Facilitating a sustainable future

SKILLS AND JOBS IN THE CONTEXT OF POWER-TO-X

- Link job assessments to identify and quantify employment opportunities arising from a green hydrogen and Power-to-X (PtX) value chain to the overall national PtX strategy
- Define in a transparent manner the scope of such assessments and clarify which parts of the value chain are considered and whether spill-over effects are possible or not
- Establish a national PtX Skills Task Force comprised of government, industry, academia and training providers
- Design and implement a strategic programme with short, medium and long-term measures (e.g., training of academic staff and trainers, practical training through internships or apprenticeships, co-operations between universities, institutionalisation of training centres, awareness-raising campaigns highlighting opportunities for all)
- Develop a monitoring and evaluation system for the strategic programme to keep up with recent developments and requirements in the PtX value chain

International PtX Hub

Supported by:

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Developments and chances

Identifying job profiles and skills needed

Analyses that examine the job potential in PtX value chains identify between 50 and 200 specific roles (Bezdek, 2019; France Hydrogène, 2022; International PtX Hub, 2023; Green Skills for Hydrogen, 2023). In doing so, the European Hydrogen Skills Strategy has made use of the classification system for European Skills, Competences, Qualifications and Occupations (ESCO). It includes a database, in which job descriptions are available (European Commission, 2023).

In terms of skills linked to occupational profiles, a White Paper for France Hydrogéne (2022) distinguishes between technical skills (e.g., materials engineering, metalworking) and non-technical skills (e.g., industrial site management, commercial negotiation) and notes that six of them are in high demand:

- electrical engineering and industrial data processing,
- mechanical engineering,
- fluid mechanics,
- metrology,
- quality, health, safety and environment,
- proficiency in English

Of 84 of the professions identified in France's value chain, 58% are expected to have at least a Master's degree, whereas 40% and 16% require a certain level of higher study or high school diplomas, respectively (France Hydrogène, 2022). In the analysis of Namibia's PtX future, authors estimate construction workers (45%), technicians (16%) and engineers (14%) to have the highest share in the total PtX workforce (International PtX Hub, 2023). The following figure provides a general overview of relevant occupational groups.

Description of occupational groups

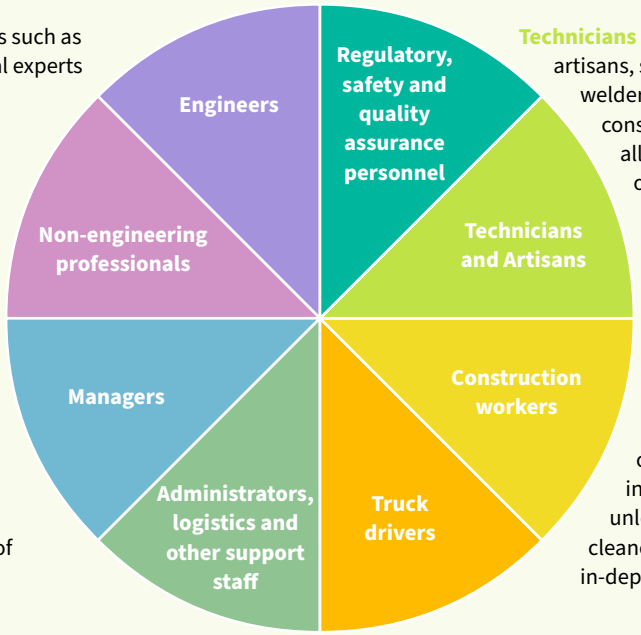
Engineers During project planning they will do preliminary design. During the engineering, procurement and construction (EPC) they are responsible for detailed design, procurement of parts, and installation supervision. Finally, they are responsible for technical plant operation and maintenance.

Non-engineering professionals 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.

Managers 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.

Administrators, logistics and other support staff
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.

Regulatory, safety and quality assurance personnel These personnel, encompassing regulators, planners, inspectors, and health and safety officers, are involved at all project stages to ensure compliance, quality and safety.



Technicians and artisans 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.

