green hydrogen

Environmental Sector
The environmental sector addresses the ecological impact of PtX activities. Assessing jobs and skills demand in this area allows for the identification of roles related to environmental monitoring, sustainability assessments, and clean technology implementation, ensuring that the industry aligns with environmental goals.

Professionals working in the environment and ecology fields could benefit from supplementary knowledge and skills in:

- Life cycle assessment of green hydrogen and PtX projects

- Waste management and circular economy in green hydrogen and PtX projects
- Environmental monitoring and compliance of green hydrogen and PtX projects
- Impacts on marine ecosystems of coastal desalination plants

Social Sector
The social sector focuses on the societal implications of PtX projects, including community engagement, and equitable development. By examining jobs and skills demand in this sector, opportunities for employment in community relations, stakeholder engagement, and social impact assessment can be identified, fostering inclusive growth.

Regarding the social element, people representing each one of the many stakeholder groups – industry players, research institutions, utilities, environmental organisations, community groups, micro-, small- and medium-sized enterprises – would benefit from strong communication and negotiation skills to foster collaboration between all parties.

2.2.7 Jobs and Skills Demand in Induced Jobs

Induced jobs are those arising through the salaries that workers in direct and indirect jobs spend. Namibia sees huge opportunities through the creation of induced jobs from the hydrogen and PtX sectors. Analysing the numbers and types of induced jobs is beyond the scope of this study. However, since there is a clear and large demand for jobs here, it is worth highlighting some key areas that could have a large, positive impact, both for individuals as well as for communities and society as a whole.

Jobs in New Housing for Influx of Workers
The areas of Namibia where green hydrogen and PtX activities will be focused, will experience significant increases in population as people move to the area to work. These people will need to be housed and the decision as to whether housing should be temporary or permanent is part of a much wider plan. In either case, housing and associated infrastructure (water and electricity lines, sewage pipes, roads, fibre cables for internet connection, etc.) will need to be designed and built. This is a great opportunity to implement best practices in sustainability in all aspects from low energy buildings, to sustainable waste management, to good public transport networks. The workforce will require appropriate knowledge and skills across the board from architects and urban planners through to owners and employees of building construction companies.

Jobs in the Service Industry
With the influx of workers will also come the need for services such as hotel accommodation, cafes, bars, grocery stores, retail shops, cinemas, hairdressers, dentists, and so on. Individuals wishing to set up their own business would benefit from knowledge and skills in entrepreneurship, basic accounting, sales and marketing, as well as in how to get start-up financing.

Jobs in Education and Health Care
Workers will need access to health care. If they also bring their families, then their children will need access to nurseries and schools. Therefore, a workforce will also be needed to initially design and build the schools and health centres, as well as then doctors, nurses and teachers to populate them.

Jobs in Public Transport
It is expected that a considerable number of bus drivers will be required to transport personnel from their homes to work and back each day. Furthermore, the implementation of PtX projects can lead to the establishment of new businesses and services that support the operation of public transport systems. These could include maintenance and repair facilities, vehicle cleaning and detailing services, ticketing and fare management systems, and administrative and management roles associated with the expanded public transport network.

Other Support Jobs
Many more support jobs which do not require a formal qualification will be created such as cleaners, security guards, people to watch cars/car park attendants, etc.

3

Conducting an Education Gap Analysis to Establish the Existing Qualifications and Skills of the Workforce and Where These Should be supplemented with PtX-specific Skills

EDUCATION GAP ANALYSIS

The education gap analysis evaluates the alignment of Namibia's education sector with the skills needed in the green hydrogen and PtX sectors. The analysis specifically assesses Technical Vocational Education and Training (TVET) and higher education qualification programmes in relation to the required green hydrogen and PtX skills. Barriers and opportunities within the education system are described, and recommendations for incorporating green hydrogen and PtX skills needs into training pathways made.

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3.1 Review of the TVET Sector

Namibia recognises the establishment of a robust TVET skills base as a critical driver in supplying relevant skills to the labour market. This rationale to prioritise TVET skills development stems from the acknowledgement of this education sub-sector as a source of skills, knowledge and technology, needed to drive productivity in knowledge-based and transitional societies for the 21st century. Accordingly, the sector's importance is accentuated in national policy imperatives as a practical avenue for acquiring readily employable skills and for creating the conditions required for inclusive economic growth.

From a service provision perspective, Namibia's TVET sector, consists of public, private and community-based training providers (TPs) offering qualification programmes of which most are registered from Level 1 to Level 3 on the National Qualifications Framework (NQF).

Note on Namibia's National Qualifications Framework (NQF)

The **NQF consists of 10 levels** that range from basic literacy and numeracy skills to highly specialised postgraduate qualifications, encompassing a diverse range of competencies and knowledge.

NQF Levels 1-2 are foundational and serve as a starting point for learners to progress to more advanced levels of education and training.

Artisans generally fall under **NQF Levels 3-4**, which represents vocational or trade qualifications.

Technicians are typically classified under **NQF Levels 5-6**, which includes diplomas and higher national diplomas in technical fields.

Bachelor degrees are classified at **NQF Level 7**.

Bachelor Honours degrees are classified at **NQF Level 8**.

Master's degrees are classified at **NQF Level 9**.

Doctoral degrees are classified at **NQF Level 10**.

From a regulation perspective, TPs are legally required to register with the Namibia Training Authority (NTA) and pursue accreditation through the Namibia Qualifications Authority (NQA). Registration gives a training provider latitude to commence training provision, while accreditation endorses training provision. Accreditation takes place when training has already commenced. At present, both registration and accreditation require TPs to actively offer training.

More than 100 credible TPs, (either accredited by the NQA, and/or registered by the NTA) offer formal TVET qualifications. Enrolment in 2022 totalled 18,810 of which about 3,300 trainees were enrolled at the seven public TPs. Private TPs contribute to the bulk of the country's year-on-year TVET graduate throughput (about 9,700). Non-formal TVET programmes are provided by the private sector, nongovernment organisations (NGOs), religious organisations and community skills development centres (COSDECs). NGOs and religious organisations tend to target socio-economically deprived sections of society offering TVET programmes to unemployed youth, women and the disabled. COSDECs, run by the Community Skills Development Foundation (COSDEF), offer short-term TVET programmes (UNESCO, 2016)

Typically, TPs offer a combination of Competence-Based Education and Training (CBET) and modular courses. Notable exceptions are the National Youth Services (NYS), which offers only CBET courses, and the Namibia Institute of Mining and Technology (NIMT), which offers both modular courses, as well as National Accredited Technical Education Diploma (NATED) courses delivered under the auspices of South Africa's Department of Higher Education and Training, and other so-called franchised courses, including and not limited to courses of the United Kingdom-based, City and Guilds.

Generally, in terms of the diversity of their respective training portfolios, most TPs offer training in traditional trades such as 'Construction' and 'Electrical General'. Some, in expanding the scope of their institutional portfolios, are focusing on emerging areas of employment such as the PtX sector, as well as on new areas of learning. For example, a unit standard-based programme developed by the NTA to address emerging requirements in the renewable energy sector, entitled 'Solar Equipment, Installation and Maintenance' is being offered at Eenhana Vocational Training Centre (EVTC), Namibia Vocational Centre (NAMVOC) and Ngato Vocational Training Centre.

3.1.1 TVET Programme Qualification Pathways

Three pathways of delivering TVET programme qualifications exists. These are:

- Institutional-Based Training with Job Attachment: A trainee undertakes theoretical training at a TP and some practical training at a workplace (typically 3-6 months).
- Apprenticeship Training: Through service level funding agreements with the NTA, eligible employers take on an apprentice to acquire occupational skills in a workplace, while learning and working under supervision. To complement the on-the-job training, the apprentice learns occupational related theory at a registered TP.
- Recognition of Prior Learning (RPL): The NTA assesses a candidate's portfolio of experience (collected over years of industry employment) against unit standards, present competences, job and life experience, and formal and/or non-formal learning. A more cumbersome procedure than the other two listed pathways, RPL combines evaluation techniques and supporting documentation of the applicant's proficiency.

The certification award is the same for all pathways.

3.1.2 TVET Qualification Programmes Currently Offered Relevant to the PtX Sector

Namibia's TVET system has gained strong traction in implementing the Competence-Based Education and Training (CBET) approach, which is the predominant approach at both NQA-accredited and NTA-registered TPs. Table 8 summarises typical PtX-relevant programmes on offer at Namibian TPs. As of June 2023, the NQA had more than 25 accredited TPs offering CBET, modular, and franchised courses in occupations relevant for PtX demand. In turn, the NTA's list of registered TPs exceeded the 100 mark.

Table 8: PtX-relevant TVET programmes offered at Levels 1-4 by NQA-accredited and/or NTA-registered training providers

No.	Programmes	NQA-Accredited TPs at Levels 1-4	NTA-Registered TPs at Levels 1-4	Enrolment per Trade 2022
1	Air Conditioning and Refrigeration	+	+	395
2	Electrical General	+	+	
3	Electronics	+	+	222
4	Electrical Engineering (Millwright)	+	-	198
5	Electrical Engineering (Instrumentation & Control)	+	-	141
6	Electrical and Electronics Engineering	+	-	
7	Telecommunications Engineering	+	-	122
8	Bricklaying & Plastering	+	+	612
9	Construction Engineering	+	-	15
10	Civil and Building Services Engineering (Bricklaying)	+	-	100
11	Civil and Building Services Engineering (Plumbing)	+	-	
12	Metal Fabrication	+	-	121
13	Boilermaking	+	+	817
14	Fitting & Machining	+	+	118
15	Welding	+	+	1036
16	Plumbing & Pipefitting	+	+	121
17	Solar Equipment Installation & Maintenance	-	+	149
18	Fitting & Turning	-	+	367
19	Joinery & Cabinetmaking	+	+	803
20	Solar Equipment Installation & Maintenance	-	+	149

3.1.3 Available TVET Workforce

Figure 4 summarises public TP graduate outputs per specific PtX-related qualification programmes, of which almost all programmes end at NQF Level 3, from 2018, and from 2020 until 2022. These results exclude outcomes for franchised courses offered by private TPs.

Figure 4 further illustrates strong TVET graduate outputs for the 'Electrical General' and 'Plumbing' occupations, whereas lesser outputs are recorded for occupations such as 'Instrumentation' and 'Millwright'. The potential of the PtX industry to absorb TVET graduates in all project phases cuts across all occupations (e.g. 'Bricklaying and Plastering' for the construction phase and 'Instrumentation' and 'Millwright' for the operations phase).

