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ECOWAS GREEN HYDROGEN REGIONAL STRATEGY AND ACTION PLANS 2023-2030 AND 2031-2050

Economic Community of Western African States (ECOWAS)

Imprint

ECOWAS Green Hydrogen Regional Strategy and Action Plans 2023-2030 and 2031-2050

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FOREWORD

The present ECOWAS Green Hydrogen Regional Strategy and Action Plans 2023-2030 and 2031-2050 were adopted by ECOWAS Ministers in charge of Energy at their meeting held on October 9, 2023, in Cotonou, Benin. These are the operationalization documents of the ECOWAS Green Hydrogen Policy and Strategy Framework adopted by the 90th Ordinary Council Session of ECOWAS Ministers, held in Bissau, Guinea Bissau, on July 6 and 7, 2023. The ECOWAS Green Hydrogen Policy and Strategy Framework aligns with the updated ECOWAS Energy Policy adopted at the same period, which promotes the development of renewable energies and energy efficiency, with particular emphasis on the need to develop clean forms of energy. Clean hydrogen is recognized as an energy source capable of decarbonizing the industrial, transport, agricultural, and power sectors. More specifically, green hydrogen, which is the most environmentally friendly form of hydrogen identified to date, is a promising solution for decarbonizing various sectors. The prominent place of green hydrogen in the mid-and long-terms decarbonization strategies of several countries around the world is a perfect illustration.

The ECOWAS regional green hydrogen strategy is multi-faceted and aims to promote this alternative energy source in the ECOWAS region, to stimulate sustainable economic growth, to reduce carbon emissions, and to enhance energy security for all Member States. It is based on short-, medium- and long-terms actions. The short-term action plan for 2023-2027 consists of laying the foundations for a viable green hydrogen ecosystem in the region, and consolidating ECREEE's pivotal role in supporting this dynamic. The medium-term action plan 2028-2030 focuses on consolidating the achievements of short-term actions. The long-term action plan 2031-2050 is based on the effective development of the green hydrogen ecosystem in ECOWAS Member States.

All these documents aim to promote green hydrogen in ECOWAS Member States, in order to contribute to strengthening regional integration in the sustainable energy sector with strong local content, while opening to other regions in Africa and the world. These texts provide clear indications in terms of institutional organization, certification schemes, infrastructure investment, capacity building, research, as well as financing mechanisms.

I would like to express my gratitude and thanks to all the stakeholders who provided their support for the development of the ECOWAS green hydrogen regional strategy and related action plans. I would like particularly to mention the German Federal Ministry of Education and Research (BMBF) and the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL).

Finally, I appeal to ECOWAS Member States and all technical and financial partners to support the implementation of the strategic documents to which all parties have subscribed.

Mr. Sédiko DOUKA
Commissioner for Infrastructure, Energy and Digitalisation
Abuja, April 8 2024

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List of Abbreviations

AFREC	The African Energy Commission
CO2	Carbon Dioxide
DRI	Direct Reduction of Iron
EBID	ECOWAS Bank for Investment and Development
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EGDC	ECOWAS Gender Development Centre
EGHDU	ECOWAS Green Hydrogen Development Unit
ERERA	ECOWAS Regional Electricity Regulatory Authority
EU	European Union
EUR	Euro
GH2	Green Hydrogen
GO	Guarantee of Origin
IRENA	International Renewable Energy Agency
kgH2	Kilogram of Hydrogen
kWh	Kilowatt-Hour
LCoE	Levelized cost of Electricity
LCoH	Levelized cost of Hydrogen
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
MT	Million Tonnes
MW	Megawatt
MWh	Megawatt-Hour
NDC	Nationally Determined Contributions
PLI	Production Linked Incentive
PNG	Piped Natural Gas
PPDU	ECOWAS Infrastructure Projects Preparation and Development Unit
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
SADC	South African Development Community
SEforALL	Sustainable Energy for All
TWh	Terawatt-hour
UEMOA	Union Economique et Monétaire Ouest Africaine
USD	United States Dollar
WAGPA	West Africa Gas Pipeline Authority
WAPP	West African Power Pool
WASCAL	West African Science Service Centre for Climate & Adapted Land Use

1.
EXECUTIVE SUMMARY

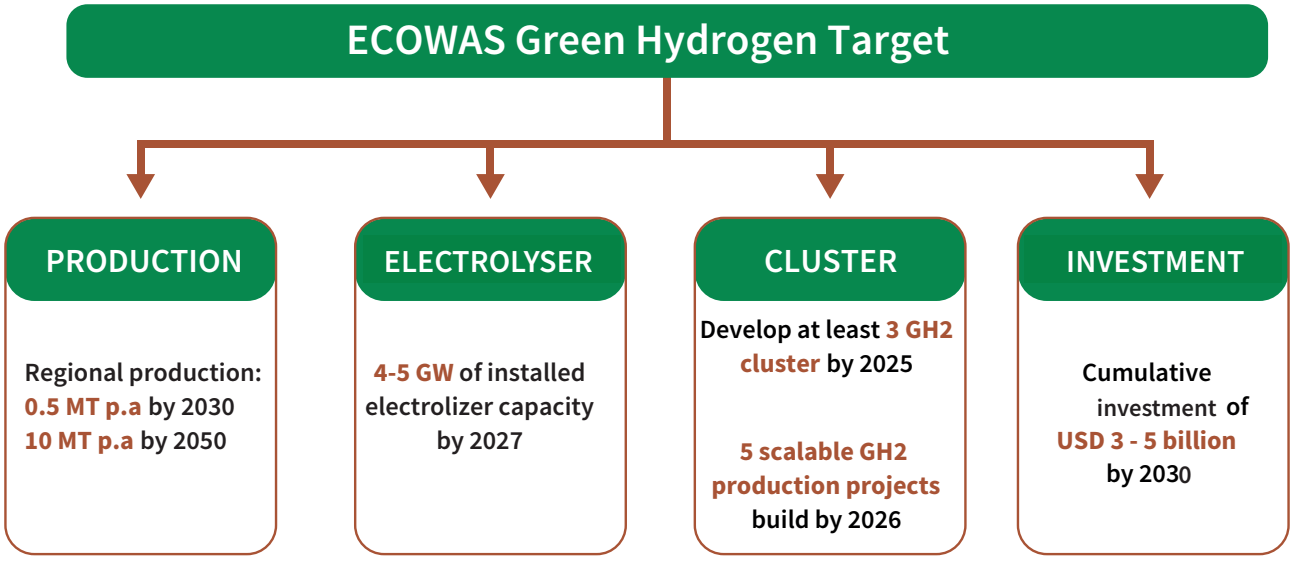
Background

The ECOWAS Green Hydrogen Policy and Strategy Framework is aligned with the updated ECOWAS Energy Policy, which aims to be ambitious and transformative as it incorporates the need to provide universal access to modern and clean energy (electricity, natural gas, butane for cooking, biogas, etc.) at a cost reasonable for the populations but also, a transition towards an energy mix based on the renewable energies available in the ECOWAS space (hydroelectricity, solar, wind and other renewable energies, and green hydrogen), on natural gas, on an improvement significant in energy efficiency.

In recent years among all renewable energy resources, green hydrogen has been the subject of growing interest within the international community. The global demand for green hydrogen has been booming with many countries having specific policies and strategies for the production and import of clean hydrogen in the coming decades.

The availability of cheap renewable energy is one of the important parameters that affect the economic viability of green hydrogen. Low-cost renewable energy potential in the ECOWAS region gives a higher edge to the region for the production of green hydrogen at a competitive price. In the most optimistic scenario, the region can produce about 35% of the total hydrogen at a price of less than USD 1.5 per kg over the next few years.

As part of the partnership between the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) and the West African Science Service Centre for Climate & Adapted Land Use (WASCAL), ECREEE developed ECOWAS Green Hydrogen Policy and Strategy Framework. The same was adopted by the ECOWAS Energy Ministers on 24th March 2023 and also by the ECOWAS Council of Ministers on 7th July 2023 in Bissau, Guinea-Bissau. The policy targets to develop three green hydrogen clusters by 2025 and scale up green hydrogen production from 0.5 MT p.a. in 2030 to 10 MT p.a. by 2050. The infographic highlighting target under ECOWAS Green Hydrogen Policy is shown below



Green hydrogen – opportunity for ECOWAS

The ECOWAS member countries contribute to less than 2% of the global GHG emissions. However, being an evolving economy, they have aligned their nationally determined contributions to reduce their emissions to the maximum extent possible while stimulating economic growth. Deployment of green hydrogen ecosystem can help ECOWAS countries in boosting economic growth and will also help in mitigating climate change issue with adoption of green hydrogen in local industries and other sectors.

ECOWAS member states can hugely benefit from resources such as solar and wind for low-cost renewable energy (RE) generation, extensive land for installing RE plant, vast coastline for desalination of water, port infrastructure for export and cost-effective workforce for production of green hydrogen. Further on the demand side, due to proximity to Europe and other countries, there exists enormous potential for export of green hydrogen and its derivatives at competitive price to demand centre. Thus, ECOWAS region can position itself as a prominent global exporter of green ammonia.

While framing the ECOWAS Green Hydrogen Policy and Strategy Framework, the following objectives were developed to position ECOWAS region as most competitive producers and suppliers of green hydrogen and its derivatives

1. Short- medium term objectives

a. Promote the development of an enabling and facilitating environment for establishment of green hydrogen industries by creating awareness, capacity and suitable legislative framework;

b. Undertake demonstration projects within the region in collaboration with relevant agencies and Member States;

c. To develop strategic long-term roadmap for development of green hydrogen consumption within the region;

d. To promote investments in supporting infrastructure required for green hydrogen investments;

e. To establish strategic partnerships for investments, technology supply and financing with private and governmental agencies.

2. Long term objectives

a. To become a competitive supplier of green hydrogen in the world

b. To improve the share of sustainable energy in the region through facilitation of green hydrogen as an energy resource;

c. To improve the energy security and cli mate change resilience of the region;

d. To promote sustainable industrial development;

e. Promote equitable socio-economic and gender development

Strategy for implementation of green hydrogen policy and strategy framework

A multifaceted strategy as highlighted below is adopted for promoting green hydrogen ecosystem in the ECOWAS region.

- **Formation of ECOWAS Green Hydrogen Development Unit (EGHDU):** EGHDU will act as a dedicated regional Green Hydrogen nodal agency that will collaborate with various departments/ agencies such as water, energy, finance, transportation, infrastructure development, training institute, and regulatory institutes to create an ecosystem for the green hydrogen.

- **Selection of Target Market:** In the short and medium term, export market will be targeted as regional demand is limited and there is a need for viability gap funding to create local demand.

In the long-term when the cost of green hydrogen reduces with advancements in technology and reduction in RE cost local demand is expected to grow.

- **Clear policy and guidelines on various aspects:** Policy and guidelines will be developed in alignment with international standards to boost the investor's confidence.

- **Market Development:** Export and local markets will be developed considering the demand and cost of green hydrogen and its derivatives in the medium and long term.

- **Capacity Building and Sensitization:** Capacity building training modules/ programs shall be tailored according to the gaps identified in the knowledge of various stakeholders such as entrepreneurs, financing institutions, government officials, investors, and skilled workforce.

- **Financial mechanism:** Investment of approximately USD 15 billion and USD 300 billion is required to meet the production target of 0.5 MT/ year and 10 MT/year by 2030 and 2050 respectively. Thus, innovative funding mechanisms and business models will be explored.

- **Research and Development:** Research Centres will be developed in association with different academic institutions and industries to carry out cutting-edge research. Exchange programs will also be initiated with leading institutes in the world.

- **Infrastructure Development:** The strategy involves fostering the growth of green hydrogen production clusters, and renewable energy plants, desalination plants, ports, storage and transport infrastructure.

Action plan for Implementation of green hydrogen policy and strategy framework

actions need to be adopted in short, medium and long term.

The ECOWAS green hydrogen policy and strategy framework is developed with the strategic vision of positioning the region as one of the most competitive producers and suppliers of green hydrogen and its derivatives while addressing socio-economic growth and sustainable development of all member states. To meet of the green hydrogen policy objectives, several

Short term action Plan (2024-2027): The focus of the short-term action plan is to laydown foundation for green hydrogen ecosystem in the region by operationalization of EGHDU, development of policy and regulatory framework, capacity building of various stakeholders, R&D, assessment of infrastructure requirement and export market development.

Medium-term action Plan (2028-2030): The focus of medium-term action plan is to build upon the foundation established in the short term. During this period, engagement with various countries/ organisation will be established on multifront such as export, R&D, exchange program by signing of memorandum of understanding. Policies will be developed and financial mechanism will be explored for the promotion of green hydrogen in the region. Infrastructure development such as port, RE cluster, GH2 Production cluster will also be initiated during this period.

Long-term action Plan (2031-2050): The focus of long-term action plan is to develop green hydrogen ecosystem across ECOWAS member states. This phase is characterized by widespread adoption and integration of green hydrogen technologies into the overall energy landscape. The key components of short-, medium- and long-term action plan is highlighted in Table 1 below.

Key Action	Short Term Prospective	Medium-Term Prospective	Long-Term Prospective
Establishing an Efficient Institutional Framework	• Operationalize the EGHDU • Formation of Regional Steering Committee • Identify and collaborate with key institutions	• Engagement with various multilateral agencies by signing of MoUs	• Review and amendment of Institutional Framework • Socio-Economic Development
Establishing a Harmonious Regulatory Framework	• Establishing a comprehensive regulatory framework and supporting policies • Development of National Green Hydrogen Policies • GH2 Management Committee in each country. • Development of Guarantee of Origin certification • Develop Framework for technical and safety standards	Development of Policy for the regional market	• Blending Target in various sectors • Cater Climate Change Issue • Regional Energy Security
Capacity Building and Sensitization	• Develop training topics/ modules based on an assessment of stakeholders' competencies. • Identify and support Centers of Excellence • Introduction of Green Hydrogen in Academics	• Review and Update Training Module	• Review and Update Training Module
Research and Development	• Collaborative R&D by establishing public-private partnership framework • Undertake Demonstration projects • Develop Research Centers	• Undertake Pilot Project: • Develop a certification scheme based on the pilot	• R&D for repurposing of hard to abate Sector
Facilitating Infrastructure Development	• Feasibility study of Green Hydrogen Clusters • Feasibility study on Port and Gas Pipeline	• Port and Cluster development • Assessment of existing and potential infrastructure	• Development of Special economic zone
Financing Support	• Fund Mobilization • Development of Green Hydrogen Sovereign Fund Framework • Soliciting Investments	• Develop Incentive Mechanism • Promote PPP collaboration	• Incentive Mechanism
Market Development	• Long Term Contract	• Participation in International tender, open bidding	• Local demand aggregation

Communication Action Plan

The communication action plan aims to support the policy through the establishment of communication channels and activities. Its objectives are as follows:

- Facilitating timely and comprehensive information sharing with all stakeholders to ensure transparency throughout the process.
- Valuing the opinions and concerns of target audience, elevating their involvement in decision-making.
- Re-strategizing the project timeline, milestones and activities based on the evaluation results.

Monitoring and Evaluation Mechanism

A well thought out ECOWAS monitoring and evaluation framework can assist greatly with thinking through programmatic strategies, objectives and planned activities, and whether they are indeed the most appropriate ones to implement.

The basic objective of a Monitoring and evaluation framework is:

- Assist in understanding and analysing the ECOWAS policy and strategy framework.
- Help to develop sound monitoring and evaluation plans and implementation of monitoring and evaluation activities.
- Articulate programme goals and measurable short, medium and long-term objectives
- Define relationships among inputs, outputs, outcomes and impact.
- Clarify the relationship between programme activities and external factors.
- Demonstrate how activities will lead to desired outcomes and impacts.

Risk assessment and mitigation mechanisms

Identifying and comprehending potential risks and challenges intrinsic to the implementation of the green hydrogen strategy is crucial.

There are several risks such as Offtake Risk, Market Risk, Technology Risk, Execution Risk, Regulatory Risk, Operational Risk, Construction risk- the system does not meet the guarantee, Construction risk-delay, Interest rate risk, Escalation risk, Safety risk that can hinder in achievement of target as set up in ECOWAS green hydrogen policy and strategy framework. To address these challenges, a robust risk mitigation measure will be undertaken during the implementation of green hydrogen policy.

