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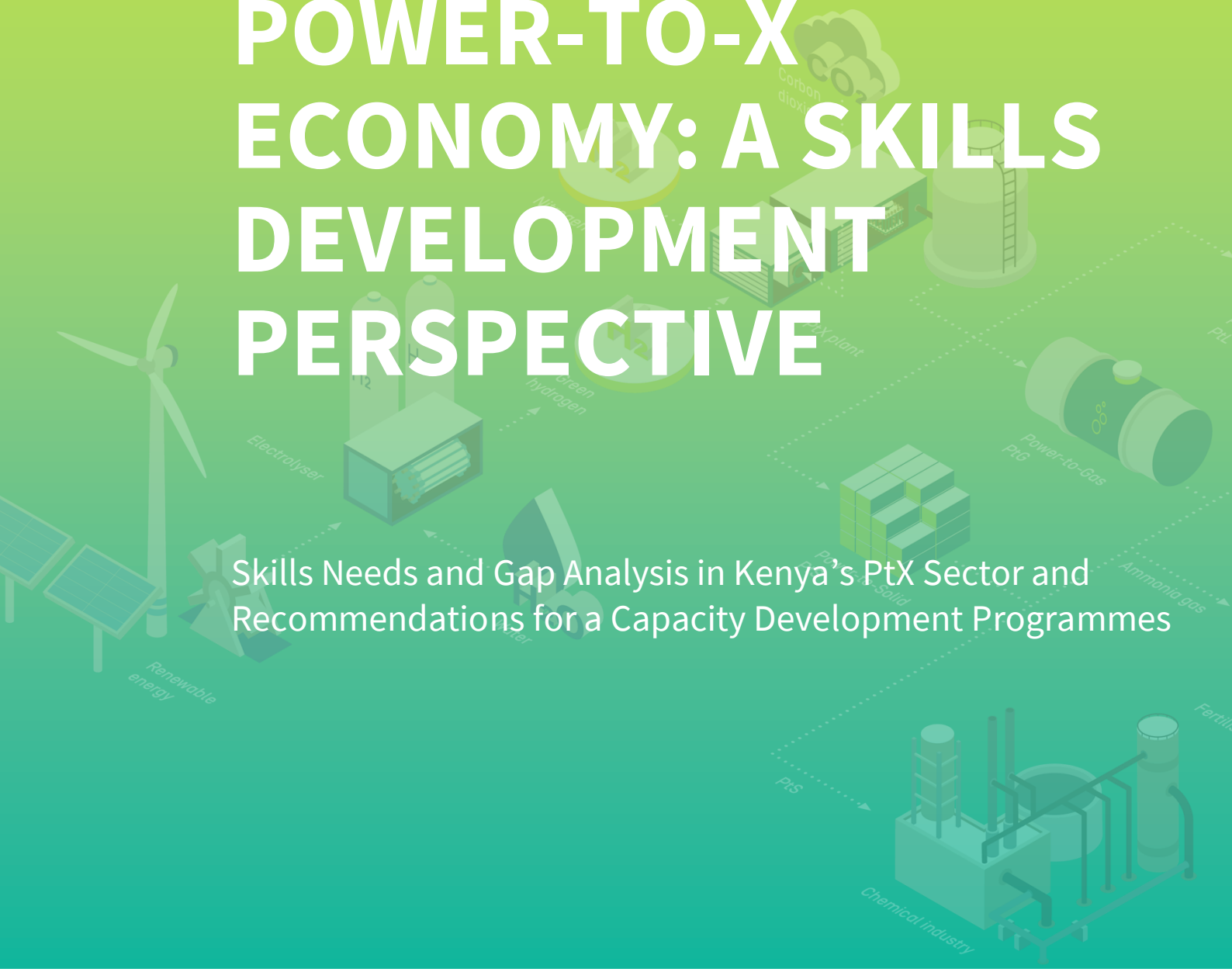
KENYA'S PATH TO A POWER-TO-X ECONOMY: A SKILLS DEVELOPMENT PERSPECTIVE



Skills Needs and Gap Analysis in Kenya's PtX Sector and Recommendations for a Capacity Development Programmes

Study conducted by

renac renewables academy

IMPRINT

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

Berlin/Nairobi, 2024

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LIST OF ABBREVIATIONS

AGHH	Africa Green Hydrogen Hub
AMEA	Arabian and Middle Eastern Association
BEng	Bachelor of Engineering
BTech	Bachelor of Technology
CAA	Civil Aviation Authority
CBET	Competence-based Education and Training
CSQ	Construction Skills Queensland
CUE	Commission for University Education
EBK	Engineer's Board of Kenya
ECB	Electricity Control Board
EU	European Union
FKE	Federation of Kenyan Employers
FTE	Full-Time Equivalent
GH2	Green Hydrogen
GH2-PCC	Green Hydrogen Programmes Coordination Committee
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
ICT	Information and Communication Technology
IFMIAs	Institutes for Professions in the Automotive Industry
ICT	Information and Communication Technology
ILO	International Labour Organisation
IRENA	International Renewable Energy Agency
ISO	International Organisation for Standardisation
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEBS	Kenya Bureau of Standards
KeNIA	Kenya National Innovation Agency
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electricity Transmission Company
KETBR	Kenya Engineering and Technologists Registration Board
KIRDI	Kenya Industrial Research Institute
KMA	Kenya Maritime Authority
KNQA	Kenya National Qualifications Authority
KNQF	Kenya National Qualifications Framework
LA	Local Authority
LNG	Liquefied Natural Gas
MoEP	Ministry of Energy and Petroleum
MoU	Memorandum of Understanding
MTCC	Maritime Technology Cooperation Centre

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MW	Megawatt
MWSI	Ministry of Water, Sanitation and Irrigation
NACOSTI	National Commission on Science, Technology and Innovation
NCRST	National Commission on Research Science and Technology
NDC	Nationally Determined Contributions
NIT	National Institute of Technology
NITA	National Industrial Training Authority
NQF	National Qualifications Framework
NP	National Polytechnics
NQF	National Qualifications Framework
NRF	National Research Fund
OEM	Original Equipment Manufacturer
PHEI	Private Higher Educational Institution
PPP	Public-Private Partnership
PSC	Public Service Commission
PV	Photovoltaic
PtX	Power-to-X
RE	Renewable Energy
REREC	Rural Electrification and Renewable Energy Corporation
RTD	Research, Technology, and Development
SAE	Society of Automotive Engineers
SAF	Sustainable Aviation Fuel
STEM	Science, Technology, Engineering and Mathematics
TP	Training Providers
TVC	Technical and Vocational College
TVET	Technical Vocation Education and Training
TVETA	Technical and Vocational Education and Training Authority
TVET CDAAC	Technical and Vocational Education and Training, Curriculum Development, Assessment and Certification Council
UNDP	United Nations Development Programmes
USAID	United States Agency for International Development
USD	United States Dollar
VTCs	Vocational Training Centres
WIL	Work Integrated Learning

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Executive Summary

Background, Objectives and Scope

Kenya is advancing towards a sustainable future with green hydrogen (GH2) and Power-to-X (PtX)playing a pivotal role in enabling the green transition. The National Green Hydrogen Strategy and Roadmap (2023) outlines Kenya's commitment to leveraging green hydrogen's transformative potential across various sectors. This strategy aligns with Kenya's vision 2030 on sustainable socio-economic development, focusing on agricultural productivity, industrialisation, and defossilisation. Key objectives include reducing import dependencies, promoting industrial growth, and enhancing agricultural productivity through local nitrogen fertiliser production.

The study aims to assess capacity needs and gaps in Kenya's Power-to-X sector, focusing on skills development and capacity building. A comprehensive capacity needs assessment was conducted to identify technical, managerial, and other skill sets required for the development of green hydrogen and its derivatives. Recommendations are provided for a human capacity development programme to be implemented by stakeholders across the green hydrogen and green ammonia value chains in Kenya.

Jobs and Skills Demands along the PtX Value Chain

Kenya's evolving PtX markets present substantial employment opportunities, particularly along the overall value chain. The PtX value chain encompasses various phases including hydrogen production, storage and distribution in which numerous activities such as system design, fabrications, installations and operation among others are undertaken across the value chain. Each of these fields requires expert know-how to ensure safety, decrease costs, and guarantee compliance with regulations, codes, and standards (RCS) highlighting the need for strategic planning and evaluation of specific skills-sets and expertise required at each stage.

Strategies for Addressing Human Capacity Gaps in PtX-related Industries

Identified Skills for Upskilling

Key existing skills requiring enhancement encompass engineers and technicians (electrical, mechanical, chemical), including renewable energy technologists, chemists, water experts, environmental impact assessors, legal experts, financial modelers, plumbers, welders, and electricians. Additionally, the development of new competencies such as standards and certification, or particular technological knowledge in sectors like aviation, shipping or carbon assessment expertise, is deemed essential. Consequently, the role of social scientists will be instrumental in enabling community acceptance of green hydrogen and PtX projects and fostering dispute resolution in especially land acquisitions for these projects.

Importance of External Expertise

As per the stakeholders interviewed for this study, Kenya anticipates importing GH2-PtX technologies, relying on external expertise for training local capacities across the value chains. Strategies aimed at bridging capacity gaps along the value chain encompass exchange programmes, short courses (particularly for professionals, technicians, and artisans), and the incorporation of emerging technology modules into university curricula across engineering, science, and technology disciplines.

Long-term Capacity Building Initiatives

For sustained development, proposals include establishing a centre of excellence to foster domestic skills and technology growth, facilitating incubation and mentorship programmes, and promoting research and development (R&D) collaborations between public and private sectors. Emphasis is placed on formulating a targeted training strategy to ensure continuous skills development and readiness for evolving demands in the PtX sector through effective resource allocation.

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Recommendations for a Human Capacity Development Programmes in Kenya: Proposed Initiatives and Timeline

Based on the findings of the study, the following **measures** for a Kenyan PtX Human Capacity Development Programme are recommended:

1 - Establishing Institutional Integration of PtX Skills Development within Existing National Structures

Objective: To institutionalise PtX skills development within Kenya's existing national structures, addressing skill gaps and ensuring targeted strategies for intersectoral alignment with Kenya's Green Hydrogen Strategy and Roadmap.

Actions:

- Initiate the establishment of a subcommittee within the Green Hydrogen Programme Coordination Committee (GH2-PCC), comprising members from the GH2-PCC, Kenya Green Hydrogen Secretariat, and relevant stakeholders in training and education.
- Task the subcommittee with developing targeted strategies to address skill gaps in the PtX sector, using resources and support from the GH2-PCC and Secretariat to ensure alignment with Kenya's Green Hydrogen Strategy and Roadmap.

Implementation:

- Integrate the subcommittee into existing national structures, such as the GH2-PCC, to leverage established frameworks and resources for effective coordination and implementation of PtX skills development initiatives.
- Ensure regular communication and collaboration among stakeholders to monitor progress and adjust strategies as needed.

2 - Developing Industry-Responsive Curricula and Training Programmes

Objective: aligning curricula and training programmes with PtX sector needs to equip students with relevant skills for industry contribution.

Actions:

- Strengthen industry collaboration for curriculum alignment and technological advancements.
- Develop and implement industry-responsive training programmes in partnership with PtX enterprises and educational institutions.
- Integrate practical training elements and establish systematic curriculum reviews for sector development.
- Organise periodic Industry-Academia symposiums to foster collaboration.

Implementation:

- Integrate PtX content into relevant curricula like Chemical and Process Engineering.
- Establish partnerships for tailored training programmes.
- Implement systematic reviews for curriculum updates.
- Organise Industry-Academia symposiums for collaboration and idea exchange.

3 - Training of Trainers and Addressing Shortage of Lecturers for the PtX Industry

Objective: addressing the shortage of PtX industry lecturers and enhancing university instructors' skills for effective PtX technology training.

Actions:

- Implement comprehensive upskilling programs for university instructors in PtX skills to improve student learning.
- Collaborate with initiatives like the International PtX Hub for specialised training abroad, addressing lecturer shortages.
- Partner with industry experts for tailored training programs aligned with PtX sector needs.
- Recruit and train qualified lecturers with PtX expertise to address university understaffing.
- Encourage industry collaboration for adjunct lecturers and retain PtX expertise through research funding.

Implementation:

- Develop upskilling programmes focusing on PtX technologies and teaching methodologies.
- Collaborate internationally to provide specialised training and address expertise shortages.

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- Engage industry partners to ensure training programme alignment with PtX sector needs.
- Recruit PtX expert lecturers to strengthen university faculty.
- Facilitate industry collaboration for adjunct lecturers and retain PtX expertise with incentives.

4 - Upskilling University and Vocational Training Staff

Objective: upskilling university and vocational training staff in PtX sector expertise for effective knowledge transfer to students.

Actions:

- Provide PtX workshops, industry exchanges, and training sessions for academic and TVET staff.
- Implement internships and Train-the-Trainer programmes with online components for continuous learning.
- Foster collaborative projects between staff and students to enhance PtX technology expertise.

Implementation:

- Organise PtX workshops and seminars to update staff knowledge.
- Facilitate exchanges with industry experts for real-world exposure.
- Develop internships and online training for effective knowledge dissemination.
- Encourage collaborative projects for hands-on experience and mentorship in PtX technologies.

5 - Up- and Re-Skilling through Continued Professional Development

Objective: facilitating up- and re-skilling of the PtX workforce through continued professional development, leveraging Kenya's TVET institutions overseen by NITA and the Ministry of Education.

Actions:

- Supplement university curricula with tailored professional courses to address PtX sector skill gaps.
- Provide targeted training programmes for PtX industries through Kenya's TVET institutions overseen by NITA and the Ministry of Education.
- Enhance PtX workforce skills development through collaboration with TVET institutions and NITA's centres, supported by the industrial training levy.

Implementation:

- Collaborate with industry experts to develop targeted professional courses supplementing university curricula.
- Partner with TVET institutions for specialised training aligned with PtX sector needs.
- Use funds from the industrial training levy to support skills development initiatives.
- Monitor and evaluate the effectiveness of professional development programmes to meet PtX industries' evolving needs.

6 - Enhancing Apprenticeship Programmes , On-the-Job-Training and Local Training Institutions

Objective: enhancing apprenticeship programmes, on-the-job training, and local training institutions to support PtX technology skills development.

Actions:

- Access Kenya's network of 200+ CBET TVET institutions and NITA's five training centres for PtX technology training.
- Use NITA's management of the industrial training levy to fund upskilling in PtX skills during industry transitions.

Implementation:

- Collaborate with local training institutions and NITA to develop tailored apprenticeship and on-the-job training programmes for the PtX sector.
- Allocate funds from the industrial training levy to support PtX skills development initiatives.
- Establish industry partnerships for mentorship and practical training opportunities in PtX skills.
- Monitor and evaluate programme effectiveness to meet PtX industries' evolving needs.

7 - Empowering Unemployed TVET Graduates through Job Opportunities

Objective: empowering unemployed TVET graduates by providing job opportunities in the PtX industry through

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targeted training and collaboration with industry stakeholders.

Actions:

- Establish a framework to identify TVET graduates needing PtX industry skills and provide tailored training programmes.
- Foster collaboration between TVET institutions and PtX stakeholders to ensure industry-aligned training programmes.
- Enhance career guidance within TVET institutions to inform students about PtX industry opportunities.
- Develop internship and apprenticeship programmes with PtX industry players to provide practical experience for TVET graduates.
- Allocate funding, including resources from the industrial training levy, to support industry-aligned training programmes.

Implementation:

- Collaborate with TVET institutions and industry stakeholders to design tailored training programmes addressing specific needs of unemployed TVET graduates.
- Facilitate partnerships for internship and apprenticeship programmes to enhance job readiness.
- Improve career guidance services within TVET institutions to raise awareness about PtX industry opportunities.
- Allocate funding from the industrial training levy and other sources to support industry-aligned training initiatives for unemployed TVET graduates.

8 - Encouraging Engineering Professionals to Register with the EBK and KETRB

Objective: encouraging engineering professionals to register with the Engineer's Board of Kenya (EBK) and the Kenya Engineering and Technologists Registration Board (KETRB) by formalising "graduate in training" programmes and implementing mentorship initiatives to enhance their skills and credibility.

Actions:

- Formalise collaborative agreements between educational institutions and the PtX sector to establish "graduate in training" programmes, providing practical experience.
- Implement mentorship initiatives to offer practical skills and support for engineering professionals, facilitating their registration with the EBK and KETRB.