Number of Level 4 TVET graduates from 2018, and from 2020 until 2022

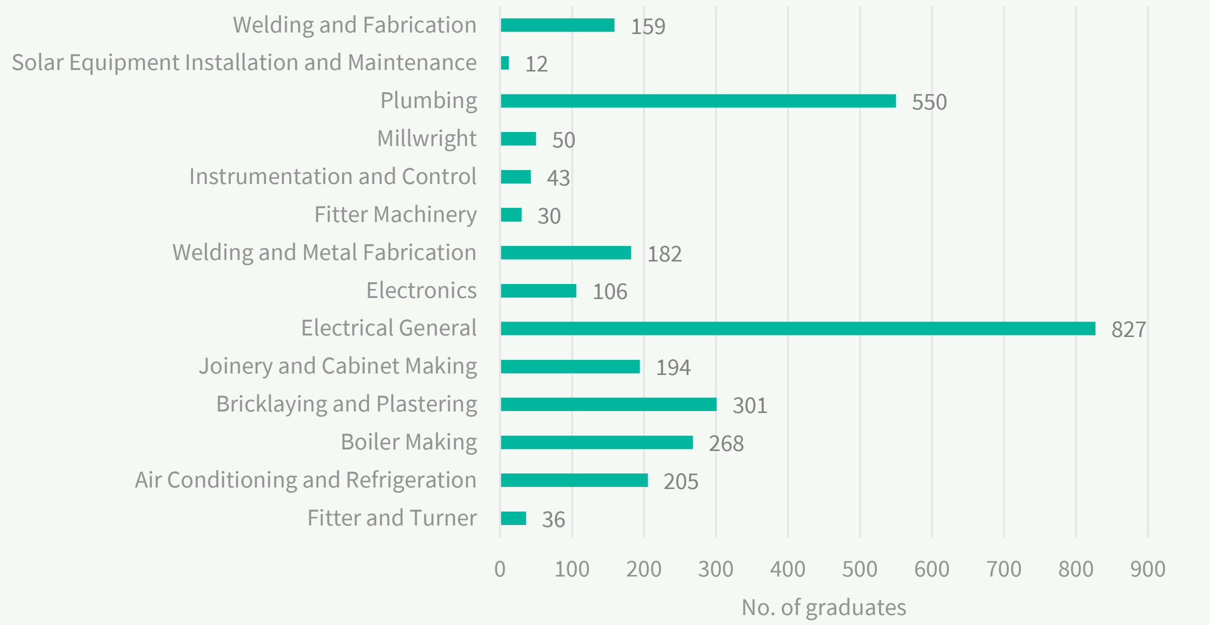

Figure 4

3.1.4 Opportunities for TVET in PtX Job Markets

In terms of its relevance to the PtX industry, Namibia's TVET sector is relatively well positioned. On the demand side, significant TVET graduate outputs in PtX-related occupations are being generated, whereas on the supply side, and in anticipation of skills needs and opportunities to come, the country's qualification programme development system and framework is well-equipped to upgrade current programmes and generate new ones relevant for the PtX industry.

Through research and consultation with various stakeholders such as the NTA and ProTVET, the following opportunities were identified:

Creation of Jobs for Unemployed TVET Graduates

TVET graduate unemployment has increased from 9 % in 2012 to 34 % in 2018, according to the Namibia Labour Force Surveys of 2012 and 2018. This supply-demand disconnect points to TVET graduate outputs not fully meeting industry needs and/or opportunities.

The Namibia Green Hydrogen and Derivative Strategy anticipates the domestic labour market to expand over the medium to long term in the production, transformation, storage and transportation, and end-use value chains, as a result of the PtX economy. This expansion should generate opportunities for unemployed TVET graduates.

A monitoring and verification system, something that goes beyond the Namibia Integrated Employment Information System (NIEIS) of the Ministry of Labour Industrial Relations and Employment Creation's (MLIREC), will need to be established to quantify the number of TVET graduates that will require upskilling or reskilling to enter the PtX industry.

Local Training Institutions, Apprenticeships and On-The-Job Training

There are currently seven public and more than 100 private NTA-registered TPs that could potentially provide PtX industry-relevant training programmes. To encourage and promote in-company training of employees, the NTA's Vocational Education and Training Levy programme, which solicits a monthly levy from eligible employers, provides for such employers to claim back 50% of annual levies paid. The programme also provides for 35% of levies collected to be applied towards financing training and apprenticeship in key national priorities. The levy offers an opportunity for the PtX industry to participate and benefit from its funding windows, for instance, by providing resources for bridging existing training gaps by upskilling TVET graduates from NQF Levels 3 up to Level 6.

Training of Trainers and Private Sector Companies

Job attachment of trainers in industry is stagnating. The knowledge of many trainers is out of date and they are out of touch with the industry. A closer collaboration between the PtX industry and qualified trainers can enhance the industry-specific needs and skills required. In addition, collaborations outside of the country could be facilitated to speed up skills transfer. An example of this is the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) project, which initiated the development of Solar Installation and Maintenance unit standards with NTA and GIZ. SOLTRAIN has been capacitating public TP trainers in solar thermal short courses that are not accredited by NQA.

System of Unit Standards and Programmes Development

The NTA coordinates the development of unit standards and qualifications. Its ten Industry Skills Committees, covering all the main economic sectors, endorse these for registration on the NQF. The committees comprise industry experts and leaders who support the NTA in identifying, overseeing and informing research into sub-sector training needs. These committees can be utilised by the PtX industry to develop unit standards to match the training courses of the public TPs to the needs of the PtX industry. Furthermore, experts from the PtX industry can join the the committees and give impetus to the training needs of the PtX industry.

3.1.5 Barriers to TVET in the PtX Job Market

Namibia's TVET sector also faces several barriers. Through research and consultation with various stakeholders, the following barriers were identified:

Lack of Industry Participation in Apprenticeship Programmes

The apprenticeship mode of training is considered as one of the best modes to equip individuals with competencies. Through structured and remunerated training, consisting of both on-the-job, as well as off-the-job learning, apprentices acquire recognised qualifications. The NTA has re-introduced TVET apprenticeship training. Currently, more than 90 employers have more than 820 apprentices. Despite the strong traction, the NTA is yet to conduct a thorough evaluation of the impact, the successes and the challenges. Apprenticeship is not mandatory and as a result, only a small number of companies have taken up this mode of training to deal with skills shortages in designated trades. For example, the NTA has developed and registered unit standards in 'Solar Equipment Installation and Maintenance', developed up to Level 5. However, only a handful of companies engaged in the solar installation and maintenance sub-sector are participating in the apprenticeship scheme.

Trainees Face Challenges Finding Job Placements

The curricula of most TPs rely on a combination of theoretical and practical training in both the classroom/workshop and in job placement settings. However, trainees struggle to find job placements due to the industry's limited ability to absorb their labour. Firms have no legal obligation or financial incentives to accept trainees for job placements, since the NTA only finances apprenticeships. On the other hand, trainees with education mainly based on theoretical training, do not have enough practical skill profiles to find jobs in the industry. Generally, TPs lack the established relationships with industry that would be helpful to facilitate job placements.

Training of Trainers Appears Inadequate

At the point of recruitment, most TVET trainers were recruited with artisanal qualifications at NQF Level 3 or 4, and a minimum of three years post-training experience. Most of these trainers find themselves conducting training without formal qualifications in training delivery, and using practical knowledge based on outdated equipment. This arrangement seriously compromises the quality of TVET graduates.

Inadequate Training Equipment in TPs

Many TPs own outdated equipment, inappropriate for training and misaligned to technological advancement. This challenge is also experienced at public and private universities, as well as laboratories. In view of upskilling and re-skilling the workforce for PtX demand, a comprehensive inventory of training tools, equipment and materials needs to be conducted.

Lack of Clarity on Content of Skills Upgrading Programmes to Meet Desired Skills and Levels

Training programmes in occupations relevant to the PtX industry are readily available and accessible in the Namibian training market. **Mere upskilling and/or reskilling will ensure improved alignment with PtX** industry-specific requirements. For example, following significant investment in the area of 'Solar Equipment Installation and Maintenance', some TPs now offer unit standards-based training in this area. However, such training, which includes a significant emphasis on photovoltaics, takes place without any connection to relevant basic training in Electrical Engineering. Photovoltaics is an essential part of Electrical Engineering, in which the majority of the required knowledge can be found.

3.2 Review of the Higher Education Sector

The higher education system in Namibia consists of public and private institutions. Public institutions in the higher education system were only founded in the early 1990s. However, the country still has only two public universities, the University of Namibia (UNAM) and the Namibia University of Science and Technology (NUST), which was transformed in 2015 from the Polytechnic of Namibia. There is one private university, the International University of Management (IUM), besides other private higher education institutions such as Triumphant College and River Higher Institute of Technology (previously known as Monitronic Success College).

3.2.1 Higher Education Pathways

The higher education sector promotes the exchange of knowledge through teaching and learning, applied research, innovation, and training, and equips students with the skills and knowledge needed to meet the demands of the labour market in Namibia and beyond. Students are equipped with a blend of contemporary knowledge, skills, and competences acquired in classrooms, simulation laboratories, fieldwork, and industrial attachment through work-integrated learning (WIL) to drive competitiveness in the knowledge economy.

3.2.2 Qualification Programmes Relevant to the PtX Sector Currently Offered

Consultation and research were undertaken to determine the type of qualifications offered that are relevant to the PtX industry. Table 9 depicts the list of qualification areas of courses offered by UNAM and NUST relevant to the PtX industry. At the point of completing the study, the information regarding the qualification areas of courses offered by private higher education institutions had not been obtained.

Table 9: List of qualification areas offered by UNAM and NUST

UNAM: Qualification Area	NQF Level	NUST: Qualification Area	NQF Level
Agriculture	L6 - L10	Agriculture	L7 - L9
Chemistry	L8 - L9	Architecture	L7 - L9
Civil Engineering	L8 - L9	Big Data	L7
Electrical Engineering	L8 - L9	Chemistry	L7 - L8
Environment	L6 - L10	Civil Engineering	L6 - L8
Information Communication Technology	L6 - L10	Electrical Engineering	L7 - L8
Mechanical Engineering	L8 - L10	Environmental Engineering	L9
Physics	L8 - L9	Industrial Engineering	L9
Renewable Energy	L9	Information Communication and Technology	L8 - L10
Water Resource Management	L9	Logistics and Supply Chain	L7 - L9
		Mechanical Engineering	L7 - L10
		Natural Resource Management	L9
		Physics	L7 - L8
		Spatial Science	L9
		Sustainable Energy Systems	L9
		TVET	L4 - L6
		Natural and Applied Sciences (yet to produce first graduates in the year 2024)	L9

3.2.3 Available Higher Education Workforce

Current higher education and training pathways in Namibia do not cater for PtX-specific skills yet. However, existing qualifications already provide the base skills which form the majority of the skills needs of the green hydrogen and PtX sectors, although the number of graduates is limited.

UNAM and NUST provided a database of graduates from the year 2018 to 2022, including graduates from courses that are relevant to the PtX industry. However, they believe that engineers involved in PtX activities will already have the majority of necessary skills from their previous education and professional experience, though the precise amount will depend on their background (for instance, those with mechanical, electrical, or electronics engineering backgrounds will probably transition more easily than those with a background in water infrastructure). For the most part, using hydrogen safely and effectively will only demand a few specialised skills and expertise. For example, the hazards associated with hydrogen's particular properties, such as its flammability and lightness, will need to be learned.