2.
INTRODUCTION

Background

Green hydrogen is recognised as an energy source which can play a crucial role in decarbonisation of industrial, transportation, agricultural and power sector. It is produced via electrolysis process using renewable energy and emits zero emissions when used for various applications. Because of its enormous potential to replace fossil fuel and decarbonize various sectors, the interest for green hydrogen and its derivatives has increased across the globe in the last few years. ECOWAS countries having low-cost renewable energy (as low as 2 EUR cent/ kWh in some regions) and proximity to demand centre have sensed the opportunity of being competitive producer of green hydrogen (in range of 4.30 EUR cent/kg to 7.10 EUR cent/kg by 2030). To take advantage of available resources, ECREEE and WASCAL initiated early steps for establishing ecosystem for green hydrogen production in the region. After continuous and dedicated efforts, the ECOWAS Green Hydrogen Policy and Strategy Framework, was developed and adopted by the ECOWAS Energy Ministers on 24th March 2023 and by the ECOWAS Council of Ministers on 7th July 2023 at Bissau, Guinea Bissau.

The ECOWAS Green Hydrogen Policy and Strategy Framework is aligned with the updated ECOWAS Energy Policy, which aims to be ambitious and transformative as it incorporates the need to provide universal access to modern and clean energy (electricity, natural gas, butane for cooking, biogas, etc.) at a cost reasonable for the populations but also, a transition towards an energy mix based on the renewable energies available in the ECOWAS space (hydroelectricity, solar, wind and other renewable energies, and green hydrogen), on natural gas, on an improvement significant in energy efficiency. To have flourishing green hydrogen economy, ECOWAS green hydrogen policy and strategy framework has set target in multiple dimensions as shown in Figure 1 below. To achieve the same, various objectives have been set for short-, medium- and long-term prospective, as detailed out in previously developed ECOWAS green hydrogen policy and strategy framework. Now, there exists a need for development of implementation strategy and action plan to drive the ecosystem of green hydrogen as discussed in the present document

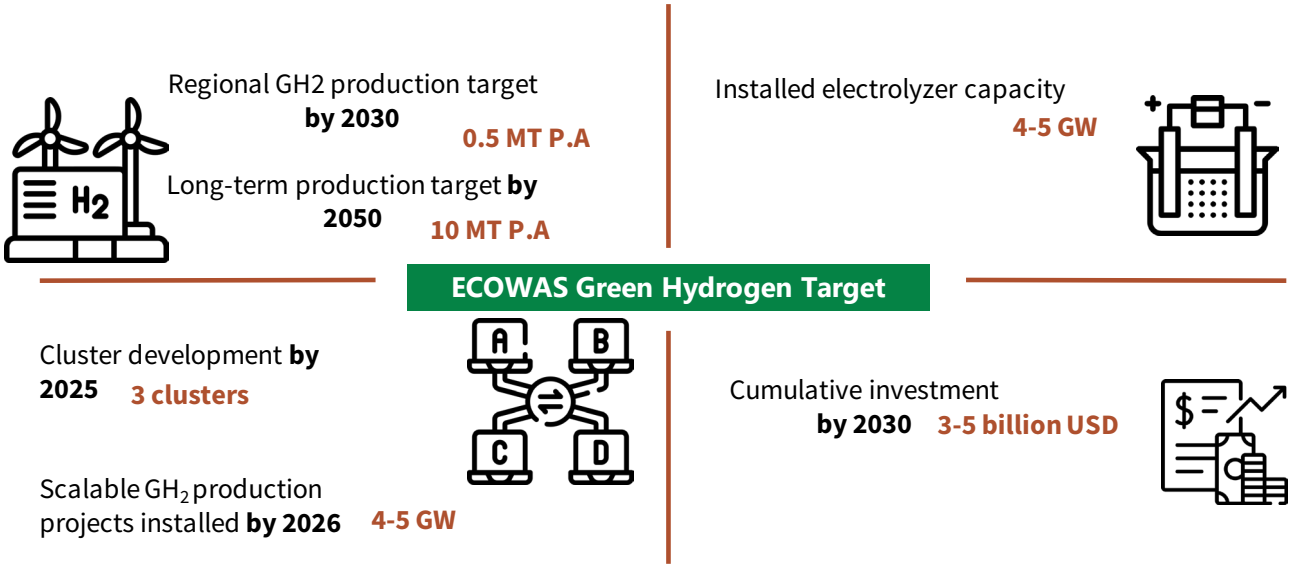


Figure 1: ECOWAS Green Hydrogen Policy target

Structure for regional strategy and action plan for implementation of Green Hydrogen Policy and Strategy Framework Document

The present document describes the regional strategy and action plan for implementation of the Green Hydrogen Policy and Strategy Framework in the short, medium and long term. The unique opportunities with the ECOWAS region such as low-cost renewable energy, proximity to demand centre, infrastructure availability and regional collaboration between member states for becoming a competitive producer of green hydrogen are highlighted in Chapter 3.
The guiding principle and implementation strategy for establishing Green Hydrogen ecosystem in the ECOWAS region is given in detail in Chapter 4. Chapter 5 highlights action plans that need to be taken in multiple directions in the short, medium, and long term to achieve a production target of 0.5 MT/year by 2030 and 10 MT/year by 2050. Monitoring and Evaluation (M&E) frameworks that are essential tools for tracking the progress, effectiveness, and impact of initiatives are given in detail in Chapter 6. The communication action plan which aims to support the policy through the establishment of communication channels and activities is given in detail in Chapter 7. Various risks that can occur during the implementation of action plans and their possible mitigation measures are given in Chapter 8

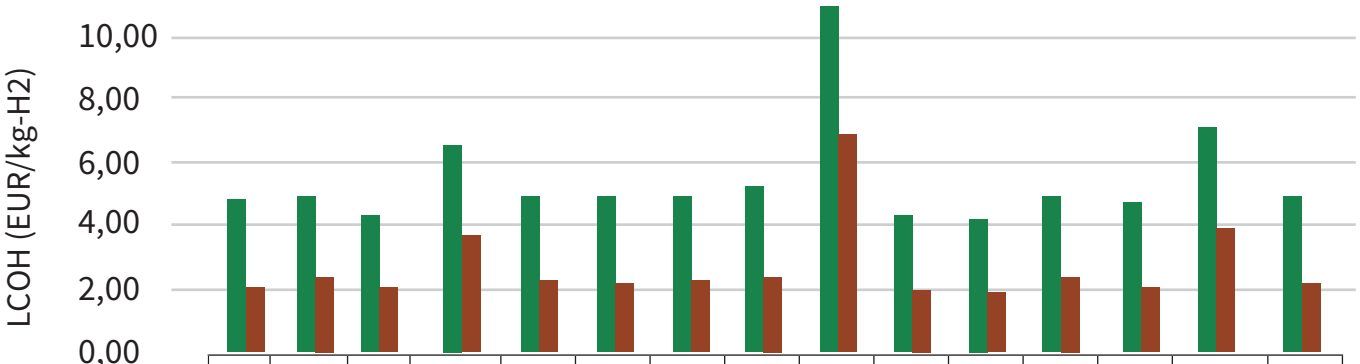
A summary of the action plan for the short, medium and long term with details of the implementing actors, estimated budget requirements, and timeline is given in the Annexure.

3.
RATIONALE

3 Green Hydrogen- Unique Opportunity for ECOWAS

The ECOWAS countries contribute to less than 2% of the global GHG emissions. However, being an evolving economies, these countries have aligned their nationally determined contributions to reduce their emissions to the maximum extent possible while stimulating economic growth. Development of green hydrogen ecosystem will help the region to enhance economy growth and will also help in catering climate change issue when green hydrogen demand in local industry will increase with decrease in green hydrogen cost and its derivatives.

ECOWAS Green Hydrogen Policy & Strategy framework highlights enormous potential of the region to become a cost-competitive producer of green hydrogen (in range of 4.30 EUR cent/kg to 7.10 EUR cent/kg by 2030 and in range of 2.20 EUR cent/kg to 6.9 EUR cent/kg by 2050) as shown in Figure 2 below. ECOWAS member states can hugely benefit from the available resources such as low-cost renewable energy (RE), extensive land availability for harnessing RE, vast coastline for desalination of water, port availability and cost-competitive manpower for production of green hydrogen.



	Benin	Burkina Faso	Cabo Verde	Côte d'ivoire	The Gam-bia	Ghana	Guinea	Guinea Bissau	Liberia	Mali	Niger	Nigeria	Sene-gal	Sierra Leonne	Togo
Avg LCOH (2020)	4,90	5,00	4,40	6,60	5,00	5,10	5,00	5,30	10,80	4,40	4,30	5,00	4,80	7,10	5,00
Avg LCOH (2050)	2,90	2,50	2,20	3,80	2,40	2,30	2,40	2,50	6,90	2,10	2,00	2,50	2,20	4,00	2,30

Figure 2: GH2 production cost in 2030 and 2050 in ECOWAS region

On the demand side, due to proximity to Europe and other countries, there exists enormous potential for export of green hydrogen and its derivatives at competitive price to demand centre. Thus, ECOWAS can position itself as a prominent global exporter of green ammonia. On the other side, ECOWAS countries having limited presence of iron & steel, fertilizer, refinery and cement industries, constitute small demand of the total hydrogen production potential in the region.

Also, regional demand of green hydrogen in sectors like transportation and power seems to remain low in near future due to their nascent stage.

In the first phase of implementation, the ECOWAS region will focus on green hydrogen production and exports. Whereas the regional market for consumption will be targeted in the medium and long-term.

The strengths of ECOWAS that can position the region as a cost-competitive global exporter of green hydrogen and its derivatives are as follows:

[1]https://africa.h2atlas.de/ecowas

3.1 Extensive Resources Availability (RE, Water, Human resource etc.)

ECOWAS region has high RE production potential for open field solar photovoltaic as well as onshore and offshore wind farms. Average levelized cost of electricity (LCOE) for open-field photovoltaic in ECOWAS ranges from as low as 2 EUR cent/kWh in the northern parts up to 4 EUR cent/kWh in the South . Hence, the open field PV provide the lowest cost of generation as they are primarily located in the northern regions. The cheap electricity cost stems from high solar radiation intensity and long sunshine duration observed throughout the year. Onshore and offshore wind installations costs between 2 and 15 EUR cent/kWh . The offshore values are significantly higher than the onshore values due to poor wind conditions along the coast.

The ECOWAS region's strategic geographical advantage, abundant in wind, water and solar resources, offers significant potential for the early establishment of large-scale hydrogen production, firmly positioning ECOWAS as a cost-competitive supplier in the global green hydrogen ecosystem.

The resource availability in ECOWAS region is shown in Figure 3 below.

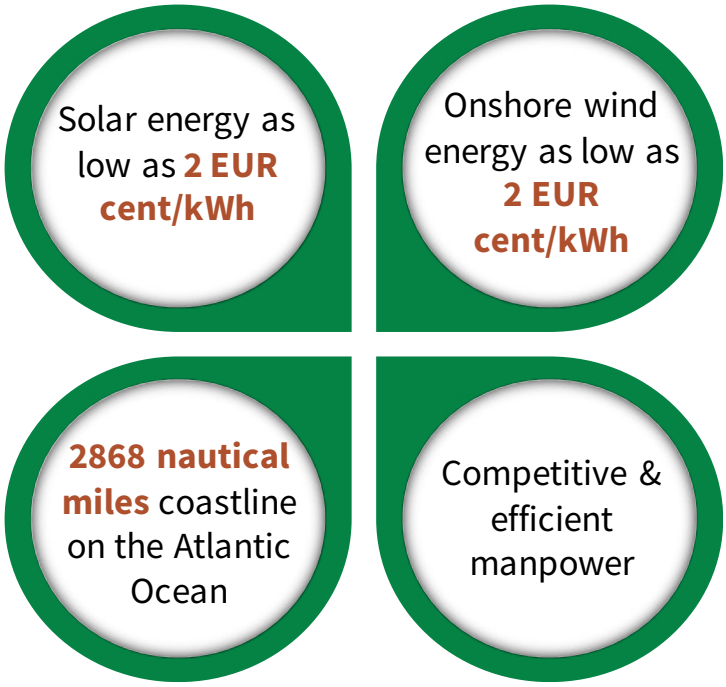


Figure 3: Resource availability in ECOWAS region

3.2 Proximity to International Demand Centre

As per REPowerEU revisions (2022) , European countries aim to import 10 Mt of renewable hydrogen, by 2030. Due to ECOWAS close geographical proximity to centres of demand in Europe, ECOWAS can gain favourable transport connectivity. The shipping distance between ports in ECOWAS region and importing countries is shown in Table 2 below. The region can benefit from reduced shipping costs and shorter transit times compared to other potential hydrogen-exporting nations.

As estimated by H2 ATLAS, WASCAL
REPowerEU revisions- https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

WAPCo's West Africa Gas Pipeline (WAGP) has the potential for hydrogen transportation and serve as the foundation for the recently initiated Nigeria-Morocco Pipeline project, with potential extensions towards Europe.

Table 2: Distance between the port in ECOWAS region and important importing countries (in KM)

IMPORTING COUNTRY									
Exporting Country	**PORT**	**USA**	**UK**	**France**	**Norway**	**Morocco**	**Germany**	**Turkey**	**Belgium**
Benin	Cotonou	11714	8469	8167	9517	6025	9154	10101	8471
Cabo Verde	Praia	7923	5828	5525	6876	3384	6512	7458	5830
	Grande Mindelo	7601	5780	5476	6828	3335	6463	7410	5782
Senegal	Dakar	8606	5356	5052	6404	2911	6039	6986	5358
Cote D'Ivoire	Abidjan	5072	7780	7478	8828	5336	8465	9410	7782
	San Pedro	10651	7406	7104	8454	4962	8091	9856	8227
Ghana	Tema	11469	8227	7923	9273	5780	8910	9856	8227
	Takoradi	11279	8034	7732	9082	5589	8719	9664	8036
Guinea Bissau	Port of Bissau	9247	6004	5700	7051	3558	6688	7634	6004
Guinea	Conakry	9280	6234	5930	7280	3787	6917	7864	6234
The Gambia	Banjul	8836	5599	5295	6647	3154	6282	7228	5600
Liberia	Monrovia	10330	7049	6747	8097	4604	7734	8678	7051
	Buchanan	10262	7019	6715	8065	4573	7702	8649	7019
	Greenville	9516	7160	6858	8208	4715	7845	8791	7162
	Harper	10586	7343	7039	8390	4897	8027	8973	7343
Togo	Lomé	11636	8360	8056	9406	5913	9043	9990	8360
Nigeria	Apapa	11860	8617	8314	9664	6171	9301	10247	8617
	Tin Can	11860	8617	8314	9664	6171	9301	10247	8617
	Harcourt	12277	9006	8703	10053	6560	9690	10636	9006
	Calabar	12377	9134	8830	10180	6688	9817	10764	9134
	Onne	12277	9006	8703	10053	6560	9690	10636	9006
	Warri	12084	8840	8536	9888	6393	9523	10469	8841
Sierra Leone	Freetown	9758	6515	6212	7562	4069	7199	8145	6515
	Pepel	9747	6504	6200	7551	4058	7188	8134	6504

3.3 Export Infrastructure Availability and Development

ECOWAS member states have an extensive coastline that stretches across thousands of kilometres along the Atlantic Ocean. This coastline provides a valuable strength for the establishment of port infrastructures that facilitate competitive export of green hydrogen and related commodities. Ports play a crucial role in facilitating the movement of goods, including energy commodities like green hydrogen. The existing port facilities can be strategically leveraged for the export of green hydrogen to international markets, especially considering the rising demand for clean energy carriers and the potential for global energy transition.

While the existing port infrastructure provides a foundational advantage for green hydrogen exports, it's important to acknowledge that further developing and adapting these facilities to support large-scale hydrogen export will require significant investment. These investments are crucial to ensure the efficient, safe, and cost-effective production and export of green hydrogen. Governments, international financial institutions, private investors, and partnerships between countries can play a role in mobilizing the necessary funds to upgrade and expand port facilities, as well as to establish the integrated infrastructure required for green hydrogen transportation.

3.4 Regional Collaboration Between ECOWAS Member States

The exists several policies and programmes that foster collaboration and cooperation among ECOWAS member states and play an important role in enhancing the region's competitive edge in green hydrogen, Moreover, it will enable each member state to reap the benefits of green hydrogen advancements in the region. The regional policy and program suitable for green hydrogen ecosystem are as follows:

- **ECOWAS Energy Policy**- It requires Member States to coordinate and harmonize national policies and programs in the field of energy.