Implementation:

- Establish collaborative agreements for "graduate in training" programmes, enabling practical experience and industry exposure.
- Implement mentorship initiatives pairing professionals with graduates for guidance and practical skills.
- Promote awareness and participation in mentorship programmes among professionals.
- Monitor and evaluate programme effectiveness, adjusting strategies as needed.

9 - Establishing Centres of Excellence

Objective: establishing centres of excellence in PtX technology to serve as hubs for interdisciplinary research, skills development, and knowledge transfer, fostering collaboration among sectors. These can be incorporated into existing centres of excellence in Kenya's TVET institutions (e.g. renewable energy centre of excellence).

Actions:

- Establish dedicated PtX technology training centres with modern infrastructure and international partnerships (in existing centres of excellence).
- Develop a PtX Centre of Excellence for interdisciplinary research and knowledge transfer, akin to the KenGen centre for Geothermal.
- Foster collaboration among sectors to enhance local PtX expertise and offer consultancy services to other African countries.

Implementation:

- Collaborate internationally to establish PtX technology training centres for skills development.
- Develop a PtX Centre of Excellence with support from academia, industry, and government.
- Establish partnerships locally and internationally to leverage expertise in PtX technologies.

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- Provide consultancy and technical assistance to African countries developing PtX capabilities.

10 - Enhancing Research and Development Initiatives

Objective: enhancing research and development (R&D) initiatives in the PtX sector through collaboration among universities, research institutions, and industry to drive innovation.

Actions:

- Foster collaboration among universities, research institutions, and industry stakeholders to facilitate PtX research and innovation.
- Provide funding for PtX-focused research projects and upgrade laboratories with modern equipment.
- Upgrade laboratories with modern equipment to enhance research capabilities and promote technology transfer.

Implementation:

- Facilitate partnerships and collaborations to leverage expertise for PtX research and innovation.
- Allocate funding for PtX-focused research projects and provide incentives for equipment acquisition.
- Upgrade laboratories with state-of-the-art equipment to support innovative projects in the PtX sector.
- Foster knowledge sharing through strategic partnerships to drive innovation in the PtX field.

11 - Accessing Financing Opportunities

Objective: accessing diverse financing opportunities to support Kenya's PtX sector skills development programmes, ensuring financial sustainability and success.

Actions:

- Explore government-led initiatives, partner with development finance bodies, and attract private sector investments through Public-Private Partnerships (PPPs) for diverse financing options.
- Seek support from international organisations, philanthropic entities, and carbon market opportunities to bolster funding for skills development initiatives.
- Allocate a portion of revenue from green hydrogen exports to a Skills Development Fund for sustainable funding.
- Align with climate financing mechanisms to enhance financial sustainability, leveraging funding opportunities available through climate finance initiatives.

Implementation:

- Collaborate with government agencies, development finance institutions, and private sector partners to explore diverse funding sources.
- Engage international organisations, philanthropic entities, and carbon market opportunities for additional funding.
- Establish a Skills Development Fund and allocate revenue from green hydrogen exports for dedicated funding.
- Monitor financing strategies to ensure adequate funding, adjusting as needed to optimise financial sustainability and success.

12 - Promoting Gender-Inclusive Career Pathways

Objective: promote gender-inclusive career pathways in the PtX sector by prioritising gender equality, ensuring equal opportunities, and actively supporting women's participation and advancement.

Actions:

- Conduct awareness campaigns to promote gender equality and inclusivity within the PtX sector.
- Develop tailored training programmes addressing the unique needs of women in the PtX industry, ensuring access to skill development.
- Implement mentorship initiatives to support women professionals, facilitating their career advancement and leadership.
- Advocate for policies promoting women's leadership and representation in PtX organisations, fostering diversity.
- Introduce flexible employment models to accommodate women's diverse needs and promote work-life balance.
- Foster international collaboration to exchange best practices in promoting gender inclusivity.

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Implementation:

- Collaborate with stakeholders to design and implement awareness campaigns promoting gender equality.
- Develop specialised training programmes addressing the needs of women professionals, ensuring accessibility.
- Establish mentorship initiatives providing guidance and networking opportunities for career advancement.
- Advocate for policies promoting women's leadership and representation, creating an inclusive work environment.
- Introduce flexible employment models to accommodate women's needs effectively.
- Engage in international collaborations to learn from global best practices, empowering women in Kenya's PtX industries.

13 - Fostering Public-Private Partnerships (with Project Developers)

Objective: foster Public-Private Partnerships (PPPs) with project developers to enhance skills development in Kenya's hydrogen and PtX sector, promoting collaboration among government, private sector, and academic institutions for sustainable programmes implementation.

Actions:

- Implement a structured PPP model for skills development, defining clear roles for government, private sector, and academic partners.
- Secure private sector financing and establish collaborative funding mechanisms to support skills development.
- Engage the government to provide policy support and create investment-friendly environments for PPPs.
- Develop specialised training infrastructure, facilitate technology transfer, ensure quality assurance, and promote ongoing learning.

Implementation:

- Collaborate with stakeholders to establish structured PPPs for skills development, outlining clear roles.
- Secure private sector financing through partnerships, leveraging resources to support initiatives.
- Work with government to create supportive policy frameworks for PPPs.
- Invest in training infrastructure and technology transfer to enhance programme quality.
- Foster a culture of ongoing learning and innovation within skills development programmes.

14 - Supporting Entrepreneurship

Objective: support entrepreneurship in Kenya's PtX sector through targeted skills development programmes, fostering innovation and job creation.

Actions:

- Implement specialised incubation programmes, university-industry collaborations, tailored financial schemes, global partnerships for technology exchange, and supportive entrepreneurial networks.
- Leverage existing incubation facilities, like the Chandaria Business and Incubation Centre, to capitalise on infrastructure and expertise within universities.

Implementation:

- Develop tailored incubation programmes for PtX entrepreneurs, providing skills, resources, and support.
- Foster university-industry collaborations for technology transfer and access to expertise.
- Design financial schemes for PtX entrepreneurs to access capital.
- Establish global partnerships for technology exchange.
- Build supportive networks connecting entrepreneurs with mentors and investors.
- Use existing incubation facilities to support PtX ventures, maximising innovation and growth potent.

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Milestones and Timeline

The proposed milestones depicted in this study are strategically aligned with the phased approach outlined in Kenya's national Green Hydrogen Strategy and Roadmap. Each set of milestones corresponds to a specific phase of development, ensuring that the workforce is equipped with the necessary skills to support the objectives of the national strategy.

In the short-term phase (2024 - 2027), the emphasis is on establishing a solid foundation for domestic market development. The milestones focus on immediate skills enhancement through targeted short courses. Transitioning into the medium-term phase (2028 - 2032), the milestones aim to consolidate domestic market growth and foster specialisation in niche areas. In the long-term phase (2032 and beyond), the milestones are geared towards preparing the workforce for advanced roles in research, development, and international trade.

Short-Term Milestones

(2024 - 2027) "Upskill"

- access financing for curricula development
- upskilling through short courses for professionals, technicians, and artisans – focus on core competences
- prioritise the training of professionals in policy formulation and regulatory compliance to support the establishment of a conducive environment for green hydrogen and PtX initiatives
- design and implement training programmes for engineers, technicians, and operators to ensure the successful operation of the first commercial-scale projects
- facilitate knowledge transfer and skill acquisition in cutting-edge technologies through collaborations with international RTD centres

Medium-Term Milestones

(2028 - 2032) "Excellence Hub"

- incorporate PtX into existing centres of excellence
- initiate incubation and mentorship programmes
- expand focus of skills development programmes to include specialised training in niche areas (e.g. green shipping fuels production)
- extend capacity-building offers to sectors beyond energy, encompassing transportation, agriculture, and manufacturing, to support the diversification of applications
- strengthen partnerships with international organisations and vocational training centres to access expertise in emerging fields and foster innovation
- support industrial research

Long-Term Milestones (2032 and beyond) "Future-proof Education"

- offer integrated emerging technology modules in university curricula to ensure continuous and timely skill development in PtX-related fields
- shift skills development programmes towards preparing the workforce for advanced roles in research, development, and export-oriented activities
- tailor training programmes to meet the evolving demands of the global green hydrogen and PtX market, with an emphasis on entrepreneurship, project management, and international trade
- continue collaborations with international partners to facilitate knowledge exchange and promote best practices

Alignment with priority actions from National Green Hydrogen Strategy and Roadmap:

The short-term priority actions outlined below are closely aligned with the goals and timeline of Kenya's national Green Hydrogen Strategy and Roadmap (first phase). These actions, spanning from Q1 2024 to Q3 2024, focus on laying the groundwork for the successful implementation of the national strategy in regard to skills development.

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Key initiatives are aimed at ensuring that workforce development remains a central pillar of Kenya's PtX agenda. By integrating workforce coordination, skills development, and capacity-building efforts into the early stages of strategy implementation, Kenya is prepared to cultivate a skilled workforce capable of driving innovation and realising the full potential of the PtX sector in line with its national objectives.

Q1 2024 - Q3 2024:

Create a high-level "green hydrogen programme coordination committee"

- Develop a workforce coordination team within the committee tasked with identifying skills needs and gaps.

Set up a green hydrogen secretariat, functioning as a centralised hub

- Establish a skills development division within the secretariat responsible for designing and implementing training programmes.

Host national PtX roundtables focused on finance and green fertiliser

- Include sessions dedicated to discussing workforce development strategies and skill requirements.

Formulate a Monitoring and Evaluation Plan

- Include indicators related to skills development and capacity-building activities.

Craft a resource mobilisation plan for the Green Hydrogen Strategy and Roadmap

- Allocate resources for skills training and capacity-building initiatives.

Integrate dedicated provisions regarding green hydrogen and PtX into the national energy policy

- Ensure the policy includes provisions for workforce development and skills enhancement.

Support and expedite catalytic projects showcasing commercial viability

- Allocate funds for training programmes linked to catalytic projects like the Olkaria green hydrogen demonstration project.

Q3 2024 - Q3 2025:

Develop a comprehensive green hydrogen and PtX stakeholder engagement and communication plan

- Engage stakeholders from the education and training sector to design tailored programmes.

Establish local and international partnerships to expand training and capacity-building efforts

- Collaborate with international training institutions to access expertise in green hydrogen technologies PtX applications.
- Initiate upskilling of short courses for the practicing professionals, technicians, artisans, and other professionals whose skills have been found to be inadequate for the PtX projects.

Q3 2024 - Q4 2026 and Beyond:

Enhance regional and international cooperation and partnerships concerning green hydrogen and PtX

- Foster collaboration on skills development initiatives with regional and international partners.

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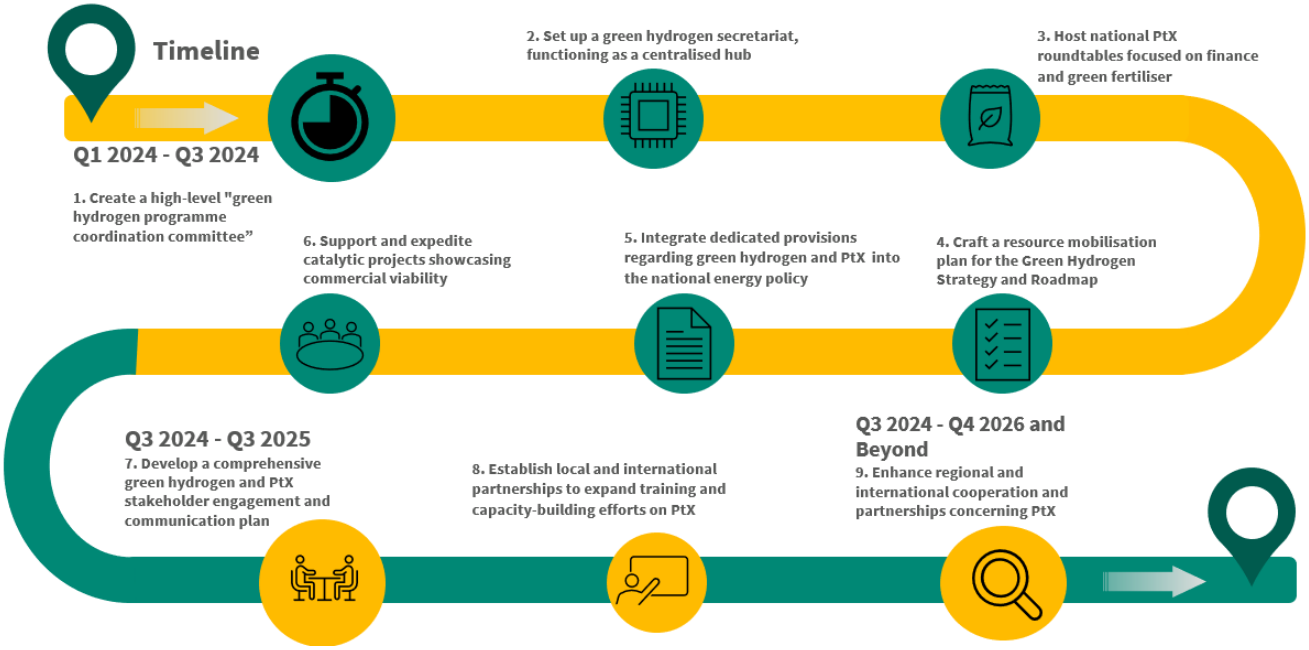

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1

Job Potential from the Green Hydrogen, Green Ammonia and PtX Economy in Kenya

INTRODUCTION

Kenya´s future Power-to-X economy offers the potential for socioeconomic development. Due to the countries' favourable conditions for and abundance of 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 Kenya to industrialise and therefore accelerate its economic development, tackling the topic of poverty reduction. The purpose of this study is to examine the skills requirements and gaps in Kenya´s Power-to-X sector and suggest measures to bridge these gaps and build on existing skills. By addressing these factors, the study aims to assist the education sector and industry stakeholders in developing effective programmes for PtX- workforce development.

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IKI INTERNATIONAL CLIMATE INITIATIVE

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Introduction and Background

As Kenya moves towards a sustainable and prosperous future with green hydrogen at the forefront, this document aims to assess capacity needs and gaps in Kenya's Power-to-X (PtX) sector, focussing on skills development and capacity building, to contribute hereby to Kenya's commitment to leveraging green hydrogen's transformative potential across various sectors.

This chapter looks at the central role of skills development. By exploring the intricacies of Kenya's national Green Hydrogen Strategy and Roadmap, the study unravels how skills training and capacity building are fundamental to unlocking the transformative potential of green hydrogen and its derivatives. From reducing imports to promoting industrialisation, skills development is proving to be a cornerstone in Kenya's journey towards a greener future.

Green hydrogen, a versatile and sustainable energy carrier, and PtX applications, have the potential to shape Kenya's journey towards a greener and more prosperous future. As outlined in Kenya's national Green Hydrogen Strategy and Roadmap, this clean energy source holds the promise of revolutionising various sectors of the Kenyan economy, including industry, transportation, and power generation. This transformative potential aligns with Kenya's development goals and presents opportunities for addressing pressing challenges.

One of the most immediate benefits of PtX production and applications domestically is the reduction of imports of hydrogen-based commodities such as nitrogen fertilisers and methanol. This shift has the potential to open export opportunities, taking advantage of Kenya's strategic regional trade position and strengthening the country's balance of payments.

Skills development is central to Kenya's green hydrogen strategy, driving economic diversification, reducing imports, and fostering industrial growth for a sustainable and prosperous future.

Green hydrogen offers the prospect of local nitrogen based fertiliser production, which can enhance agricultural productivity and food security. By creating a domestic fertiliser industry, it not only makes fertilisers more accessible to farmers but also promotes sustainable agricultural practices. This, in turn, reduces vulnerability to international market fluctuations, bolstering resilience in the agricultural sector.

PtX plays a vital role in promoting industrialisation by establishing manufacturing value chains, creating jobs, and fostering downstream industries. It acts as a reliable source of demand, encouraging the growth of renewable energy sources, expanding the power grid, and improving access to electricity. Replacing fossil fuel-derived hydrogen with sustainable alternatives contributes significantly to global defossilisation efforts and opens up new export markets.

The PtX sector has the potential to attract substantial public and private investments, fostering economic diversification, generating job opportunities, and driving industrial growth across various sectors. Investments in this sector encompass the entire value chain, from power generation to the production of green hydrogen and its derivates, and downstream industries.

