



GREEN HYDROGEN STRATEGY AND ROADMAP FOR KENYA



GREEN HYDROGEN STRATEGY AND ROADMAP FOR KENYA

EXECUTIVE SUMMARY





FOREWORD



he energy sector is a key enabler in the pursuit of nationally set goals as espoused in the Kenya Vision 2030 and internationally set obligations that include the sustainable development goals (SDGs), climate agreements like the Paris Agreement and Africa Agenda 2063. Kenya has also made improvement of livelihoods and welfare of its citizens a top priority through the Bottom-Up Economic Transformation Agenda. Development of green hydrogen and its derivatives aligns with these national objectives. As the world navigates the evolving landscape of sustainable energy solutions, this green hydrogen strategy stands as a beacon of innovation and commitment towards a greener and more resilient future.

Through meticulous research, collaboration, and forward-thinking insights, this strategy charts a course towards harnessing the potential of green hydrogen as a key driver of our energy transition. The analysis showed that Kenya has sufficient renewable energy resources that are available in the country for large scale production of green hydrogen without harming the availability and supply to electricity consumers.

This comprehensive approach underscores the strategy's commitment to nurturing a shared vision, elevating green hydrogen to a pivotal cross-cutting factor in Kenya's development agenda. By acting as a catalyst for sustainable socio-economic advancement, the strategy harmonizes with the nation's steadfast pursuit of sustainable growth.

This commitment to sustainable advancement is palpable in the strategy's objectives, prudently crafted to prioritize economic expansion, the creation of job opportunities, and the promotion of environmental stewardship. As both a visionary framework and a pragmatic guide, it articulates our collective ambition while concurrently providing tangible direction to navigate the passage from conception to realization.

Davis Chirchir
Cabinet Secretary
Ministry of Energy and Petroleum



PREFACE

he significance of green hydrogen production and its multifaceted applications are deeply woven into Kenya's ambitious green economy agenda. Four pivotal areas have been identified where the focus will be resolute: the formulation of an all-encompassing green hydrogen strategy and a roadmap; secondly, the cultivation of an environment conducive to growth facilitated through the establishment of regulatory and policy frameworks that will enable and propel green hydrogen endeavours; thirdly, the facilitation of financial mechanisms and technical guidance to foster its deployment; and finally, the dynamic exploration and testing of cross-sector applications that capitalise on the potential of green hydrogen.

Kenya's green hydrogen strategy is the product of concerted effort by the Green Hydrogen Working Group comprising officials from government, development partners, private sector and academia. I would like to extend special thanks to European Delegation to Kenya who supported the development of the Strategy by availing the Technical Assistance Facility (TAF) team of consultants. Special thanks



also to the continued support of the German government through GIZ in supporting the development of the green hydrogen baseline study and contributing to the strategy and roadmap development process and finalisation.

I would like to express deep appreciation to the Technical Working Group, all parties and stakeholders who have wholeheartedly supported the development of the strategy and roadmap. Their unwavering commitment and valuable contributions have been pivotal in crafting a comprehensive Green Hydrogen Strategy and Roadmap towards a greener and sustainable energy future for Kenya.

Alex K. Wachira
Principal Secretary
State Department for Energy



ACKNOWLEDGEMENTS

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Davide Danelli (EU)

Eng. Isaac Kiva (MoEP)

Eng. Benson Mwakina (MoEP)

Eng. Mungai Kihara (MoEP)

Edna Mutevu (MoEP)

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Kevin Mwangi (GIZ)

Furthermore, the process received extensive support from a diverse range of stakeholders, including the Green Hydrogen Working Group (co-chaired by MoEP and EU), government ministries, public sector institutions, academia, development finance institutions (DFIs), the private sector, and the Green Hydrogen Organisation.