- **ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)**- The Agency aims to improve energy access, energy security, combat climate change and reduce carbon emissions in ECOWAS Member States. The activities of the agency cover a range of areas, including policy development, capacity building, resource assessment, knowledge management, and investment promotion.

- **ECOWAS Renewable Energy Policy (EREP)**- The policy ensures increased use of renewable energy sources such as solar, wind, small-scale hydro, and bioenergy for grid electricity supply and the provision of access to energy services in rural areas.

- **Sustainable Energy for All (SEforALL)**- Drive faster action towards the achievement of Sustainable Development Goal 7 (SDG7) which calls for universal access to affordable, reliable, sustainable and modern energy for all by 2030.

- **West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)**- The agency works to strengthen the research infrastructure and capacity in West Africa related to climate change by pooling the expertise of ten West African countries and Germany.

- **West African Power Pool (WAPP)**- It promote and develops infrastructure for power generation and transmission as well as coordinates electric power exchanges between ECOWAS Member States.

4.
STRATEGY

4 Guiding Principles and Strategy

4.1 SWOT Analysis and Guiding Principles

As highlighted in ECOWAS green hydrogen policy and strategy framework, the ECOWAS region aims to become one of the most competitive suppliers of green hydrogen and its derivatives in the world, with a production target of at least 0.5 million tonnes of GH2 per annum by 2030 and at least 10 million tonnes by 2050. This is expected to yield an annual revenue of nearly USD 1.25 billion per year by 2030. To achieve the target, SWOT analysis is carried out for the ECOWAS region as shown in Figure 4 below.

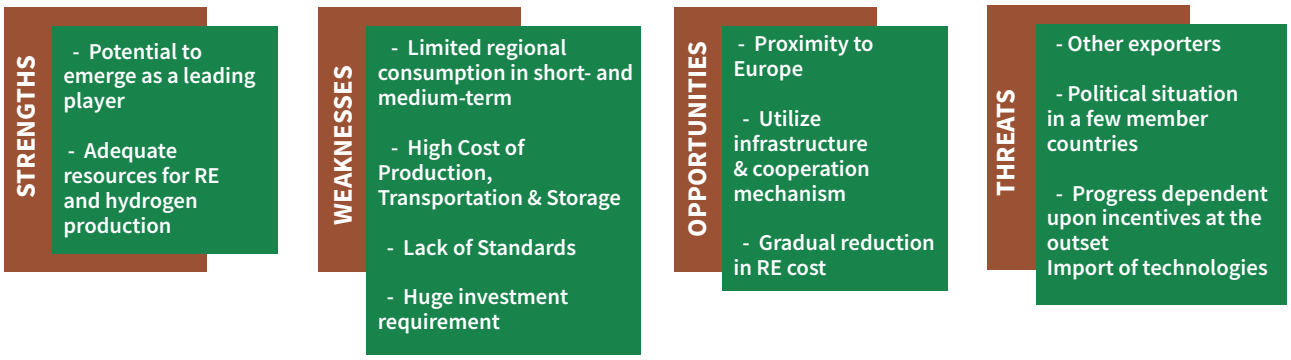


Figure 4: SWOT analysis for the implementation of GH2 policy

The SWOT analysis for the ECOWAS region to develop GH2 ecosystem:

Strength: Abundant Renewable Energy Sources

ECOWAS (Economic Community of West African States) possesses a significant advantage in terms of its potential to become a prominent player in the emerging green hydrogen industry. This strength arises from the region's abundant renewable energy resources. Renewable sources like solar, wind, and hydroelectric power are prevalent in many ECOWAS member states. These sources can be harnessed to produce green hydrogen through electrolysis. This abundance of renewable energy positions ECOWAS as a leading player in the global green hydrogen market.

Weakness: Limited Regional Consumption and Manufacturing Expertise

Despite its potential, ECOWAS faces certain weaknesses in its green hydrogen ambitions. One such weakness is the limited regional consumption of green hydrogen in the short and medium term due to high cost.

Green hydrogen technology is in early stage, thus cost of production, transportation and storage is quite high in present case scenario. Green hydrogen ecosystem requires significant infrastructure development in various sectors like transportation, industry, and power generation. Additionally, the region lacks expertise in the manufacturing of critical equipment required for the production of green hydrogen. This manufacturing gap could lead to reliance on imported technology for electrolysers, which

may impact the overall cost-effectiveness and competitiveness of green hydrogen production within the region.

Opportunities: Proximity to European Markets and Infrastructure

ECOWAS Member States have a strategic geographical advantage due to their proximity to Europe, a major global hub for imports. This proximity opens up opportunities for exporting green hydrogen to European markets, where there is a growing demand for clean energy carriers to support decarbonization efforts. Moreover, the region can leverage existing infrastructure and cooperation mechanisms established by the West Africa Power Pool, which facilitates the exchange of electricity across the member states. This infrastructure can potentially be adapted or expanded to support the distribution of green hydrogen within the region. The ongoing advancements in technology and the decreasing costs of renewable energy sources and electrolysis technology offer a significant opportunity for ECOWAS to make green hydrogen production cost-effective across various industries and sectors. This technological progress can enable the region to rapidly establish a competitive advantage in green hydrogen production and accelerate its adoption in a relatively short period.

Threats: Competition, Political Situations, and Technology Import

One of the major threats to ECOWAS is competition from other leading green hydrogen exporters. As the global green hydrogen market evolves, other countries and regions may also develop their production capacities, leading to potential price competition and market saturation. Political situations in some member states could impact the availability of financial investments from funding institutions. Political instability, regulatory uncertainties, or changes in government priorities could deter potential investors and slow down the progress of green hydrogen projects.

As the green hydrogen industry in ECOWAS is still in its initial stages, its advancement heavily relies on incentives such as government policies, subsidies, and international partnerships. Changes in these incentives could significantly affect the pace of development. Furthermore, the import of technologies required for green hydrogen production could act as a constraint. Reliance on foreign technology suppliers might lead to issues such as technology transfer limitations, dependency on external sources, and potential intellectual property challenges.

In conclusion, ECOWAS has significant strengths such as abundant renewable energy resources and geographical proximity to major markets, but it also faces weaknesses in terms of limited consumption, manufacturing expertise, and potential threats from competition and political instability. By capitalizing on opportunities and addressing threats, the region can work towards establishing itself as a competitive player in the global green hydrogen landscape.

Implementation of ECOWAS green hydrogen policy follows several guiding principles as shown in Figure 5 below.

- **Clear role and responsibility-** Development of clear role and responsibility of various stakeholder and agencies to ensure seamless flow of communication.

- **Flourish Green hydrogen economy-** Promote investment through a conducive business ecosystem for various stakeholders involved across the entire value chain of green hydrogen/ ammonia. Incentives support in the form of subsidies on CAPEX & interest, tax reimbursement, exemption of stamp duty, wheeling charges exemption on electricity etc.

- **Strengthening and focusing on regional infrastructure-** Seamless use of available resources and infrastructure and regional support among ECOWAS member states for infrastructure

development.

• **Foster collaboration-** Establishing trust among stakeholders for adoption of green hydrogen and its derivatives and support for research and development activities to reduce costs.

• **Competitive supplier of GH2 & Derivatives-** Development of policy and initiatives to become competitive supplier of green hydrogen and its derivatives across the world.

• **Socio-economic development-** Ensure involvement of regional and local communities in the deployment of green hydrogen value chain.

• **Matching International benchmarks-** Establish policies and develop regulations meeting international benchmark for production of green hydrogen and its derivatives

• **Which Market to Cater to in the short-**medium- and long-term

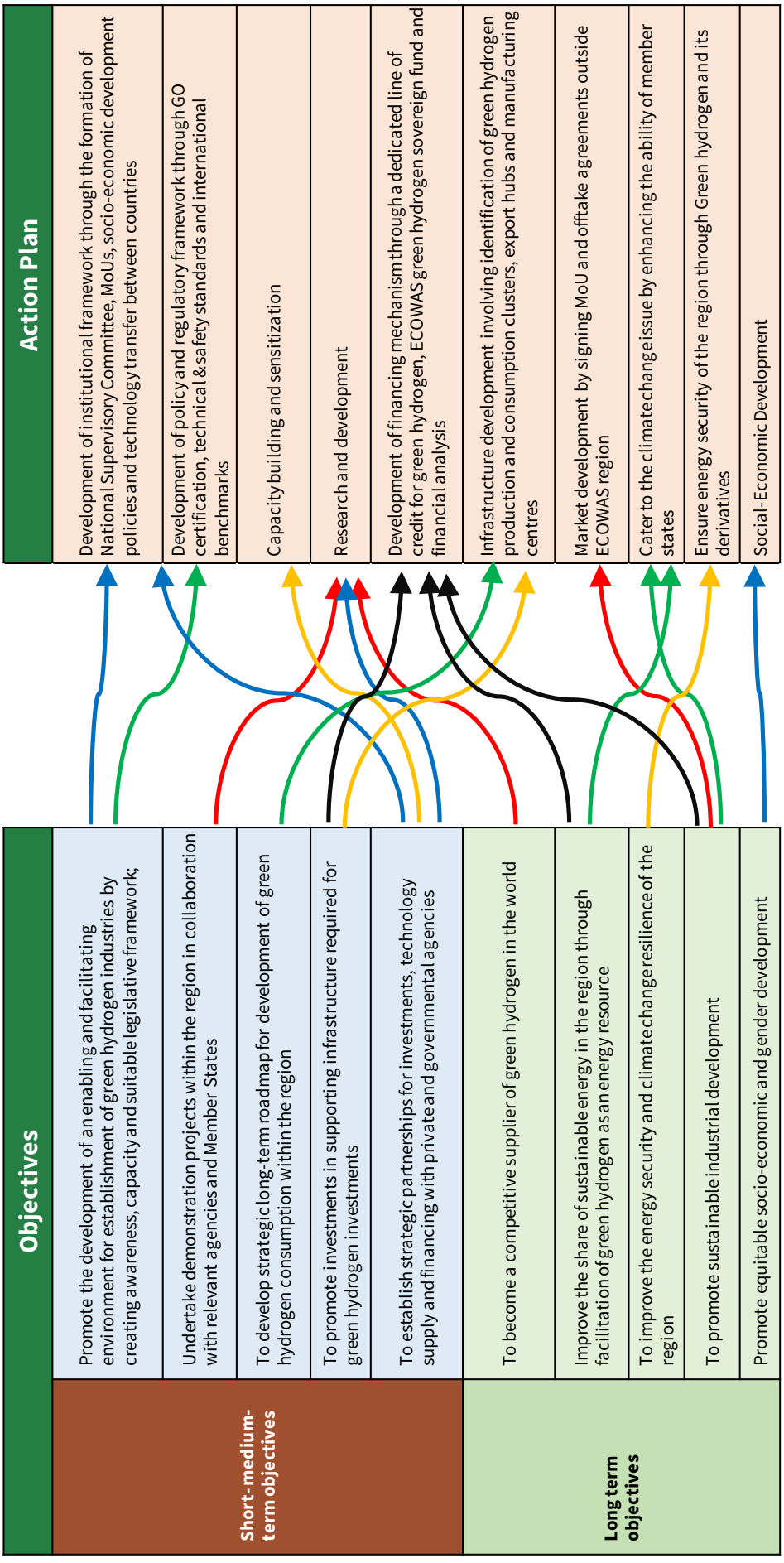
• **Investment Requirement:** Looking for funding sources as there is a limitation of funds

To meet the short-, medium- and long-term objectives of the green hydrogen policy, several actions have to be taken by various agencies/ organizations.

For example, for creating a favorable ecosystem/ environment which boosts investor confidence, policies and regulatory framework such as GoO certification, safety and technical standards will be developed in alignment with international benchmark. Figure 6 highlights mapping of all the strategic actions for achieving objectives of the ECOWAS Green Hydrogen Policy and Strategy Framework.

Figure 5: Guiding principles for implementation of GH2 policy and strategy framework

Figure 6: Mapping of ECOWAS Green Hydrogen Policy Objectives with Action Plan



Clear policy and guidelines on various aspects

- Establish a credible certification mechanism for green hydrogen production.
- Alignment of safety standards with international requirements

Institutional Framework

- Formulation of central nodal agency
- Ensure regional framework.
- Facilitate following but not limited to
- Research and development
- Capacity building,
- Monitoring and evaluation
- Investments in the region

Market Development

- Selection of target market
- Market building through local demand aggregation, model & off-take agreements, competitive bidding process.
- Project development through decentralised mode of production

Capacity Building

- Identify training topics and prepare training modules for stakeholders
- Include green hydrogen and renewable energy in academic courses
- Exchange program

Infrastructure Development

- Identify clusters for
- Green hydrogen Production,
- Renewable energy Plants
- Local manufacturing
- Development of existing ports
- Storage infrastructure
- Desalination plants near clusters

Financial

- Evaluate fiscal incentives
- Explore inventive funding mechanisms and incorporate PPPs
- Opt for bids denominated in foreign currency to mitigate exchange rate risks

Research and Development

- Demonstration projects
- Project development through decentralised mode of production

4.2 Strategy for Implementation of Regional Green Hydrogen Policy and Strategy Framework

S1 Formation of ECOWAS Green Hydrogen Development Unit (EGHDU)

Involvement of Agencies/Departments required for Institutional Framework

There is need for establishment of dedicated Nodal agency that collaborate with various departments/ agencies such as water, energy, finance, transportation, infrastructure development, training institute, policy formation body to create ecosystem for the green hydrogen as illustrated in Figure 7 below.

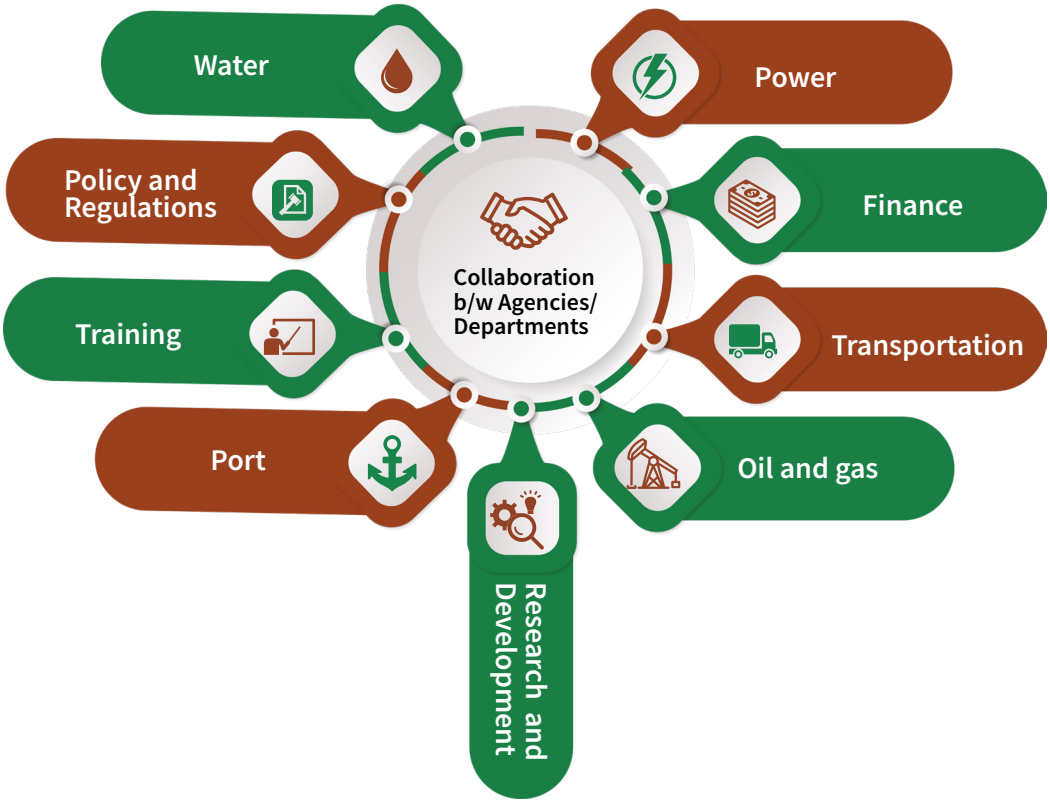


Figure 7: Collaboration between various Agencies/ Department for establishment of GH2 Ecosystem

The ECOWAS Green Hydrogen Policy and Strategy Framework makes the provision for a unit within ECREEE for the development of green hydrogen at the institutional level. The ECOWAS Green Hydrogen Development Unit will be responsible for overall coordination and execution of the "Development of Regional Strategy and Action Plan for Implementation of Green Hydrogen Policy and Strategy Framework" within different institutions across ECOWAS member states. Institutional Framework for ECOWAS Green Hydrogen Development Unit (EGHDU) is shown in Figure 8 below. EGHD will collaborate with the following organisations performing the aforementioned roles:

1. **ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)-** It is the nodal agency for renewable energy that will assess the feasibility of renewable energy sources for green hydrogen and identify locations for the installation of renewable energy plants. It will also provide support to existing green hydrogen projects by facilitating renewable energy storage

and open access energy sources.