International PtX Hub

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1.1 Overall Context

Kenya's vision, "Green Hydrogen for Sustainable Socio-Economic Development," underscores the country's commitment to leveraging its abundant renewable energy sources. This commitment aims to enhance agricultural production, industrialisation, and defossilisation through a phased and demand-driven approach, as outlined in the implementation plan, spanning Phase 1 (2023-2027) and Phase 2 (2028-2032).

1.1.1 Priority Actions for Success

To realise this vision, a series of priority actions have been identified under the national Green Hydrogen Strategy and Roadmap, which include the establishment of a high-level "green hydrogen Programme coordination committee" and a dedicated secretariat to serve as a "one-stop-shop." National Green Hydrogen roundtables on finance and green fertilisers, the development of a comprehensive strategy and roadmap, and the inclusion of provisions for green hydrogen in the national energy policy are integral steps. The support and fast-tracking of catalytic projects, such as those that produce nitrogen-based fertilisers, are critical milestones. Furthermore, expanding regional and international cooperation and partnerships, along with comprehensive stakeholder engagement and communication plans, will be pivotal in scaling up training and capacity building efforts.

1.1.2 Hydrogen Use Cases for Kenya

PtX's versatility opens up various use cases in Kenya, including ammonia for fertiliser production, methanol production, transportation, green steel production, and

1.2 Aim and Scope

This study aims to conduct a comprehensive capacity needs assessment with the overarching objective of pinpointing the precise technical, managerial, and other skill sets required within Kenya to bolster the development of PtX and its derivatives, including green hydrogen, ammonia, and methanol. This assessment will encompass both short and long-term perspectives and will address existing gaps and barriers in the education sector across various sectors such as energy, agriculture, and industry.

These applications demonstrate the breadth of opportunities that green hydrogen offers, aligning with Kenya's developmental priorities and the global transition towards a sustainable and carbon-neutral future.

Kenya stands at the threshold of a transformative journey towards green hydrogen and PtX adoption. With its abundant renewable energy resources (IRENA, 2023) and a clear strategy, Kenya is positioned to harness the potential of PtX to drive economic growth, enhance food security, and contribute to global sustainability efforts. This study aims to assess capacity needs and gaps in Kenya's green hydrogen and PtX sector, providing valuable insights to propel the nation towards a more sustainable and prosperous future.

In addition to the broader goals and strategies outlined in Kenya's national green hydrogen strategy, a crucial aspect of achieving success in the green hydrogen and PtX sector lies in skills development. The development of a skilled workforce and expertise across various stages of the value chain is fundamental to realising the full potential of PtX in Kenya. Here, we delve into the importance of skills development and capacity building for each stage of the PtX value chain.

Skills development and capacity building are integral components of Kenya's green hydrogen strategy. A well-trained workforce, equipped with the knowledge and expertise needed at each stage of the value chain, will drive innovation, ensure safety, and maximise the socioeconomic benefits of green hydrogen adoption. By investing in skills development, Kenya can position itself as a leader in the emerging PtX industry and contribute to its sustainable growth and development.

Additionally, the study will recommend a human capacity development Programmes along with measures to be undertaken by diverse stakeholders, across the green hydrogen (GH2) and green ammonia (GNH3) value chains in the country.

Kenya's commitment to green hydrogen for sustainable socio-economic development emphasises the crucial role of skills development in driving innovation and maximising the benefits of green hydrogen adoption.

By enabling the production of ammonia through green hydrogen, Kenya can secure a sustainable source of fertiliser to bolster stable agricultural production. Ultimately, the study aims to offer valuable insights and actionable recommendations to guide policy formulation, investment decisions, and education and training strategies, thereby accelerating the growth of Kenya's hydrogen, ammonia, and PtX economy while gathering local support for green hydrogen and PtX investments by underscoring their social and economic benefits for the Kenyan people.

Outside the scope of this study:

Outside of scope is a quantitative analysis of job demands, the identification of jobs and skills in parallel industries or sectors, and an analysis of indirect and induced jobs (however, indicative estimations are provided in chapter 2).

1.3 Methodology

This study includes 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 programmes.

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 Kenya´s PtX sector. Understanding the stakeholders and their respective interests, roles, and capabilities is essential for realising the collaborative efforts and partnerships required for successful skills development.

For the **assessment of capacity needs and related skills gaps**, a multifaceted approach was employed, incorporating focused group discussions (FGDs), bilateral interviews, and online surveys. These interactions were instrumental in gathering insights from relevant stakeholders representing diverse backgrounds, including the public sector, private sector, and academia, encompassing both higher education and Technical and Vocational Education and Training (TVET) institutions.

To provide a holistic understanding, three FGDs were facilitated, and four bilateral interviews were conducted, including an insightful site visit to Kenya's sole GH2 production facility to date. Additionally, online surveys were distributed to 44 stakeholders, gathering valuable responses from 11 entities that contribute significantly to the analysis (Annex 04).

The results and recommendations serve as **the basis for elaborating a human capacity development programme or roadmap** for Kenya´s PtX industry.

The analysis of the online survey results are depicted in Annex 08.

Stakeholder Mapping

The **key stakeholders** for this study were first categorised as the demand side stakeholders who require the skills, who in general were the private sector companies and public sector institutions. On the skills' supply side, Kenya's tertiary education sector was analysed with regards to gaps and the status of the existing workforce for PtX skills.

The identified stakeholders were further mapped as key, primary and secondary stakeholders. The key stakeholders are the most relevant to the skills development required in the PtX sector. The primary stakeholders are influential in having the PtX sector develop. The secondary stakeholders are those who interact with the PtX sector.

The stakeholders who participated in this work through the focussed group discussions, bilateral interviews and the survey are as listed below.

Private Sector

- Capstone Hydrogen Energy
- Dongo Kundu Energy
- EDF
- Electric Sector Association of Kenya (ESAK)
- EmoruHydrogen LLP
- Enterprise Eslunia
- Kenya Airways
- Siemens Energy
- Sowitec/KEPSA (GH2 Working Group)
- Talus Renewables
- Tana Viridis
- WTS Energy

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Education Sector

- Institute of Energy Studies & Research
- Jomo Kenyatta University of Agriculture and Technology (JKUAT)
- Kenya Industrial Research and Development Institute (KIRDI)
- Kenyatta University
- Machakos University
- Moi University
- Muranga University of Technology
- Save Tek
- Strathmore University
- Technical University Kenya
- Technical University Kenya (TUK & HSRM)
- The University of Nairobi
- TVET Curriculum Development Assessment and Certification Council (TVET CDACC)
- University Eldoret

Public Sector

- Energy and Petroleum Regulatory Authority (EPRA)
- Geothermal Development Company (GDC)
- Kenya Bureau of Standards (KEBS)
- Kenya Civil Aviation Authority (KCAA)
- Kenya Electricity Generating Company (KenGen)
- Kenya Electricity Transmission Company (KETRACO)
- Kenya Maritime Authority (KMA)
- Kenya Ports Authority (KPA)
- Ministry of Agriculture and Livestock Development
- Ministry of Energy and Petroleum (MoEP)
- Ministry of Water, Sanitation and Irrigation (MWSI)
- Mechanical and Transport Division
- Rural Electrification and Renewable Energy Corporation (REREC)

For further information on key, primary and secondary stakeholders, please refer to the stakeholder mapping in Annex 05

1.4 Planned Private Sector PtX Projects in Kenya and Training Initiatives

Despite Kenya´s high potential in green hydrogen production and PtX applications, few projects are yet known to be in the planning phase. This report lists projects in planning that are published. Potentially, further projects are foreseen but not publicly announced due to disclosure or competitive reasons.

The following projects were available at the time of research (Ministry of Energy and Petroleum, 2022):

- **Modular Fertiliser plant:**
  The Kenya Nut Company has partnered with the US startup TalusAg, a leading green ammonia technology provider, to introduce the world's first commercial modular green ammonia system. This collaboration already produces reliable and sustainable fertiliser, offering potential benefits such as reduced costs, improved predictability, and a noteworthy decrease in GHG emissions. It is Kenya´s first farm to produce Fossil-Fuel free fertiliser on site. The plant located in Naivasha uses solar power for the electrolysis process of splitting water to hydrogen and oxygen. The hydrogen bonds with nitrogen in the air to form liquid ammonia. Both companies are working based on a supply agreement of 15 years of 1 ton of ammonia every day, which is be applied to crops as fertiliser. (Talus, 2023)
- **Power-to-fertiliser plant:**
  Maire Tecnimont S.p.A. signed an NDA with the Oserian Development Company (owner and operator of Two Lakes industrial park) to run a Power-to-fertiliser plant. The Italian company Maire aims at producing Calcium Ammonium Nitrate or NPK fertiliser from geothermal and PV sources. Start of construction is expected to be 2025.

- **Green hydrogen and ammonia project:**
  The Australian green energy company Fortescue Future Industries (FFI) signed a Framework Agreement with the government during COP27 for the potential development of an integrated large-scale green hydrogen and ammonia production facility, which would be powered by electricity from geothermal resources in Olkaria.

- **Research and development project:**
  Strathmore University's Energy Research Centre (SERC) together with the research project Steamology are currently planning a R&D demonstration project on zero-emission energy generation and storage technology. The UK technology development company SERC specialises in utilising steam to generate electricity.
  The Water to Water (W2W) system uses renewable energy for electrolysis, splitting water into hydrogen and oxygen gases. These gases can be recombined on demand to produce steam, regenerating electricity. This versatile solution can replace traditional batteries, serving in off-grid electricity generation and as a backup to diesel generators. The modular design allows scalable, large-scale storage, with the system capable of producing up to 1MW of power.

  The University together with Curtin University and Griffith University have also launched the Africa Green Hydrogen Hub (AGHH) to serve as case study for innovation, knowledge dissemination and strategic partnerships in harnessing the potential of green hydrogen.

- **Green Hydrogen facility:**
  Dubai-based renewable energy firm, AMEA Power, has unveiled ambitious plans to construct a green hydrogen facility at the port of Mombasa, Kenya. The 1 GW electrolyzer plant will produce hydrogen from geothermal energy produced inland. The suitable planned location at the Mombasa part is a good gateway for hydrogen exports (energynews, 2023)

- **Long-term hydrogen-based storage**:
  The French independent power producer HDF is known for pioneer hydrogen infrastructure and high-power fuel cells projects. The storage planned will be located at the coastal region with a planned capacity of 180MW from solar PV and 500MWh of long-term hydrogen-based storage with an estimated investment of 500mio USD. Hydrogen will be stored and used to generate electricity on-demand using proprietary multi-megawatt fuel cells to distribute power to regions without access to hydropower and geothermal energy (energynews II, 2023). By this, the plant will ensure uninterrupted power supply. The plant is also able to deliver grid stabilising services. (See Annex 08)

- **Sustainable Aviation Fuel:**
  Emoru Hydrogen LLP is a green hydrogen development partner in Lomaro hydrogen company. The company seeks to produce green hydrogen based sustainable aviation fuel (SAF) in Samburu, Kenya. The company plans to use a mix of renewable energy sources including, 200 MW wind and 1000 MW solar PV to generate green hydrogen by 2030. Water will be sourced through the innovative atmospheric water harvesting. As SAF requires carbon dioxide, the company plans to use direct air capture (DAC) technology to obtain the required CO_2. The project is in early-stage development, but on actualisation, the company intends to generate about 150,000 tonnes of SAF in phase 1 which is to be expanded to 600,000 tonnes in phase 2.

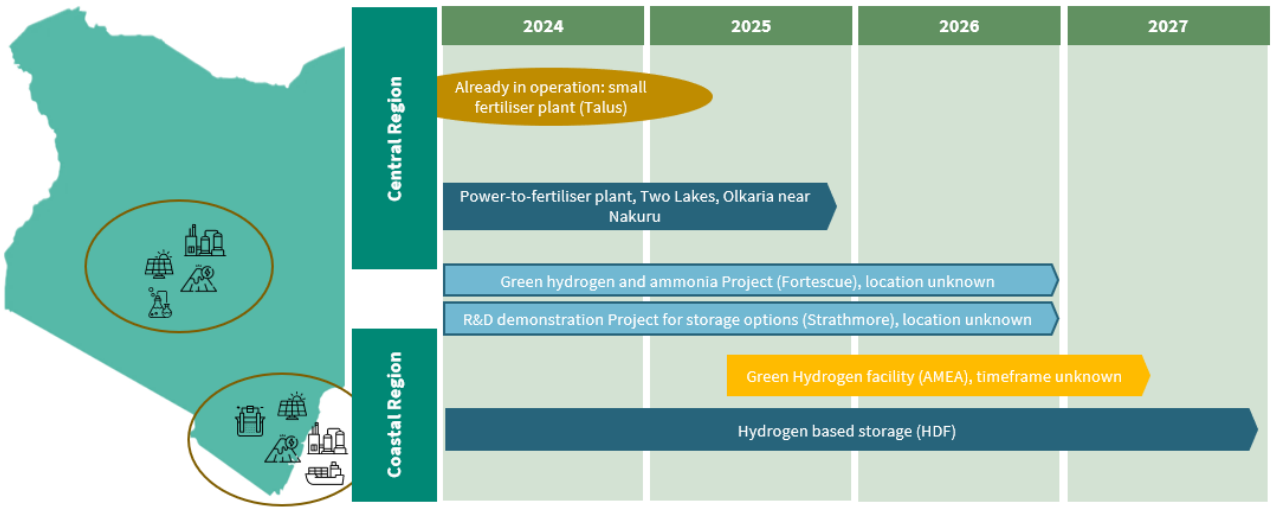

Figure 1: Planed PtX projects in Kenya's green hydrogen regions and their approximate construction timelines

It is not known whether the private sector companies mentioned above are planning capacity building activities. During the conducted structured discussions and stakeholder interviews public institutions (Strathmore, Fortescue) highlighted planned training activities.

It is recommendable that the private sector companies will conduct studies to assess their PtX jobs and skills demands during the planning stages of their projects.

The following events and training initiatives did take place:

- **Renewable PtX Training in Kenya** (2022 - 2023) organised by the International PtX Hub on creating awareness on the fundamentals of PtX technologies, sustainability, economics, and related policies. Aviation and shipping specific trainings were organised by the International PtX Hub to train relevant stakeholders in these on the role of PtX in defossilising the shipping and aviation sectors. The International PtX Hub has carried out three trainings for public and private sector including academia. There have been several workshops by International PtX Hub on green hydrogen where discussions and exchanges on this topic for accelerated GH2 deployment were discussed. This included the Green Hydrogen Symposium and the Sustainable Aviation Fuel (SAF) workshops.
- **German Training Week** (2023) organised by Project Development Programmes for Green Hydrogen (PDP H2) on creating awareness on the fundamentals of PtX technologies, sustainability, economics, and related policies. The focus of the training was for the private sector.
- **Africa Climate Summit, Nairobi, Kenya** during the Africa Green Hydrogen Forum on 5 September 2023. The forum brought together approximately 200 senior representatives from governments, industry, and civil society to articulate financing targets and mobilise commitments to achieve a speedy, sustainable, and transparent renewable energy and green hydrogen industry scale-up. As part of the summit the Green Hydrogen Strategy and Roadmap was developed and released for Kenya.

Project Database for GH2/PtX in Kenya

According to the DRAFT "Green Hydrogen Guidelines" published by EPRA in May 2024, "[t]he Ministry of Energy and Petroleum shall maintain and publish a register of projects approved under these guidelines on its website".