UNAM has a programme which is currently offered by the school of science called Master of Science in Renewable Energy. This programme has two streams: material science, photovoltaics, and a newly developed green hydrogen and synthetic fuels stream. Under the School of Engineering and the Built Environment, UNAM is currently developing a programme that is more related to engineering rather than science, called Master of Science in Renewable Energy Engineering, hopefully, to roll out by 2024. Students in this programme will learn about solar and wind technologies. Through this programme, UNAM will train engineers who will go out and develop renewable energy systems. One of the courses to be taught under this programme is green hydrogen systems. UNAM also has renewable energy technology courses for undergraduate students under the Department of Electrical and Computer Engineering. The university is currently assessing how best to introduce green hydrogen courses in its offering.

UNAM's results depicted in Figure 5 show that most programmes offered under these qualification areas are at level 8 to level 9. Most graduates from UNAM are from the agriculture and information communication and technology (ICT) qualification areas, and only a few from the renewable energy and water resource management qualification areas which were recently introduced.

UNAM graduates from 2018 to 2022

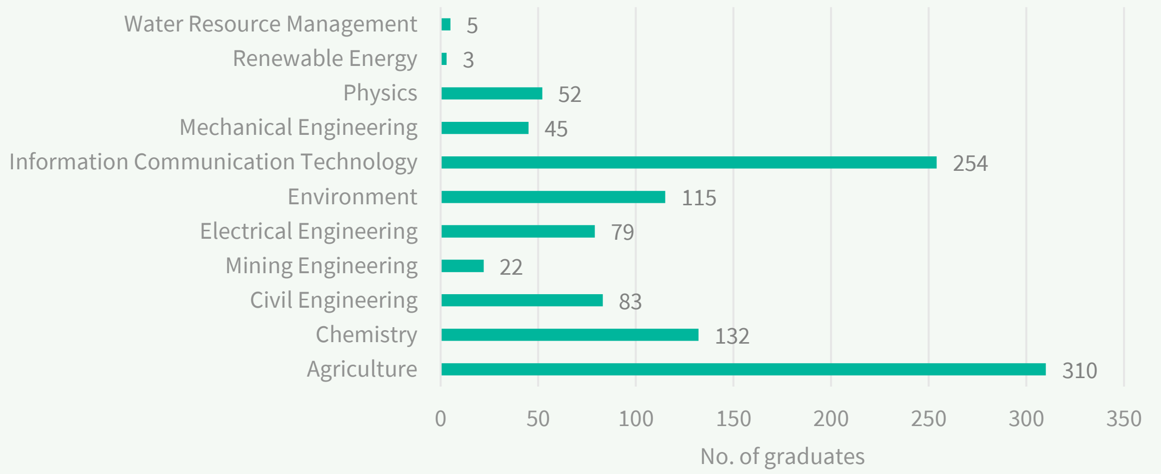

Figure 5

NUST offers engineering qualification programmes such as electrical engineering, power engineering, chemical engineering, mechanical engineering, civil engineering, electronic engineering, environmental engineering, and mining engineering. It also offers science courses such as physics and chemistry. In addition, it offers two renewable energy-related programmes at the master's level; a Master of Sustainable Energy Systems and a Master of Environmental Engineering under the Faculty of Engineering and the Built Environment. On the other hand, the TVET programme only focuses on pedagogy for vocational training providers (TPs) and vocational TP centre management, and not vocational trade skills. In science stream courses, NUST offers a Bachelor of Science (Physics major) at level 7, with a module called Energy and Environment, and Bachelor of Science Honours in Applied Physics at level 8 focusing on energy, which deals with the component of green hydrogen, instrumentation and materials physics. These degrees are foundational and applied to the energy sector. In addition, the Master's in Natural and Applied Science (level 9) with a specialisation in Applied Physics and Applied Chemistry (research-based level 9), focuses on green hydrogen production, storage and application research components.

Figure 6 shows that most NUST's programmes offered under the various qualification areas are at level 7 to level 9. Most graduates from NUSTUNAM are from the logistics and supply chain and TVET qualification areas, and a few from environmental engineering, spatial sciences, and sustainable energy systems which was recently introduced.

UNAM graduates from 2018 to 2022

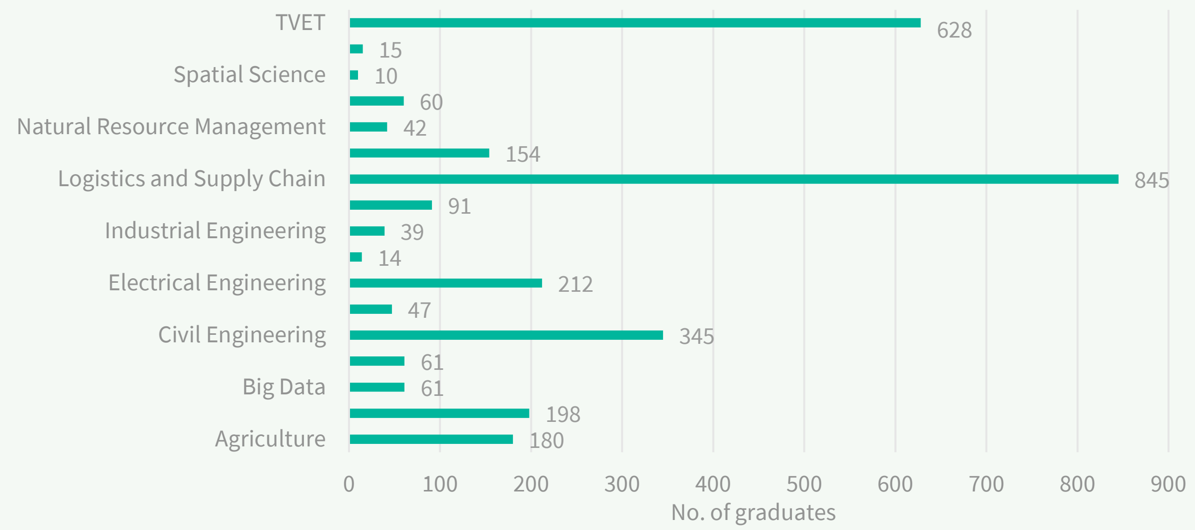

Figure 6

3.2.4 Opportunities for Higher Education in PtX Job Market

Namibia's higher education sector has a number of opportunities in the available skilled workforce as well as skilled development programmes that are relevant for the PtX industry. Through research and consultation with various stakeholders, such as the UNAM, and NUST, the following opportunities were identified:

UNAM Initiatives in the PtX Industry

UNAM is currently developing a new school/faculty of Alternative and Renewable Energy in partnership with universities in Germany. As soon as the industry need assessment is conducted, a curriculum will be developed for this school/faculty (including green hydrogen) in collaboration with universities in Germany. The newly introduced green hydrogen stream under the Master of Science in Renewable Energy is an opportunity where the PtX related topics can be taught.

On the other hand, UNAM, under the School of Engineering and the Built Environment, is currently developing a programme that is more related to engineering rather than science, called the Master of Science in Renewable Energy Engineering, which is envisaged to roll out by 2024. Students of this programme will learn more details about solar and wind technologies. Through this programme, UNAM intends to train engineers who will go out and develop renewable energy systems. One of the courses to be taught under this programme is green hydrogen systems. Furthermore, UNAM has a renewable energy technology course for third-year undergraduate students under the Department of Electrical and Computer Engineering. Around 200 students have already graduated from this programme since it was developed. Currently, the course is being reviewed to incorporate aspects of green hydrogen.

NUST Initiatives in the PtX Industry

NUST currently offers a Master's of Sustainable Energy Systems under the Department of Mechanical, Industrial, and Electrical Engineering. The programme does not have a course specifically related to PtX, but the university is embedding PtX topics in the existing courses. Furthermore, NUST plans to have a project with the students of Master of Sustainable Energy Systems degree to identify and conduct an analysis on how to develop a 100% renewable energy power plant. NUST is also in the process of developing a PhD in Natural and Applied Sciences with a specialisation in Applied Physics focussing on the PtX value chain along with an Applied Chemistry specialisation on hydrogen production using different energy components such as biofuels, bush encroachers, electrolysers, fuel cells, and other energy related projects which will be offered in the year 2024. Specific green hydrogen and fuel cell short courses will be developed and will also be included in Master's and PhD in Natural and Applied Science degree courses.

NUST is responding to a directive from the MHETI and the NTA to transform the Department of TVET at NUST to a Faculty of TVET. The mission of the Faculty of TVET is to prepare graduates for the world of work and by developing skills for employability and citizenship through high quality, relevant and effective qualifications, and to stimulate best and innovative practices and research in TVET. This will be based on national needs and international standards. The TVET department worked together with NEI and GIZ to create a technical curriculum that complements pedagogical content. The curriculum focuses on the installation and maintenance of solar equipment and aims to enhance the skills of TVET trainers so that they can obtain a higher level of accreditation. The students of the Master in Natural and Applied Science who will graduate in the year 2024-25 are now working on green hydrogen production and storage, electrolyser development, and the design of electrolysis systems and sensors in collaboration with the German partner, Rhein-Main institute. This is crucial for the energy sector, especially PtX applications.

Local and International Research Partnership by NEI and NGHRI

NEI contributes to the development of academic programmes through local and international partnership projects with academic institutions. For instance, the implementation of the EDULINK II-funded projects at NEI led to the development of the Master in Sustainable Energy Systems degree at NUST and the development of the Master in Renewable Energy degree at the University of Namibia. Additionally, NEI contributed to the development of a curriculum for the VTC in solar energy through the Namibia Training Authority (NTA) in collaboration with the SOLTRAIN project. Furthermore, NEI has a strong collaboration with regional centres such as the Southern African Development Community (SADC) Centre of Renewable Energy and Energy Efficiency (SACREEE) and the Kafue Gorge Regional Training Centre (KFGRTC) as well international partners.

NGHRI is working together with the Federal Institute for Materials Research and Testing (BAM), a research institute working on hydrogen safety and material compatibility, where UNAM students and staff will go for practical exposure to green hydrogen for a duration of six months. Currently, the BAM Director is an advisor to NGHRI and UNAM Vice Chancellor on green hydrogen. Furthermore, NGHRI is planning to establish a green hydrogen laboratory in collaboration with BAM. In 2022 NGHRI assisted UNAM in establishing green hydrogen and synthetic fuels stream under the Masters of Science in Renewable Energy; this stream is running as of this year, 2023. On the other hand, the UNAM Ogongo campus (UNAM campus that focuses on agriculture), through NGHRI, is collaborating with the PtX firms, such as Daures Green Hydrogen, which is the only pilot project to synthesis fertiliser from green hydrogen, and testing the fertiliser, where construction work has started.

UNAM and NUST intend to collaborate with the PtX industry to strengthen the practical skills of their students in the green hydrogen sector.