2. ECOWAS Regional Electricity Regulatory Authority (ERERA)- It is the nodal agency for development of regional electricity market that will oversight the development of infrastructure and regulatory frameworks to ensure transmission of renewable energy for green hydrogen production at minimum costs. It will also establish standards and protocols for green hydrogen including extensive development of the necessary infrastructure of the power system infrastructure. A working group will be formed to discuss matters related to green hydrogen.

3. West African Power Pool (WAPP)- It is the agency for development of infrastructure for cross border trade of electricity that will facilitate renewable energy for green hydrogen production and help in expediting negotiations as well as agreements.

4. ECOWAS Bank for Investment and Development (EBID)- It is involved in funding of development projects. It assesses the financial viability of green hydrogen projects and facilitates their access to funding and investments.

5. ECOWAS Infrastructure Projects Preparation and Development Unit (PPDU)- It is the agency for the development of regional infrastructure for Transport, Energy and Water in ECOWAS. It will assess the infrastructure requirements through testing facilities and pilot projects. The representatives from PPDU will collaborate with stakeholders for the distribution of green hydrogen. This will facilitate development of latest technology and provide aid infrastructural development in the region.

6. ECOWAS Gender Development Centre (EGDC)-It will promote gender equitable investment in the region by coordinating with EGHDU and other units for promoting women's participation in this growing sector. Suitable gender impact assessments will also be conducted by experts at regular intervals.

7. ECOWAS Directorate of Energy and Mines- It will play a supervisory role and coordinate with the ECOWAS Energy Agencies. It will also facilitate the development of regulations through aforementioned energy agencies. This will ensure the development of new projects with maximum possible green hydrogen deployment to substitute for the reliance on fossil fuel by the refineries.

8. The national level representatives from ministry of energy and industries will represent ministry's interests in forums and provide strategic guidance and support. They will undertake dialogue to facilitate communication across stakeholders in different departments.

9. UEMOA Regional Monetary Authority- It plays a crucial role in streamlining and harmonizing legal aspects pertaining to sharing or trade of renewable energy and green hydrogen. It will also ensure the creation of a common market for green hydrogen and its derivatives. This sub-unit is formed to strengthen the economic and financial competitiveness of the member states.

10. West African Science Service Center on Climate Change and Adapted Land Use (WASCAL)- It plays a crucial role in West Africa by conducting research, providing data and information, and building the capacity of local institutions and individuals to address the challenges of climate change and sustainable land use.

11. Private Sector Directorate of ECOWAS Commission- The designated person is responsible for creating a favourable business environment, fostering investment, and promoting competitiveness in the ECOWAS region through sound private sector policies, programs, and projects.

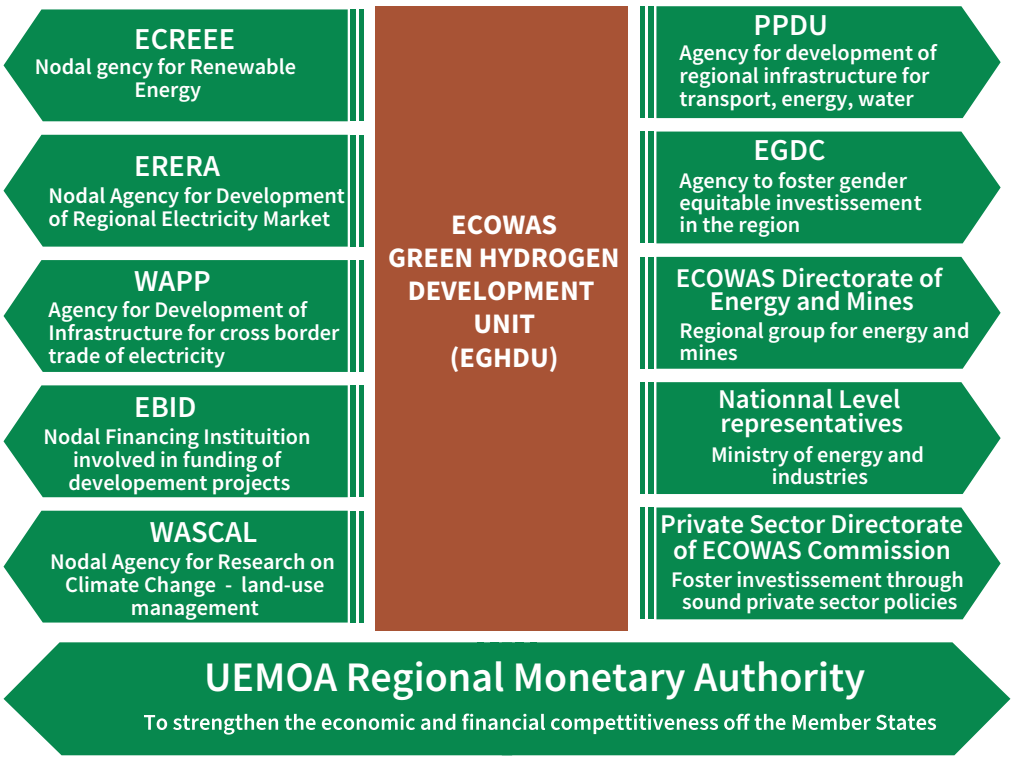


Figure 8: Institutional Framework for ECOWAS Green Hydrogen Development Unit (EGHDU)

S2 Selection of Target Market

In the short and medium term, export market will be targeted as regional demand is limited and there is need for viability gap funding to create local demand. As an example, presently cost of grey ammonia is approximately USD 300/ton and cost of green ammonia is USD 800/ton, thus, to create local demand viability gap funding of USD 500/ton is needed. However, internationally many countries have allocated funds for usage of green hydrogen and its derivatives which can be targeted by ECOWAS region for the export.

Due to proximity, Europe shall be targeted initially which have import target of 10 MT by 2030. However, the local demand for green hydrogen and its derivatives in the region is expected to grow in the long term (after 2040) when cost of green hydrogen reduces with advancement in technology and reduction in RE cost. In international market, details of top importers of ammonia are presented in Figure 9 below.

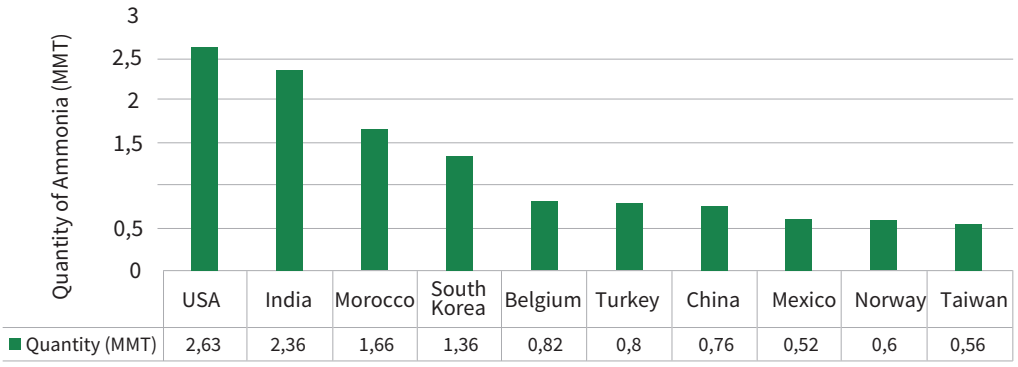


Figure 9: Top 10 importers of ammonia in 2021

Source: Market Study & Location Assessment for green Ammonia production in India, Deloitte (2023)

S3 Clear Policies and Guidelines on Various Aspects

The strategy encapsulates a focused approach involving collaboration with national standardization agencies and the establishment of a credible certification mechanism. This will ensure authenticity and foster trust among investors and partners, promoting the uptake of green hydrogen in the region. Specific attention will be given to developing testing facilities for hydrogen system components as they are crucial to validate technologies involving various institutions at different levels. The strategy enforces that safety standards should align with international requirements to streamline domestic procedures and enhance export potential from the ECOWAS region. Harmonizing regulations with international benchmarks will also accelerate approval processes and cut costs. It will also facilitate the process of trading carbon credits in the international market. The establishment of an inter-departmental system to coordinate the actions of different ministries and divisions is essential for attaining the targets of ECOWAS Green Hydrogen Policy and Strategy Framework. Moreover, the national level policies must be aligned with ECOWAS Green Hydrogen Policy. Ultimately, the strategy fosters regional collaboration, creates a level playing field, and positions ECOWAS as a reliable player in the global green hydrogen market, aligned with sustainable development goals and economic growth aspirations.

S4 Market Development

S.4.1 Export Market building mechanisms

- **Off-take Agreement:**

The «offtake» model, applied to export contracts, establishes a contractual framework where the buyer commits to either acquiring a set amount of exported goods or paying a predetermined sum even if they don't exercise their offtake rights. This model ensures revenue predictability for exporters and flexibility for buyers to adjust offtake based on market needs. Exporters gain stability amidst demand fluctuations, ensuring financial security, while buyers can adapt purchases to market changes while respecting agreement terms. This agreement fosters collaboration, minimizes uncertainties, and aligns interests, facilitating effective communication between exporters and purchasers.

S.4.2 Local Market Demand Aggregation

ECOWAS region largely imports commodities like fertilizers, crude oil, machinery. Presence of local industries like petrochemicals, iron and steel etc are concentrated in a few countries. Iron ore industries are largely present in Liberia, Sierra Leone. In terms of fertilizer industries blending facilities are present across all ECOWAS regions, however, production facilities are identified only in Senegal, Togo, Mali, and Nigeria. Niger and Guinea are in the developmental stages of establishing their own fertilizer industries. In terms of natural gas industry Senegal, Nigeria and, Niger have natural gas projects while Burkina Faso is implementing a biogas production unit. The demand of green hydrogen and its derivatives will be feasible and created in the long term when the cost of green hydrogen production will reduce owing advancement in technology.

- **Model Agreement:**

A model agreement serves as a standardized contract framework providing a foundation for negotiations between parties involved in green hydrogen projects. This legally binding template outlines terms, responsibilities, risks, and benefits of each project. By streamlining negotiations and reducing legal complexities, model agreements expedite project implementation and encourage broader participation.

- **Competitive Bidding:**

To establish a robust and stable foundation for green hydrogen, demand aggregation through structured bidding and procurement processes is essential. The strategy involves introduction of comprehensive guidelines for competitive bidding mechanisms involving green hydrogen and its derivatives. The project allocation via bidding involves soliciting proposals from potential project developers. The bids are evaluated based on predetermined criteria, allowing for fair and transparent selection encouraging competition and optimal project execution while aligning with broader energy goals and market dynamics.

- **Project Development through decentralised mode of production**

Exploring decentralized green hydrogen production holds considerable promise, particularly through biomass-based hydrogen production systems or modular electrolysers integrated with rooftop solar panels and other Decentralized Renewable Energy (DRE) facilities. This approach, while not suited for immediate implementation, has significant potential in the long term, especially if a substantial local market materializes. The adoption of decentralized methods for Green Hydrogen production offers several benefits, including a reduction in the need for long-distance transportation. Additionally, this approach promotes efficient utilization of various resources like land, water, and renewable energy potential. The decentralized green hydrogen production can be explored using the following methods:

1. Implementing hydrogen production systems based on biomass.

2. Deploying modular electrolysers that are integrated with rooftop solar panels or other decentralized renewable energy sources like small hydropower facilities.

Biomass-based hydrogen systems utilise organic materials to generate hydrogen, offering a sustainable pathway that aligns with environmental goals.

The integration of modular electrolysers with RE resources helps in optimizing energy utilization in the ECOWAS region. To meet long-distance transportation requirements, it will be necessary to establish decentralized Green Hydrogen production. This requires linking of hydrogen refueling stations in urban areas and along highways with decentralized renewable energy facilities for on-site production of green hydrogen.

A model introduced by "Solar Corporation of India" (SECI) can be adapted for green hydrogen in the ECOWAS region whereby the local demand is aggregated to optimize procurement. SECI signs Power Purchase Agreements (PPAs) with project developers and on the other hand signs Power Sale Agreements (PSAs) with off-takers. It includes competitive bidding to select suppliers based on predefined terms. This optimizes resource utilization, curtails expenses, and augments market predictability in the green hydrogen sector. Just as it has successfully driven solar energy projects, this model enhances the viability and competitiveness of green hydrogen initiatives by fostering efficient allocation of resources and promoting a stable market framework for green hydrogen.

S5 Capacity Building and Sensitization

The strategy and action plan for developing capacity building programs shall be tailored according to the gaps identified in the knowledge of various stakeholders such as entrepreneurs, financing institutions, government officials, investors, and skilled workforce. Based on these assessments, several strategic initiatives can be introduced to provide targeted training, education, and skill development programs on handling of electrolysers, water desalination, safety, storage and transportation requirements, RTC power and renewable energy in academic institutions.

The strategy for capacity building and sensitization aims to provide training to the forthcoming workforce based on their current competencies and skillset. The training programme shall be developed through the collective involvement of the EGHDU, WASCAL and other public/private research institutes to facilitate the transition towards green hydrogen economy in ECOWAS. The sensitization programme will also identify and support Centres of Excellence for the training and technology development of green hydrogen in the region. This will ensure the region's readiness for effectively adopting green hydrogen technology in the long term.

S6 Financial Mechanism

Financial Assessment

An essential step in green hydrogen deployment is arrangement of fiscal investment. It is estimated that achieving Green Hydrogen production target of 0.5 MT/year by 2030 and 10 MT/year by 2050, require financial investment of approximately USD 15 billion and USD 300 billion by the year 2030 and 2050 respectively. This involves a detailed fiscal evaluation, identifying requisite fiscal and financial incentives thorough examination of costs, revenue streams, and potential gaps that demand strategic financial intervention to ensure project viability.

Innovative Funding Mechanisms and Business Models

This involves exploring unconventional funding mechanisms that can infuse capital into green hydrogen ventures. Public-Private Partnerships (PPPs) can play a pivotal role in balancing investment responsibilities and sharing risks. A disintegrated approach to project development, involving diverse stakeholders, can also foster collective expertise and diversified resources.

Foreign Currency Denomination Bids

Considering the international scope of green hydrogen trade, adopting foreign currency denomination bids holds strategic significance This shields projects from currency exchange rate fluctuations, ensuring financial stability and predictability.

This approach also enhances investor confidence by mitigating currency-related risks and offering a more stable investment environment.

In conclusion, conducting comprehensive financial assessments, embracing inventive funding mechanisms and business models, and adopting foreign currency denomination strategies collectively foster the financial viability and sustainability of green hydrogen projects. These measures provide a robust foundation for the growth of green hydrogen ecosystem in ECOWAS, attracting investments and driving the transition towards a more sustainable energy landscape.

S7 Research and Development

EGHDU shall collaborate with research institutes for knowledge exchange. A public-private partnership framework will be explored for R&D with WASCAL or other relevant research institutions. The insights captured from knowledge transfer shall act as a catalyst for launching substantial demonstration projects.

Research Centre will be developed in association with different academic institutions and industries for providing cutting-edge research facilities. The research Centre shall also collaborate with stakeholders from academic institutions and renewable energy developers to facilitate the development of green hydrogen in the ECOWAS region. The strategy for promoting research and development will also focus on priority areas in green hydrogen value chain, such as electrolysers, storage, transport and end-use applications

S8 Infrastructure Development

The strategy involves fostering the growth of green hydrogen production centres and establishing necessary port infrastructure. This will stimulate the export potential and create a positive feedback loop by strengthening local demand. The focus is on identifying special clusters dedicated to green hydrogen production, renewable energy generation, and manufacturing centres. By establishing these clusters in port regions, the strategy capitalizes on the inherent advantages of port infrastructure for international trade. This includes assessing which ports within the ECOWAS region have the maximum number of vessels suitable for green hydrogen transportation. The number of vessels required should be determined based on export demands and production capacities. This well-established transport networks in port areas can be utilized to ensure efficient movement of green hydrogen and its derivatives from ECOWAS production centres to the global green hydrogen market.