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

Estimated jobs according to own calculation under the assumption of MW size of electrolyser while considering one off and recurrent labour demand under the classification from CE Delft Study.[i]

Project owner	Location	Project activities	Estimated number of jobs	PtX end use	Timeline
The Kenya Nut Company and Talus AG	Nairobi	Solar power used to produce hydrogen and nitrogen that bonds in the air to form liquid ammonia	23	1 tonne of ammonia/ day to be used as fertiliser for agriculture of The Kenya Nut Company	Already implemented, supply agreement for the next 15 years
Maire Tecnimont and The Oserian Development Company	Two lakes industrial park btw. Nairobi and Nakuru	RE power-to-fertiliser plant (100MW geothermal and PV energy will produce 200,000t nitrogen fertiliser)	More than 300	Calcium Ammonium Nitrate or NPK fertiliser for national agriculture	2025
Fortescue Future Industries	tbd	Green hydrogen and ammonia project, 300 MW	approx. 500	Green hydrogen and ammonia, fertiliser for the national market	2025/26
Strathmore Energy Research Centre (SERC) and research project Steamology	tbd	Research and development demonstration project on zero-emission energy generation and storage technology	Not indicated	Steam for electricity to serve as storage option, replacing traditional (diesel) batteries of 1MW	tbd
AMEA Power	Port of Mombasa	Green hydrogen facility with 1 GW electrolyser will produce hydrogen from geothermal energy , hydrogen exports; 800,000 t of green ammonia	2,880	Hydrogen for exports; 800,000 t of green ammonia	tbd
HDF	Coastal region	A long-term hydrogen-based storage with capacity of 180MW from solar PV and 500MWh of long-term hydrogen-based storage	Direct jobs during development phase are limited and require main skills sets: Business and project development, engineering (design), legal & finance. Construction phase: direct jobs = 542; indirect = 813 Operations phase: direct jobs = 81; indirect = 122	Hydrogen based storage from solar PV	implementation planned towards financial close of 2026 project start: April 2028 project end: April 2048

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

2 SKILLS NEEDS ASSESSMENT

This skills needs assessment aims to identify jobs and skills along the PtX value chain that Kenya 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 Kenyan workforce and support the development of a skilled workforce in the PtX economy.

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1.5 PtX Value Chain

The Power-to-X value chain describes the series of steps from producing and distributing hydrogen and its derivatives, like ammonia and synthetic fuels, to their ultimate use in various PtX applications. This includes upstream activities, which cover the production and storage of green hydrogen, and downstream activities, focusing on the consumption of these energy sources.

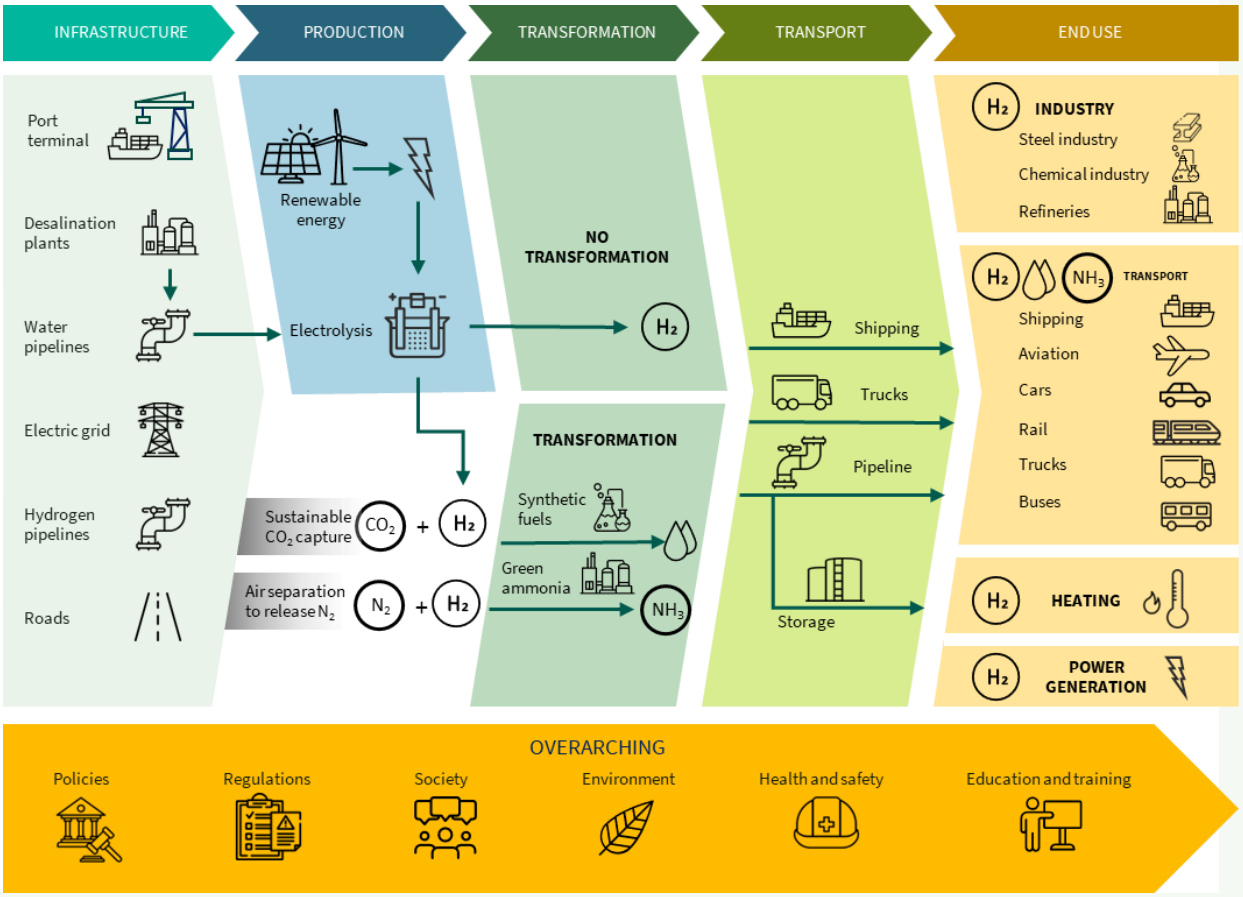

Figure 2: PtX value chain, adapted and modified from IRENA (2020), Green Hydrogen: A guide to policy making, International Renewable Energy Agency, Abu Dhabi

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The study breaks down the Power-to-X value chain into six key phases:

1. Infrastructure

This phase includes the creation of essential infrastructure needed for the PtX development in general, such as desalination plants, water and hydrogen pipelines, grid extensions, roads, and deep-sea port terminals for ammonia ship transport. As planned renewable energy and PtX production projects dwarf existing energy generation facilities, a massive expansion of infrastructure will be required. It emphasises the importance of seamlessly integrating new PtX technologies with existing infrastructure.

2. Production

This stage is centred on producing green hydrogen through electrolysis, powered by electricity from wind and solar parks, and utilising water from newly established desalination plants.

3. Transformation

During the transformation phase, the focus is on converting hydrogen into ammonia by adding nitrogen extracted from the air. The long-term vision includes the

production of synthetic fuels by incorporating sustainably captured CO_2.

4. Storage and Transportation
This phase examines hydrogen storage and its distribution via pipelines, ships or tanker trucks, along with the storage and shipment of hydrogen derivatives like ammonia, focusing particularly on ammonia's exportation.

5. End use
In the short term, PtX applications in Kenya are the use of ammonia for exports, fertiliser production, powering locomotives, and tugboats, and producing green steel. Looking ahead, the plan extends to manufacturing carbon-based synthetic fuels and green steel, opening up additional industrial opportunities.

6. Overarching
Overarching considerations encompass the broader factors affecting the value chain, such as policy and regulation, social and environmental impacts, health and safety standards, and the need for targeted education and training programmes.

1.6 Jobs and Skills Demands along the PtX Value Chain

As the PtX markets in Kenya 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.

Figure 3: Project phases from planning and design through to construction and, finally, operation (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:

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.

- Green hydrogen production (PV, wind geothermal, battery storage, electrolysis)
- Green hydrogen compression, storage and transportation
- Green ammonia production
- Aviation Industry (Sustainable Aviation Fuels)
- Maritime Industry (Sustainable Marine Fuels)

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 07 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**.

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

Photovoltaics (PV)

As of December 2023, Kenya had a solar PV installed capacity of 410.4 megawatts, which was about 11.76% of the total installed capacity (EPRA, 2024). This included 210.3 megawatts of grid-interconnected capacity, 196.2 megawatts of captive capacity, and 3.9 megawatts of off-grid capacity. Captive power generation can be defined as production exceeding one megawatt consumed by the generator itself rather than sold to a third party, accounted for the latter.

Strategic planning and efficient installation processes have been key to Kenya's success in establishing solar PV plants. Thorough feasibility studies and adherence to international standards ensure sustainable development and seamless integration into the national grid. (KENPRO, 2023).

Ongoing monitoring and maintenance efforts, coupled with community involvement, ensure optimal performance and longevity of PV plants, contributing to Kenya's energy security and environmental goals (IRENA, 2023).

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: : Estimated workforce demand for a 50 MW utility-scale PV plant 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
	Workforce Demand [Person-days/year for 50 MW]	**Workforce Demand [Persons per year for 50 MW]**	**Employment Factor [jobs/MW]**
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

Kenya has a substantial wind energy installed capacity. As of December 2023, Kenya's wind power generation installed capacity was 436.1 megawatts, accounting for 12.5% of the total installed capacity (EPRA, 2024). The nation has made significant investments in wind energy, exemplified by the inauguration of the Lake Turkana Wind Power Plant in 2019, recognised as Africa's largest wind power project. Other plants include Kipeto Wind Farm and Ngong Wind.

Kenya's success in wind power stems from meticulous planning and efficient installation processes. Thorough feasibility studies and adherence to regulations ensure optimal site selection and reliable turbine installation. (International Trade Administration, 2023).

Ongoing monitoring and maintenance efforts ensure the smooth operation and performance optimisation of wind power plants. Community involvement fosters economic development and social cohesion (IRENA, 2023).

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: Estimated workforce demand for a 50 MW utility scale onshore wind plant 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
	Workforce Demand [Person-days/year for 50 MW]	**Workforce Demand [Persons per year for 50 MW]**	**Employment Factor [jobs/MW]**
Operation & Maintenance	2665	10	0.21

Geothermal

Kenya boasts of a significant geothermal installed capacity, showcasing its leadership in renewable energy. As of December 2023, Kenya registered an installed capacity to generate 943.7 megawatts of electricity from geothermal energy (EPRA, 2024).Accurate planning and skilled professionals drive Kenya's success in geothermal energy. Feasibility studies and environmental assessments ensure sustainable development.Skilled personnel maintain and monitor geothermal plants, emphasising community engagement for positive impacts.

The demand for skilled workers in the geothermal energy sector spans various project phases. From planning to operation, professionals like engineers, geoscientists, and social experts are needed. During construction, there is a surge in job opportunities, with up to 400 subcontractors and craftspeople involved in peak times for a 50 MW plant. Once operational, ongoing employment is provided for maintenance technicians, engineers, and site operators, ensuring the sustainability of the workforce (KenGen, 2024), (EPRA, 2024).

Oserian's evolution from a small vegetable farm to a robust utility in Kenya's Nakuru County, leveraging geothermal heat for greenhouse operations, has driven substantial economic growth and diversification. By tapping into geothermal heat in 2000, Oserian expanded rapidly, In 2004, the company developed the first wellhead plant in the country and developed a second wellhead plant in 2007. The two wellhead plants have a combined capacity of 3.2 megawatts (ESMAP World Bank, 2023). *In 2018, the company also added 1 MW of solar PV to its mini grid. By the time the company sold its rose operations covering over 100 hectares of greenhouse space in 2021, the company employed 3,000 people in the greenhouses, and 25 individuals dedicated to plant operation and maintenance* (ESMAP World Bank, 2023). *This transformation underscores the significant impact of geothermal energy on job creation and industrial development in the region.*

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 (Ministry of Energy and Petroleum, 2022).

Electrolysers

Kenya envisions a strategic expansion of its electrolyser capacity, with plans to install 100 MW between 2023 and 2027, followed by a significant increase to 150-250 MW between 2028 and 2032. This ambitious initiative aims to generate at least 25,000 direct jobs by 2032 in the entire PtX value chain. In the initial phase, Kenya aims to have the first commercial-scale green hydrogen projects operational by 2027, achieving 100 MW of installed electrolyser capacity. This capacity could facilitate the production of 100,000 tons per year of nitrogen fertilisers, potentially replacing approximately 20% of Kenya's current fertiliser imports. Subsequently, in the second phase spanning from 2028 to 2032, Kenya targets expanding its installed electrolyser capacity to 150-250 MW, with the objective of increasing domestic fertiliser production to up to 400,000 tons per year. (Ministry of Energy and Petroleum, 2023)

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”.

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Table 4: Jobs and skills for green hydrogen production (including PV, wind, geothermal, battery, electrolyser plants) mapped along the project phases (Queensland Government, 2022)

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, wind, geothermal 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* **Quartermasters, 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**

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**

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

The transportation of hydrogen can be done through pipelines, specialised tanker trucks or via ships. For pipeline transport, hydrogen is highly compressed (of 100-900 bar, as compared to natural gas with 30-100 bar) and sent through dedicated pipelines to reach distribution points or consumers. Tanker truck transport requires compressing or liquefying hydrogen at extremely low temperatures (-253°C) before it is transported. Similarly, ships can transport hydrogen, often by liquefying it at low temperatures and loading it onto specially designed vessels equipped to handle the unique challenges of transporting this volatile substance. All these methods necessitate storage and transportation equipment designed to handle high pressures and low temperatures, equipped with safety mechanisms for hydrogen's safe release if needed.

Key safety considerations include:

- Hydrogen's high flammability necessitates measures to prevent and manage fires and explosions.
- Its low molecular weight makes hydrogen hard to contain, and leaks challenging to detect, requiring robust detection and mitigation systems.
- Hydrogen can cause certain metals to become brittle, potentially leading to material failure. It is crucial to use hydrogen-compatible materials, adhere to testing standards, and have skilled personnel to identify and address potential issues.

International safety 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.

The complexity and safety considerations of hydrogen systems demand highly skilled professionals for their design, installation, operation, maintenance, and inspection. This includes engineers, pipefitters, gas inspectors, and safety and quality control personnel, all of whom must have extensive training in hydrogen safety and standards. Internationally recognised training programmes, such as those offered by TÜV Süd, already offer courses on hydrogen safety and may play a crucial role in preparing the workforce for handling hydrogen safely (Green Skills for Hydrogen, 2022).

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* **Quartermasters, 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 other engineer**
			Perform facility and pipeline inspection at intervals **Instrumentation technicians, engineering inspectors**
			Perform plant inspections at intervals **Engineering inspectors**

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1.6.3 Jobs and Skills Demand in Green Ammonia Production

Green ammonia production primarily relies on the Haber-Bosch process, which begins with extracting nitrogen from the air using an air separation unit. This nitrogen is then combined with hydrogen, and the mixture reacts over a catalyst under high pressure and temperature to produce ammonia. Key components of a green ammonia plant include compressors, which boost gas pressures; heat exchangers, designed to dissipate excess heat from the chemical reaction; separation units, tasked with isolating ammonia gas from any residual hydrogen or nitrogen; and condensers, which cool and condense unreacted gases or by-products. Additionally, the facility comprises storage tanks for the resulting ammonia, along with essential utilities like cooling water systems, power supply mechanisms, and instrument and control systems for efficient operation. The design and construction of these plants are a collaborative effort involving industrial process engineers, who layout the plant, industrial piping engineers, who plan the process piping, and industrial pipefitters, who carry out the primary installation tasks (Queensland Government, 2022).

Furthermore, ammonia transportation, especially for exportation, often involves ships. Therefore, capacities required at the ports during bunkering need to be considered. Ships play a vital role in transporting ammonia to various destinations, necessitating appropriate infrastructure and logistics support at ports.

The first operating plant in Kenya aims to produce 10 tonnes of ammonia fertiliser per day, requiring 11.5 MW of solar power input. This results in 23 FTE jobs, with 16.5 in construction, and 6.5 in operation and maintenance. (RENAC, 2024).)

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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, chemical and process 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* **Quartermasters, 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, chemical and process 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**	

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1.6.4 Jobs and Skills Demand in the Aviation Industry (Sustainable Aviation Fuels)

The pressing demand for sustainable aviation fuels is not only transforming the energy landscape but also creating significant employment opportunities. A study on the employment impact of a commercial-scale SAF production facility underscores this trend. On average, such a facility generates 2,210 jobs during the construction phase and sustains 1,440 ongoing jobs once operational. (Rhodium Group, 2023) These positions span a diverse spectrum of professions, encompassing construction trades, engineering roles, agricultural workers, and various business operations. The demand for skilled labour in areas such as construction, metalworking, engineering, executive management, and machinery maintenance underscores the multifaceted nature of job opportunities within the sustainable aviation fuels sector (International PtX Hub, 2022).