3.2.5 Barriers to Higher Education in the PtX Job Market

Namibia's higher education system also has some barriers to offering suitably skilled graduates to the PtX job market. Through research and consultation with various stakeholders, the following barriers were identified:

Shortage of Lecturers for the PtX Industry

The PtX industry is still in its infancy. Hence, Namibia does not have the capacity to engage actively in PtX-related activities due to a shortage of theoretical knowledge and practical skills in the PtX industry. To correct this, UNAM collaborates with BAM to improve the capacity of both lecturers and students.

Inadequate Laboratory Equipment

The study established that higher education institutions do not have adequate laboratory infrastructures, equipment, and teaching/learning materials, where practical skills related to the PtX industry can be acquired.

Students Find it Challenging to Find Placement for WIL

It has also been noted that training providers lack established relationships with industry for WIL placement. This is true for some PtX-related qualification areas identified.

Minimal Registration of Engineering Professionals with the ECN

Although there are many engineering graduates from national, regional, and international higher education institutions, Namibia has only around 2015 professionals registered with the Engineering Council of Namibia (ECN). These professionals include Technicians in Training, Technicians, Incorporated Engineers in Training, Incorporated Engineers, Engineers in Training, and Professional Engineers. Most professionals are from the civil (894), mechanical (320), and electrical engineering (462) disciplines, which are the disciplines relevant to the PtX industry. There are a smaller number of chemical (40), mining (62), electronics (125), industrial (22), and other (90) engineers registered with ECN, which are also relevant to the PtX industry. The minimal registration can be associated with limited numbers of graduates of training programmes that are initiated in collaboration agreements between training institutions and industry. Additionally, a lack of mentorship programmes coupled with limited industry demand can also be the cause of low numbers of registered professionals.

Lack of Overarching Coordination Between Institutions

Stakeholders indicated that there is no proper coordination between institutions such as government ministries, public and private higher education institutions, public and private vocational education training providers, and industry.

Lack of Coverage of TVET Level 4 and Level 5

In Namibia's public education sector, there is a big gap, as illustrated in Figure 7, between vocational education training providers and universities in terms of levels. Presently, Namibia experiences a gap in its educational system, specifically in the area of polytechnic education. This gap emerged when the former Polytechnic of Namibia was transformed into NUST, resulting in a void between vocational education training providers' programmes and the entry requirements for universities. Most VET centres stop at level 3, so graduates from public VTCs, for instance, cannot qualify for access to university. Stakeholders repeatedly emphasised the lack of coverage of levels 4 and 5 as a key deficiency of the VET system in its present state. Only NIMT is currently bridging this gap by sending graduates to South Africa to complete their training as they are still using the South African model, which was being used before Namibia's independence in 1990. In addition, NIMT admits grade 12 graduates based on their mathematics, science, and English marks; there are no specific thresholds, but high demand for the institute implies that only students with high marks are admitted.

NTA developed some unit standards targeting to bridge the gap for the course "solar equipment and maintenance" up to Level 5 as illustrated in Figure 7. However, due to the limited qualified trainers, the course is only offered up to level 3.

NQF qualification levels

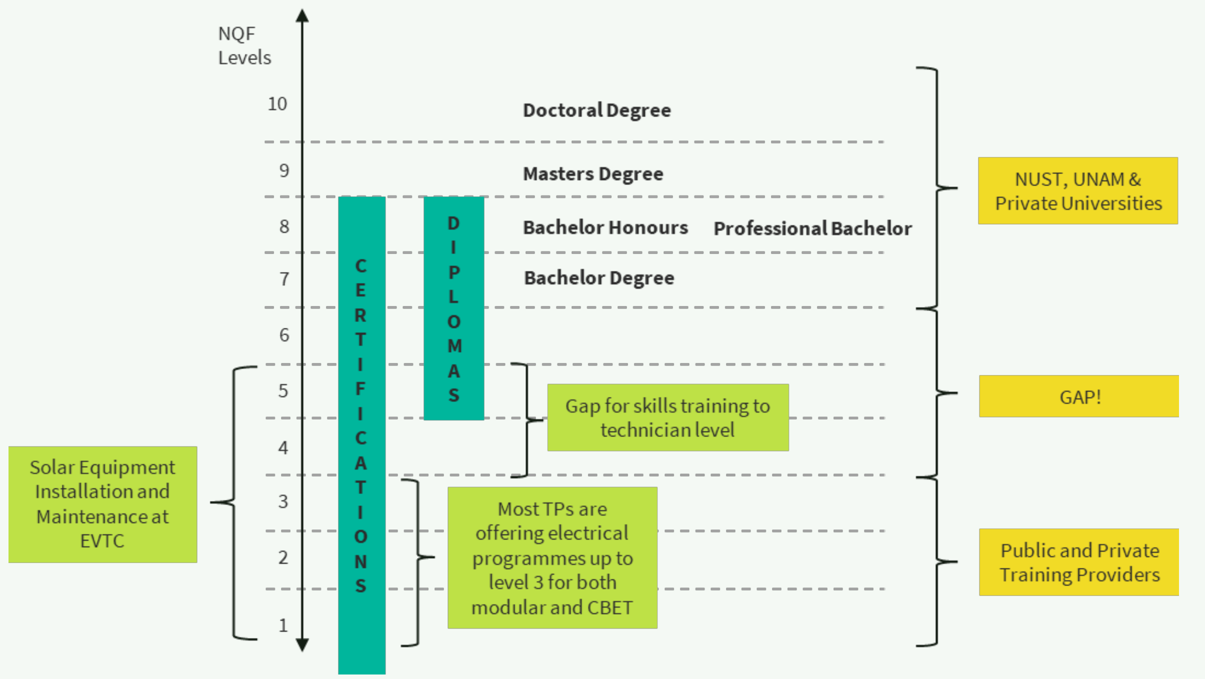

Figure 7

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4

Identification of PtX Skills Gaps

IDENTIFYING SKILLS GAPS

The skills assessment conducted has successfully identified the critical job roles and skills requirements within the green hydrogen and PtX sectors in Namibia. Additionally, the analysis of education gaps has examined the number of graduates from relevant qualifications programs in TVET and higher education. This chapter consolidates these findings and highlights the disparities between the skills offered by the education sector and the skills demanded by the green hydrogen and PtX industry for each specific job role.

International PtX Hub

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4.1 Introduction to Occupational Groups

The key jobs identified in the skills needs assessment have first been clustered into occupational groups according to skills, areas of use, and approximate qualification levels (Section 0). For all occupational groups, only few new skills specific to the burgeoning green hydrogen and PtX sectors are required.

Engineers (14%) and technicians and artisans (16%) with appropriate PtX skills will be in high demand, but it is the construction workers (45%) with either no formal qualifications or with qualification levels typically up to NQF Level 2 who will be needed in largest numbers.

The size (as a percentage) of each occupational group relative to the others shown in Table 10. These percentages have been derived from an analysis and aggregation of workforce demand data for utility-scale PV projects from “Renewable Energy Benefits: Leveraging Local Capacity for Solar PV” (IRENA, 2017b) and “Queensland's Renewable Future: Investment, Jobs and Skills”(Construction Skills Queensland (CSQ), 2022). It has been assumed that the relative sizes of the occupational groups will be similar in the other large construction projects such as wind farms.

Although this study does not provide a quantitative analysis, this breakdown will be of use to educational institutions and PtX companies alike once Namibia does have a clearer idea of numbers of jobs that will be created. Engineers (14%) and technicians and artisans (16%) with appropriate PtX skills will be in high demand, but it is the construction workers (45%) with either no formal qualifications or with qualification levels typically up to NQF Level 2 who will be needed in largest numbers.

Table 10: Occupational groups and their relative size

Occupational Groups	Relative Size [%]
Engineers	14%
Non-Engineering Professionals	7%
Managers	3%
Administrators, logistics, other support staff	1%
Regulatory, safety and quality assurance personnel	5%
Technicians and artisans	16%
Construction workers	45%
Truck drivers	9%
Total	**100%**

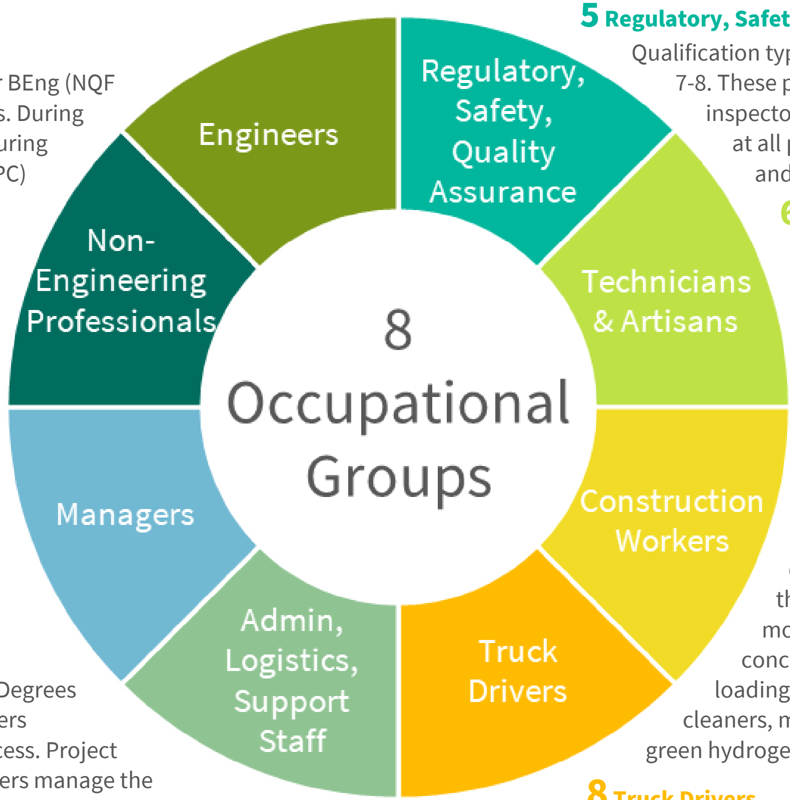
Table 11 in Section 4.3 then shows for each job the current qualification, the number of graduates (in the timeframe 2018-2022), the desired qualification (if different), and the gap in terms of required green hydrogen and PtX skills are listed.

The gap identification table presented in this chapter may be used as a starting point for prioritising training development activities primarily in the short term (the next 1-3 years).

Key insights from this analysis and gap identification are listed in Section 4.4.

4.2 Description of Occupational Groups

In Section 2, a considerable number of jobs has been identified. This study categorises these into eight occupational groups according to skills, areas of use, and approximate qualification levels.



1 Engineers

Qualification type and level: BTech (NQF Level 7) or BEng (NQF Level 8). Engineers are required at all project stages. During project planning they will do preliminary design. During the engineering, procurement and construction (EPC) they are responsible for detailed design, procurement of parts, and installation supervision. Finally, they are responsible for technical plant operation and maintenance.