Government ministries and public sector institutions:

- Ministry of Agriculture and Livestock Development.
- · Ministry of Investments, Trade, and Industry
- Ministry of Roads and Transport
- The National Treasury and Economic Planning
- Energy and Petroleum Regulatory Authority (EPRA)



- Geothermal Development Company (GDC)
- Kenya Association of Manufacturers (KAM)
- Kenya Bureau of Standards (KEBS)
- Kenya Electricity Generating Company (KenGen)
- Kenya Electricity Transmission Company (KETRACO)
- Kenya Power and Lighting Company (KPLC)
- Rural Electrification and Renewable Energy Corporation (REREC)

Private sector associations:

- Kenya Private Sector Alliance (KEPSA)
- Electricity Sector Association of Kenyan (ESAK)

Academia:

- Jomo Kenyatta University of Agriculture and Technology
- Kenyatta University
- Strathmore University
- Machakos University
- Technical University of Kenya

Development finance institutions:

- European Investment Bank (EIB)
- Agence Française de Développement (AfD)
- Kreditanstalt für Wiederaufbau (KfW)
- Japan International Cooperation Agency (JICA)
- Foreign, Commonwealth & Development Office (FCDO)



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ABBREVIATIONS

ADC	Agricultural Development Corporation
AFA	Agriculture and Food Authority
AfCTA	African Continental Free Trade Area
AGs office	Office of the Attorney General
AGHA	Africa Green Hydrogen Alliance
AHP	African Hydrogen Partnership
ASAL	Arid and Semi-Arid Lands
ASTGS	Agricultural Sector Transformation and Growth Strategy
BAU	Business As Usual
BESS	Battery Energy Storage System
BETA	Bottom-up Economic Transformation Agenda
BNEF	Bloomberg New Energy Finance Limited
Btu	British Thermal Unit
CAN	Calcium Ammonium Nitrate
CAPEX	Capital Expenditure
CBAM	Carbon Border Adjustment Mechanism
СВО	Community Based Organisations
CFD	Contract-For-Difference
CIDP	County Integrated Development Plan
CO2	Carbon Dioxide
DAP	Diammonium Phosphate
DFI	Development Finance Institution
DRI	Direct Reduced Iron
DSM	Demand Side Management
EBRD	European Bank for Reconstruction and Development
EFTA	European Free Trade Association (Iceland, Liechtenstein, Norway, Switzerland)
e.g.	For example
EHB	European Hydrogen Bank
EIB	European Investment Bank
EPRA	Energy and Petroleum Regulatory Authority
ERC	Energy Regulatory Commission
ESAK	Electricity Sector Association of Kenya
ETC	Energy Transitions Commission
EU	European Union
EUD	EU Delegation
EV	Electric Vehicle
FAFB	Fertilizer and Animal Foodstuffs Board



FAO	Food and Agriculture Organisation
FCC	Fuel Energy Cost
FERFA	Foreign Exchange Rate Fluctuation Adjustment
FFI	Fortescue Future Industries
FID	Final Investment Decision
FiT	Feed-in-Tariff
GDC	Geothermal Development Company
GH2	Green Hydrogen
GH2-PCC	Green Hydrogen Program Coordination Committee
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTAF	Global Technical Assistance Facility
GW	Gigawatt
GWEC	Global Wind Energy Council
H4D	Hydrogen for Development
HDV	Heavy Duty Vehicle
HINT.CO	Hydrogen Intermediary Company GmbH
IA	Inflation Adjustment
IEA	International Energy Agency
IFC	International Finance Corporation
IPCEI	Important Project of Common European Interest
IPP	Independent Power Producer
IPS	Industrial Promotion Services
IRA	Inflation Reduction Act
IRENA	International Renewable Energy Agency
ISO	International Organization for Standardization
KALRO	Kenya Agricultural and Livestock Research Organization
KAM	Kenya Association of Manufacturers
KCAA	Kenya Civil Aviation Authority
KE	Key Expert
KEBS	Kenya Bureau of Standards
KenGen	Kenya Electricity Generating Company
KEPHIS	Kenya Plant Health Inspectorate Service
KEPSA	Kenya Private Sector Alliance
KEREA	Kenya Renewable Energy Association
KETRACO	Kenya Electricity Transmission Company
KfW	Kreditanstalt für Wiederaufbau
kg	Kilogramme
KNBS	Kenya National Bureau of Statistics
KNTC	Kenya National Trading Corporation