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Table 7: Jobs and skills for sustainable aviation fuels mapped along the project phases

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform planning, approvals and compliance processes **Project developers, planners, regulators**	*Organising shipments of feedstocks and SAF products via maritime routes, if applicable* **Shipping coordinators**	*Designing and overseeing the construction of infrastructure, such as production facilities and storage tanks, installing and maintaining equipment used in SAF production* **Mechanical, civil engineers**	*Monitoring and controlling the SAF production process to ensure efficiency and quality* **Plant operators**
Ensure compliance with safety and environmental regulations, permitting and other standards **Regulators, inspectors**	*Coordinating the transportation of raw materials and products to and from the SAF production facility* **Logistics personnel**	*Wiring and installing electrical systems within production facilities* **Electricians** *Fabricating and welding metal structures and components* **Welders** *Installing and connecting piping systems for the transportation of feedstocks and SAF products* **Pipefitters**	*Conducting routine maintenance and repairs on equipment and machinery* **Maintenance technicians** *Calibrating and maintaining instrumentation systems used in SAF production* **Instrumentation technicians** *Testing SAF products for quality and purity to meet industry standards* **Quality control inspectors**
Perform preliminary design and optimisation of the SAF production process **Chemical and process engineers**	*Transporting feedstocks and finished SAF products between suppliers, production facilities, and distribution centres* **Quartermasters, Truck drivers**	*Oversee green methanol plant construction and installation, supervising construction activities and ensuring adherence to safety and quality standards* **Construction manager**	*Implementing safety protocols and ensuring compliance with environmental regulations during operation* **Environmental, health and safety specialists**
		Conducting inspections to ensure compliance with safety regulations during construction **Safety inspectors**	*Overseeing day-to-day operations, scheduling maintenance activities, and managing personnel* **Facility managers**

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1.6.5 Jobs and Skills Demand in the Maritime Industry (Sustainable Marine Fuels)

In the coming years, the development of renewable methanol and ammonia projects will drive demand for skilled professionals and fuel industrial growth within the maritime sector. This growth will create job opportunities across sectors like research, manufacturing, and operations along the renewable methanol and ammonia value chains. In Kenya's maritime sector, skilled experts in engineering, renewable energy, and project management will be crucial for designing, developing, and optimising production facilities. Additionally, specialists in material science, logistics, and regulatory compliance will be needed to integrate sustainable fuels such as methanol and ammonia into shipping operations and ensure adherence to cleaner energy standards (GIZ, 2022), (Maritime Just Transition Task Force, 2022).

Furthermore, ammonia presents a promising avenue in the transport sector, particularly for shipping. In Kenya, current methanol projects primarily focus on cooking fuels; however, opportunities for methanol and ammonia as shipping fuels are on the rise (Yara Clean Ammonia, 2023).

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Table 8: Jobs and skills for sustainable marine fuels mapped along the project phases

Planning & Design	Transportation	Construction & Installation	Operation & Maintenance
Perform planning, approvals and compliance processes **Project developers, planners, regulators**	*Coordinating the transportation of sustainable marine fuels from production facilities to ports and onboard vessels* **Logistics personnel**	*Supervising construction activities and ensuring adherence to safety and quality standards during vessel construction or retrofitting* **Shipyard managers**	*Operating and maintaining propulsion systems and machinery powered by sustainable marine fuels* **Marine engineers** *Conducting routine maintenance and repairs on engines and fuel systems onboard vessels* **Engine technicians** *Managing onboard fuel storage and handling systems to ensure safe and efficient fuel usage* **Fuel technicians**
Designing vessels optimised for the use of sustainable marine fuels **Naval architects** *Developing propulsion systems and machinery compatible with alternative fuels* **Marine engineers**	*Providing bunkering services for vessels to refuel with sustainable marine fuels at ports, ensuring the safe and efficient transfer of fuel from storage facilities to vessels* **Bunker suppliers**	*Constructing and assembling vessel structures and components designed for sustainable marine fuel use* **Welders and fabricators** *Installing and integrating electrical systems optimised for alternative fuel propulsion* **Marine electricians** *Installing and connecting fuel delivery systems onboard vessels* **Pipefitters**	*Overseeing vessel operations, scheduling maintenance activities, and managing personnel to ensure the efficient and sustainable use of marine fuels* **Fleet managers**
Assessing environmental impacts and ensuring compliance with regulations **Environmental engineers** *Incorporating sustainable practices into vessel design and fuel procurement plans* **Sustainability specialists**		*Conducting inspections to ensure compliance with safety regulations during construction and installation processes* **Safety inspectors**	*Testing fuel quality and purity to meet industry standards and regulatory requirements* **Quality control inspectors** *Implementing safety protocols and environmental management practices during fuel storage, handling, and combustion processes* **Environmental health & safety officers**

1.6.6 Jobs and Skills Demand in Infrastructure

While this study does not delve deeply into the indirect job roles and skill requirements associated with the infrastructure projects underpinning the Power-to-X sector, this section offers initial insights into the types of activities and employment opportunities these projects may generate. Key infrastructure components such as deep-water ports, desalination plants, power transmission lines, water pipelines, and roads will be explored.

Deep-Water Ports

A deep-water port consists of either a permanent or floating artificial structure designed to accommodate even the largest fully loaded ships. An example is the Port of Rotterdam, with a water depth of 20 meters. The essential elements of a deep sea port include a turning basin, which is a spacious water area within the port where ships can anchor and turn; an approach channel, serving as the water passage for ships to reach the turning basin; breakwaters, constructed offshore to protect the turning basin and entrance channel from waves, currents, and sediment buildup; berths, where vessels dock to load or unload; and quay walls, sturdy structures adjacent to the berths that support cargo handling devices like cranes and conveyor belts.

Constructing a deep-water port demands a fleet of vessels and machinery: dredgers to excavate the seabed, pile drivers for establishing foundations, crane ships for heavy lifting, tugboats for manoeuvring other vessels, as well as excavators and earthmoving machinery for land-based operations. Additionally, concrete mixers, pump trucks for concrete placement, jack-up barges for stable work platforms on water, and diving support vessels for underwater construction are indispensable in building the port's various components.

The Port of Mombasa serves as a bustling trading hub for the region, while the Port of Lamu, equipped with state-of-the-art infrastructure and deep-water capabilities, is poised to become a key component in the transportation of green hydrogen and ammonia, facilitating their export and import as maritime fuels, especially given its capacity to handle liquid bulk cargo, including Liquefied Natural Gas (LNG) and product oil. (Kenya Ports Authority, 2024)

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

Desalination facilities utilize the reverse osmosis technique, a process that eliminates salt and various contaminants from seawater by filtering it through multiple semi-permeable membranes. These plants are constructed from modular units, which are prefabricated elsewhere before being assembled at the intended site. The modular units are interconnected through an extensive network of pipework, which includes pipes, valves, and fittings, to facilitate the flow and treatment of seawater.

Since September 18, 2023, Mshomoroni in Mombasa County, Kenya, has benefited from a new solar-powered water desalination system installed by GivePower, enhancing water services for the community. Additionally, Almar Water Solutions is pioneering the development of Kenya's first large-capacity desalination plant in Mombasa's North Mainland area, with a capacity of 100,000 cubic meters per day, addressing water needs for over a million people and potentially providing sustainable water sources for the operation of green hydrogen and ammonia production facilities in the region. (co2balance, 2023)

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

Kenya is 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.

The adoption of a 20-year rolling plan in Kenya's electricity sub-sector, aimed at aligning with Vision targets, includes priority transmission projects identified by Kenya Electricity Transmission Company (KETRACO) to enhance power supply reliability and security, expand transmission capacity, and reduce technical losses. Among these projects is the construction of a 95km double-circuit 132KV transmission line from Kabarnet to Rumuruti, facilitating the interconnection efforts within the Eastern Africa Power Pool and supporting regional electricity integration initiatives such as the Lessos-Tororo, Eastern Electricity Highway, and Kenya-Tanzania Interconnector transmission lines. (EPRA, Power Transmission & Distribution System, 2024)

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, earthmoving plant and machinery operators, and general construction workers.

Water Supply Network

To transport water from desalination plants to electrolyser plants, as well as to provide water to local communities, a comprehensive water supply network is essential. This network will include water treatment facilities, pumping stations, water pipelines, valves, hydrants, and connections for end users. This infrastructure is crucial for ensuring the efficient movement and accessibility of water for industrial processes and community needs alike.

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 expected 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, Kenya´s roads will require rehabilitation and extension.

Jobs and Skills in Constructing Roads

Kenya´s 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.

1.6.7 Jobs and Skills Demand in Overarching Areas

This section examines the anticipated demand for skills within the regulatory, environmental, and social sectors. Analysing the needs for jobs and skills across these broader areas, allows a holistic view of the Power-to-X industry's influence and possibilities. This comprehensive perspective enables policymakers, stakeholders in the industry, and educational bodies to synchronise workforce development efforts with the wider objectives of adhering to regulations, ensuring environmental sustainability, and fulfilling social responsibilities within Kenya.

Regulatory Sector

Kenya is planning to introduce policies, legislation and regulations to ensure the right enabling environment for the green hydrogen and PtX economies.

EPRA has developed a draft on “Kenya ‘s Guidelines for Green Hydrogen and its Derivatives”.

The primary aim of these guidelines is to foster the growth of a green hydrogen economy within Kenya. The specific objectives include:

a) Establishing sustainability criteria for green hydrogen projects in Kenya;

b) Expediting the approval processes to encourage the development of green hydrogen and PtX projects in the country;

c) Encouraging the production and safe management of green hydrogen and its derivatives;

d) Generating employment opportunities through the advancement of a green hydrogen and PtX economy;

e) Advocating for adherence to relevant local and international standards, regulations, and industry best practices;

f) Establishing a framework for monitoring the progress of green hydrogen and PtX projects in Kenya; and

g) Facilitating capacity building, research, and development initiatives related to green hydrogen and its derivatives within Kenya. (EPRA, Kenya's Guidelines on Green Hydrogen and its Derivatives, 2024)

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

- **Green Hydrogen and PtX Technologies** for effective oversight and promotion of sustainable practices.
- **Environmental and Climate Science** necessary to assess the benefits and potential environmental impacts of green hydrogen and PtX technologies, especially in terms of defossilising the energy, transport, and industrial sectors.
- **Regulatory Incentives and Support Mechanisms** as well as carbon pricing, emissions standards, and renewable energy targets.
- **Economics and Financing** for evaluating the financial viability, pricing models, and cost-effectiveness of green hydrogen and PtX projects, including understanding financing options.
- **Market Dynamics**, competitive forces, and potential business models that could influence the PtX sector is critical for fostering a healthy market environment.
- **Technical Standards and Safety Regulations** related to green hydrogen production, storage, and distribution to ensure industry compliance and public safety.

Environmental Sector

The environmental sector focuses on the ecological effects of PtX operations. By evaluating the demand for jobs and skills within this domain, it is possible to identify positions associated with the environmental oversight, evaluation of sustainability, and the adoption of eco-friendly technologies, which helps align the sector with ecological objectives.

Experts in environmental and ecological sciences might find it advantageous to enhance their qualifications with additional knowledge and skills in:

- 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

PtX projects may have societal implications such as including community engagement, and equitable development. Reviewing the need for jobs and expertise in this field uncovers positions in maintaining community connections, involving stakeholders, and evaluating the social consequences, which encourages growth that benefits all sections of society.

When it comes to the social facets, representatives from diverse stakeholder groups—including industry professionals, academic and research entities, utility services, environmental agencies, community organisations, and businesses of varying sizes (from micro to medium)—would find it advantageous to possess enhanced skills in communication and negotiation. These competencies are vital for nurturing cooperative relationships and achieving consensus among all stakeholders.

1.6.8 Jobs and Skills Demand in Induced Jobs

Jobs created as a result of the spending by employees in direct and indirect positions are referred to as **induced jobs**. The hydrogen and PtX sectors offer the potential for such job creation in Kenya. While a detailed analysis of the number and nature of these induced jobs falls outside the scope of this study, the evident and substantial job demand merits attention to certain areas

likely to benefit both individuals and communities broadly.

Jobs in Housing Developments for an Expanding Workforce

As the focus on green hydrogen and PtX ventures intensifies in specific Kenyan regions, there is an expected population growth due to workers relocating for job opportunities. These individuals will require accommodation, leading to debates on the need for temporary versus permanent housing as part of a broader strategic development plan. This scenario opens avenues for embracing sustainable development practices in constructing housing and essential services like water and electricity supply, sewage systems, transportation infrastructure, and internet connectivity. A wide range of professionals from architects and city planners to construction company staff will need to be versed in sustainability practices.

Jobs in the Service Sector

The arrival of new workers will drive demand for various services, including accommodations, eateries, retail outlets, entertainment venues, personal care services, and healthcare facilities. This situation presents a prime opportunity for aspiring entrepreneurs, who will benefit from a grasp of business fundamentals, such as entrepreneurship, financial management, and marketing, along with knowledge on securing startup capital.

Jobs in Education and Health Care

The incoming workforce and their families will necessitate access to educational and healthcare services. This demand not only involves the initial design and construction of schools and healthcare facilities but also the staffing of these institutions with educators, medical professionals, and support staff.

Jobs in Public Transport

An increase in public transport staff, particularly bus drivers, will be essential to facilitate daily commutes for the growing workforce. Additionally, PtX project advancements may spur the creation of new enterprises and services that bolster public transport systems, including vehicle maintenance, cleaning services, ticketing solutions, and various administrative roles.

Additional 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 a Skills Needs Assessment and Gaps Analysis to Establish the Existing Qualifications and Skills of the Workforce and Where These Should be Supplemented with PtX-specific Skills

KENYA'S TERTIARY EDUCATION

The assessment of skills requirements and gaps analysis focuses on how well Kenya's educational framework, particularly its Technical Vocational Education and Training (TVET) and higher education programmes, matches the skills demands of the Power-to-X industry. This analysis looks into how these educational pathways align with the specific skill sets needed for the burgeoning green hydrogen and PtX sectors. It identifies the challenges and prospects within the educational system and proposes strategies for integrating the necessary skills for green hydrogen and PtX into the curriculum and training programmes.

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1.7 TVET Sector Overview: A Dynamic Framework for Skills Development

The effectiveness and flexibility of the education sector in Kenya will play a crucial role in shaping the country´s sustainable future by including the Technical and Vocational Education and Training (TVET) institutions and higher education (universities). This chapter explores Kenya´s TVET and higher educational landscape, assessing their pivotal contribution to preparing a skilled labour force for the nascent PtX sector. This review considers the range of apprenticeship models, practical training, and advanced educational courses designed around PtX technologies, shedding light on how both TVET and university sectors play a foundational role in nurturing a workforce adept at supporting the growth of these innovative industries in Kenya.

In Kenya, the emphasis on strengthening the TVET framework is seen as key to contributing to the labour market with the necessary skills. This focus on boosting the development of TVET competencies is driven by an understanding that this educational segment serves as a critical reservoir for the skills, knowledge, and technological expertise required to enhance productivity in both knowledge-driven and evolving societies. Consequently, the value of TVET is highlighted within the country's policy agendas, portraying it as a vital route for acquiring skills that are immediately applicable in the workforce and instrumental in laying the groundwork for widespread economic development.

KENYA 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.

1.7.1 Structure and Size

The TVET sector in Kenya operates under the supervision of key institutions, primarily the Technical and Vocational Education and Training Authority (TVETA) , the Technical and Vocational Education and Training Curriculum Development, Assessment and Certification Council (TVET CDACC) and the Ministry of Education. The National Industrial Training Authority (NITA) which is under the Ministry of Labour, offers industrial training from KNQF level 2 to 5 as well as short courses. These entities collectively ensure the effective management and development of the TVET sector. Within Kenya's educational landscape, TVET institutions are diverse, encompassing vocational training centres, technical training institutes, and polytechnics.

1.7.2 TVET Programmes Qualification Pathways

The TVET programmes in Kenya are thoroughly structured, offering a progression through different qualification levels. These levels include Artisan, Craft Certificate, Diploma, and Higher Diploma. This tiered approach allows students to choose qualification pathways aligned with their individual interests and career objectives. Whether aspiring to attain foundational skills as an artisan or pursuing advanced knowledge through a Higher Diploma, the TVET sector accommodates a spectrum of educational pathways.

1.7.3 TVET Qualification Programmes

Diverse and comprehensive, TVET institutions in Kenya provide an array of programmes spanning various fields. These fields include but are not limited to engineering, agriculture, business, health, and information technology. Whereas the existing programmes relate to a broad spectrum of industries, there is an increasing awareness of the emerging significance of Power-to-X technologies.