Construction workers 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.

Truck drivers 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.

Figure 1: Own illustration

Quantifying job potentials in the PtX value chain and beyond

It should be acknowledged that there will be a shift in the proportions of occupational groups, as soon as the value chain is established. For instance, construction workers will be needed primarily in the initial phase of projects to build infrastructure and facilities, while technicians and other workers will become more important in the operational phase. For example, the Hyphen consortium, which wants to establish a value chain for green ammonia in Namibia, plans to create 15,000 one-off and 3,000 recurring jobs 'for qualified specialists' (Ernst & Young, 2022). As the working landscape and demands on workers evolve, a monitoring system seems relevant to meet the changing requirements.

With respect to the Hyphen project in Namibia, consultants expect that 'the future ammonia boom will create an affluent class that will demand services, such as legal services and leisure activities amongst others' (Ernst & Young, 2022). This creates additional employment opportunities beyond the direct PtX value chain through spill-over effects on other sectors. It is also noteworthy that line ministries, subordinated agencies and municipalities will also have to have human resources, e.g. to facilitate regulation, planning, permitting and monitoring of PtX-related activities (International PtX Hub, 2023).

Job creation is, indeed, an important aspect in several national or regional hydrogen and PtX strategies (DECHEMA & acatech, 2022; Victorian Hydrogen Hub, 2022). Several governments have started to scope job potentials as shown in Table 1. According to a World Bank expert, green hydrogen and PtX provide a pathway to shift from growth without employment benefits to job-rich growth job-oriented growth. It is pertinent to note that the actual potential of these solutions is as diverse as the countries implementing them.

Table 1: Overview of job potentials in different countries

Country	Hydrogen and PtX production	Job potential	Target year	Source
Australia	2.6 Mt / yr	13,150-16,050	2030	(PwC Consulting, 2022)
Chile	1.6 Mt / yr	100,000	2040	(Energy Partnership Chile Alemania, 2020)
Germany	10 GW (electrolysis capacity)	13,000	2030	(Zenk et al., 2023)
India	5 Mt / yr	600,000	2030	(Government of India, n. d.)
Namibia	1-2 Mt / yr	280,000 of which 90,000 in the industry	2030	(Ministry of Mines and Energy Namibia, 2022)
Namibia / Hyphen only (Phase 1 and 2)	0.36 Mt / yr (2 Mt / yr of ammonia)	15,000 one-off 3,000 permanent	2029	(Ernst & Young, 2022)
Netherlands	10-40 PJ	1,800 – 4,700 one-off 4,200 – 12,500 permanent	2030	(CE Delft, 2021)
South Africa	500,000 t / yr	20,000	2030	(Department Science and Innovation, 2021)

Strategies and in-depth analyses of employment potential show a different granularity regarding a differentiation of the hydrogen value chain, also considering country-specific circumstances. For example, the Federal Institute for Vocational Education and Training (BIBB) has carried out a sector-specific analysis for Germany that takes into account not only the domestic production, transportation and storage of hydrogen, but also the use of hydrogen in basic chemicals and in the refinery sector, as this sector is of considerable economic importance in Germany. One remarkable example which can be cited here is of the Federal Institute for Vocational Education and Training (BIBB), which carried out sector specific analysis for Germany, considering not only the domestic production, transportation and storage of hydrogen but also its use in basic chemicals and refinery sector. Although the BIBB acknowledges loss of jobs in other areas, it however expects a net increase of 13,000 jobs between 2022 and 2030 compared to a 'business-as-usual' scenario, which also takes into account jobs from technology exports such as electrolysers (Zenk et al., 2023). Australia distinguishes between core areas of the hydrogen supply chain; in contrast to Germany, which will not export any significant quantities of hydrogen in the future, the Australian employment analysis also took into account the export of hydrogen (PwC Consulting, 2022).