The strategy also requires sufficient storage infrastructure which ensures a stable supply and supports variable demand patterns. Since, the green hydrogen production requires a significant amount of renewable energy, the strategy involves securing adequate solar or wind power sources, to power the electrolysis process. It is also crucial to evaluate the feasibility of establishing extensive desalination facilities near recognized cluster areas due to unavailability of water in the ECOWAS region. The infrastructure requirement across value chain of green hydrogen and its derivates is shown in Figure 10 below.

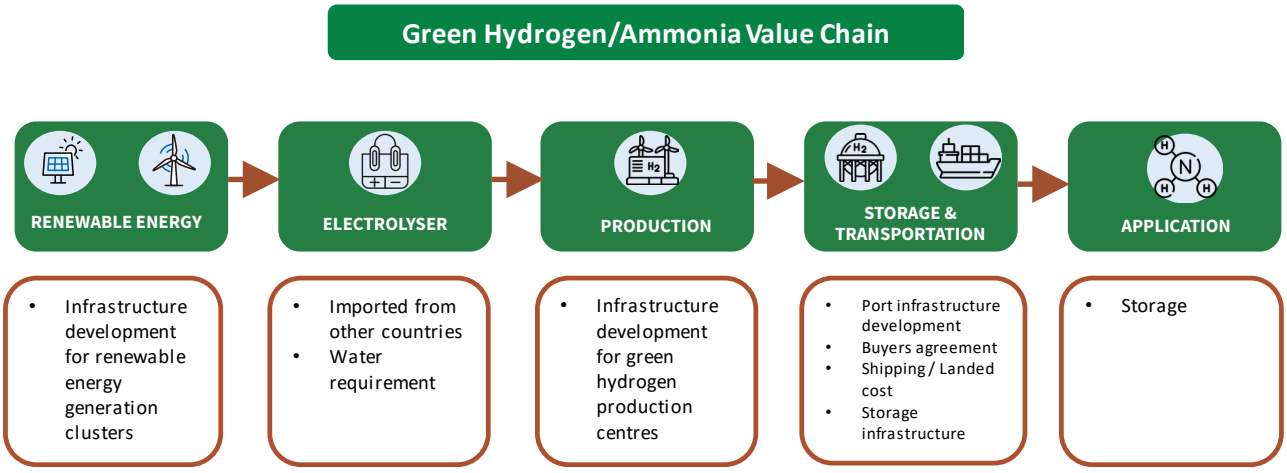


Figure 10: Infrastructure requirement across value chain of GH2 and its derivatives

5.
ACTION PLAN

5. Action plan for Implementation of ECOWAS Green Hydrogen Objectives:

Within this chapter, a structured analysis of the action plan for implementation of ECOWAS green hydrogen objectives is depicted. Herein, Figure 11 presents a macro-level view of the actions described across short, medium, and long-terms. Complementing this workplan, a quarter-wise timeline is also presented in the annexure, providing essential details such as expected results, budget estimations, implementation frameworks and the implementing actors responsible for each action.

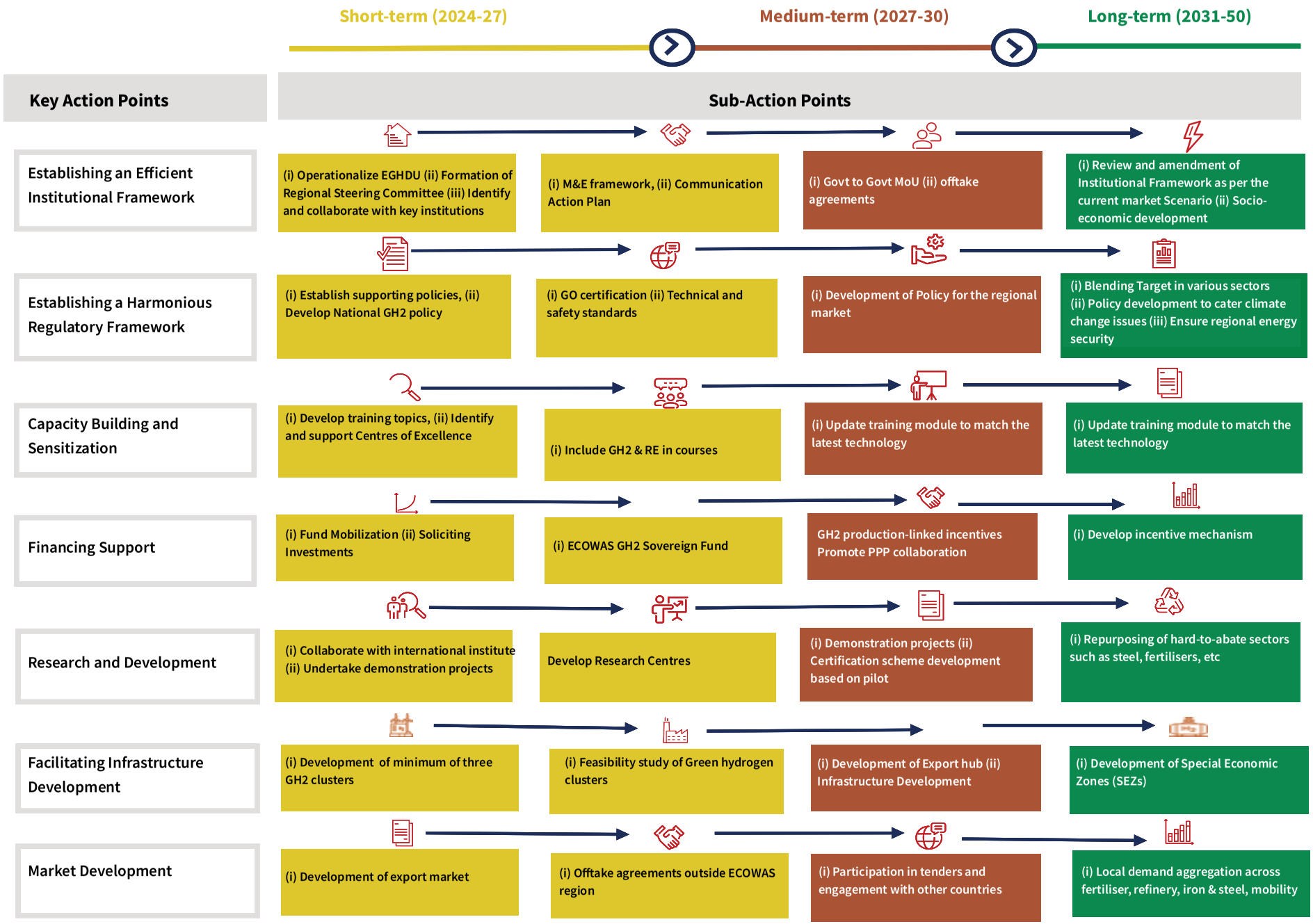


Figure 11: Overview of Action plan for Implementation of ECOWAS Green Hydrogen

Overview of Action Plan for short-term prospective

Establishing an Efficient Institutional Framework

- Operationalise EGHDU
- Formation of Regional Steering Committee
- Identify and collaborate with key institutions.

Establishing a Harmonious Regulatory Framework

- Establish comprehensive regulatory framework & supporting policies
- Develop national GH2 policies
- Form GH2 Management Committee
- Framework for technical and safety standards for the entire value chain

Capacity Building and Sensitization

- Develop training topics/ modules
- Identify and support Centres of Excellence
- Introduction of Green Hydrogen in Academics

Research and Development

- Establish PPP frameworks
- Undertake demonstration projects
- Develop Research Centres

Financing Support

- Fund Mobilization
- Development of Green Hydrogen Sovereign Fund Framework
- Soliciting Investments

Facilitating Infrastructure Development

- Feasibility study of Green hydrogen clusters
- Feasibility study on Port and Gas Pipeline

Market Development

- Long-term contracts

5.1 Action Plan for Short-Term

In the short term, the focus of the Action Plan for implementing ECOWAS Green Hydrogen Objectives is to lay down the foundation for preparatory and regulatory tasks. This phase, spanning approximately four years, prioritizes initial steps to kickstart the transition toward green hydrogen in the region. The key components of the short-term implementation include:

A.1 Establishing an Efficient Institutional Framework

A.1.1 Operationalization of EGHDU

The ECOWAS Green Hydrogen Policy and Strategy Framework makes the provision for a unit within ECREEE for the development of green hydrogen at the institutional level. The ECOWAS Green Hydrogen Development Unit will be responsible for overall coordination and execution of the "Development of Regional Strategy and Action Plan for Implementation of Green Hydrogen Policy and Strategy Framework" within different institutions across ECOWAS member states.

The ECOWAS Green Hydrogen Development Unit (EGHDU) would perform the following roles and responsibilities:

- **Foster the development of National Green Hydrogen Policy and Strategy Frameworks and National Action Plans as per the ECOWAS Green Hydrogen Policy and Strategy Framework.**
- **Execute research and development initiatives in close partnership with specialized research entities, including WASCAL.**
- **Conduct regular assessments of policy achievements in relation to set targets.**
- **Reassess policy objectives every five years to align with regional and global advancements in green hydrogen.**
- **Identify and collaborate with specialized agencies to formulate regulations related to safety, certification, specifications, and standardization.**
- **Construct a harmonious regulatory framework**
- **Establish programs for training and capacity building to develop skills of the workforce in the green hydrogen ecosystem**
- **Effectively coordinate with all partner institutions within EGHDU, harnessing their strengths for the progressive growth of the green hydrogen sector in the ECOWAS region.**
- **Engage and collaborate with the industry to develop investment interests, requirements for skill enhancement, technology partnerships, necessary financing support, and facilitate necessary government actions.**
- **Provide support for the creation of frameworks and institutional mechanisms at the national level to encourage investments within member countries.**

The ECOWAS Green Hydrogen Development Unit will collaborate with the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), ECOWAS Regional Electricity Regulatory Authority (ERERA), West African Power Pool (WAPP), ECOWAS Bank for Investment and Development (EBID), ECOWAS Infrastructure Projects Preparation and Development Unit (PPDU), ECOWAS Gender Development Centre (EGDC), ECOWAS Directorate of Energy and Mines, West Africa Economy and Monetary Union (WAEMU), and national level representatives. To oversee critical initiatives, a Regional Supervisory Committee will also be established in close collaboration with EGHDU, comprising representatives from vital bodies such as ECREEE, WAPP, ERERA, and the ECOWAS Directorate of Energy and Mines and representative from ECOWAS member states. This committee will also play a key role in recommending a regional framework for the necessary standards and regulations essential for the green hydrogen ecosystem.

A.1.2 Identify and collaborate with key Institutions.

To advance the growth and interconnectedness of the hydrogen economy within ECOWAS and on a global scale, it is necessary to focus on collaborative agreements, such as Memorandum of Understanding (MoUs). The ECOWAS Green Hydrogen Development Unit (EGHDU) will identify key institutions, both within the ECOWAS region and internationally, that play crucial role in the hydrogen sector. This may include research organizations, industry associations, governmental bodies, and international agencies involved in hydrogen-related activities. The EGHDU, in collaboration with relevant ECOWAS member states and international partners, will initiate the formation of MoUs aimed at cultivating hydrogen markets and driving mutual growth. These MoUs will outline the objectives, areas of cooperation, and commitments of the signatory institutions. The MoUs will also include provisions for information sharing, technology transfer, and collaborative research and development projects that facilitate the exchange of knowledge and expertise.

A2 Establishing a Harmonious Regulatory Framework

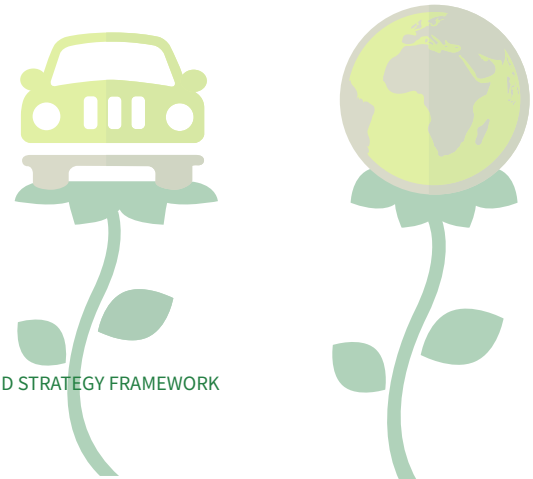
To advance the growth and interconnectedness of the hydrogen economy within ECOWAS and on a global scale, it is necessary to focus on collaborative agreements, such as Memorandum of Understanding (MoUs). The ECOWAS Green Hydrogen Development Unit (EGHDU) will identify key institutions, both within the ECOWAS region and internationally, that play crucial role in the hydrogen sector. This may include research organizations, industry associations, governmental bodies, and international agencies involved in hydrogen-related activities. The EGHDU, in collaboration with relevant ECOWAS member states and international partners, will initiate the formation of MoUs aimed at cultivating hydrogen markets and driving mutual growth.

These MoUs will outline the objectives, areas of cooperation, and commitments of the signatory institutions.The MoUs will also include provisions for information sharing, technology transfer, and collaborative research and development projects that facilitate the exchange of knowledge and expertise.

A.2.1 Establishing a Comprehensive Regulatory Framework and Supporting Policies

To facilitate the development of green hydrogen and ensure its adherence to established standards, a comprehensive regulatory framework will be established. This framework will include multiple policy measures, including the exemption of inter-regional transmission charges, enabling renewable energy banking, facilitating open access approvals, defining of Green Hydrogen based on production method. Additionally, existing policies and schemes promoting the development and utilization of infrastructure, such as Solar Parks, Manufacturing Zones, and Special Economic Zones (SEZs), will be expanded to encompass activities related to green hydrogen.

In addition to these policy initiatives, immediate action will focus on enhancing the ease of doing business by simplifying processes and utilizing technology to accelerate approvals of pilots and demonstration projects. A web-based portal will be developed to provide a database of all relevant regulations and standards at both the Central and State levels. The portal will also offer regulatory approvals for various aspects of hydrogen production, storage, and usage.



A.2.2 Development of National Green Hydrogen Policies

Support will be provided to ECOWAS member countries in development of the national green hydrogen policies or modification of existing policies to include green hydrogen in line with the regional ECOWAS Green Hydrogen Policy and Strategy Framework. At the national level, EGHDU will work in close cooperation with each member country for the development of national standards. EGHDU will help in formation of Green Hydrogen management committee in ECOWAS country members.

A.2.3 Development of Guarantee of Origin (GoO) certification

EGHDU will collaborate with standardisation agencies within member states of ECOWAS to develop a feasible mechanism for certifying green hydrogen production. The existing certification mechanisms will be analysed to assess its applicability in the ECOWAS region. Additionally, these certificates will include details about energy quantity, production facility, methodology, production timeframe, greenhouse gas impact and other sustainability benchmarks.

To enforce guarantee of origin certification for green hydrogen production in the ECOWAS region, EGHDU will engage in collaboration with key regional organizations, including ECREEE, ERERA, UEMOA, AFREC, ECOWAS, and WASCAL. Furthermore, the existing nodal agencies and programs like West Africa Competitiveness Programme (WACOMP) will define the criteria for providing certification for green hydrogen. This will validate the credentials of produced green hydrogen, assuring consumers and stakeholders of its authenticity and adherence to established standards. Furthermore, green hydrogen testing facilities will be developed in the ECOWAS region with inputs from national and international research institutions.

A.2.4 Develop Framework for technical and safety standards

This will involve development of framework for technical and safety standards for the entire value chain of green hydrogen i.e. RE generation & transmission, Electrolyser handling, GH2 production, storage, transportation etc.) in alignment with international best practices and guidelines. The responsible regulatory authority will also provide clear justifications for any mandatory use of hydrogen and will actively engage in the development of technical codes/ standards, and safety protocols. This entails sharing knowledge about GH2 safety and best practices with relevant stakeholders.