The TVET sector in Kenya is characterised by a well-organised structure managed by key educational authorities. Its diverse qualification pathways and extensive programmes offerings reflect a commitment to meeting the evolving needs of both students and industries. As the demand for skills in PtX grows, it becomes imperative to explore and enhance the alignment of TVET programmes with the dynamic requirements of this emerging sector.

1.7.4 TVET Qualification Programmes Relevant to PtX

To address the needs of the PtX sector, stakeholders should identify TVET programmes covering skills relevant to renewable energy, chemical and process engineering, and environmental studies. Moreover, they should seek specific courses or modules related to green hydrogen production and PtX technologies.

Note on Kenya'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**.

Post graduate diplomas degrees are classified at **NQF Level 8**.

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

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

Kenya is transitioning its TVET education system to the Competence-Based Education and Training (CBET). The education system focuses on acquiring competence to meet industry demands, ensuring individuals perform to employment standards consistently. It emphasises achieving high-quality performance crucial for industry success, defining general competence as the ability to adhere to set standards and transfer skills across various occupational contexts. **Error! Reference source not found.** summarises typical PtX-relevant programmes on offer in Kenyan TVETs. As of 2022, the TVET CDACC had more than 200 TVETs registered to offer CBET courses in occupations relevant for PtX demand.

Table 9: PtX-relevant TVET programmes offered at Levels 3-6 approved by TVET CDACC

No.	Programmes	No. of KNQF accredited institutions				Approved enrolment
		Level 3	Level 4	Level 5	Level 6	
1	Air Conditioning and Refrigeration		3	7	3	110
2	Electrical installation	20	21	28	15	1701
3	Electronics	1	2	2	3	150
4	Electrical Engineering (power)			8	12	245
5	Instrumentation & Control		7	5	4	320
6	Electrical (operations)			5		50
7	Oil pipeline instrumentation and control			5		75
8	Masonry	20	10			700
9	Construction Management			1	2	20
10	Building Technician		4		14	310
11	Plumbing	20	10	2		710
12	Mechanical production	1	6	2	3	210
13	Mechanical heavy and light machinery operations	2				20
14	Welding	1	18	10	8	705
15	Solar PV installation	6	2	1		230
16	Carpentry and Joinery		5	3		120
17	Mechanical technology and maintenance				3	75

1.7.5 Available TVET Workforce

The TVET Act of 2013 classified TVET institutions into Vocational Training Centres (VTC), Technical and Vocational Colleges (TVC), National Polytechnics (NP), and the Technical Trainers College (now known as Kenya School of TVET). The number of TVET institutions has steadily risen from 1,769 in 2018 to 2,401 in 2022 as depicted in Table 11.

Table 10: Number of TVETs in Kenya (KNBS, 2023)

TVET	2018	2019	2020	2021	2022
Public Vocational Training Centres	982	1,149	1,156	1,031	1,051
Private Vocational Training Centres	47	47	83	88	88
Public Technical and Vocational Colleges	101	191	230	255	277
Private Technical and Vocational Colleges	628	742	820	885	973
National Polytechnics	11	11	12	12	12
Total	**1,769**	**2,140**	**2,301**	**2,271**	**2,401**

The report of the Presidential Working Party on Education Reform indicates that there was a 250% increase in enrolment in TVETs in Kenya between 2017 to 2021. However, this surge in enrolment was not met with a proportional increase in the recruitment of trainers.

As of 2023, there were only 6,205 trainers in public TVET institutions under the Ministry of Education, serving a student population of 318,179. According to the TVET Accreditation Handbook of 2021, the recommended trainer-to-trainee ratio for STEM and business-related courses is 1:20 and 1:30 respectively. This indicates a need for 15,022 trainers in TVET institutions under the Ministry of Education for effective curriculum implementation. Hence, there is a deficit of 8,817 trainers.

1.7.6 Opportunities for TVET in PtX Job Markets

Kenya's TVET sector is relatively well positioned to support the PtX industry especially with the country transitioning to the CBET education system.

Through research and consultation with various stakeholders, the following opportunities were identified:

Creation of Jobs for Unemployed TVET Graduates

To combat youth unemployment, closing the gap between educational institutions and industry demands has emerged as a critical focus. Currently, there exists a substantial disparity between the skills imparted by training institutions and those sought after by industries. However, the country is addressing it by transitioning to CBET and specifically developing industry-oriented competency-based curricula and conducting assessments based on competencies.

This is anticipated to cure the past flaw whereby TVET graduates lacked the requisite skills demanded by various industries.

Kenya's Green Hydrogen Strategy and Roadmap anticipates that investing in the PtX and associated sectors could stimulate economic growth and job creation from manufacturing to research and development.

Given that the PtX sector is new in Kenya, the country needs to set up a framework for TVET graduates quantifying those who need upskilling and reskilling to enter the industry.

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

Kenya has more than 200 TVET institutions registered to offer CBET trainings whereas NITA has 5 training centres for offering industrial training. These institutions could potentially offer PtX training as the industry evolves. NITA is also responsible for administration of industrial training levy, which is paid monthly by employers to support the cost of training employees. The levy could offer a suitable route to support upskilling of employees with PtX skills in industries that venture into this sector.

Partnerships and Collaboration

A survey by the Federation of Kenya Employers (FKE) indicated that the technical skills in highest demand include electrical, masonry, plumbing and plant operations. Already companies have plans to make their products more sustainably and environmentally friendly. There is therefore a huge opportunity for TVETs to collaborate with the industry to meet the demand for these skills. This collaboration should also include the PtX industries to help and upskill the trainers with the requisite PtX skills. The government in collaboration with GIZ is developing dual TVET system aimed at minimising the job skills mismatch. The programmes combines instructions and industry exposure with a student splitting their time evenly between a TVET institution and an industry.

The collaboration should also include partnerships outside Kenya to speed up skills transfer. For example, the International PtX hub, hosted by GIZ, has been conducting capacity building on PtX in Kenya and has also conducted a few training-of-trainers in Germany.

1.7.7 Barriers to TVET in the PtX Job Market

Kenya has been working to modernise its TVET sector and make it more accessible to students. However, the sector is faced with several challenges as follows.

Recruitment of Trainers

The recruitment and qualifications of trainers in TVETs is currently not harmonised. The Public Service Commission (PSC) currently recruits trainers for the institutions under the Ministry of Education whereas other ministries, county governments, and private institutions recruit on their own. There is a need to develop a structure of qualifying TVET trainers in line with the sector requirements as the quality of graduates largely depend on the trainers.

Lack of Coordinated Industry Linkage

The TVET sector in Kenya has weak linkages with industry. Although there is room for enhancing connections with the industry, this has not materialised. Rather, various institutions independently strive to forge these connections. The lack of effective coordination among multiple stakeholders, including private and public entities, as well as formal and informal sectors, who offer support to TVETs, poses challenges in establishing robust linkages.

Policy Coordination and Implementation

Currently, the Ministry of Education manages most of the TVETs except the vocational training centres that are managed by the counties. Most of the vocational training centres have challenges in terms of human resource and infrastructure.

Trainees Face Challenges Finding Job Placements

TVETs need to bridge the gap between the skills sought after by employers and the programmes provided by educational institutions. Currently, there is a noticeable misalignment between the curriculum offered by training institutions and the practical skills required by industries. This disparity underscores the urgent need for collaboration and partnership between training institutions and employers.

By integrating input from employers into curriculum development and training initiatives, including attachments, internships, and apprenticeship opportunities, TVET programmes can empower a greater number of graduates with the skill sets demanded by the industry, thus contributing significantly to narrowing the prevailing gap.

Inadequate Training Equipment

The infrastructure and training apparatus within certain aging TVET institutions are deteriorating and outdated. Although newer TVET institutions have more modern infrastructure, they are not adequate to meet the training needs. This inadequacy is impeding the delivery of quality and pertinent training. It is imperative to renovate, rehabilitate, and furnish these institutions with modern training equipment that aligns with modern industrial technologies.

1.8 Higher Education in Kenya: Shaping Future Leaders in Green Hydrogen and PtX Technologies

Kenya's higher education system comprises of public and private universities. The country has a total of over 60 universities as depicted in **Error! Reference source not found.**.

Table 11: Number of universities in Kenya

University	2018	2019	2020	201	2022
Public Universities	31	31	31	32	35
Private Universities	32	32	33	33	33
Total	**63**	**63**	**64**	**65**	**68**

1.8.1 Structure and Size

Higher education in Kenya is delivered through a network of universities and tertiary institutions. Overseeing the quality and standards of university education is the Commission for University Education (CUE). This regulatory body ensures adherence to rigorous standards, fostering a culture of educational excellence within the higher education landscape.

1.8.2 Qualification Programmes

Kenyan universities are renowned for offering a diverse array of programmes to both undergraduate and postgraduate students. Across various disciplines, students can pursue degrees that align with their academic and career aspirations.

Notably, specific programmes in fields related to green hydrogen and Power-to-X may find a home within departments such as engineering, environmental science, and energy studies, among others. These specialised programmes equip students with the knowledge and skills required to navigate the complexities of these emerging and environmentally significant sectors.

Kenya has experienced phenomenal growth in the University education sector with over 60 universities operating in 2023. The sector fosters the sharing of knowledge through instructional methods, research, innovative initiatives, and comprehensive training programmes. It empowers students with the requisite skills and knowledge to effectively address the demands of the job market both within Kenya and internationally.

1.8.3 Qualification Programmes Relevant to PtX

Kenyan universities should identify specific degree programmes, research centres, or departments focusing on renewable energy, sustainable engineering, or environmental science. Investigating specialised courses or research projects related to PtX technologies will ensure graduates are well-equipped for the evolving job market.

1.8.4 Higher Education Pathways

The university programmes in Kenya are well structured, offering a progression through different qualification levels. A number of universities, have courses starting from the diploma level. Most of the universities start from bachelors, masters up to doctorate levels. There are a limited number of universities that offer postgraduate diplomas.

To pursue bachelor's degrees, the universities admit the qualified students directly from high school or those who have either pursued diploma or higher national diploma in the relevant field.

1.8.5 Qualification Programmes Relevant to the PtX Sector Currently Offered

Consultations and research were conducted to determine the qualifications relevant to the PtX industry that are offered in Kenyan universities. **Error! References ource not found.** depicts a summary of the relevant qualifications offered in Kenyan universities. While most of the courses were offered at bachelor's degree (KNQA level 7), the least courses were offered at the postgraduate diploma level (KNQF level 8). It is also noted that several universities have research programmes at master's and doctorate levels.

Table 12: PtX relevant qualification areas offered by Kenyan Universities

Qualification area	No of course	KNOF Level
Agriculture	48	7, 9, 10
Chemistry	112	7,9,10
Chemical (and Process) Engineering	3	7,9
Civil Engineering	23	7,9,10
Electrical Engineering	32	7,8,9,10
Environment	159	7,8,9,10
Information Technology	105	7,8,9,10
Mechanical Engineering	35	7,9,10
Physics	67	7,9,10
Renewable Energy	13	7,9
Energy	13	7,9,10
Water Resources Management	25	7,8,9,10
Mechatronic Engineering	5	7,9,10
Instrumentation and Control	6	7,9
Geothermal Technology	2	8,9
Industrial Engineering	6	7,9,10

1.8.6 State of Engineering and Renewable Energy Education in Kenya

Engineering courses offered by Kenyan universities need to be accredited by the Engineer's Board of Kenya (EBK). There are 14 universities in Kenya that offer accredited engineering courses. These include the following engineering disciplines: aerospace, agricultural, chemical and process, civil, electronics and computer, electrical and electronic, marine, materials & metallurgical, mechanical and production, mechatronics, and telecommunications and information engineering.

Thus, all the disciplines relevant to PtX projects are offered. Some of the universities offer various postgraduate programmes in engineering.

Renewable energy (RE) skills are currently in high demand in Kenya. At the time of the survey, there were over eleven (11) universities offering courses in RE, both at undergraduate and postgraduate levels. Undergraduate RE courses provide the basics with the specialisation (including research) taking place at postgraduate level.

The courses are predominantly delivered face-to-face due to the practical nature of technical training. However, there is a noted lack of collaborative hands-on training due to limited funds in Kenya. To address this gap, it is essential to incorporate collaborative hands-on training under the Technical and Vocational Education and Training Authority (TVETA). Industry collaboration, such as the donation of electrolysis equipment or other derivative manufacturing plant equipment, could significantly enhance hands-on training opportunities. An example of successful industry collaboration can be seen in the partnership between the National Industrial Training Authority (NITA) and Hyundai under Electric Vehicle (EV) mobility initiatives (Hyundai, 2021).

A few institutions were reported to possess equipment for training on various renewable energy technologies such as solar PV, parabolic solar thermal, biogas generators, biodiesel plants, and gasifiers, as well as fuel combustion analysers and bomb calorimeters. However, there is a pressing need for the government to adequately finance the education sector and commit to investing in training equipment to meet the growing demand for skilled professionals in engineering and renewable energy fields.

1.8.7 Available Higher Education Workforce

Kenya's higher education sector, overseen by the CUE, stands as a dynamic hub of academic and professional development. The sector not only offers a broad spectrum of qualification programmes but also actively engages in cultivating the expertise required for emerging sectors, positioning the workforce to meet the demands of a rapidly evolving global landscape.

The Kenya Institute for Public Policy Research and Analysis (KIPPRA) reports that most universities in Kenya are understaffed with a high academic staff to student's ratio of 1:30 against the recommended ratio of 1:18. This is despite the university students' intake increasing from about 500,000 in 2021 to 600,000 in 2023.

1.8.8 Opportunities for Higher Education in PtX Job Market

Kenya's PtX sector is in nascent stages and therefore, the universities are yet to provide training in specific PtX skills. It was however noted that the base PtX skills are already being provided. Additionally, a few research projects in PtX were being conducted at the postgraduate level.
The higher education sector in Kenya boasts numerous opportunities within its skilled workforce and relevant development programmes tailored for the PtX industry. Following extensive research and consultation with stakeholders, the subsequent opportunities have been identified as:

Training of Trainers

There is a need to equip university instructors with PtX skills. Although a few universities reported that they were conducting small-scale research on PtX related topics at postgraduate level, upskilling the instructors will enable them to effectively pass on the skills to students. Currently, the International PtX hub hosted by GIZ has taken a number of university researchers in Kenya for training in Germany. The trained researchers

have reported the skills have been useful in teaching and researching in PtX related topics.

JKUAT hosting MTCC Africa

The Jomo Kenyatta University of Agriculture and Technology (JKUAT) has been hosting the Maritime Technology Cooperation Centre (MTCC) for Africa in collaboration with Kenya Maritime Authority (KMA) and Kenya Ports Authority (KPA). MTCC Africa is a centre of excellence with the responsibility of building capacity for climate change mitigation in the African maritime shipping industry. With the project aiming at enhancing energy efficiency of the growing shipping industry, capacity building on PtX skills would be crucial to help the project go further and evaluate and even pilot the use of PtX in Kenya's maritime sector.

Local and International Research Partnership by Strathmore University

Strathmore University is creating international partnerships with players such as Fortescue, Clean Hydrogen Partnership, and the European Union to develop the PtX skills in the country. Additionally, the Africa Green Hydrogen Hub (AGHH) has been initiated by the university with the aim of pioneering the transition towards sustainable energy models. Led by Strathmore University, Curtin University, and Griffith University, this endeavour is focused on serving as a model for innovation, spreading knowledge, and forming strategic collaborations in utilising green hydrogen and effectively contributing to the development of the PtX sector.

Development of PtX Centre of Excellence

Kenya's Green Hydrogen Strategy and Roadmap identified having a centre of excellence on PtX as instrumental for local research, development and skills transfer. During this study, the formation of the centre of excellence was also a dominant recommendation by various stakeholders. This could borrow from KenGen's geothermal centre of excellence, that has seen Kenya not only develop local skills on geothermal energy but also train and provide consultancies to other African countries.

1.8.9 Barriers to Higher Education in the PtX Job Market

Kenya´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

Although student enrolment in Kenyan universities has been increasing, research by KIPPRA indicates that most universities are understaffed with student to lecturer ratio being higher than recommended. The shortage of lecturers with updated PtX skills is even higher. This limits the ability to adequately train qualified students, conduct research geared at providing local solutions to the challenges that may face the PtX sector in Kenya.