KRA Kenya Revenue Authority Ksh Kenya shillings KTDA Kenya Tea Development Agency KWh Kilowatt Hour KWp Kilowatt peak LCOE Levelised Cost of Electricity LCOH Levelised Cost of Flydrogen LCPDP Least Cost Power Development Plan LT-LEDS Long-Term Low Emissions and Development Strategy m Metre M&E Monitoring and Evaluation MTBE Methyl Tert-Butyl Ether MDB Multilateral Development Bank MITI Ministry of Investments, Trade and Industry MoALD Ministry of Agriculture and Livestock Development MoE Ministry of East African Community, the ASALs, and Regional Development MoECCF Ministry of East African Community, the ASALs, and Regional Development MoECCF Ministry of Energy and Petroleum MoPSGAA Ministry of Public Service, Gender, and Affirmative Action MoICT Ministry of Information, Communications and The Digital Economy MoLPWH Ministry of Roads and Transport MoWSI Ministry of Water, Sanitation and Irrigation MoYASA Ministry of Water, Sanitation and Irrigation MOYASA Ministry of Porth Affairs, Sports and The Arts Mt Million Tons MTP Medium Term Plan MTPA Metric Ton Per Annum MW Megawatt NCA National Construction Authority NCCAP National Cimate Change Action Plan NCPB National Cereals and Produce Board NDC National Industrial Training Authority NGC Non-Governmental Organisation NITA National Industrial Training Authority NKE Non-Key Expert NLC National Land Commission	KPLC	Kenya Power and Lighting Company
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NGO Non-Governmental Organisation NITA National Industrial Training Authority NKE Non-Key Expert	NDC	Nationally Determined Contribution
NITA National Industrial Training Authority NKE Non-Key Expert	NEMA	National Environment Management Authority
NKE Non-Key Expert	NGO	Non-Governmental Organisation
, ,	NITA	National Industrial Training Authority
NLC National Land Commission	NKE	Non-Key Expert
	NLC	National Land Commission
NZE Net Zero Emissions	NZE	Net Zero Emissions



OPEX	Operational Expenditure
PPA I	Power Purchase Agreement
PPP I	Public-Private Partnership
PTC I	Production Tax Credit
PtX I	Power-to-X
PV	Photovoltaic
RDI I	Research, Development and Innovation
RE I	Renewable Energy
RER I	Rural Electrification Program
REREC I	Rural Electrification and Renewable Energy Corporation
SAF	Sustainable Aviation Fuels
SDG :	Sustainable Development Goal
SEZ :	Special Economic Zone
SGR	Standard Gauge Railway
SWOT	Strengths, Weaknesses, Opportunities, Threats
TAF	Technical Assistance Facility
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States Dollar
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital
WARMA	Water Resource Management Authority
WRA	Water Resources Authority



EXECUTIVE SUMMARY

n line with Kenya's Vision 2030, which seeks to accelerate sustainable growth and transform the country into a competitive and prosperous country with a high quality of life, Kenya has made improving the livelihoods and welfare of its citizens a top priority through the Bottom-Up Economic Transformation Agenda. Recognising the significance of green hydrogen beyond its role as an energy source, Kenya now aims to harness its transformative potential as a cross-cutting enabler for the country's development agenda and as a catalyst for sustainable socio-economic development.

Recent years have witnessed a growing sense of urgency to transition to sustainable and clean energy sources driven by the pressing challenges of climate change and the imperative to reduce carbon emissions. Africa holds more than 10,000 GW in renewable energy potential, positioning the continent as a powerhouse that can contribute to keeping global temperature rise within the 1.5°C objective of the Paris Agreement.¹ A particularly promising avenue that has gained traction is the use of green hydrogen derived from renewable energy sources. Green hydrogen has the potential to play a pivotal role in global energy transformation, offering substantial opportunities to decarbonise various sectors, enable sustainable industrial processes, and facilitate the transition to a low-carbon future.