The more qualitative analysis of the skills gap in Namibia also factors in upstream activities such as the development of electricity and water infrastructure (International PtX Hub, 2023). Similarly, a study on the environmental and socio-economic sustainability requirements for a hydrogen value chain in Chile distinguishes between upstream, midstream and downstream activities including desalination, water treatment and carbon sources (ILF & LBST, 2021). The value chain of green hydrogen and PtX can also promote the production of local content. To give an example, if PV solar modules, wind turbines, electrical connections or cables are manufactured in emerging and developing countries, this will lead to additional local jobs. For South Africa, experts estimate that adding 12 to 14 GW of renewable energy to the country's existing power system may result in 500,000 permanent jobs in addition to more jobs in the core hydrogen value chain (Bischof-Niemez & Creamer, 2022).

While employment opportunities are present in each step of the PtX value chain (including installation and operation), renewable energy can be a significant driver of job creation. Spill-overs are also possible. So as to identify national or regional job potential, assessments must therefore make transparent which parts of the value chain they cover, whether they include the installation and operating phases and to what extent spill-over effects on other sectors are analysed.

Realising opportunities

Apart from the quantitative question of how many jobs can be generated, analyses also focus on how the training and education system can empower the future workforce.

Assessing the education system to facilitate change

When analysing education systems, technical and vocational education and training (TVET) programmes as well as higher education qualification programmes are often considered. In Victoria‘s Hydrogen Hub, even primary and secondary school curricula could be adapted to introduce hydrogen as a subject (Victorian Hydrogen Hub, 2022). Given the relative novelty of the topic, it seems likely that trainers and teachers need to be empowered. In Namibia, for example, more than 100 training providers could potentially offer PtX-related training, but many of them lack the relevant industry knowledge (Internationa PtX Hub, 2023).

Train-of-Trainer events conducted by the International PtX Hub

The International PtX Hub offers periodically Train-of-Trainer events, preparing multiplicators worldwide to facilitate trainings on Green Hydrogen and Power-to-X and related topics, developed by the International PtX Hub.

Since 2022, around 100 professors and experts in the field of renewable energy, hydrogen, but also physics or chemistry were trained. Two regional editions for the MENA region were realised. The alumni stay connected in the international PtX.Trainer Network where they support improving and adapting the training materials and learn from each other. The group also exchanges on curricula development initiatives in their institutions, enhancing a sustainable local and long-term capacity development in the field.

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International cooperation can also take other forms. For example, universities such as the University of Namibia (UNAM) or the German-Jordanian University are working together with foreign universities to develop and transfer hydrogen-related curricula. Along these lines, a new school/faculty for alternative and renewable energies and a study programme for green hydrogen and synthetic fuels will become part of the master‘s programme for renewable energies at UNAM. The German Federal Institute for Materials Research and Testing is also supporting the establishment of hydrogen technology laboratories in Namibia (International PtX Hub, 2023). The West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) offers full scholarships for its international Master‘s programme in Energy and Green Hydrogen especially for Bachelor‘s graduates from West African countries (WASCAL, 2023).

A coordination mechanism or actors who take on the role of coordinator are important to avoid duplication of work in the often-fragmented educational landscapes. This may also include the development of measures to empower the population. Coordinating actors can be, for example, ministries of (higher) education. However, even in countries such as Australia, coordinating PtX education is considered an ambitious endeavour with conflicts between top-down and bottom-up approaches. While government-led education efforts may be slow to respond to industry needs, industry-led education could hinder the ‘broader development of skills that are transferable across technologies and equipment’ (Beasy et al., 2023).

Industry should play a key role in empowering the labour force, as it knows its labour requirements best. Apprenticeships and internships offered by industry can be key a driving force for students to gain practical insights. In South Africa, GIZ is running a Female Internship Partnership to train unemployed female graduates for the green hydrogen sector.

Skills and jobs for a just transition

Local employment effects related to infrastructural developments are hampered when foreign companies bring their own labour force. In this regard, countries such as Ghana are taking a more restrictive approach to limiting the influx of foreign labour (Ghiselli & Morgan, 2023). For hydrogen and PtX production in particular, the Government of Namibia already included contractual clauses to generate local employment when awarding the Hyphen consortium.