2 Non-Engineering Professionals

Qualification type and level: Higher level degrees at NQF Levels 7-10. Experts such as lawyers (to negotiate contracts), financial experts (to secure financing), or environmental experts (to perform studies) are mainly required during project planning. At later stages, water treatment experts (ensuring water quality from desalination plants), and chemists (required in green ammonia production) are enlisted.

3 Managers

Qualification type and level: Bachelors or Masters' Degrees at NQF Levels 7-9. From the outset project developers manage the whole planning and development process. Project managers, lead engineers and construction managers manage the construction phase. During operation, asset managers will manage a portfolio of energy assets.

4 Administrators, Logistics and Other Support Staff

Qualification type and level: Qualifications at NQF Levels 5-8. This group will fulfil support roles and will, for example, be administrators, accountants and office staff; shipping agents facilitating delivery of parts through customs; and logistics teams ensuring delivery of parts to site.

5 Regulatory, Safety and Quality Assurance Personnel

Qualification type and level: Bachelor's Degrees at NQF Levels 7-8. These personnel, encompassing regulators, planners, inspectors, and health and safety officers, are involved at all project stages to ensure compliance, quality and safety.

6 Technicians and Artisans

Qualification type and level: NQF Levels 2-4. The technicians and artisans, such as electricians, pipe fitters and welders, will use their skills in preparing, constructing, installing and commissioning all aspects of the plants. During the operation phase they will perform hands-on, technical preventive and corrective maintenance.

7 Construction Workers

Qualification type and level: No formal qualification up to NQF Level 2. This is by far the largest group and encompasses earth moving plant and machinery operators, concreters, mechanical installers and labourers, loading and unloading staff, security guards and cleaners, most of whom will not require any in-depth green hydrogen or PtX-specific skills.

8 Truck Drivers

Qualification type and level: No formal qualification up to NQF Level 2. Truck drivers may require some specific training for safe transport of certain components (e.g. wind turbine blades). Since it is expected that a significant number of truck drivers will be needed, it should be ensured that enough people complete the necessary truck driver training and certification.

4.3 Existing Qualifications and Gap Identification for All PtX-Related Jobs

All jobs identified as being in demand for the green hydrogen and PtX sectors already exist in industry. In many cases, the base skills from these jobs need to be supplemented with a new PtX-specific skillset. Table 11 lists the jobs in each occupational group, provides a brief description of the base skillset, the current qualification available in Namibia, the PtX-required qualification (as far as one already exists), and the supplementary PtX-specific skills required (defined as the "gap" to be filled). Additionally, the table provides the number of graduates from each qualification in the past five years (2018-2022), as far as these figures are available. Note that for TVET qualifications, only Level 4 graduate numbers are given. Graduate numbers for Levels 1-3 are provided in Annex 5. Considering Namibia's high unemployment rate, the number of graduates gives decision makers and private sector companies an indication of the size of the workforce available in the labour market, the types of skills they should already possess, and the types of skills they would still need to acquire. Note that induced jobs are not included in this table.

Table 11: Identification of PtX skills gaps for key jobs relevant to the green hydrogen and PtX sectors. Note that skills gaps have been defined in terms of possible training offers.

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Engineers				
Electrical/electronics engineer (Base skills: Design electrical/electronic systems, oversee installation and operation, monitor and optimise performance)	BTech in Electrical Engineering (NQF 7) BEng (NQF 8)	156	Same qualification with supplementary PtX modules	Elective modules in: All modules to incorporate design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • Electrics of PV systems • Electrics of wind systems • Electrics of battery energy storage systems • Electrical grids with high shares of renewables • Electrics of electrolyser systems • Fuel cells

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Mechanical engineer (Base skills: Design mechanical systems, oversee installation and operation, monitor and optimise performance)	BTech in Mechanical Engineering (NQF 7) or BEng (NQF 8)	102	Same qualification with supplementary PtX modules	Elective modules in: All modules to incorporate design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • PV mounting structures • Mechanics of wind systems • Mechanics of electrolyser systems • Hydrogen production, storage, compression and transportation (via pipelines and trucks) • Mechanics of green ammonia production • Desalination plants • Fuel cells
Civil engineer (Base skills: Design large structures such as plants and pipelines, oversee construction and operation, monitor and optimise performance)	BTech in Civil Engineering (NQF 7) or BEng (NQF 8)	319	Same qualification with supplementary PtX modules	Elective modules in: All modules to incorporate design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • Civil engineering in PV systems • Civil engineering in wind systems • Civil engineering in electrolyser systems
Grid connection/power systems engineer	BTech in Power Engineering (NQF 7) or BEng (NQF 8) in Electrical Power Engineering	212	Same qualification with supplementary PtX modules	Elective modules in: All modules to incorporate design, installation, commissioning,

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
(Base skills: Design, implement and monitor connection of energy generators to the distribution and transmission grids)				operation & maintenance, standards, quality and safety aspects. • Electrical grids with high shares of renewables
Industrial/process engineer (Base skills: Same base skills as mechanical engineer, with further specialisation and experience in industrial systems and processes)	BEng (NQF 8)	43	Same qualification with supplementary PtX modules	Elective modules in: All modules to incorporate design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • Electrolyser systems • Hydrogen production, storage, compression and transportation (via pipelines and trucks) • Green ammonia production • Desalination plants • Fertiliser production plants
Instrumentation engineer (Base skills: Same base skills as mechanical or electrical engineer, with further specialisation and experience in measurement and control systems in industrial processes and equipment)	BTech (NQF 7) or BEng (NQF 8) in Electrical or Mechanical Engineering	168	Same qualification with supplementary PtX modules	Short course in: • Instrumentation for electrolyser systems, hydrogen systems, ammonia systems
Chemical engineer (Base skills: Design chemical processes and the chemical plants which house them,	BEng (NQF 8)	12	Same qualification with supplementary PtX modules	Elective modules in: • Properties of hydrogen and effects on different materials

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
oversee construction and operation, monitor and optimise performance)				• Materials used in hydrogen production, storage, compression and transportation (via pipelines and trucks) • Green ammonia production • Fertiliser production
ICT engineer (Base skills: Design, implement and manage ICT systems like networks, software applications and hardware infrastructure)	Bachelor of Computer Science (NQF 8)	1 329	Same qualification	No gap
Non-engineering professionals				
Lawyer/legal expert (Base skills: Interpret and apply legal principles, advocate for clients, analyse complex legal issues, provide sound legal advice and representation)	Bachelor of Law (Honours) (NQF 8) Master of Laws (NQF 9) Doctor in Philosophy in Law (NQF 10)	642	Same qualification with supplementary PtX training	Elective modules / short courses in: • Legal frameworks and contracts in renewable energy projects, green hydrogen projects, ammonia production projects
Financial expert (Base skills: Analyse and interpret financial data, assess investment opportunities, develop financial plans, analyse and mitigate financial risk)	Certificate up to Acc. Chartered Accountancy (NQF 5-8) Master of Business Admin (Finance) (NQF 8) Master of Science: Accounting & Finance (NQF 8)	2822	Same qualification with supplementary PtX training	Short courses in: • Financial planning of renewable energy projects, green hydrogen projects, ammonia production projects

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Environmental expert / natural resource manager (Base skills: Assess, analyse and address environmental issues, conduct environmental impact assessments, provide guidance for conservation and protection of natural resources)	BSc Environmental Biology (Honours) (NQF 8) Bachelor of Environmental Health Sciences (NQF 8) Master of Environmental Engineering (NQF 9) Master of Natural Resource Management (NQF 9)	346	Same qualification with supplementary PtX training	Elective modules / short courses in: • Environmental considerations specific to renewable energy projects, green hydrogen projects, ammonia production projects
Water treatment expert (Base skills: Design, operate and maintain water treatment systems, analyse water quality, implement purification processes, ensure provision of safe and clean water)	Bachelor of Technology in Civil Engineering (Water) (NQF 7) Master of Integrated Water Resource Management (NQF 9)	71	Same qualification	No gap
Chemist (Base skills: Apply scientific principles and conduct experiments to analyse chemical substances and develop new compounds)	BSc Chemistry or Applied Chemistry (Honours) (NQF 8) Master of Science in Chemistry (NQF 9)	201	Same qualification with supplementary PtX modules	Elective module in: • Hydrogen, green ammonia, and fertiliser production
Managers				
Project developer (Base skills: Identify, plan, coordinate and execute projects)	Bachelor Degree in an Engineering discipline or similar (NQF 7-8)	-	Same qualification with supplementary PtX training	Short courses in: • Project development of renewable energy projects, green hydrogen projects,

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
				ammonia production projects
Project manager (Base skills: Initiate, plan, execute, monitor and control projects)	Bachelor Degree in an Engineering discipline or similar (NQF 7-8)	-	Same qualification with supplementary PtX training	Short courses in: • Project management of renewable energy projects, green hydrogen projects, ammonia production projects
Engineering lead (Base skills: Provide technical guidance, oversee engineering projects, coordinate teams, ensure quality)	Bachelor Degree in an Engineering discipline (NQF 7-8)	-	Same qualification with supplementary PtX training	Depending on construction project, should have a relevant base qualification and have completed elective engineering modules or short courses in all relevant fields: PV, wind, electrolysers, ammonia plants, etc.
Construction manager/supervisor (Base skills: Manage and coordinate construction activities, monitor progress, ensure adherence to safety and quality standards)	Bachelor Degree in an Engineering discipline (NQF 6-8)	-	Same qualification with supplementary PtX training	Depending on construction project, should have a relevant base qualification and have completed elective engineering or TVET modules or short courses in all relevant fields: PV, wind, electrolysers, ammonia plants, etc.
Operation and maintenance manager (Base skills: Oversee and optimise daily operations of a plant, manage maintenance activities, ensure compliance with regulations, optimise plant performance)	Bachelor Degree in an Engineering discipline (NQF 6-8)	-	Same qualification with supplementary PtX training	Depending on project, should have a relevant base qualification and have completed elective engineering or TVET modules or short courses in all relevant fields: PV, wind, electrolysers, ammonia plants, etc.