Amidst this global wave of interest in green hydrogen, Kenya finds itself uniquely positioned to capitalise on the unprecedented political and business momentum surrounding this nascent industry. With a remarkable track record in developing a diversified power generation mix, approximately 90% of Kenya's electricity is currently sourced from renewable energy sources.² The country has vast untapped renewable energy potential - including a leading position in geothermal power within Africa.

Exploring options for producing green hydrogen from green electricity is a logical next step in building a green economy in Kenya and is driven by a robust culture of innovation and a long-standing commitment to sustainable development. This juncture presents a unique window of opportunity for Kenya to pursue business opportunities in the emerging green hydrogen industry. By doing so Kenya can drive green economic growth, contribute to the profound socio-economic transformation of the country, and play a proactive role in global collaborative efforts to tackle the impacts of climate change. The vibrant private sector that is actively pursuing multiple green hydrogen projects in Kenya provides compelling evidence of the country's preparedness and potential in the field of green hydrogen.

² EPRA. Biannual Energy and Petroleum Statistics Report, Financial Year 2022/2023. (2023). https://www.epra.go.ke/biannual-energy-and-petroleum-statistics-report-for-the-financial-year-2022-2023/



¹ AfDB. Africa's Climate Opportunity: Adapting and thriving. (2015). https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/COP21/The_African_Development_Bank_at_the_UNFCCC_COP21_meeting.pdf



Figure 1: Kenya's unique window of opportunity in green hydrogen – sustainable economic transformation and green growth

Green hydrogen has potential applications across several important sectors in Kenya, including industry, transport, and power. Green hydrogen is a versatile feedstock in the chemical industry, specifically for the production of ammonia (used in nitrogen fertilisers) and methanol. Additionally, hydrogen can play a role in decarbonising the road transport sector, and its derivatives can decarbonise shipping (via ammonia or methanol) and aviation (via sustainable aviation fuels, SAF). Furthermore, hydrogen offers a means of energy storage and can provide baseload power in the electricity sector. However, to accelerate the establishment of a green hydrogen industry in Kenya, it is advisable to prioritise those specific applications of hydrogen that not only yield significant advantages for the country but also align with its overarching developmental objectives and broader development goals. Concurrently, these applications should demonstrate the highest potential for short-term commercial viability.

Identifying the most promising green hydrogen use cases naturally brings the agricultural sector into focus. The agricultural sector is the cornerstone of Kenya's economy, providing livelihood and employment for most of the population, while generating a large share of export earnings. The



sector additionally contributes to value addition and job creation through linkages to other sectors such as manufacturing and agro processing industries. Moreover, the agricultural sector relies entirely on imported fertilisers, leading to substantial government expenditure and subsidies on fertiliser imports and making it susceptible to fluctuations in global commodity prices, as observed in 2021 and 2022. So, investing in the agricultural value chain and establishing a domestic fertiliser production industry based on green hydrogen and ammonia represents a no-regret option for Kenya.

More generally, by substituting hydrogen commodity imports like fertiliser or methanol with domestically produced green alternatives, Kenya can foster the emergence of new industrial processes, mitigate supply risks, and reduce the uncertainties linked to market price volatility. The utilisation of green hydrogen therefore presents a promising pathway to unlock opportunities for sustainable manufacturing and drive industrialisation, aligning with the objectives of Kenya's Vision 2030, the development blueprint for the country.

Despite the growing momentum surrounding hydrogen, the vision of green hydrogen, although technically feasible, has yet to achieve commercial viability. Building a green hydrogen economy presents challenges that are present in every country seeking to embrace this energy source. The development of a market for green hydrogen and its derivatives, whether domestically or internationally, presents challenges that Kenya is not immune to. A crucial factor in any hydrogen strategy is the ability to identify early off-takers; the primary risk revolves around uncertainties related to market demand and pricing (affordability and willingness to pay) for green hydrogen and its derivative products. However, Kenya possesses a unique and advantageous starting position due its endowment with geothermal energy with its high capacity factor. More than this, with abundant wind, solar and hydro renewable energy sources, Kenya holds a further advantage in the emerging green hydrogen economy.