A3 Capacity Building and Sensitization

A.3.1 Develop Training Topics/ Modules

The training topics will be developed by assessing the competencies of the stakeholders (such as entrepreneurs, financing institutions, government officials, investors, and skilled workforce) within the region and target domains demanding skill enhancement and capacity reinforcement. Based on the findings from the needs assessment and competency analysis, a list of training topics will be compiled to ensure that these training topics address both immediate and long-term needs in the context of GH2 technology. By gauging the workforce's proficiency and identifying potential gaps, strategic initiatives will be designed to provide targeted training, education, and skill development programs, ensuring a knowledgeable and adept workforce capable of driving the seamless integration and successful implementation of green hydrogen technology. With the rapid evolution of technologies, a proficiency in digital skills will also be emphasized during training, and the use of effective e-learning platforms for education and training will be encouraged. Additionally, entrepreneurs, investors, and financing institutions will be targeted to develop a specialized training manual focused on green hydrogen business development.

A.3.2 Identify and support Centres of Excellence

This will involve identification and supporting of Centres of Excellence focused on training and technology development in the field of GH2. Develop training modules, to enhance expertise in both the production and utilization of GH2. These centres of excellence will encompass training on the handling of electrolysers, water desalination, safety protocols, storage and transportation requirements, RTC power, and renewable energy applications.

A.3.3 Introduction of green hydrogen in academic

The implementation of Green Hydrogen Policy and Strategy Framework in ECOWAS will significantly shape the skill sets needed in vocational and university education from the forthcoming workforce. The states will strengthen industry-academia collaboration through coverage of green hydrogen and renewable energy in the curriculum of doctoral level programmes. The EGHDU, WASCAL and various public/private research institutes will pool resources to form a comprehensive training programme on green hydrogen. The sensitization programme will also identify and support Centres of Excellence for the training and technology development of green hydrogen in the region. Practical experience of technologies through guidelines for laboratory set ups in schools and higher education institutions will also be encouraged.

A4 Research and Development

A.4.1 Collaborate with research institutes.

EGHDU will facilitate strong partnerships between academic institutions, industries, and governmental bodies to encourage the exchange of knowledge and insights across various projects. This collaboration is essential to address critical knowledge gaps related to the production, cost-effectiveness, utilization, transportation, and storage of hydrogen. The knowledge exchange will also facilitate collection of data to understand ECOWAS' competitive standing on the global stage, prioritize key export markets, and identify obstacles to market access. A public-private partnership framework is also proposed for R&D with WASCAL or any other relevant research institutions. This will help in accessing funds for promoting green hydrogen in the region, with contributions from international funding agencies (such as Green Climate Fund). Other funding sources will also be explored to fulfil current and future demands of R&D projects. The R&D programme under the framework will focus on creation of value chains and joint research activities through conferences and seminars.

A.4.2 Undertake Demonstration projects

In collaboration with relevant stakeholders, Initiate and oversee the planning and execution of demonstration projects focused on different types of electrolysers, DRE-based GH2 production, and storage. These projects will be meticulously designed to showcase the viability, efficiency, and practical applications of green hydrogen across various sectors. Further, a technology platform and a demonstrative project will be developed at ECREEE. An interactive GIS Hydrogen Mapping Tool like H2-Atlas will be developed to locate all hydrogen-related activities and projects within the ECOWAS region.

A.4.3 Development research centres

This will involve development of research centres through collaborative efforts between the EGHDU, national and international Academic/Research institutions, and industries. Furthermore, technology transfer initiatives will be undertaken to foster collaboration between ECOWAS and the other leading countries, with a specific emphasis on technologies like electrolysers, RE and storage facilities.

Lastly, various scheme such as «Hydrogen Innovation Scheme» will be introduced to provide support for the advancement of GH2 technology in the region

A.5 Facilitating Infrastructure Development

A.5.1 Feasibility study of Green hydrogen clusters

Various attributes influence the appropriateness of a location for a green hydrogen production centre. The major parameters are proximity to low cost RE sources, proximity to export centres for accessing global market, export handling capacity of the port, nearness to green hydrogen production centres, and provision to storage facilities. The Green Hydrogen Policy and Strategy Framework aims to identify and develop at least three clusters for green hydrogen by 2025. During the regional kick-off workshop, the potential locations for green hydrogen production centres have been identified in Senegal, Ghana, Nigeria and Cabo Verde, whereas the consumption clusters can be located in the European Union, the USA, Nigeria, Niger and Mali. However, further assessment needs to be undertaken in future. As a primary focus, we will encourage the creation of an industry-government forum with a specific emphasis on export activities. This initiative will enable ECOWAS authorities to collect vital industry insights pertaining to green hydrogen.

There is need for development of Renewable Energy (RE) clusters where low cost RE can be obtained. In the northern ECOWAS region, the solar energy can be procured for as little as 2 EUR cent per kilowatt-hour (kWh), alongside offshore wind energy also attainable at a comparable rate of 2 EUR cent/kWh. However, to effectively facilitate cross-border energy trade, the green hydrogen production clusters must be in close proximity to ports. As a result, a comprehensive regional action plan will seamlessly connect the energy generated at RE facilities to the green hydrogen production installations.

A.5.2 Feasibility study on Port and Gas Pipeline

This will involve feasibility study for development/ restructuring of port infrastructure and pipelines for bulk green hydrogen transport.

A6 Financing Support

A.6.1 Fund Mobilization

Engage with international and regional financing institutions to Mobilize investments GH2 production, domestic utilization, and exports within the region.

A.6.2 Soliciting Investments

Initiate the establishment of a dedicated Green Hydrogen Sovereign Fund at the national or regional level, with active participation from ECOWAS member states. This fund should be designed to exclusively channel investments towards the advancement of the GH2 sector. Collaborate closely with relevant governmental bodies, financial institutions, and stakeholders to define the fund's objectives, governance structure, and investment guidelines. Ensure that the fund's resources are strategically directed towards critical areas, including research and development, pilot projects, infrastructure development, and technology innovation.

A.6.3 Development of Green Hydrogen Sovereign Fund Framework

This will involve organization round table/ roadshow to create awareness and secure necessary investments for GH2 projects implementation.

A7 Market Development

A.7.1 Long Term Contract

This will involve Implementation of a structured approach to develop take-or-pay export contracts for green hydrogen and its derivates. Additionally, explore the establishment of government-backed agreements spanning 15 to 20 years to facilitate trade with prominent global importers of green hydrogen. This will also initiate discussions with stakeholders from potential importing countries to lay the groundwork for future international trading platforms.

Overview of Action Plan for medium-term prospective

Establishing an Efficient Institutional Framework

- Memorandum of Understanding (MoUs

Establishing a Harmonious Regulatory Framework

- Development of Policy for the Regional market

Capacity Building and Sensitization

- Review and update training module

Research and Development

- Undertake pilot projects
- Develop a certification scheme based on the pilot

Financing Support

- Develop production-linked incentive mechanism
- Promote PPP collaboration

Facilitating Infrastructure Development

- Port and Cluster development
- Assessment of existing and potential infrastructure requirements

Market Development

- Participation in International tender, open bidding and engagement with various countries for long term contracts

5.2 Action Plan for Medium-Term

The medium-term phase, spanning around three years, builds upon the foundation established in the short term. During this period, the Action Plan aims to deepen the integration of green hydrogen technologies across the ECOWAS region, leading to tangible reduction in cost. The key components of the medium-term implementation include:

A1 Establishing an Efficient Institutional Framework

A.1.1 Engagement with various multilateral agencies.

Engagement with various multilateral agencies by signing of Memorandum of Understanding (MoUs) to boost the coordination on several areas such as power, water, land acquisition, Port development, Lending intuitions, research and training institute etc.

A2 Establishing a Harmonious Regulatory Framework

A.2.1 Development of Policy for the regional market

In the short and medium term, the ECOWAS region will focus on export market due to need for viability gap funding in green hydrogen and its derivatives. However, in the long-term local market will also be targeted. As a preparatory work for usage of green hydrogen in local market, the focus of this action point is to develop policies for usage of green hydrogen and its derivatives in the regional market.

A3 Capacity Building and Sensitization

A.3.1 Review and update training module

In response to evolving market dynamics, academic and research institutions should embark on a comprehensive review and enhancement of existing green hydrogen training modules through global scientific cooperation, public administration, research institutes etc. Concurrently, addressing identified gaps in the training modules to provide both theoretical and practical knowledge to the future workforce. Extensive research into various challenges associated with the hydrogen economy will influence job requirements and the foundational education at university level. The integration of latest research findings into educational contexts, along with the recruitment of new faculty members across all stages of research and implementation is crucial. This will ensure that the training content remains relevant and up-to-date, equipping stakeholders with the latest knowledge and skills required to navigate the green hydrogen ecosystem in the ECOWAS region.

A4 Financing Support

A.4.1 Develop Incentive Mechanism

To stimulate the growth of green hydrogen production and cultivate a conducive environment for industries, a system of production-linked incentives will be introduced. A well-defined and transparent structure for these incentives encompassing clear eligibility criteria, calculation methods, and incentive rates based on the volume and quality of green hydrogen produced will also be developed. These incentives reward the entities engaged in green hydrogen production, thereby motivating increased output and investment in the sector. It also promotes competitiveness by linking incentives directly to production levels, thereby increasing economic efficiency.

A.4.2 Promote PPP Collaboration

Efficiently sourcing funding for the development of green hydrogen projects requires a comprehensive strategy encompassing diverse funding sources, with a significant emphasis on the Public-Private Partnership (PPP) model. The identification of potential funding sources encompasses exploring governmental grants, venture capital, impact investors, and international funding bodies that are in line with

sustainable energy projects.

However, the Public-Private Partnerships present a dynamic avenue to pool resources, expertise, and risk-sharing for large-scale infrastructure projects like green hydrogen. By collaborating with private entities, governments can tap into the innovative capacities of the private sector while ensuring efficient project execution through shared responsibilities. By creating an attractive environment for private investments, we can establish conducive regulatory framework and provide financial incentives such as tax breaks or guaranteed returns. The PPP model, with its inherent risk-sharing nature, is particularly enticing for private investors as it balances profitability with long-term sustainability objectives.

The mechanisms to attract private investments should incorporate well-structured contractual agreements, transparent risk-sharing frameworks, and mechanisms to ensure a fair return on investment. While diverse funding sources play a vital role, harnessing the power of the PPP model offers a strategic path to foster sustainable, well-funded green hydrogen projects. It promotes collaboration, risk-sharing, and innovation, encapsulating the essence of effective public and private sector synergy in advancing the transition towards clean energy paradigms.

A5 Research and Development

A.5.1 Undertake Pilot Project

This will involve Undertaking of five pilot projects aimed at testing and validation of GH2 production and applications focused on sectors such as mining, refineries, fertilizer, mobility and blending with Chemical/Natural gas etc. Enhance the effectiveness of these demonstration projects by involving investors, users, and customers, to actively participate in their execution. Consolidate implementation and outcome data from these pilot projects to inform future decisions and strategies for harnessing the GH2 potential within the ECOWAS regions.

A.5.2 Develop a Certification Scheme

This will involve Development of a certification scheme based on the pilot. The development of the certification scheme should involve collaboration between ECOWAS member states, industry stakeholders, environmental organizations, and relevant international bodies. Various experts in hydrogen production, renewable energy, and environmental sustainability should be consulted to define the specific criteria and standards for certification. The pilot program should serve as a testing ground for the certification scheme, allowing for refinement and improvement before wider implementation. The lessons learned from the pilot can inform adjustments to the certification criteria and process.

A6 Facilitating Infrastructure Development

This will involve Development of a certification scheme based on the pilot. The development of the certification scheme should involve collaboration between ECOWAS member states, industry stakeholders, environmental organizations, and relevant international bodies. Various experts in hydrogen production, renewable energy, and environmental sustainability should be consulted to define the specific criteria and standards for certification. The pilot program should serve as a testing ground for the certification scheme, allowing for refinement and improvement before wider implementation. The lessons learned from the pilot can inform adjustments to the certification criteria and process.

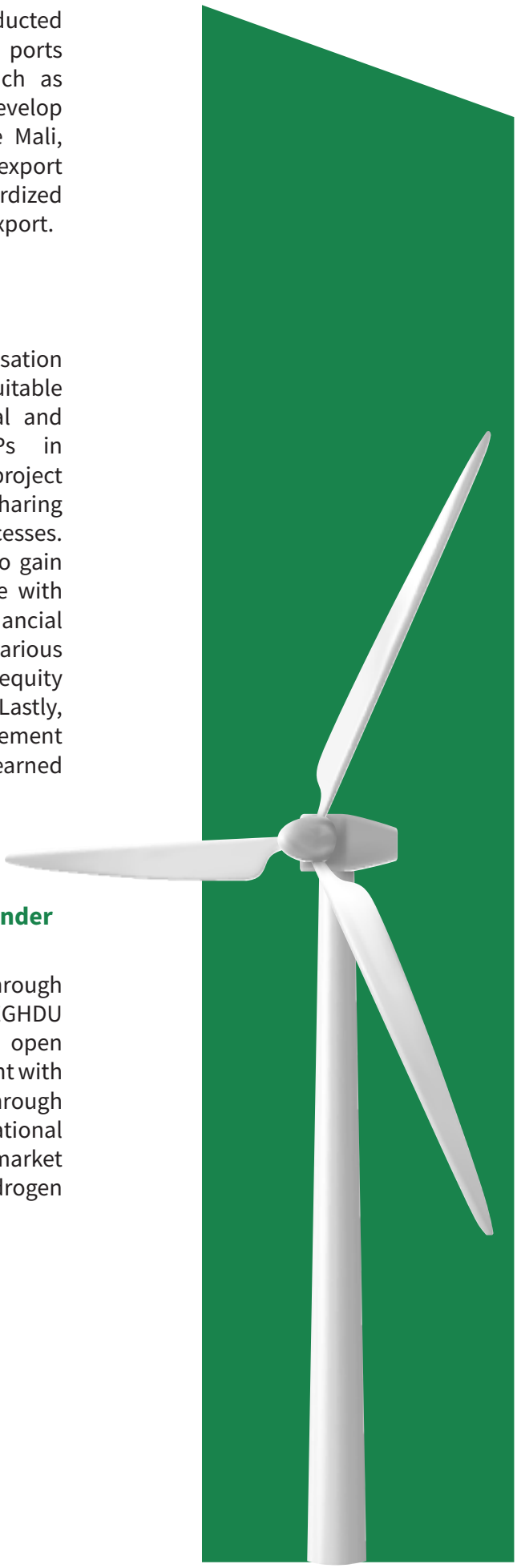
A.6.1 Port and Cluster Development

Due to the high costs of production and consumption, the ECOWAS region will focus on exports in the medium-term. To foster the export of green hydrogen in the ECOWAS region, the EGHDU will identify the most suitable ports for exporting green hydrogen and develop pipeline for land locked regions such as Mali, Niger and Burkina Faso. The norms and standards for green hydrogen/derivatives export will also be developed under the regional incentive mechanism.

Comprehensive assessment will be conducted to identify the most strategically suitable ports for GH2 exports, considering factors such as proximity to GH2 production clusters. Develop plans to connect landlocked regions like Mali, Niger, and Burkina Faso to the selected export ports. Formulate and implement standardized norms and standards for GH2/derivatives export.

A.6.2 Promote PPP Collaboration

This will involve identification and prioritisation of green hydrogen projects that are suitable for PPP collaboration. Enhance the legal and regulatory framework governing PPPs in the GH2 sector to provide clarity on project governance, risk allocation, revenue-sharing mechanisms, and dispute resolution processes. Involve potential private sector partners to gain inputs on PPP project design. Collaborate with financial institutions to design optimal financial structures for PPP projects, considering various funding sources such as debt financing, equity investments, and blended finance models. Lastly, perform continuous evaluation and refinement of the PPP framework based on lessons learned from project experiences.



A7 Infrastructure Development

A.7.1 Participation in International Tender

In additional to long term contracts through government-to-government engagement, EGHDU will participate in international tender, open bidding and will look for long for engagement with various countries/agencies/industries through competitive bidding. By engaging in international tenders, EGHDU can access a global market and enhance its visibility in the green hydrogen ecosystem.