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Administrators, logistics, other support staff				
Administration staff (Base skills: Organise, coordinate and manage administrative tasks)	Office Administration (NQF 4)	-	Same qualification	No gap
Accountant (Base skills: Record, analyse, interpret financial transactions, prepare financial statements, ensure compliance with financial regulations)	Certificate up to Acc. Chartered Accountancy (NQF 5-8) Master of Business Admin (Finance) (NQF 8) Master of Science: Accounting & Finance (NQF 8)	-	Same qualification	No gap
Shipping agent (Base skills: Coordinate and manage logistics of shipping operations including documentation, customs clearance, freight handling)	Certificate in Logistics and Transport (NQF 4)	-	Same qualification	No gap
Logistics personnel (Base skills: Plan, coordinate and manage the efficient flow of goods, information and resources, ensure smooth supply chain operations)	Certificate in Logistics and Transport (NQF 4)	-	Same qualification	No gap
Regulatory, safety and quality assurance personnel				

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Regulator (Base skills: Enforce compliance with laws, regulations and standards conduct inspections, assess risks, monitor activities)	Bachelor Degree in a range of disciplines (NQF 6-8)	-	Same qualification with supplementary PtX training	Short courses in: • Regulations, standards, safety requirements of renewable energy projects, green hydrogen projects, ammonia production projects
Planner (Base skills: Evaluate land use, make and review development plans, ensure compliance with planning regulations)	Bachelor Degree Town and Regional Planning or other discipline (NQF 6-8)	-	Same qualification with supplementary PtX training	Short courses in: • Compliance, permissions and approvals in renewable energy projects, green hydrogen projects, ammonia production projects
Gas inspector (Base skills: Inspect gas systems, assess safety protocols, enforce regulations, ensure compliance with gas handling, storage and distribution standards)	Bachelor Degree in Engineering or related field (NQF 6-8)	-	Same qualification with supplementary PtX training	Short courses in: • Regulations, standards and safety requirements of hydrogen storage, compression, transportation systems renewable energy projects, green hydrogen projects, ammonia production projects • Regulations, standards and safety requirements of ammonia production plants
Electrical installations inspector	BTech in Electrical Engineering (NQF 7) BEng (NQF 8)	-	Same qualification with supplementary PtX modules/training	Elective modules in: All modules to incorporate design, installation, commissioning,

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
(Base skills: Inspect electrical systems, assess compliance with electrical codes and regulations, identify potential hazards, ensure safe installation and operation of electrical systems)				operation & maintenance, standards, quality and safety aspects. • Electrics of PV systems • Electrics of wind systems • Electrics of battery energy storage systems • Electrical grids with high shares of renewables • Electrics of electrolyser systems
Mechanical installations inspector (Base skills: Inspect mechanical systems, assess compliance with regulations and industry standards, identify potential issues, ensure safe installation and operation of mechanical equipment and systems)	BTech in Mechanical Engineering (NQF 7) BEng (NQF 8)	-	Same qualification with supplementary PtX modules/training	Elective modules in: All modules to incorporate design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • PV mounting structures • Mechanics of wind systems • Mechanics of electrolyser systems • Hydrogen production, storage, compression and transportation (via pipelines and trucks) • Mechanics of green ammonia production • Desalination plants
Quality control officer (Base skills: Develop and implement quality control processes, conduct inspections, analyse quality,	Bachelor in Engineering or related field (NQF 7-8)	-	Same qualification with supplementary PtX modules/training	Depending on technology, should have a relevant base qualification and have completed elective engineering or TVET modules or short courses in

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
identify issues, ensure adherence to quality standards for continuous improvement)				all relevant fields: PV, wind, electrolysers, ammonia plants, etc.
Occupational health and safety officer (Base skills: Identify and assess workplace hazards, develop safety protocols and procedures, conduct safety trainng, investigate incidents, promote health and safety to employees)	Diploma in Occupational Health and Safety Operations (NQF 5)	-	Same qualification with supplementary PtX modules/training	Short courses in: • Safety standards and safety requirements of PV, wind, electrolysers, hydrogen storage, compression, transportation, and ammonia production
Technicians and artisans				
Electrician (Base skills: Install, maintain, repair electrical systems, diagnose electrical faults, interpret electrical diagrams)	Electrical General (NQF 4) Wireman's License	827	Same qualification PV-specific qualifications such as NTA Solar Equipment Installation and Maintenance NQF Levels 1-3 For some electrical tasks, higher level qualifications such as SAQA Solar Photovoltaic Service Technician NQF Level 5	Elective modules aimed at Level 4-5 in: All modules to incorporate design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • Electrics of PV systems • Electrics of wind systems • Electrics of battery energy storage systems • Grid connection of renewable energy systems • Electrics of electrolyser systems
Electrical assistant	Electrical General (NQF 1-3)	-	Same qualification	Elective modules aimed at up to Level 3 in: All modules to incorporate basic

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
(Base skills: Assist in the installation, testing, faultfinding and maintenance of electrical systems under the guidance of an electrician)			PV-specific qualifications such as NTA Solar Equipment Installation and Maintenance NQF Levels 1-3	design, installation, commissioning, operation & maintenance, standards, quality and safety aspects. • Electrics of PV systems (may have a focus only on DC-side) • Electrics of wind systems • Electrics of battery energy storage systems • Grid connection of renewable energy systems • Electrics of electrolyser systems
Pipe fitter / plumber (Base skills: Install, assemble and repair piping systems, interpret piping diagrams, cut and thread pipes)	Plumbing (NQF 4) (This qualification has a focus on domestic plumbing and pipe fitting.)	550	For example, SAQA Mechanical Engineering: Pipe-Fitting Level 4 (This qualification has a focus on pipe fitting in industrial plants.)	Elective modules supplementing a Level 4 industrial pipe fitting qualification in: • Regulations and safety standards for working with hydrogen, nitrogen, oxygen and ammonia • Pipefitting for hydrogen systems • Pipefitting for ammonia systems
Metal worker (Base skills: Fabricate, shape and assemble metal components, operate machine tools, perform precision machining)	Fitting and Turning, or Fitting and Machining (NQF 4)	341	Same qualification with supplementary PtX modules/training	Elective modules in: • Regulations and safety standards for working with hydrogen, nitrogen, oxygen and ammonia • Metal working for hydrogen systems

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
				• Metal working for ammonia systems
Boiler maker (Base skills: Fabricate, assemble and repair boilers, pressure vessels and other large metal structures, perform welding and metalworking tasks)	Boiler Making (NQF 4)	268	Same qualification with supplementary PtX modules/training	Elective modules in: • Regulations and safety standards for working with hydrogen, nitrogen, oxygen and ammonia • Boiler making for hydrogen systems • Boiler making for ammonia systems
Welder (Base skills: Join metal parts together, ensuring strong and structurally sound connections, using various welding techniques)	Welding and Metal Fabrication (NQF 4)	341	Same qualification with supplementary PtX modules/training Existing qualifications should be compared against internationally recognised qualifications such as those of the International Institute of Welding	Elective modules in: • Regulations and safety standards for working with hydrogen, nitrogen, oxygen and ammonia • Welding for hydrogen systems
Instrumentation technician (Base skills: Install, calibrate, fault-find, and maintain instrumentation and control systems)	Instrumentation and Control (NQF 4)	43	SAQA Instrument Mechanician (NQF 5) with supplementary PtX modules/training	Elective modules in: • Regulations and safety standards for working with hydrogen, nitrogen, oxygen and ammonia • Properties of hydrogen, nitrogen, oxygen and ammonia and their practical application
Mechanic (Base skills: Diagnose, repair and maintain mechanical	Fitter Machinery (NQF 1-3) Auto Mechanic (NQF 4)	-	Same qualification with supplementary PtX modules/training	Elective modules in: • Regulations and safety standards for working with

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
systems, components and vehicles)				hydrogen, nitrogen, oxygen and ammonia • Maintenance and repair of hydrogen fuel cell vehicles
Vehicle technician (Base skills: Diagnose, service and repair automotive vehicles)	Auto Mechanic (NQF 3)	-	Same qualification with supplementary PtX modules/training	Elective modules in: • Regulations and safety standards for working with hydrogen, nitrogen, oxygen and ammonia • Maintenance and repair of hydrogen fuel cell vehicles
Air conditioning technician (Base skills: Install, fault find, maintain and repair air conditioning and refrigeration systems)	Air conditioning and Refrigeration (NQF 1-3)	205	Equivalent qualification with focus on industrial ammonia plants	Elective modules in: • Working with ammonia in industrial plants
Construction workers				
Earth moving plant and machinery operator (Base skills: Operate heavy machinery such as excavators, bulldozers, and loaders effectively and safely)	Code B or BE / CE Driver's License NQA Heavy Plant Operation (NQF 3)	-	Same qualification	No gap
Concreter (Base skills: Prepare, pour, level and finish concrete surfaces)	NQA Concrete Operations Labourer (NQF 2)	-	Same qualification	No gap

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Mechanical installer (Base skills: In the context of PV installation, handling, installing, mounting and fixing PV mounting frames and PV modules)	No formal qualification required.	n/a	n/a	On-site training in, for example, PV mounting frame installation and PV module mounting, provided by PV installation contractor prior to commencing work.
Loading and unloading staff (Base skills: Safely and efficiently handle goods, operate handling equipment, document inventory)	No formal qualification required.	n/a	n/a	No gap
Labourer (Base skills: Perform physical tasks, follow instructions, operate basic tools and equipment)	No formal qualification required.	n/a	n/a	No gap
Security guard (Base skills: Monitor and patrol premises, enforce security protocols, handle emergency situations, provide a safe and secure environment)	No formal qualification required.	n/a	n/a	No gap
Cleaner	No formal qualification required.	n/a	n/a	No gap
Truck drivers				

Occupational groupings	Current qualification (NQF level)	Total no. of graduates 2018-2022	Desired qualification	Gap (required GH or PtX skills)
Truck driver (Base skills: Safety and effectively drive trucks, follow traffic regulations, perform vehicle inspections)	Code CE Driver's License	-	Same qualification	Some specific training may be required for safe transport of certain components, e.g. wind turbine blades

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4.4 Key Insights

4.4.1 Engineering: Solid Foundation in all Disciplines to be Supplemented by PtX-specific Content

The analysis of the status of higher education in Namibia showed that existing engineering education serves as a solid foundation, equipping graduates with the necessary knowledge and skills for implementing complex projects. However, it is crucial to expand and enhance the curriculum to integrate hydrogen and PtX-specific knowledge. This applies to various engineering disciplines, including energy, electrical, electronics, and power systems engineering, as well as process and industrial engineering, mechanical, chemical engineering, and civil engineering.

To address this need, engineering curricula should be supplemented with elective courses focused on deepening knowledge of hydrogen and PtX topics. For example, in electrical and electronics engineering, a course on "Electrolysis and Hydrogen Fuel Cells" could be introduced. Similarly, process or industrial engineering could offer a course on "Process Optimization for Hydrogen Production and PtX Manufacturing." These courses would provide specialised knowledge and skills for successful implementation of hydrogen and PtX projects.

For the establishment of a green hydrogen and PtX industry, it is crucial to also have a sufficient number of engineers who are capable of designing and operating renewable energy systems. Although Namibian university curricula already offer courses about these technologies, the number of qualified engineers in this area would not be sufficient for establishing the capacities necessary to power green hydrogen projects. Consequently, the education offer in this area should also be enhanced to provide for the necessary capacities. Similar to the other disciplines, offering elective courses in existing study programmes seems to be an efficient way forward.

Furthermore, it is essential to recognize that solely focusing on educating young engineers will not be sufficient in Namibia. Experienced engineers play a pivotal role in planning and implementing complex projects related to hydrogen and PtX technologies. Establishing further training opportunities for this group is vital. Repurposing the developed elective courses can create a continuing education program, offering experienced engineers the chance to enhance their knowledge in hydrogen and PtX technologies. This empowers professionals to contribute effectively to the development and deployment of hydrogen and PtX projects in Namibia.