While green hydrogen requires long-term commitment, Kenya stands to gain substantial benefits across four key dimensions from the successful establishment of a green hydrogen industry:

- 1. Improved balance of payments: Producing green hydrogen for use as feedstock in industrial processing plants, will reduce Kenya's imports of hydrogen-based commodities like nitrogen fertiliser and methanol. Once a domestic market for green hydrogen derivatives has been established, this will also open opportunities for export, taking advantage of Kenya's strategic geographic position as a regional trading hub. Ultimately, this will enhance Kenya's balance of payments.
- 2. **Food security and resilience:** Green hydrogen has the potential to improve food security and enhance resilience by enabling the local production of nitrogen fertiliser. Fertilisers play a critical role in boosting agricultural productivity. Establishing a domestic fertiliser production industry can significantly improve the availability and accessibility of fertilisers to Kenyan



farmers, leading to increased agricultural output. The use of green fertilisers that are produced in Kenya will also promote sustainable agricultural practices and add value to agricultural produce. This self-sufficiency will also help mitigate the impact of international commodity market fluctuations, further reinforcing resilience in the agricultural sector.

- 3. **Green industrialisation and decarbonisation:** Green hydrogen can serve as a catalyst for industrialisation as it enables the establishment of manufacturing value chains dedicated to producing green hydrogen and its derivatives. This, in turn, fosters the development of various downstream industries and creates employment opportunities across the entire green hydrogen value chain. Additionally, the green hydrogen industry can act as an anchor off-taker providing the demand reliability necessary to drive the expansion of the power grid, accelerate the growth of the renewable energy sector, and ultimately improve access to electricity services for the people of Kenya. Replacing conventional hydrogen commodities derived from fossil fuels with sustainable alternatives will also contribute to global decarbonisation efforts and pave the way for the development of new export markets for low-carbon products.
- 4. **Investment in the country:** Green hydrogen has the potential to attract substantial public and private investments to Kenya, with the primary objective of establishing a green hydrogen value chain that spans various sectors and industrial applications including power generation and transmission, hydrogen production, and related downstream industrial facilities. Investing in this value chain will lead to economic diversification, job creation, and industrial growth.



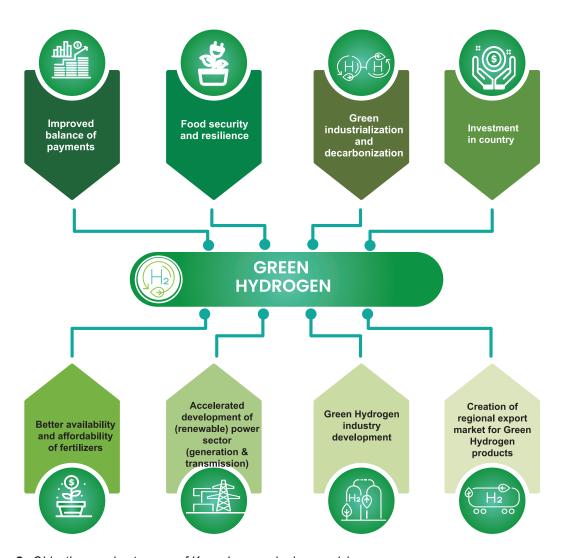


Figure 2: Objectives and outcomes of Kenya's green hydrogen vision

This is therefore an opportune moment for Kenya to launch this *Green Hydrogen Strategy and Roadmap for Kenya* and align itself with global trends in technology, applications, policy, and regulation, while also capitalising on available funding opportunities. This dedicated national hydrogen strategy is essential for Kenya, as for any country in the world aiming to establish a robust hydrogen industry, as it provides a clear vision, direction, and framework for the development of the hydrogen sector.