Overview of Action Plan for long-term prospective

Establishing an Efficient Institutional Framework

- Review and amendment of Institutional Framework
- Socio-Economic Development

Establishing a Harmonious Regulatory Framework

- Set up blending target in various sectors
- Cater climate change issue
- Ensure regional energy security

Capacity Building and Sensitization

- Review and update training module

Research and Development

- R&D for repurposing of hard to abate sectors

Financing Support

- Develop incentive mechanism in the form of low-cost rate of interest, tax holiday, subsidy, rebate

Facilitating Infrastructure Development

- Development of Special economic zone, hydrogen clusters, ports, gas pipeline, transport and storage infrastructure

Market Development

- Local demand aggregation

5.3 Action Plan for Long-Term

The long-term phase, extending beyond twenty years, envisions the development of green hydrogen ecosystem across ECOWAS member states. This phase is characterized by widespread adoption and integration of green hydrogen technologies into the overall energy landscape.The key components of the long-term implementation include:

A1 Establishing an Efficient Institutional Framework

A.1.1 Review and Amendment of Institutional Framework

This will involve review and amendment of Institutional Framework as per the current market Scenario and promote equitable socio-economic and gender development in the ECOWAS region.

A.1.2 Socio-Economic Development

As the landscape of green hydrogen continues to evolve, it is crucial to ensure that socio-economic aspects are taken into consideration. Therefore, these will be reviewed and, if necessary, amendment will be made to the existing policies to incorporate green hydrogen-related elements.

The ECOWAS Gender Development Centre will initiate a comprehensive review of existing energy and environmental policies to assess their alignment with the emerging green hydrogen sector. The review will specifically focus on identifying areas where current policies can be enhanced or revised to accommodate green hydrogen-related aspects. Upon completion of the policy review, a comprehensive report will be submitted to member states. The report will provide clear guidance on how existing policies can be adapted to harness the benefits of green hydrogen while mitigating any adverse socio-economic impacts.

A2 Establishing a Harmonious Regulatory Framework

A.2.1 Blending Target in Various Sectors

This will involve Setting up blending targets in various application sectors such as fertilizer, refinery, iron and steel, domestic cooking etc.

A.2.2 Cater Climate Change Issue

The ECOWAS countries contribute to less than 2% of the global GHG emissions. However, being an evolving economy, they have aligned their nationally determined contributions to reduce their emissions to the maximum extent possible while stimulating economic growth. Development of green hydrogen industry in the region is an incentive for the region to stimulate industries further while helping international regions achieve their goals for carbon emissions mitigation.

The long-term prospects of a green hydrogen strategy and action plan are poised to play a pivotal role in addressing the pressing issue of climate change as green hydrogen offers a promising avenue to decarbonize various sectors of the economy. This will be possible through a comprehensive policy framework encompassing incentives, research and development funding and regulatory support.

Furthermore, the deployment of green hydrogen technologies can foster economic growth and job creation. Investment in research, development, and deployment of hydrogen-related infrastructure will stimulate innovation and establish new industries. This will result in the creation of green jobs across the value chain, from production and transportation to equipment manufacturing and maintenance. We will enable the establishment of ‘Net Zero Transition Manager’ positions within high-emission industrial sites to pinpoint and advance decarbonization opportunities. This includes exploring options such as low-carbon hydrogen to promote the enduring sustainability of industrial enterprises.

The action plan indicates towards establishment of green markets through government incentive frameworks. These benefits will be provided primarily to green hydrogen users to generate demand and willingness to pay for clean energy in the ECOWAS region. Moreover, expedited measures for the obligatory utilization of green materials will also be formulated. The ECOWAS government must formulate a regulatory structure and carefully examine the consideration of quotas and criteria for the obligatory use of materials manufactured using green hydrogen.

A.2.3 Regional Energy Security

Apart from enhancing the overall economic efficiency, the green hydrogen strategy and action plan holds significant promise for ensuring energy supply security within the ECOWAS region. The member states can diversify their energy mix by leveraging renewable resources to produce green hydrogen and reduce their dependence on fossil fuels. The feasibility and benefits of establishing a national strategic hydrogen reserve will be examined and assessed in relation to the market developments in the future. This will also safeguard the region from supply disruptions and geopolitical tensions. Moreover, the development of domestic green hydrogen production centres will promote a self-sustaining energy ecosystem.

A3 Capacity Building and Sensitization

A.3.1 Review and Update Training Module

In response to evolving market dynamics, academic and research institutions should embark on a comprehensive review and enhancement of existing green hydrogen training modules through global scientific cooperation, public administration, research institutes etc. Academic and research institutions should initiate a thorough review of existing green hydrogen training modules. This review should encompass content, delivery methods, and the alignment of training objectives with industry needs.

A4 Research and Development

A.4.1 R&D for Repurposing of Hard to Abate Sectors

This will involve research and development for repurposing of hard to abate Sector such as Iron & Steel, Fertilizer, Refinery etc.

A5 Facilitating Infrastructure Development

A.5.1 Development of Special Economic Zones

This will involve development of Special economic zone, hydrogen clusters, ports, gas pipeline, transport and storage infrastructure for enhancing the production of green hydrogen and its derivatives at low cost for local consumption and offering of competitive price at international market

A6 Financing Support

A.6.1 Incentive Mechanism

To boost production and local usage of green hydrogen and its derivatives incentive mechanism in the form of low-cost rate of interest, tax holiday, subsidy, rebate etc will be provided. Providing tax holidays to green hydrogen producers and related industries can encourage investment by allowing them to defer or reduce tax payments for a specified period. Tax incentives can free up capital for reinvestment in research and development, infrastructure, and expanding production capacity. Direct subsidies can be provided to green hydrogen production projects to lower the overall production costs, making green hydrogen more competitive with other energy sources. Rebates are effective in incentivizing the purchase and deployment of green hydrogen-based technologies, such as fuel cells and hydrogen vehicles, by offering partial refunds on the purchase price.

A7 Market Support

A.7.1 Local Demand Aggregation

As the costs of green hydrogen become competitive during the medium-term, there will be an opportunity to accelerate growth of local production. The feasibility of developing large-scale green hydrogen projects in industries such as steel, long-haul transportation, and shipping will be explored depending on cost and market demand. Simultaneously, pilot projects will be launched in other promising sectors such as railways and aviation. The activities in the long-term will aim to expand green hydrogen adoption across all potential sectors to significantly reduce carbon emissions throughout the ECOWAS regions.

To stimulate the growth of green hydrogen production and create substantial demand, the ECOWAS governments will establish a mandated minimum percentage of green hydrogen or its derivative products, such as green ammonia or green methanol, to be consumed as energy or feedstock by designated consumers. The specific year-wise targets for this minimum consumption share will be determined by the ECOWAS Green Hydrogen Development Unit (EGHDU). The EGHDU will consider factors such as resource availability, relative costs, and other economic factors while setting these targets.

Expanding on the goal of demand aggregation, a comprehensive framework for competitive bidding and procurement processes will be instituted. EGHDU will formulate comprehensive model guidelines for transparent competitive bidding processes to procure green hydrogen and its derivatives. To guarantee the quality and effectiveness of equipment, the eligibility standards for engagement in competitive bidding for the procurement of green hydrogen and its derivatives will necessitate that projects must employ equipment endorsed by the ECOWAS government in alignment with specified quality and performance criteria. There is a potential for the growth of sectors such as fertilizer, Iron & Steel, refinery and mobility in the long term as discussed below:

- **Fertilizer Sector:** Green hydrogen presents a viable alternative for hydrogen used in ammonia production for fertilizers. Fertilizer blending facilities are already present in all ECOWAS regions, with production facilities identified in Senegal, Togo, Mali, and Nigeria. This will facilitate the sector's transition to lower carbon emissions and reduce reliance on imports.

- **Iron and Steel Sector:** Given the decreasing costs of renewable energy and electrolysers, there is a growing expectation that green hydrogen-based steel production can achieve cost competitiveness in the coming decade within the ECOWAS region. The introduction of carbon credits and the implementation of market constraints on carbon-intensive steel manufacturing are anticipated to further enhance the economic viability of Green Hydrogen-based steel production within the region. The ECOWAS Green Hydrogen Policy and Strategy Framework will actively support initiatives aimed at bolstering low-carbon steel production capacity. Initially, existing steel plants in the ECOWAS region will incorporate moderate use of green hydrogen in their processes. However, the proportion of green hydrogen in the blend will be gradually increased with technological advancements and cost efficiency.

- **Refinery Sector:** Hydrogen plays a crucial role in the desulfurization of petroleum products like petrol and diesel. The demand for green hydrogen in the refinery sector will increase if low-carbon measures are not strictly enforced, making it a potential growth area.

- **Mobility Sector:** With advancement in technology and reduction in prices green hydrogen as a fuel can be used in mobility sector specially in long haul freight. However, the market that green hydrogen can capture depends upon competitive sector like fuel cell electric vehicles and battery electric vehicles.

These strategic initiatives collectively align with the ECOWAS region's commitment to advancing green hydrogen production and utilization while fostering sustainable economic growth and emissions reduction.

6.
Monitoring and Evaluation (M&E) Mechanism

6. Monitoring and Evaluation (M&E) Mechanism

Monitoring and Evaluation (M&E) frameworks are essential tools for tracking the progress, effectiveness, and impact of initiatives. When it comes to implementing Green Hydrogen initiatives in the ECOWAS region of Africa, the M&E framework should be comprehensive and adaptable to the specific context.

The Green Hydrogen initiatives in the Economic Community of West African States (ECOWAS) region aim to harness the potential of hydrogen produced from renewable sources to drive sustainable economic growth, reduce carbon emissions, and enhance energy security. These initiatives focus on leveraging the region's abundant renewable energy resources, such as solar and wind, to produce hydrogen through electrolysis.

6.1 Objectives of the M&E Framework

The Monitoring and Evaluation (M&E) framework for the Green Hydrogen initiatives in the ECOWAS region serves a range of objectives to ensure the effective implementation, progress tracking, and impact assessment of the initiatives. The main objectives include:

- **Progress Tracking:** The M&E framework aims to systematically track the progress of various aspects of the Green Hydrogen initiatives. This includes monitoring the development of hydrogen production infrastructure, policy implementation, investment attraction, research advancements, and other key indicators.

- **Effectiveness Assessment:** The framework seeks to evaluate the effectiveness of the initiatives in achieving their intended goals. It assesses whether the implemented actions and strategies are leading to the desired outcomes, such as increased hydrogen production capacity, emissions reduction, and economic growth.

- **Accountability and Transparency:** M&E ensures accountability among stakeholders involved in the initiatives. By providing clear and measurable indicators, the framework holds responsible parties, including governments, private sector entities, and international partners, accountable for their commitments and contributions.

- **Evidence-Based Decision-Making:** The M&E framework provides data and insights that enable informed decision-making. By analyzing real-time and historical data, decision-makers can make adjustments to strategies, resource allocation, and policies to optimize the outcomes of the initiatives.

- **Lesson Learning and Knowledge Sharing:** Through the M&E process, valuable lessons are learned from both successes and challenges encountered during the initiatives. This knowledge can be shared among stakeholders to enhance the effectiveness of similar projects in the region and beyond.

- **Policy Alignment and Revision:** M&E helps ensure that policies and regulations related to the Green Hydrogen initiatives are aligned with evolving circumstances and goals. If inconsistencies or gaps are identified, the framework supports the revision of policies for better alignment with objectives.

- **Resource Optimization:** By analyzing the data collected through M&E, stakeholders can identify areas where resources are being optimally utilized and areas where adjustments are needed to maximize the impact of investments.

How the M&E framework will contribute to achieving these objectives

The M&E framework will directly contribute to each objective in the following manner:

Progress Tracking:

- **Indicator Measurement:** The M&E framework defines specific indicators to measure the

progress of various aspects of the initiatives, such as hydrogen production capacity, infrastructure development, policy implementation, and investment attraction.

- **Data Collection:** Regular data collection based on these indicators allows stakeholders to monitor the advancement of initiatives in real-time.

- **Contribution:** Progress tracking ensures that the initiatives are on track and meeting milestones within established timelines.

Effectiveness Assessment:

- **Outcome Indicators:** The framework defines outcome indicators that directly measure the effectiveness of the initiatives, such as emissions reduction, job creation, and economic growth.

- **Evaluation:** Through periodic evaluations, stakeholders assess whether the initiatives are producing the intended outcomes and identify any gaps between expected and actual results.

- **Adaptation:** Based on effectiveness assessments, adjustments can be made to strategies and actions to enhance the initiatives' impact and success.

Accountability and Transparency:

- **Clear Indicators:** Well-defined indicators ensure that stakeholders have clear expectations and benchmarks to meet.

- **Regular Reporting:** M&E reporting provides a transparent account of progress and outcomes, holding stakeholders accountable for their roles in the initiatives.

- **Visibility:** Transparent reporting enhances public trust and confidence in the initiatives' management and implementation.

Evidence-Based Decision-Making:

- **Data Analysis:** The M&E framework analyzes collected data to provide insights into trends, patterns, and challenges.

- **Informed Choices:** Decision-makers use these insights to make informed choices, adjust strategies, allocate resources, and optimize outcomes.

Adaptive Management:

- **Regular Evaluation:** Periodic evaluations within the M&E framework identify emerging trends, challenges, and opportunities.

- **Flexibility:** The framework allows stakeholders to adjust strategies and actions in response to changing circumstances, enhancing the initiatives' adaptive capacity.

- **Continuous Improvement:** By adapting to new information, the initiatives can continually improve their effectiveness and impact.

Lesson Learning and Knowledge Sharing:

- **Analysis of Challenges:** The M&E framework identifies challenges and obstacles faced during implementation.

- **Learning from Failures:** Lessons learned from challenges and failures are shared among stakeholders to avoid repeating mistakes and improve future projects.

- **Replication of Successes:** Success stories and best practices are disseminated to guide similar initiatives across the region and beyond.

Policy Alignment and Revision:

- **Data-Informed Policy:** The M&E framework provides data to assess the alignment of policies with initiative goals.

- **Policy Adaptation:** If discrepancies are found, policies can be revised or refined based on evidence and feedback, ensuring effective support for the initiatives.

Resource Optimization:

- **Resource Allocation:** M&E data helps stakeholders assess whether resources are being optimally allocated across various components of the initiatives.

- **Efficiency:** Insights from the framework guide adjustments in resource allocation to maximize efficiency and impact.

In essence, the M&E framework serves as a dynamic tool that guides, informs, and empowers stakeholders to make strategic decisions, enhance accountability, and ensure the successful implementation and impact of the Green Hydrogen initiatives in the ECOWAS region.

6.2 M&E Framework

The intent is to design a system which can record various parameters critical from the policy and operations perspective of the program for each stakeholder and generate analytical output which provides actionable inferences. The M&E framework will suffice the need to develop a system that will provide information on a wide range of technical, operational, and financial parameters. Based on the diagnostic as-is study, the monitoring framework will cover the following:

I Identify the information needs that underpins M&E

II Develop a set of key performance indicators

III Establish a baseline against which future improvements will be tracked

IV Able to respond to information needs of internal and external stakeholders

Development of a Data Management System (DMS)

The objective also involves the implementation of the monitoring framework in the form of a DMS which will be developed keeping in mind that the data should be presented in a timely and concise manner to the relevant internal and external target audience and at different levels of hierarchy of various stakeholders. This activity will be initiated with defining reporting requirements and formats for standard reports, which include the data to be collected, the source of data, the frequency of data collection, and the parties responsible for collecting, analyzing, reporting, and using the data.

6.3 Attributes of the Proposed Monitoring and Evaluation Framework

Focus on all aspects in the results chain: The focus has been to develop performance indicators across the entire causal chain from project intervention to on-the-ground impacts. Attempt has been made to identify the information needs that underpin M&E based on a clear understanding of the causal chain through which the project interventions will lead to the desired outputs and outcomes. The aim is to create the results chain from resource mobilization to installation of systems to actual use and draw inferences related to improving efficiency and technological advancements in the system and assess the impact of the system on various stakeholders. One of the critical elements of M&E is to assess the efficacy of intervention and thus the focus is not only on the activities undertaken and the outputs but also the impact on the beneficiaries. This is critical to gain a better perspective of the impact of the interventions and to support future planning processes and decision-making.
The indicators have been classified in the following heads:

- **Inputs:** This includes technical, financial, regulatory, R&D activities, infrastructure development etc. mobilized to implement the green hydrogen initiative in the ECOWAS region.

- **Outputs:** This includes the aspects such as number of projects, volume of production, number of regulations finalised, total export volume etc.

- **Outcomes:** The outcomes measure the uptake, adoption, job creation, reduction in cost of production etc.

- **Impacts:** These include long-term outcomes near or at the end of the results chain such as the effect of implementing green hydrogen on the reduction of fossil fuel-based energy, reduction in carbon footprint, benefits of promotion of renewable energy-based interventions, etc.