4.4.2 Non-engineering Professionals

The study reveals a similar pattern among academics in the fields of finance, legal/law, and environmental and natural resource management in Namibia. While the universities provide fundamental education in these disciplines, PtX-specific knowledge is not yet addressed. Similar to the engineering field, it is recommended to expand the existing curriculum. In the field of finance, for instance, an elective course such as "Financing Hydrogen and PtX Projects" could be introduced, focusing on the specific financing mechanisms, investment evaluation, and risk management in the context of PtX projects. In the legal/law domain, a course like "Legal Aspects of Hydrogen and PtX Technologies" could be offered, addressing the legal frameworks, regulations, and contract considerations related to hydrogen and PtX projects.

Similar to the field of engineering, courses developed for university students should also be repurposed as training courses for professionals who already work in their field of expertise.

4.4.3 Technicians and Artisans

The group of technicians and artisans plays a vital role in the implementation of PtX and renewable energy projects. They occupy various positions throughout the process, including electricians, electrical technicians, pipe fitters and plumbers, metal workers, boiler makers, and welders. The study identified that the existing vocational training in Namibia typically brings apprentices to a maximum of Level 2 or 3 of the Namibian Qualification Framework (NQF). Level 3 signifies a competent worker who can perform tasks independently under supervision, demonstrating a sound understanding of the field and its applications.

However, to meet the requirements of complex renewable energy and PtX installations, it is crucial for this professional group that talented individuals also reach higher levels, specifically Levels 4 or 5. At Level 4, artisans possess advanced skills and knowledge, allowing them to carry out complex tasks independently. They have a comprehensive understanding of the industry and can apply their expertise effectively. Level 5 represents a level, where individuals demonstrate good mastery of their field, including the ability to lead and supervise others.

To prepare technicians and artisans for these higher-level roles, it is essential for the vocational training system to create suitable conditions. This can be accomplished by offering relevant elective courses during apprenticeships that focus on renewable energy and PtX topics. Additionally, continuing education programs can be developed to provide in-depth training for professionals already employed in technical disciplines, enabling them to enhance their knowledge and skills and obtain potentially necessary certifications.

In the context of industrial advancement, renewable energies and innovative chemical industries (such as PtX) are set to play an important role in Namibia. Therefore, it is important to integrate these innovative technologies into existing foundational vocational training curricula.

4.4.4 Compliance Managers and Officers and Installations Inspectors

Renewable energy installations and PtX systems possess distinct technical characteristics that differ from conventional industries. For example, operating wind turbines requires specific safety measures for working at heights, while handling hydrogen necessitates specialised technical precautions for safe operations. Appropriate regulations must be introduced, implemented, and monitored to ensure compliance. Accordingly, relevant professional groups in Namibia need to possess the necessary knowledge and expertise and should receive specialised training and further education. Currently, such offerings are not available in Namibia, but the gap can be addressed through the provision of specific continuing education courses. Additionally, it is key for such novel compliance topics to be integrated into the curricula of foundational vocational training, either as an integral part of the basic education or through separately offered elective courses.

4.4.5 Professionals with Management Roles

When it comes to personnel involved in management roles related to green PtX projects, such as renewable and/or PtX project development, project management, engineering lead, construction manager and supervisor, and operations and maintenance managers, there are typically no dedicated university courses. Professionals with relevant backgrounds can oversee various types of projects. However, it would be advisable to provide these individuals with the opportunity to acquire PtX-specific knowledge either during their academic training, their vocational or through specialised short courses. In some cases, granting access to existing elective courses in engineering or vocational training programs could be suitable. Alternatively, specific elective courses tailored to PtX projects, such as "Renewable Energy Project/PtX Project Development" could be offered at universities within existing curricula or as continuing education course outside of universities.

5

Recommendations for a Green Hydrogen and PtX Skills Development Programme

SKILLS DEVELOPMENT PROGRAMME

Based on the preceding analyses, this chapter proposes a plan of action for a holistic Skills Development Programme to ramp up a PtX industry in Namibia. The proposed measures address skills gaps, promote inclusive training programs, foster public-private collaborations, and prioritize the socioeconomic well-being of individuals and communities. The proposed action items include specific recommendations for enhancing existing TVET and higher education training programs to align them with the skills requirements of the PtX sector. This may be used as a basis for stakeholders from education, private sector and government to come together to develop collaborative activities to skill up the workforce. A recommended framework for a PtX skills development roadmap is presented in Annex 5.

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5.1 Recommended Action Items

5.1.1 Establishing a National PtX Skills Task Force

- Form a **diverse task force** comprising government representatives, industry leaders, academia, and training providers.
- Refine existing mandates for the existing Research and Development working group (Namibia Private Sector Green Hydrogen Task Force) and re-align to the new National PtX Skills Task Force.
- Develop a **strategic programme and action plan** to address identified skill gaps and enhance workforce capabilities.

5.1.2 Developing Industry-Driven Curricula and Training Programmes

Contributions from PtX companies ensure that curricula are in line with industry requirements and address the specific needs and advancements in PtX technologies. The educational regulators ensure that the requirements of formal qualifications are met.

- Design and implement **industry-driven curricula and training programmes** for higher education as well as vocational training pathways in collaboration with PtX industry, higher education, and vocational training institutions.
- Incorporate practical, hands-on training modules, internships, and apprenticeships to **ensure real-world industry experience.**
- Establish a mechanism that ensures a **permanent and regular review and further development of curricula** to meet the high development dynamics of the PtX industry.

5.1.3 Up- and re-skilling the Existing Workforce through Continued Professional Development

Alongside enhancing existing university curricula for undergraduates, **offer specialised and accredited continued professional training courses** related to the PtX industry.

5.1.4 Enhancing the Apprenticeship Programme

The Apprenticeship Programme offers an opportunity to equip youth with skills needed in the PtX industry. Regulating and mandating apprenticeships with PtX companies might yield better skills development outcomes. The scope of such regulation can cover designated trades, entry requirements, wages, preferred TPs, mentor qualifications, duration of training and bonding of apprentices after training. This can be included in the agreements that the PtX industry signs with the Government of Namibia.

Collaboration between the NTA and the private sector in developing guidelines and training standards is encouraged.

5.1.5 Upskilling Academic and Vocational Training Staff

It is essential that academic staff and TVET trainers get the opportunity to upskill themselves. The following measures are recommended:

- Develop PtX-related workshops and seminars and facilitate attendance of teaching staff.
- Facilitate intensive exchange with PtX industry experts to transfer practical know-how to training staff.
- Involve PtX industry experts in delivering trainings
- Facilitate industry internships – not just for students but also for teaching staff.
- Establish a Train-the-Trainer platform with an online component where teachers can gain theoretical knowledge, coupled with practical training from abroad where the industry is more mature.
- Teaching staff undertake collaborative projects with students to enhance own knowledge while guiding and mentoring students.

5.1.6 Supporting the Bridging of Gap Between TVET Level 4 and Level 6

The proposed Faculty of TVET at NUST is recommended to bridge the gap between TVET Level 3 or 4 and Level 6. This faculty will be instrumental in capacitating the TVET trainers that are able to teach at training providers. Furthermore, this faculty will enhance the technical knowhow of the trainer to be able to effectively teach at training providers.

NUST should also design undergraduate and postgraduate programmes, which focus on technical, pedagogical and research skills to train qualified trainers who will be able to train up to NQF level 6 in the VTCs.

5.1.7 Enhancing Research and Development Initiatives

- Establish **collaboration between universities, research institutions, and industry partners** to promote research and innovation in PtX technologies.
- Provide **funding support for research projects** focused on improving PtX processes, efficiency, and sustainability.
- **Encouragement of knowledge sharing and technology transfer** through partnerships and networking platforms.

Universities should conduct research on real PtX projects to stay at the forefront of industry developments. NCRST is mandated to coordinate, promote and development of research, science and technology as well as research regulations in Namibia. Moreover, NCRST and counterparts can also finance research on real PtX projects.

5.1.8 Establishing Centers of Excellence

- **Creation of specialised training centres or institutes** focused on PtX technologies, applications and processes.
- Centres to **provide state-of-the-art infrastructure, equipment, and resources for hands-on training and research activities**.
- Collaboration with **international partners for knowledge exchange** and benchmarking.

In order to consolidate theoretical learning, students from all training pathways should have access to a high proportion of practical, hands-on training in fit-for-purpose labs or training centres. Consideration should be given to how educational institutions and the PtX private sector can collaborate in locating, designing, implementing and using such labs to make the initial and continued investments (e.g. to upgrade equipment to stay in line with industry developments) worthwhile.

5.1.9 Promoting Registration of Engineering Professionals with the ECN

It is recommended that the “graduate in training” programmes should be initiated and formalised in collaboration agreements between training institutions and the PtX industry to increase the number of young registered professional with ECN. Furthermore, mentorship programmes need to be put in place.

5.1.10 Promoting Gender-Inclusive Career Pathways

Namibia's emerging hydrogen economy presents a valuable opportunity to foster socioeconomic growth and sustainable development. To ensure the long-term success and inclusivity of this sector, it is crucial to implement gender equality and actively promote gender-inclusive career pathways. By breaking down traditional barriers and fostering equal opportunities, Namibia can harness the full potential of its diverse talent pool and empower women to participate meaningfully in the hydrogen and PtX industry.

- **Launch targeted campaigns** to raise awareness about the benefits of gender equality in the hydrogen/PtX economy. This may include showcasing the opportunities available for women in various career paths within the industry.
- **Develop training programmes that encourage all genders’ participation** in technical and STEM-related fields. Collaborate with educational institutions and industry stakeholders to ensure access to quality education and training for women interested in pursuing careers in the PtX sector.
- **Create mentorship programmes** that pair experienced professionals, including both women and men, with young women aspiring to enter the hydrogen/PtX industry. These programmes can provide guidance, support, and opportunities for networking and skills development.
- **Encourage women's participation in leadership roles** within hydrogen-related organisations, research institutions, and government bodies. Implement policies that aim to increase the representation of women on decision-making boards and in managerial positions.
- **Create flexible training and work arrangements**, such as online/remote courses and flexible schedules, to support the work-life balance of women in the hydrogen industry. These arrangements can help address challenges faced by women in traditional gender roles (childcare, household).
- Seek opportunities for **international cooperation and knowledge exchange** with countries that have made progress in promoting gender inclusivity in the energy and hydrogen sectors. Learn from their experiences and adapt successful practices to Namibia's context.

5.1.11 Engaging Stakeholders

The successful implementation of a roadmap relies on active stakeholder engagement and the creation of ownership among key actors. This recommendation outlines activities to engage stakeholders and foster a sense of ownership for the effective implementation of a skills development roadmap in Namibia's PtX sector.