The *Green Hydrogen Strategy and Roadmap for Kenya* has been informed by a thorough analysis of the country's dynamics, potential and opportunities in conjunction with extensive stakeholder consultations. It highlights the country's shared green hydrogen vision for developing and utilising green hydrogen as a cross-cutting enabler for Kenya's development agenda and as a catalyst for sustainable socio-economic development. Moreover, the development of the *Green Hydrogen Strategy and Roadmap* for Kenya aligns closely with the country's national climate action plans and its commitment to the global targets outlined in the Paris Agreement.



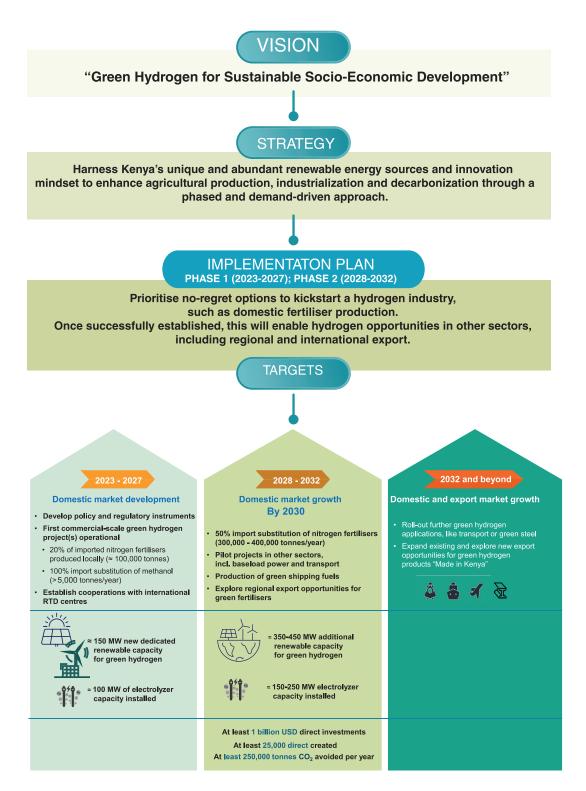


Figure 3: Kenya's green hydrogen vision and targets

The establishment of a green hydrogen industry in Kenya requires a clear and focused enabling and supportive environment based on strong and well-aligned pillars, the building blocks/enablers. These enablers collectively provide the necessary foundation, support, and conducive environment for the implementation of the *Green Hydrogen Strategy and Roadmap for Kenya* to achieve its green hydrogen vision.



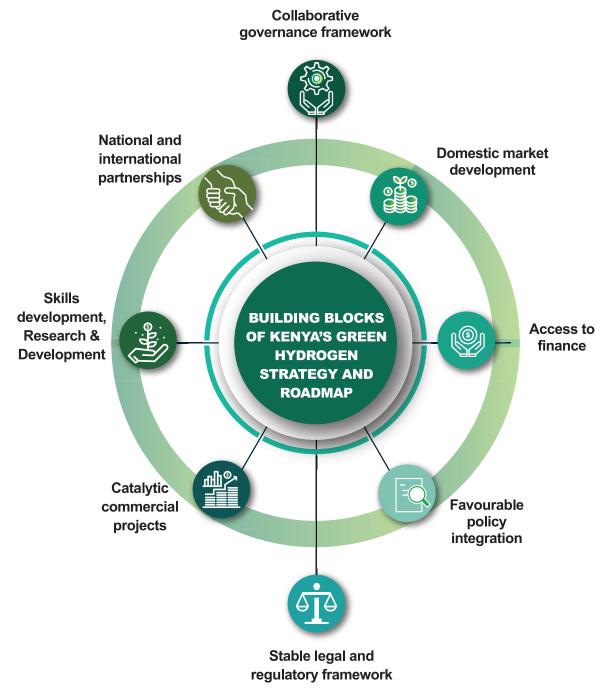


Figure 4: Building blocks of Kenya's green hydrogen vision

Translating the strategy into specific actions, milestones, and timelines helps to coordinate and guide the efforts of implementing it and provides a path for stakeholders to follow to achieve the stated objectives. This process puts in place a structured framework for collaboration among all stakeholders, from government agencies to private sector participants. By proposing a concrete action plan and establishing short-term priorities, the strategy and roadmap are meant to serve as a practical guide for decision-making within the Kenyan government and a solid foundation for the establishment of a green hydrogen industry in the country. A set of priority actions have been identified to operationalise the *Green Hydrogen Strategy and Roadmap for Kenya*:

PRIORITY ACTIONS

Q1 2024 - Q3 2024

- Establish a high-level "green hydrogen program coordination committee".
- Establish a green hydrogen secretariat to operate as a "one-stop-shop".
- Organize National Green Hydrogen roundtables on finance and green fertilizer.
- Develop a Monitoring and Evaluation Plan
- Develop a green hydrogen strategy and roadmap resource mobilization plan.
- Include dedicated provision on green hydrogen in the national energy policy.
- Support / fast track catalytic projects that demonstrate commercial viability, including implementation of KenGen's Olkaria green hydrogen demonstration project.

Q3 2024 - Q3 2025

- Develop a green hydrogen stakeholder engagement and communication plan.
- Establish local and international partnerships to scale up training and capacity building.

Q3 2024 - Q4 2026 and beyond

• Expand regional and international cooperation and partnerships on green hydrogen.

Given the nascent state of green hydrogen and the rapidly evolving nature of the industry, the strategy will be implemented in a phased manner over an initial ten-year period. This period will be split into two five-year phases, allowing for incremental learning and a gradual scale-up of initiatives as the supportive environment for green hydrogen matures. It is important to highlight that Kenya's phased green hydrogen implementation plan closely aligns with the government's developmental planning process, particularly Medium Term Plans IV (MTP IV). This alignment aims to connect priority actions for establishing a green hydrogen economy to national development planning. The initial phase (2023-2027) of the plan, corresponding to MTP IV, will primarily focus on cultivating domestic demand and implementing the first catalytic commercial projects to kickstart the hydrogen industry. Following this, during the second phase (2028-2032), the plan will consider market developments and other external factors to leverage the lessons learnt from the initial phase to explore new hydrogen opportunities such as regional export.

To ensure the success of the roadmap, it is crucial to deliver a pioneering commercial project in Kenya within the next five years. This achievement will provide a powerful demonstration of Kenya's capabilities in the field of green hydrogen and will bolster its regional and international reputation as a prime location to grow a green hydrogen industry. It will also enable Kenya to develop essential expertise, explore and foster partnerships, and make informed decisions about its involvement in the green hydrogen value chain. Moreover, it will catalyse the interest and participation of other local and international private sector players in the hydrogen industry in Kenya.



Considering the current early stage of the green hydrogen market, coordinated efforts, ambitious political targets, strategic partnerships, and active engagement with the private sector are pivotal in harnessing the potential of green hydrogen for Kenya. Specifically, Kenya must establish an effective and fit-for-purpose regulatory and institutional framework that stimulates demand for green hydrogen and creates an inviting investment environment. This will, in turn, attract private sector investment into green hydrogen initiatives within the country.

To ensure the commercial viability and bankability of green hydrogen projects and enable their successful implementation it is essential to mitigate project and market risks by adopting effective de-risking measures for projects and market functioning. Initiatives have already emerged and others are being tuned to support the development of the green hydrogen sector globally. The European Union has announced the establishment of the **Hydrogen Bank** facility, while it also supports the development of projects through the **Global Gateway strategy** to boost smart and sustainable investments including green hydrogen, the **EU-EDFI facility (EEDF)** to support investments through the **European Development Fund (EDF)**, or the **EFSD+** guarantee facility, whereas the H2-Global instrument aims to bridge cost gaps and facilitate GH2 and derivatives market functioning.

Blended financing and innovative financial instruments will play a crucial role in spurring green hydrogen investments in Kenya. As highlighted in the Nouakchott Message, Development finance institutions (DFIs), with their wealth of experience in successfully scaling up investments in renewable energy development, can play a vital role in deploying effective financing strategies and instruments to enable initial commercial projects and drive the growth of the green hydrogen industry in Kenya.