Inadequate Laboratory Equipment

The universities reported that the laboratories are not well equipped to train on the PtX sector. Generally, the universities do not have sufficient laboratories, and some have old and outdated equipment that have been overtaken by technological developments.

Governance of Research

Governance of research in Kenya is currently fragmented with several institutions conducting research related functions include the National Commission on Science, Technology, and Innovation (NACOSTI), the National Research Fund (NRF), and the Kenya National Innovation Agency (KeNIA). Despite having several bodies, industry players reported that the current research bodies are heavily biased towards academic research with none funding applied and industrial research. This leaves a huge gap for universities and applied research bodies such as Kenya Industrial Research Institute (KIRDI) to effectively provide solutions to practical problems that will face PtX and related industries.

Insufficient Engineers in the Country

Although the universities are training many engineering graduates, very few of them transition to register as Professional Engineers. This means that the country is having a shortage of qualified engineers. Lack of local engineers to take part in the growth and development of the country's economy by tapping their knowledge, skills, and new technologies is hampering the potential to unlock emerging technologies including PtX.

Limited academia-industry collaboration

The country faces a situation where there is limited collaboration between the industry and academia. There are institutions that have collaboration agreements with industries. However, these agreements mostly focus on student attachment placement. With universities having the knowledge, they ought to produce sufficient intellectual property (IP) rights and collaborate with industries to use the research and innovations to provide solutions to the industries. This could provide the academia with the much-needed finances for research and innovation.

Table 13: Opportunities and barriers in higher education in the PtX job market

Opportunities for Higher Education in the PtX Job Market	Barriers to Higher Education in the PtX Job Market
Training of Trainers: Equipping university instructors with PtX skills	**Shortage of PtX Lecturers:** Lack of qualified instructors in PtX field
JKUAT hosting MTCC Africa: Capacity building for climate change mitigation in maritime sector	**Inadequate Laboratory Equipment:** Insufficient resources for hands-on PtX training
Research Partnership by Strathmore Universi ty: International partnerships for PtX skill development	**Governance of Research:** Fragmented research governance hindering PtX innovation
Development of PtX Centre of Excellence: Establishing a hub for PtX research and skill transfer	**Insufficient Engineers:** Lack of engineers with PtX expertise
	Limited academia-industry collaboration: Weak collaboration hampering PtX skill development

4

Identification of PtX Skills Gaps in Kenya

IDENTIFYING SKILLS GAPS

The skills assessment conducted has successfully identified the critical job roles and skills requirements within the PtX sectors in Kenya. Additionally, the analysis of education gaps has (partially) examined the number of graduates from relevant qualifications programmes 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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Federal Ministry for Economic Affairs and Climate Action
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Study conducted by
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1.9 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 1.10). For all occupational groups, only few new skills specific to the burgeoning PtX sector 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 KNQF Level 2 who will be needed in largest numbers.

The size (as a percentage) of each occupational group relative to the others shown in **Error! Reference sourcen ot found.** 14. 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 Kenya 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 14: 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%**

1.10 Description of Occupational Groups

In Section 1.6 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.

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1.11 Current PtX Activities in Kenya

At the time of the study, there was only one plant that was producing green ammonia fertiliser in the country. The plant was supplied with power from solar PV. At the time of the visit, the plant had not started operations and was at the commissioning stage. The plant had an off-taker for the fertiliser.

Other activities in PtX that were on-going at the time of the study included;

- Identification of global trends in the area of GH2. Ammonia was prioritised due to its ease of handling. Additionally, there is no fertiliser manufacturer in the country and hence all supplies have to be imported and hence, this presents a huge opportunity for the country. Some prospective GH2 project developers expressed interest in developing fuels for aviation and shipping industries.
- Resources identification such as renewable energy resource assessment, land, and financing.
- Business case assessment and financial modelling.
- Identifying potential off-takers of the PtX products.

Only one entity reported that they were conducting a detailed feasibility study for a project to produce e-methanol. Thereafter, they would reach a financial close. Most of the prospective project developers indicated that were considering solar PV, wind or geothermal for power generation for the GH2 projects.

The standards body indicated that they were developing standards for green hydrogen, green ammonia, and green fuels projects.

1.12 State of locally available skills for PtX

All jobs identified as being in demand for the GH2 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. The locally available skills include:

- RE power generation; engineering, financial analysts, and environmental scientists.
- The skills including carbon dioxide (CO_2) and nitrogen (N2) capture are available but may be inadequate and insufficient.

One entity indicated that they were engaged in capacity-building initiatives for PtX and defossilisation, alongside plans for potential green hydrogen/ammonia projects. Others indicated that they had collaborations with educational institutions for R&D and capacity building. However, it was noted that capacity-building initiatives focusing on safety and technical aspects were planned for implementation through external providers.

1.13 Workforce Development and Capacity-Building Initiatives

Several universities and training institutions already have courses related to energy topics, showcasing a foundational understanding in relevant fields such as engineering disciplines and renewable energy. However, the direct inclusion of GH2 and PtX-related topics was somewhat limited across the institutions. Only a subset demonstrated active planning or development of courses specifically targeting these emerging technologies.

There are several institutions offering courses in the fields of non-engineering professionals, managerial and administrative roles. Due to their diverse nature, these are not discussed in the report.

1.14 Strategies for bridging the skills gaps for all PtX-related jobs

The existing skills that would need upskilling include:

- Engineers; electrical, mechanical, chemical and process
- Chemists and water experts
- Environmental impact assessment experts
- Legal experts
- Financial modelling experts
- Plumbers, welders, and electricians

Some of the new skills that need to be developed include:

- Standards and certification e.g. in aviation sector
- Carbon assessment experts

It is anticipated that the GH2-PtX technologies will mainly be imported. The country will rely on external expertise in the early stages as the local supervisors and technicians get trained by the original equipment manufacturers (OEM) on the operation and maintenance of the systems. Other strategies cited include:

- Exchange programmes should be encouraged. This could include the public sector learning from the private sector, local to international exchange and peer-to-peer learning through round table discussions.
- Development of short courses for upskilling the existing human capacity.
- As a long-term strategy, a unit/module on emerging technologies could be added to relevant existing university curricula. This would handle GH2 and other emerging technologies.
- Development of a centre of excellence for growing homemade skills and technologies in the medium term. This could spur manufacturing and could include testing.
- Develop incubation and mentorship programmes.
- R&D to develop local components with Kenya focusing on what it would be good at. Partnerships between public and private sectors, and development partners should be encouraged.
- Enhance and support industrial research to enable local production of various parts and equipment.

There is a need to develop a strategy on who is to be trained and for what purpose, to avoid spending money on people who will not work in the GH2 industry. The Kenya education system is transitioning to competency based with the first cohort expected to complete high school in 2028/2029. The universities' curriculums are expected to be aligned with the education system before the first cohort joins. This presents a perfect opportunity to introduce PtX and emerging technologies modules in the curriculums.

1.15 Skills Development Short-Term Timeline Education Sector

- **0-2 years**
  - upskilling short courses for the practicing professionals, technicians, artisans, and other professionals whose skills have been found to be inadequate for the PtX projects
  - focus on skilling workforce for project development (first part value chain)
  - accessing financing for curricula development
  - develop short courses, curricula incl. hands-on curricula for TVET
  - incorporate PtX topics as units in existing courses
  - offer in-house training (private sector)
  - leverage private sector funding for small PtX training kits
- **2-4 years:**
  - develop a unit/module on emerging technologies to be included in relevant existing university curricula. This should handle PtX and other emerging technologies. The Kenya education system is transitioning to competency based with the first cohort expected to complete high school in 2028. The universities curriculums are expected to be aligned with the education system before the first cohort joins. This presents a perfect opportunity to introduce PtX and emerging technologies modules in the curriculums.
- **over 4 years:**
  - development of a centre of excellence within existing centres of excellence (e.g. RE in TVET), incubation and mentorship programmes; enhance and support industrial research.

5

Recommendations for a Green Hydrogen and PtX Human Capacity Development Programme for Kenya

HUMAN CAPACITY DEVELOPMENT PROGRAMME

Based on the preceding analyses, this chapter proposes measures and initiatives for a holistic skills development programme to ramp up a PtX industry in Kenya. The suggested initiatives include specific recommendations for enhancing existing TVET and higher education training programmes 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 06.

International PtX Hub

Supported by: Federal Ministry for Economic Affairs and Climate Action

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Study conducted by renac renewables academy

1.16 Proposed Initiatives and Suggested Measures

1.16.1 Establishing Institutional Integration of PtX Skills Development within Existing National Structures

Objective: to institutionalise PtX skills development within Kenya's existing national structures.

- Establish a subcommittee within the Green Hydrogen Programme Coordination Committee (GH2-PCC) focused on skills development for the PtX sector.
- Compose the subcommittee of members from the GH2-PCC, Kenya Green Hydrogen Secretariat (Secretariat), and relevant stakeholders with expertise in training and education.
- Task the subcommittee with developing targeted strategies and initiatives to address skill gaps and enhance workforce capabilities within the PtX sector.
- Integrate the subcommittee into existing national structures to leverage established frameworks and resources for effective coordination and implementation of PtX skills development initiatives.
- Ensure alignment of the subcommittee's activities with broader national objectives and priorities outlined in Kenya's Green Hydrogen Strategy and Roadmap.

1.16.2 Developing Industry-Responsive Curricula and Training Programmes

Collaboration with PtX enterprises guarantees that curricula align with industry demands and encompass the latest advancements in PtX technologies. Regulatory bodies overseeing education ensure compliance with formal qualification standards.

Objective: to align educational curricula and training programmes with industry demands in the PtX sector, ensuring relevance, practical applicability, and responsiveness to rapid technological advancements.

- Strengthen coordinated linkages with industry.
- Develop and execute industry-responsive curricula and training initiatives for both higher education and vocational pathways in partnership with PtX enterprises, higher education institutions, and vocational training centres.
- Integrate practical, hands-on training modules, internships, and apprenticeships to provide practical industry exposure.
- Establish a mechanism for ongoing and systematic review and enhancement of curricula to adapt to the rapid developments within the PtX sector.

1.16.3 Training of Trainers and Addressing Shortage of Lecturers for the PtX Industry

Objective: to address the shortage of lecturers and train university instructors in PtX skills to ensure effective knowledge transfer and research advancement in the PtX industry.

- Implement comprehensive upskilling programmes for university instructors to equip them with PtX skills, facilitating effective knowledge transfer to students.
- Collaborate with initiatives such as the International PtX Hub hosted by GIZ to provide opportunities for university researchers in Kenya to receive specialised training in PtX-related topics abroad, addressing the shortage of lecturers with updated PtX skills.
- Establish partnerships with industry experts and PtX practitioners to develop tailored training programmes for university instructors, focusing on practical applications and current industry trends.
- Address the understaffing of Kenyan universities, particularly in the PtX field, by recruiting and training qualified lecturers with updated PtX skills, ensuring a sufficient pool of instructors to adequately train students and conduct relevant research.

- Encourage collaboration between universities and industry partners to identify and attract experienced professionals in the PtX sector to serve as adjunct lecturers or visiting faculty, bridging the gap between academia and industry.

- Develop incentive programmes to attract and retain lecturers with expertise in PtX technologies, prioritising research funding and institutional support for PtX-related projects to engage lecturers in research activities that contribute to addressing local challenges.

1.16.4 Upskilling University and Vocational Training Staff

Ensuring academic staff and TVET trainers are equipped with the necessary skills to effectively train students in the PtX sector is paramount. To achieve this, the following measures are recommended:

Objective: to ensure that academic and vocational training staff are equipped with the necessary skills to effectively train students in the PtX sector.

- 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.
- Engage PtX industry experts in delivering training sessions to impart real-world knowledge and experiences.
- Facilitate industry internships for both students and teaching staff, providing firsthand exposure to PtX technologies and practices.
- Establish a Train-the-Trainer platform with an online component, enabling teaching staff to access theoretical knowledge and practical training from international experts.
- Encourage collaborative projects between teaching staff and students to foster continuous learning and mentorship opportunities while enhancing staff expertise in PtX technologies.

1.16.5 Up- and Re-Skilling the Existing Workforce through Continued Professional Development and Enhancing the Apprenticeship Programmes, On-the-Job-Training and Local Training Institutions

Given Kenya's extensive network of Technical and Vocational Education and Training (TVET) institutions and the oversight of the National Industrial Training Authority (NITA), there exists a robust infrastructure for upskilling the existing workforce in the PtX sector and enhancing training institutions. This initiative aims to improve Kenya's capacity for specialised training in PtX technologies and enhance the skills of its workforce.

Objective: enhance the skills of Kenya's existing workforce in the PtX sector through specialised professional training tailored to industry needs, leveraging TVET institutions and NITA's infrastructure. Additionally, improve Kenya's capacity for specialised training in PtX technologies through its network of TVET institutions and NITA centres, supported by the industrial training levy to upskill employees in PtX skills.

- Implement specialised and accredited continued professional training courses tailored to PtX industry needs, effectively enhancing the skills of employees in industries transitioning to PtX technologies via NITA's infrastructure.
- Explore mechanisms, such as the industrial training levy managed by NITA, to finance employee training costs within industries venturing into the PtX sector.
- Enhance apprenticeship programmes, on-the-job training initiatives, and local training institutions to improve skills development in PtX technologies.

1.16.6 Empowering Unemployed TVET Graduates through Job Opportunities

Objective: to empower unemployed TVET graduates by bridging the skills gap and providing targeted training programmes to facilitate their entry into the PtX industry.

- Establish a framework for identifying TVET graduates in need of upskilling and reskilling to enter the PtX industry, quantifying the skills gap and providing targeted training programmes.
- Foster collaboration between TVET institutions and PtX industry stakeholders to ensure that training programmes meet industry standards and address specific skill requirements.
- Enhance career guidance and counselling services within TVET institutions to inform students about the opportunities available in the PtX sector and provide guidance on skill development pathways.
- Develop internship and apprenticeship programmes in partnership with PtX industry players to provide students with practical experience and facilitate their transition into the workforce.
- Allocate funding and resources to support the development and implementation of industry-aligned training programmes, leveraging existing initiatives such as the industrial training levy administered by NITA.

1.16.7 Encouraging Engineering Professionals to Register with the EBK and KETRB

Objective: to encourage engineering professionals' registration with the Engineer's Board of Kenya (EBK) and the Kenya Engineering and Technologists Registration Board (KETRB) through collaboration agreements, mentorship programs, and practical skill development initiatives

Collaboration agreements between educational institutions and the PtX sector could bring formalisation and credibility to “graduate in training” programmes. Even more so, mentorship programmes will equip engineering professionals with practical skills and support. As a result, more young professionals will be registered by the Engineer’s Board of Kenya and the Kenya Engineering and Technologists Registration Board.

1.16.8 Establishing PtX Centres of Excellence

Objective: to establish PtX Centres of Excellence, serving as interdisciplinary institutions for research, skills development, knowledge exchange, and consultancy to enhance expertise and foster collaboration among stakeholders.

- Establishing dedicated training centres or institutes focused on PtX technologies, their applications and processes. Incorporate in existing centres of excellence.
- These centres should offer cutting-edge infrastructure, equipment, and resources to support practical training and research activities.
- Engaging in partnerships with international entities to facilitate the exchange of knowledge and to set benchmarks.

A PtX Centre for Excellence could act as an interdisciplinary institution offering local research, skills development and transfer as well as an exchange platform to all stakeholders and students from different learning paths. The KenGen centre of excellence for Geothermal could act as a best practise example.

The centre could act as a bridge between the private, the public and academic sector, plus enhancing local expertise, while providing consultancy to other African countries.

1.16.9 Enhancing Research and Development Initiatives

Objective: to promote collaboration and funding support for research and innovation in PtX technologies, ensuring universities remain at the forefront of industry advancements.

- 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.
- Incentivise universities to prioritise securing funding or grants to acquire state-of-the-art equipment relevant to PtX technologies. This investment ensures that students receive training on the latest tools and methodologies used in the field.
- Allocate resources to upgrade existing laboratories by replacing outdated equipment with modern alternatives.
- 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.