Governance coordination should also pay attention to the jobs that could be lost as a result of the green transition. Workers and trade unions from the traditional energy sectors could become veto players, making the transition more difficult, as new sectors such as green hydrogen and PtX could be perceived as a threat (Stamm et al., 2023). Workers from conventional sectors such as fossil energy production or mining are often well paid, so their integration into new value chains requires not only higher qualifications but also appropriate financial compensation. In countries such as South Africa, which has years of experience with the Fischer-Tropsch process also relevant for the production of synthetic fuels, slightly different educational measures need to be taken than in countries without significant industrial production.

Local job creation and the development of local businesses can be a means of gaining public acceptance of hydrogen and PtX-related projects for the development of infrastructure such as roads or transmission grids. At this point, however, it should be ensured that benefits such as income generation improve the living conditions of the affected communities pragmatically, as otherwise ‘social unrest is likely to rise because of skewed benefit-sharing’ (GIZ, 2023; Waters-Bayer & Tadicha Wario, 2022). It should also be avoided that well-educated elites settle in communities that leave fewer opportunities for the locals and even lead to higher living costs for these community members (Ernst & Young, 2022). However, the skills of people in local communities can make it difficult to assign skilled tasks to them; training for the local community could help to empower them but may come at an additional cost.

Ways forward

It will be anything but an easy task to create competences and jobs for a new value chain in a country. While the development and improvement of education system structures requires a customised approach that takes into account the country-specific vision of a hydrogen and PtX economy, some general conclusions can be drawn from the above.

The value chain must be broken down so as to determine the required job profiles and qualifications. These requirements must be compared with the current situation of the labour force and the capacities of the existing education system.
An assessment of existing educational structures includes

- schools,
- vocational training centres and
- academic institutions.

However, new physical units may also be required to complement the existing system. In other cases, adjustments to existing structures, e.g. at universities, may be sufficient (i.e. the introduction of new degree programmes). It must be ensured that trainers and university staff have the appropriate industry knowledge. The perspective of industry deserves particular attention, as it is likely to know best what qualifications are needed. Industry should also be seen as a knowledge broker, e.g. by providing apprenticeships, internships or other programmes that empower the workforce. A coordination mechanism is key to coordinate the roles of the different actors and to design and implement appropriate measures to bridge the skills gap. A national PtX Skills Task Force, which also looks at the quality of jobs, could fulfil such a function.

In many ways, lessons learnt from other countries can help avoid mistakes and several countries are currently developing official national roadmaps for skills and jobs, including Namibia and Kenya. A process has just been finalised in Namibia that aims to bring together the various short-, medium- and long-term measures to promote skills and jobs in the African country as shown in Table 2.

Table 2: Example of a process to orchestrate various short-, medium- and long-term measures to facilitate skills and jobs in Namibia (International PtX Hub, 2023)

Short-Term Milestones (1-3 years)	Medium-Term Milestones (4-10 years)	Long-Term Milestones (11-30 years)
Establish partnerships to design and implement training programmes and short courses.	Expand PtX-related training programmes and collaborations in the growing PtX sector.	Strengthen PtX research and development within Namibia.
Upgrade existing solar equipment installation and maintenance course.	Establish a Hydrogen/PtX Centre of Excellence or Research Institute.	Foster entrepreneurship and innovation.
Upgrade pipe fitter/plumber qualification.	Develop partnerships with international organisations, experts and training providers to leverage global PtX-related expertise.	Establish knowledge-sharing platforms.
Develop and launch vocational training programmes providing basic skills training in PtX-related areas.	Scale up TVET programmes, incl. the offer of internship and apprenticeship opportunities.	Continuously evaluate and update the PtX Skills Development Programme.
Initiate on-the-job training, internships, and apprenticeships for trainers, trainees, and students.	Continuously evaluate and update the programmes.	Regularly assess and update long-term targets and milestones.
Establish the proposed Faculty of TVET.	Develop advanced degree programmes and postgraduate courses that incorporate newest PtX and related.	
Implement monitoring and evaluation framework.		

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