- The **stakeholder mapping** in this report identified the key stakeholders to design and implement the skills development roadmap.
- **Develop a comprehensive plan to engage with stakeholders at various stages of implementing the skills development programmes**. This plan should include regular meetings, workshops, consultations, and forums to gather feedback and insights, and address concerns. Effective communication and collaboration will foster a sense of ownership among stakeholders.
- Form task forces and working groups (see Section 0).
- **Encourage active participation and input from all stakeholders during the process of developing the skills development programme**. This can be achieved through workshops, focus group discussions, and online platforms that allow for collaboration and idea sharing.
- **Engage with international organisations, development agencies, and private sector entities** to secure financial resources for the implementation of the skills development roadmap. Present a compelling case highlighting the potential benefits of a skilled PtX workforce for Namibia's sustainable development goals and just energy transition.
- **Public-Private Partnerships** can create a sense of shared responsibility and ownership among private sector stakeholders (see Section 0)
- **Foster a culture of continuous learning and improvement** by creating platforms for stakeholders to share experiences, best practices, and lessons learned.

5.1.12 Tapping Financing Opportunities

Implementing a comprehensive skills development programme for Namibia's Power-to-X (PtX) sector requires adequate financing to support training programmes, infrastructure development, and capacity building initiatives. To tap into financing opportunities, it is crucial to identify and leverage various funding sources and mechanisms. This recommendation outlines strategies to access financing for the successful implementation of a skills development programme in Namibia's PtX sector.

- **Explore government programmes** and initiatives that support skills development, renewable energy, and sustainable industries. Engage with relevant ministries (.i.e. Ministry of Mines and Energy, Ministry of Higher Education Technology and Innovation, Ministry of Finance and Public Enterprises, Ministry of Labour Industrial relations and Employment Creation) and National Commission on Research Science and Technology, to understand available workforce, available funding schemes and eligibility criteria.
- **Collaborate with regional and international development finance institutions**, such as the African Development Bank (AfDB) or the World Bank that promote renewable energy and skills development. These institutions often provide grants, loans, or technical assistance for capacity building initiatives in the energy sector.
- **Attract private sector investment via Public-Private-Partnerships** (see Section 0).
- **Seek grants from international organisations, foundations, and initiatives** that prioritise sustainable development, renewable energy, and skills training. Examples include the Green Climate Fund.
- Research **philanthropic organisations that focus on sustainable development, education, and skills training**. Develop partnerships and proposals that align with their priorities and objectives, emphasising the positive socioeconomic impacts of supporting skills development in Namibia's hydrogen and PtX sector.
- Explore opportunities in **carbon markets** to generate revenue through the sale of carbon credits or offsets associated with PtX projects. This revenue can be reinvested in skills development initiatives. Engage with carbon market platforms and consult with experts in carbon finance to navigate the process effectively.
- Allocate a portion of the revenues generated from the export of green hydrogen and PtX products in Namibia's sector towards a dedicated "Skills Development Fund." This fund would be specifically designed to upskill workers, and drive global competitiveness.
- Align the skills development programme with **climate finance mechanisms**, such as the

Nationally Determined Contributions (NDCs) and Green Climate Fund financing windows. Emphasise the linkages between skills development, climate action, and the achievement of sustainable development goals to increase the chances of securing climate finance support.

5.1.13 Fostering Public-Private Partnerships (with Project Developers)

By adopting a structured PPP model for skills development in Namibia's hydrogen and PtX economy, the government, private sector, and educational institutions can combine their strengths and resources.

- Firstly, a **PPP framework should be established to outline the roles, responsibilities, and contributions of the public and private sector entities involved**. This framework would serve as the basis for collaboration and ensure effective coordination among stakeholders.
- **Engage with private sector companies operating in the PtX sector** to secure their financial support for the skills development programme. Highlight the long-term benefits of a skilled workforce and the potential for a strong talent pool that can contribute to the growth and competitiveness of their businesses.
- **Explore opportunities for joint funding initiatives with private sector entities**, where both public and private stakeholders contribute to a shared funding pool dedicated to skills development. This collaborative approach enhances accountability, fosters ownership, and attracts additional financial resources.
- **The government should demonstrate a strong commitment to the partnership** by providing policy and regulatory support, creating a favourable investment climate, and offering incentives for project developers and workforce development initiatives.
- **Establish specialised training facilities and infrastructure** to support the skills development programme. This could include laboratories, research centres, simulation facilities, and demonstration sites. Public and private entities can jointly invest in the development and maintenance of these infrastructure assets.
- **Facilitate technology and knowledge transfer from international partners and project developers to local stakeholders**. This can be achieved through partnerships, joint ventures, and capacity-building initiatives that enable local workers to acquire the necessary expertise and experience in green hydrogen and PtX technologies.
- **Develop mechanisms to ensure the quality of skills development programmes**. This may involve accrediting institutions, certification of trainers, and establishing industry standards for skill assessment and certification. Regular monitoring and evaluation should be conducted to assess the effectiveness of the programmes and make necessary improvements.
- **The PPP model should promote a culture of continuous learning and adaptation** to keep pace with the evolving needs of Namibia's hydrogen economy. Regular feedback mechanisms, industry consultations, and collaboration forums can be established to gather inputs and adjust the skills development initiatives accordingly.
- **Design the skills development PPP model with long-term sustainability and scalability** in mind. Explore opportunities for replication and expansion to other sectors or regions within Namibia, allowing for the continued growth and development of the country's workforce.

Example of a Public-Private Partnership for Skills Development in Morocco[1]

The PPP "Training Institutes for Professions in the Automotive Industry (IFMIAs) in Morocco" demonstrates the application of the delegated management model to support the automotive sector. The establishment of IFMIAs is in accordance with Moroccan law on delegated management. The training centres in Casablanca and Tangier were created by a special decree, while the centre in Kenitra was established through an additional decree. The main objective of IFMIAs is to

[1] https://www.etf.europa.eu/sites/default/files/2021-01/ppps_for_skills_development_volume_ii.pdf

strengthen the public-private partnership in vocational training and contribute to the development of training, research, and expertise in the automotive industry. The specific goals of IFMIAs include supporting sector economic strategies, delivering targeted and complementary training, bridging the gap between education and industry needs, and providing various training programmes for different roles in the automotive sector. The overall mission of IFMIAs is to enhance skills development in the automotive industry through pre-employment training, qualification programmes for specialists, continuous and advanced training for companies, and conducting laboratory tests.[2]

5.1.14 Supporting Entrepreneurship

Supporting entrepreneurship in Namibia's PtX sector through focused skills development initiatives is crucial for empowering individuals with the expertise and knowledge needed to drive innovation, and create employment opportunities. Recommendations to support entrepreneurship include:

- **Create dedicated incubation and acceleration programmes** specifically tailored to the green hydrogen and PtX industries. These programmes can provide aspiring entrepreneurs with mentorship, business development support, access to funding opportunities, and shared workspace facilities. By encouraging innovative start-ups, these programmes can increase entrepreneurial growth in the sector.
- **Facilitate partnerships between universities and industry stakeholders** to bridge the gap between academia and the entrepreneurial sphere. Encourage knowledge exchange, joint research projects, and the commercialisation of academic research. This collaboration can help entrepreneurs access new technologies and expertise while universities benefit from real-world application of their research.
- **Develop financing mechanisms tailored to the specific needs of entrepreneurs in the green hydrogen and PtX sector**. This can include venture capital funds, angel investor networks, grants, and low-interest loans. We recommend to simplify the application and approval processes to ensure that entrepreneurs can readily access the necessary funding to start and scale their businesses.
- **Facilitate international collaborations and partnerships** to promote technology transfer, market access, and knowledge sharing. Engage with global players in the green hydrogen and PtX industries to explore joint ventures, joint research projects, and technology licensing agreements. Such partnerships can provide Namibian entrepreneurs with valuable expertise and market opportunities.

Foster networks and communities of entrepreneurs in the green hydrogen and PtX sectors. Encourage the formation of industry associations, networking events, and knowledge-sharing platforms. These platforms can provide entrepreneurs with opportunities to connect, collaborate, and learn from each other.

5.2 Milestones & Timeline

The proposed timeline outlines the key milestones for the implementation of a skills development programme for the Power-to-X sector in Namibia, based on the country's National Hydrogen Strategy. The following timeline highlights milestones along the ramp-up targets for different time periods.

5.2.1 Short-Term Milestones (1-3 years)

- **Establish partnerships** with educational institutions, industry associations, and PtX project developers to design and implement initial training programmes and short courses (in face-to-face and online formats). Short courses can be conducted locally or abroad complemented with industry attachments
- **Upgrade existing Solar Equipment Installation and Maintenance Course from level 3 to level 5** to upskill the current instructors, training equipment and delivery.

[22] https://www.etf.europa.eu/sites/default/files/2021-01/ppps_for_skills_development_volume_ii.pdf , p.26

- **Upgrade existing pipe fitter/plumber qualification (Levels 3 & 4) to encompass industrial pipe fitting knowledge and skills.**
- **Develop and launch vocational training (TVET) programmes** to provide basic skills training in areas such as PtX technologies, safety measures, project planning, and management.
- **Initiate on-the-job training opportunities, internships, and apprenticeships for trainers, trainees and students** in existing PtX projects to foster practical skills development.
- **Establish the proposed Faculty of TVET at NUST** to upgrade the skills of TVET trainers in VTCs to offer NQF Level 3 and higher in solar technology. Furthermore, this Faculty will enhance the technical knowhow of the TVET trainers to be able to effectively teach at VTCs.
- Establish a monitoring and evaluation framework to track the progress and effectiveness of the skills development initiatives.

5.2.2 Medium-Term Milestones (4-10 years)

- **Expand the range of training programmes designed to specialised skill needs** in the growing PtX sector, process optimisation, and advanced technology applications.
- **Strengthen collaboration between educational institutions and industry partners** to align curriculum with industry requirements and emerging technologies.
- **Establish a Hydrogen/PtX Centre of Excellence** or Research Institute to promote research and development activities and drive innovation in the sector.
- **Develop partnerships with international organisations, experts, and training providers** to leverage global expertise and best practices.
- **Scale up the TVET programmes, internships, and apprenticeships** to accommodate a larger number of participants and increase hands-on experience.
- **Continuously evaluate and update the programme** based on feedback and changing industry dynamics.
- **Develop advanced degree programmes and postgraduate courses focused on newest PtX technologies.**

5.2.3 Long-Term Milestones (11-30 years)

- **Strengthen the research and development capabilities within Namibia** to support the growth of PtX technologies and applications.
- **Foster entrepreneurship and innovation** in the PtX sector through incubation and acceleration programmes, funding opportunities, and business support services.
- **Establish knowledge-sharing platforms, conferences, and industry events** to encourage collaboration, networking, and sharing of best practices.
- **Continuously evaluate the skills development programme** to align with the evolving needs of the PtX sector, taking into account advancements in technology and changing market dynamics.
- **Regularly assess and update the long-term targets and milestones** based on the progress made towards achieving the previously established objectives (according to SMART).

It's important to note that the milestones and timeline can be adjusted based on the specific circumstances, resources, and industry developments in Namibia. Regular monitoring, evaluation, and flexibility will ensure that the programme remains relevant and effective in achieving the set goals.

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