1.16.10 Accessing Financing Opportunities

Suitable financing opportunities are a key component to develop and implement a comprehensive skills development programmes for Kenya´s PtX sector that includes training programmes, infrastructure development as well as further capacity building measures. Accessing financial resources is pivotal, demanding the identification and utilisation of diverse funding avenues and mechanisms. This guidance presents strategies for securing the financial support needed to execute a successful skills development programmes in Kenya's PtX sector:

Objective: to secure diverse financing opportunities for comprehensive skills development programmes in Kenya's PtX sector, enabling training, infrastructure development, and capacity building to support sustainable industry growth.

- Investigate government-led programmes and initiatives aimed at fostering skills enhancement, renewable energy, and sustainable industry growth. Engage with pertinent government departments to gain insights into the workforce, funding opportunities, and the criteria required for eligibility.
- Partner with regional and global development finance bodies, like the African Development Bank (AfDB) or the World Bank/ IFC, known for their support in renewable energy and skills enhancement. These entities often extend grants, loans, or advisory services for capacity-building efforts within the energy domain.
- Draw private sector investments through Public-Private Partnerships (refer to Section 5.1.12).
- Pursue funding from international organisations, foundations, and initiatives committed to sustainable development, renewable energy, and training in essential skills (e.g. the Green Climate Fund, GCF).
- Explore philanthropic entities (e.g. foundations) dedicated to sustainable growth, education, and skillset enhancement. Forge partnerships and craft proposals that resonate with their mission and goals, highlighting the socio-economic benefits of backing skills development in Kenya's hydrogen and PtX sector.
- Capitalise on carbon market opportunities to generate income via the trade of carbon credits or offsets stemming from PtX projects. This income could be redirected into skills development ventures. Engage with carbon trading platforms and consult carbon finance experts to effectively navigate this avenue.
- Designate a portion of the revenue from the export of green hydrogen and PtX commodities within Kenya's sector to a "Skills Development Fund," specifically aimed at refining worker skills and bolstering global competitiveness.
- Synchronise the skills development agenda with climate financing mechanisms, including Nationally Determined Contributions (NDCs) and Green Climate Fund financing options. Highlighting the synergy between skills development, climate mitigation, and the fulfilment of sustainable development objectives can amplify the likelihood of obtaining climate finance backing.

1.16.11 Promoting Gender-Inclusive Career Pathways

Kenya´s emerging hydrogen economy offers a significant chance for socioeconomic growth and sustainable development. For the sustainable success and inclusivity of this sector, it is pivotal to implement gender equality and actively promote gender-inclusive career pathways. Overcoming conventional obstacles and ensuring equal opportunities will enable Kenya to leverage its varied talent pool fully. This approach will empower women to contribute significantly to the hydrogen and PtX sectors.

Objective: to promote gender inclusivity in Kenya's hydrogen and PtX sectors through awareness, training, mentorship, leadership promotion, adaptable employment, and international collaboration for sectoral growth and sustainability.

- Initiate focused campaigns to raise awareness about the importance of gender equality within the hydrogen/PtX economy, possibly highlighting career opportunities for women across various roles in the sector.
- Establish training programmes aimed at encouraging participation from all genders in technical and STEM fields. Create partnerships with educational bodies and sector stakeholders to provide women with access to high-quality education and training, paving the way for their careers in the PtX industry.
- Set up mentorship programmes that connect young women aspiring to join the hydrogen/PtX industry with senior professionals from both genders. These programmes can offer guidance, support, networking opportunities, and help in skill development.
- Promote the inclusion of women in leadership positions across hydrogen-related organisations, research entities, and governmental agencies. Enact policies targeted at enhancing women's representation in executive roles and on decision-making boards.
- Implement adaptable training and employment models, including online or remote learning options and flexible work schedules, to support women in the hydrogen sector in balancing professional and personal responsibilities. These models aim to mitigate the impact of traditional gender roles, such as childcare and household duties.
- Pursue international collaboration and knowledge sharing with nations that have advanced gender inclusivity in the energy and hydrogen sectors.
- Adapt and apply successful strategies to the Kenyan context, learning from their achievements in promoting gender diversity.

1.16.12 Fostering Public-Private Partnerships (with Project Developers)

Implementing a structured Public-Private Partnership (PPP) model for skills development within Kenya's hydrogen and PtX economy allows all players (government, private sector, and academic institutions) to synergise their capabilities and resources.

Objective: to foster structured Public-Private Partnerships (PPPs) in Kenya's PtX economy for comprehensive skills development, ensuring collaboration among government, private sector, and academic institutions to create a skilled workforce and drive industry growth.

- Initially, a PPP framework should define roles, responsibilities, and contributions of both public and private sector participants. This foundation will facilitate collaboration and ensure effective coordination among all parties involved.
- Solicit financial backing from private sector firms in the PtX sector by emphasising the long-term advantages of nurturing a skilled workforce and the creation of a robust talent pool that can drive their businesses' growth and competitiveness.
- Seek possibilities for collaborative funding efforts with private entities, where contributions from both public and private sectors feed into a mutual fund earmarked for skills development. This joint approach promotes accountability, encourages ownership, and leverages additional funds.
- The government's role is crucial, showing commitment through policy and regulatory backing, fostering an investment-friendly environment, and providing incentives to both project initiators and workforce training programmes.
- Create specialised training venues and infrastructures, such as labs, research facilities, simulation areas, and pilot sites, with investments from both public and private sectors for their development and upkeep.
- Enhance local capacity by facilitating the transfer of technology and knowledge from global partners and project developers to local entities. This can be achieved via partnerships, joint ventures, and capacity-building efforts that equip local workers with the necessary skills and experience in green hydrogen and PtX technologies.
- Introduce quality assurance mechanisms for skills development programmes, potentially through institution accreditation, trainer certification, and the setting of industry benchmarks for skills evaluation and certification. Regular assessments should be conducted to gauge programme's effectiveness and guide improvements.

- Encourage a culture of ongoing learning and agility within the PPP model to stay aligned with the dynamic requirements of Kenya's hydrogen economy.
- Establish feedback channels, industry consultations, and collaborative forums to adapt skills development measures as needed.
- Design the skills development PPP framework to be sustainable and scalable over the long term, looking for replication and expansion possibilities into other industries or regions across Kenya, thereby fostering the continuous advancement of the national workforce.

Box 1: 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 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]

1.16.13 Facilitating Entrepreneurship

Enhancing entrepreneurship within Kenya's PtX sector via targeted skills development programmes is vital for equipping individuals with the necessary skills and knowledge to spur innovation and generate job opportunities. Recommendations to bolster entrepreneurship entail:

Objective: to facilitate entrepreneurship within Kenya's PtX sector through targeted skills development programs, fostering innovation, job creation, and collaboration among entrepreneurs, academia, and industry players.

- Leverage existing incubation facilities, like the Chandaria Business and Incubation Centre, to capitalise on infrastructure and expertise within universities.
- Establish specialised incubation and acceleration programmes designed for the green hydrogen and PtX markets. These initiatives can offer mentoring to entrepreneurs to be, in terms of business development guidance, funding access, and co-working spaces. By fostering innovative startups, such efforts are poised to accelerate entrepreneurial activity in the domain.
- Promote collaborations between higher education institutions and industry players to close the gap between academic theory and entrepreneurial practice. Such partnerships should facilitate the exchange of knowledge, co-developed research endeavours, and the commercialisation of academic findings, aiding entrepreneurs in accessing cutting-edge technologies and expertise while providing academia with practical insights from their research.
- Introduce financial schemes specifically catering to the needs of entrepreneurs in the green hydrogen and PtX fields. Options could include venture capital, angel investing networks, grants, and subsidised loans, with streamlined application and approval processes to ease entrepreneurs' access to essential capital for launching and expanding their ventures.
- Encourage global cooperation and alliances to enable technology exchanges, market entry, and

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

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

shared knowledge. Engaging with international leaders in the green hydrogen and PtX sectors to pursue collaborative ventures, joint research, and technology licensing can offer Kenyan entrepreneurs' critical insights and market access.
- Cultivate networks and communities among entrepreneurs focused on green hydrogen and PtX.
- Support the creation of sector-specific associations, networking gatherings, and forums for knowledge exchange, providing a platform for entrepreneurs to connect, collaborate, and share experiences, thus fostering a supportive entrepreneurial ecosystem in the sector.

1.16.14 Engaging Stakeholders

Achieving the goals outlined in Kenya´s roadmap depends heavily on the active involvement of stakeholders and ensuring that key players feel a sense of ownership. The recommendations lists steps to involve stakeholders and cultivate ownership, crucial for the successful roll-out of a skills development roadmap in Kenya's PtX industry.

Objective: to foster stakeholder engagement and ownership in Kenya's PtX industry skills development roadmap through comprehensive strategies, collaboration, and ongoing learning opportunities.

- The stakeholder mapping (Annex 05) has identified key stakeholders along the different levels of implementation of the skills development roadmap.
- Create an in-depth strategy for stakeholder engagement throughout the various phases of the skills development programmes. This strategy should encompass frequent meetings, workshops, consultations, and forums to solicit feedback and viewpoints, addressing any concerns. Effective communication and cooperation are key to building ownership among stakeholders.
- Establish task forces and working groups (refer to Section 5.1.1).
- Promote active involvement and contributions from all stakeholders in the definition of the skills development programmes. This can be achieved through workshops, focus group discussions, and digital platforms that encourage joint efforts and the exchange of ideas. Especially stakeholders from the education and training sectors should be addressed.
- Seek collaboration with international bodies, development agencies, and private sector players to gather financial backing for the skills development roadmap and access expertise in GH2 and PtX technologies. Make a strong case for the benefits of a proficient PtX workforce in achieving Kenya's sustainable development objectives and a fair energy transition.
- Public-Private Partnerships should be leveraged to foster a sense of mutual responsibility and ownership among stakeholders in the private sector (see Section 5.1.13).
- Encourage an ongoing culture of learning and enhancement by providing venues for stakeholders to exchange experiences, best practices, and learned lessons.

1.17 Milestones & Timeline

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

1.17.1 Short-Term Milestones (2024 - 2027)

- Upskilling through short courses for professionals, technicians, and artisans (core competences).
- Access financing for curricula development (university and hands-on TVET).
- Prioritise the training of professionals in policy formulation and regulatory compliance to support the establishment of a conducive environment for green hydrogen and PtX initiatives.
- Design and implement training programmes for engineers, technicians, and operators to ensure the successful operation of the first commercial-scale projects.
- Facilitate knowledge transfer and skill acquisition in cutting-edge technologies through collaborations with international RTD centres.

- Offer in-house trainings via private sector.

1.17.2 Medium-Term Milestones (2028 - 2032)

- Establish a PtX centre of excellence within existing centres.
- Initiate incubation and mentorship programmes
- shift skills development programmes towards preparing the workforce for advanced roles in research, development, and export-oriented activities.
- Tailor training programmes to meet the evolving demands of the global green hydrogen market, with an emphasis on entrepreneurship, project management, and international trade.
- Continue collaborations with international partners to facilitate knowledge exchange and promote best practices.
- Support industrial research.

1.17.3 Long-Term Milestones (2032 and beyond)

- Integrate emerging technology modules into university curricula to ensure continuous skill development in PtX-related fields.
- Shift skills development programmes towards preparing the workforce for advanced roles in research, development, and export-oriented activities.
- Tailor training programmes to meet the evolving demands of the global green hydrogen market, with an emphasis on entrepreneurship, project management, and international trade.

- Continue collaborations with international partners to facilitate knowledge exchange and promote best practices.

Alignment with priority actions from the national Green Hydrogen Strategy and Roadmap

The short-term priority actions outlined below are closely aligned with the goals and timeline of Kenya's national Green Hydrogen Strategy and Roadmap (first phase). These actions, spanning from Q1 2024 to Q3 2024, focus on laying the groundwork for the successful implementation of the national strategy in regard to skills development.

Key initiatives are aimed at ensuring that workforce development remains a central pillar of Kenya's PtX agenda. By integrating workforce coordination, skills development, and capacity-building efforts into the early stages of strategy implementation, Kenya is prepared to cultivate a skilled workforce capable of driving innovation and realising the full potential of the PtX sector in line with its national objectives.

Q1 2024 - Q3 2024:

Create a high-level "green hydrogen programme coordination committee"

o Develop a workforce coordination team within the committee tasked with identifying skills needs and gaps.

Set up a green hydrogen secretariat, functioning as a centralised hub

o Establish a skills development division within the secretariat responsible for designing and implementing training programmes.

Host National Green Hydrogen roundtables focused on finance and green fertiliser

o Include sessions dedicated to discussing workforce development strategies and skill requirements.

Formulate a Monitoring and Evaluation Plan

o Include indicators related to skills development and capacity-building activities.

Craft a resource mobilisation plan for the green hydrogen strategy and roadmap

o Allocate resources for skills training and capacity-building initiatives.

Integrate dedicated provisions regarding green hydrogen into the national energy policy.

o Ensure the policy includes provisions for workforce development and skills enhancement.

Support and expedite catalytic projects showcasing commercial viability

o Allocate funds for training programmes linked to catalytic projects like the Olkaria green hydrogen demonstration project.

Q3 2024 - Q3 2025:

Develop a comprehensive green hydrogen stakeholder engagement and communication plan

o Engage stakeholders from the education and training sector to design tailored programmes.

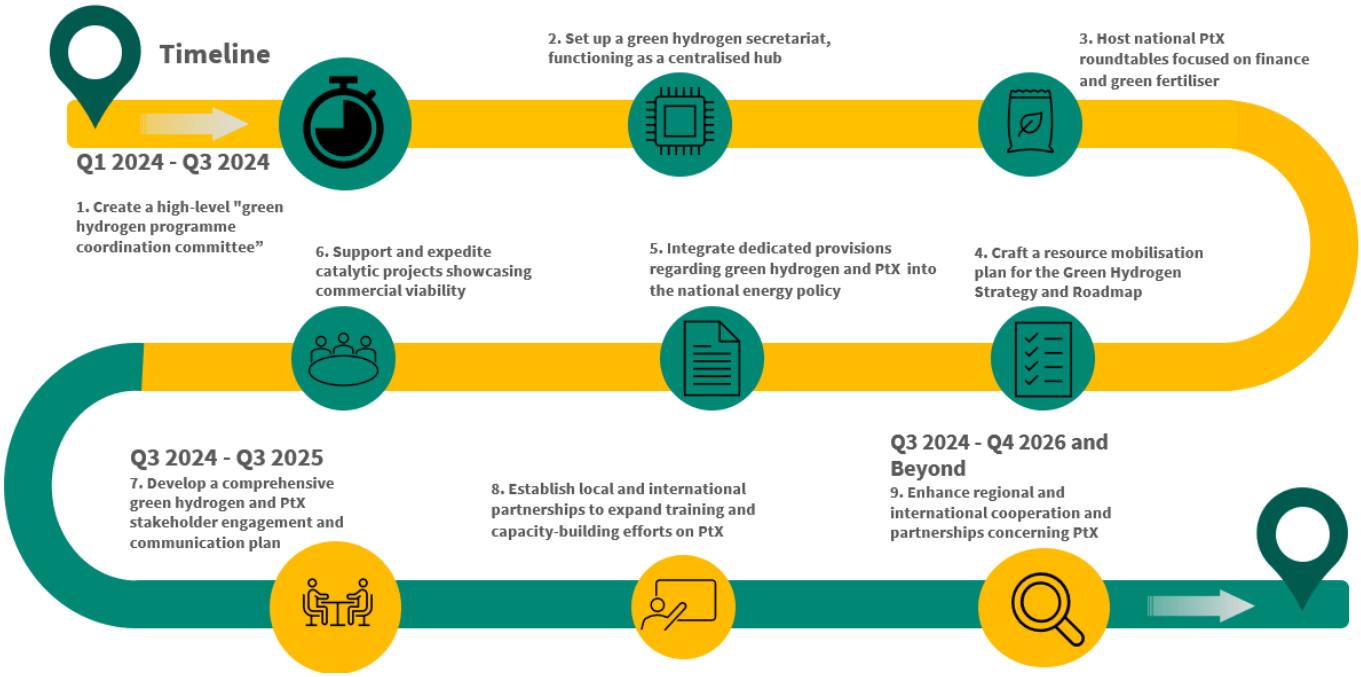
Establish local and international partnerships to expand training and capacity-building efforts

o Collaborate with international training institutions to access expertise in green hydrogen technologies.

Q3 2024 - Q4 2026 and Beyond:

Enhance regional and international cooperation and partnerships concerning green hydrogen

o Foster collaboration on skills development initiatives with regional and international partners.



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