Since this information needs to be collected through secondary research as well as at ground level, it is suggested to undertake third party-based evaluation study in every two years.

Key Performance Indicators (Input, Output, Outcome) - The baseline data for the inputs, outputs, and outcome KPIs needs to be gathered with the objective to establish a baseline against which the future improvements will be tracked on a regular basis. Particular attention needs to be provided to ensure that the proposed M&E system supplements and links to any existing M&E system of the stakeholders and takes into consideration the capacity of the stakeholder officials.

The KPIs have been selected to facilitate informed decision-making. The indicators are designed to monitor the implementation throughout to assess progress toward program objectives. These standard indicators have been identified for each of the stakeholder associated with the program.

6.4 Indicators and Metrics

Develop a set of quantitative and qualitative indicators to measure various aspects of the initiatives. These can include:

Production and Infrastructure:

- Installed hydrogen production capacity.
- No. of green hydrogen cluster -3 by 2025 and 5 by 2026
- Number of hydrogen production facilities established.
- Hydrogen production volume -0.5 MT/year by 2030 and 10 MT/year by 2050.
- Port infrastructure - 1 by 2028
- Infrastructure development progress (e.g., electrolyzer capacity, storage capacity).

Policy and Regulation:

- Formation of EGHDU and regional steering committee by 2024.
- National Green Hydrogen Policy -15 by 2024.
- National Green Hydrogen Action Plan and Implementation Strategy - 15 by 2025.

Economic Impact:

- Investment attracted for green hydrogen projects- USD 5 billion by 2025, USD 15 billion by 2030 and USD 300 billion by 2050.
- Job creation in the green hydrogen sector- 60,000 by 2030 and 1,200,000 by 2050
- Contribution to regional and member country GDP growth.

Environmental Impact:

- Reduction in greenhouse gas emissions.
- Water usage efficiency in hydrogen production.
- Development of policy and regulatory guidelines to enhance the ability of member states to deal with climate change using Green Hydrogen by 2035

Technological Innovation:

- Demonstrative project - 3 by 2026.
- Pilot Project- 5 by 2028
- Number of research and development projects related to green hydrogen.
- Technological advancements achieved.

Table 3: Overview of M&E Framework

INPUTS	OUTPUTS	OUTCOMES	IMPACT
Policy & Regulatory • Development of National Green Hydrogen Policies • Technical standards • Safety standards • Policy intervention to enhance ease of doing business	**Policy and Regulation –** • Form EGHDU & Regional Steering Committee by 2024 • Develop 15 National GH2 policies by 2024 • Develop 15 National GH2 Strategy and Action Plan by 2025	**Policy & Regulatory –** • Increase in production • Increase in domestic consumption • Ecosystem for promoting business activities	**Technical –** • Reduction in CO2 emission • Generation of employment • Reduction in conventional energy demand
Implementation – • Development of electrolysis infrastructure • Formation of EGHDU and National Supervisory Committee • Cluster Development • Demonstration projects • GH2 Export Hubs • Capacity building training • Public-private partnerships • Private sector involvement	**Technical –** • 3 Demonstration projects by 2026 • 5 Pilot projects by 2028 • Number of research and development projects related to green hydrogen. • Technological advancements achieved.	**Technical –** • Technology transfer • Compliance with safety standards • Production target achieved (million tons)	**Financial –** • Ease of doing business will attract investors • Reduction in cost of local production
Technical – • Renewable Energy Integration • Cost optimization	**Financial and Economic–** • Return on Investment • Competitive LCoH • Job creation - 60,000 by 2030 and 1,200,000 by 2050 • Investment attraction- USD 5 bn by 2025, USD 15 bn by 2030, USD 300 bn by 2050	**Financial –** • Increase in investment • Total funding received from international funding institutes • Total grants received	**Economic –** • Improvement in GDP • Increase in social welfare • Demonstration projects
Financial – • Dedicated line of credit • Sovereign Fund • Subsidy or financing arrangement • Production-linked Incentives (PLI) • Budgetary Provision	**Operational Efficiency –** • Hydrogen delivery reliability • Effective performance of electrolysers • Consistent production of GH2	**Implementation –** • Become cost-competitive supplier of green hydrogen in the world	
	Production & Infrastructure • Cluster development - 3 by 2025 and 5 by 2026 • GH2 Production - 0.5 MT/year by 2030 and 10 MT/year by 2050 • Develop 1 port by 2028		

7.

Communication Action Plan

7. Communication Action Plan

The communication action plan is significant for the successful «Development of the Strategy and Action Plans» for the ECOWAS Green Hydrogen Policy and Strategy Framework. This policy's implication extends to various stakeholders who are directly or indirectly influenced by it, making effective communication essential.

To develop a holistic approach to communication in this project, it is necessary to evaluate the economic opportunities of green hydrogen development in the ECOWAS region. This will facilitate the project's economic viability, ensuring its effective implementation in the short, medium, and long term.

The communication action plan aims to support the policy through the establishment of communication channels and activities. Its objectives are as follows:

- Facilitating timely and comprehensive information sharing with all stakeholders to ensure transparency throughout the process.
- Valuing the opinions and concerns of target audience, elevating their involvement in decision-making.
- Re-strategizing the project timeline, milestones and activities based on the evaluation results

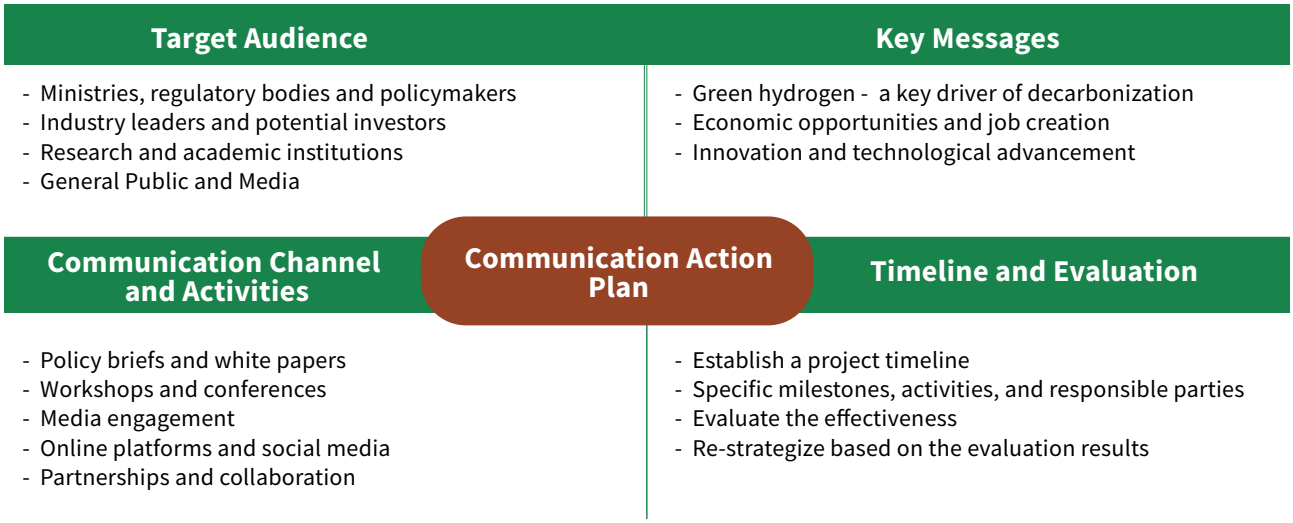


Figure 12: Overview of Communication Action Plan

As highlighted in Figure 12, the communication action plan has four main activities as:

- Identification of the target audience who are directly or indirectly related to Green Hydrogen Ecosystem
- Understanding of relevant economic opportunities and innovations in the green hydrogen sector in the ECOWAS region.
- Establishment of various communication channels and activities for stakeholders
- Establishment of project timeline and evaluation mechanism.

Brief Description of Components and Actions

Target Audience

The communication action plan will help in facilitating communication among target audience groups. The target audience for this policy are:

- Ministries, regulatory bodies and policymakers
- Industry leaders
- National and International investors
- Research and academic institutions
- General Public and Media

Communication Channel and Activities
The activities envisaged under this component are:

• Developing policy briefs and white papers to support the policy and strategy framework
• Organizing workshops and conferences involving different stakeholders on strategic communication, or other relevant issues.
• Managing media engagement
• Establishing communication procedures protocols to share information and opinions among involved institutions.This includes online platforms such as social media.
• Enabling partnerships and collaboration among various stakeholders and institutions

Target Audience

The ECOWAS Green Hydrogen Policy and Strategy Framework involves the interests of various stakeholders including ministries, regulatory bodies, policymakers, industry leaders and potential investors. Due to their varying roles and responsibilities, the communication action plan aims to strategically employ a range of communication methods, strategies, and instruments to engage the target audience. It prioritizes coordination among stakeholders at all levels. The target audience is as follows:

Research and Academic Institutions

The research and academic institutions involved in the ECOWAS Green Hydrogen Policy and Strategy Framework will be a part of the communication program as well. This will enable effective collaboration and skills transfer between member states. The communication action plan also fosters knowledge transfer through conferences and seminars.

General Public

With the increasing potential for global green hydrogen production in sub-Saharan Africa, there is a growing public interest in Green Hydrogen. As per a study done by the International Renewable Energy Agency (IRENA), the total technical potential for green hydrogen production under US $1.5 per kg of hydrogen by 2040 is calculated to be 1923 EJ for Sub Saharan Africa. An estimate by the H2 Atlas shows that ECOWAS has the potential to produce around 120,000 TWh (432 EJ) under the same price benchmark, which represents nearly 25% of the total potential of the Sub-Saharan area. However, green hydrogen is becoming a growing topic of interest in several regions of West Africa.

Media

Engaging with print and broadcast media through newspapers, magazines, radio, and TV is crucial to effectively communicate with the general public. African news organizations have diversified their presence, by utilising online platforms in addition to print media and radios. Studies conducted by the International Telecommunication Union indicated that Africa had 629 million active mobile-cellular subscriptions, representing a penetration rate of nearly 70 subscriptions per 100 inhabitants. Hence, the growth in mobile phone adoption and usage has played a significant role in expanding media's reach.

Communication Action Plan Implementation

This study focused on:

• Perceptions of stakeholders concerning the project
• Establishment of Public-private public partnership across the value chain of green Hydrogen,
• Existing communication channels and systems.
• Communication needs at regional, National and Community level.

The CU will carry out CAP implementation through monthly working plans to be discussed and approved by the Technical Committee under the supervision of the project team, Monitoring and evaluation activities are embedded in the CAP so as to assess the degree of participation of the key stakeholders during implementation and provide project updates and status reports. The overview of communication action plan implementation framework is shown in the infographic below.


ANALYSE THE INTERNAL ENVIRONMENT OF THE COMMUNITY / ACTION GROUP
IDENTIFY THE STRATEGIC STAKEHOLDERS
(in the internal and external environment) – Internal Env = Org's vision, mission, values; External env = political, economic, social issues impacting the organisation
IDENTIFY THE NEEDS AND DESCRIBE THE KEY STRATEGIC ISSUES
(differentiate between types of strategic issues)
DETERMINE THE IMPLICATIONS OF THE NEEDS/ STRATEGIC ISSUES FOR THE
COMMUNITY'S STAKEHOLDERS
DECIDE ON THE COMMUNICATION STRATEGY
(what must be communicated to solve the community's problems/capitalise on the opportunities)
SET COMMUNICATION GOALS
(based on the communication strategy)
DEVELOP COMMUNICATION POLICY
(who should communicate what to whom)
CONSULT WITH TRADITIONAL LEADERS/ OTHER ROLE PLAYERS REGARDING THE
STRATEGY FOR DEVELOPMENT COMMUNICATION
CONDUCT AN OVERALL COMMUNICATION MEDIA ANALYSIS
(which kind of media best suit the organisation and its stakeholders)
DEVELOP A STRATEGIC COMMUNICATION ACTION PLAN
(focused on the community and its stakeholders)

8.

Risk Assessment & Mitigation Mechanisms

8. Risk Assessment and Mitigation Mechanisms

Identifying and comprehending potential risks and challenges intrinsic to the implementation of the green hydrogen strategy is crucial. The technological uncertainties, where advancements may fall short of expectations can impede the progress of green hydrogen projects. Market fluctuations, both in supply and demand, could disrupt the economic viability of green hydrogen projects. Moreover, the volatile nature of political environments could introduce instability, affecting policy support and cross-border collaborations.

Risk mitigation could be structured through a comprehensive approach involving risk assessment, continuous monitoring, and timely corrective actions. Allocating such strategies can safeguard against unexpected financial losses. Detail of various types of risk, likely consequences and risk mitigation measure for the implementation of green hydrogen policy and strategy framework is highlighted in Table 4 below.

Table 4: Risk Assessment and Mitigation Mechanisms

Keys Actions	Action Points	Potentials Risk	Mitigation Measures
Establishing an Efficient Institutional Framework	Operationalize the EGHDU	Political changes or instability within ECOWAS member states could impact the commitment to the EGHDU's goals and objectives.	Foster strong political support by engaging with policymakers and advocating for the importance of the Green Hydrogen Policy in achieving sustainable energy goals.
	Formation of Regional Steering Committee	Different ministries and member states may have conflicting interests or priorities, making it challenging to reach an agreement.	Establish conflict resolution mechanisms to address disagreements.
	Identify and collaborate with key institutions	Sharing sensitive information and technology with partner institutions may pose security risk	Implement technology transfer agreements that protect sensitive information such as non-disclosure agreements.
	Socio-Economic Development	Lack of community engagement and misalignment of initiatives with community needs.	Establish mechanisms for community members to provide feedback, raise concerns, and offer suggestions throughout the project's lifecycle. Incorporate cultural norms, traditions, and values into development initiatives.
Establishing a Harmonious Regulatory Framework	Establishing a comprehensive regulatory framework and supporting policies	Ineffective monitoring and enforcement mechanisms for supporting policies	Establish monitoring and evaluation mechanisms to ensure compliance with established regulations.
	Development of National Green Hydrogen Policies	Member countries may face resource constraints which could hinder the development of national GH2 policies.	Establish line of credit

	Green Hydrogen Management Committee in each country.	Lack of clear mandates for committees.	Define clear mandates and provide necessary staffing to ensure their effective functioning.
	Development of Guarantee of Origin GoO) certification that is aligned with international standards.	The certification systems may not be aligned with international standards.	Establish a rigorous compliance management system to ensure that regional certifications adhere to local and national regulations as well as international standards.
	Develop Framework for technical and safety standards for the entire value chain (RE generation, GH2 production, Electrolyser handling, storage, transportation etc.)	Implementing agencies may lack understanding of the developed standards which may result in difficulty for them to implement them effectively.	Provide resources and guidance to assist agencies in implementing the standards correctly.
	Cater Climate Change Issue	High likelihood of resistance from fossil fuel industries	Provide economic incentives, such as carbon pricing or emissions trading to industries for ensuring just transition
Capacity Building and Sensitization	Develop training topics/ modules based on an assessment of stakeholders' competencies.	The initial assessment may not accurately identify the competencies required by each stakeholder group.	Conduct a detailed assessment using surveys, interviews, and expert consultations to gather accurate data.
	Identify and support Centres of Excellence focused on training and technology development	Lack of adequate funding for supporting development of Centres of Excellence and training modules.	Seek a mix of public and private funding, international partnerships, and grants to ensure the continued operation of Centres of Excellence.
	Introduction of Green Hydrogen in Academics	Challenges to ensuring the quality and relevance of academic programs and laboratories.	Implement quality control mechanisms such as program assessments, curriculum reviews, and accreditation processes. reviews, and accreditation processes.
Research and Development	Collaborative R&D by establishing public-private partnership framework	Collaborative R&D may lead to concerns about the ownership and protection of intellectual property.	Establish fair and equitable agreements to address ownership, usage and protection of intellectual property generated during research collaborations.
	Undertake Demonstration projects	Demonstration projects may encounter unforeseen technical or operational challenges that can lead to delays or inefficiencies.	Conduct feasibility studies, risk assessments and contingency planning prior to the initiation of demonstration projects to identify and address potential technical and operational challenges

	Develop Research Centers	The transfer of advanced technologies, such as electrolysers and renewable energy systems, can be complex, involving legal, financial, and technical challenges.	Ensure clear agreements and mechanisms for the acquisition, implementation, and maintenance of advanced technologies to establish a framework for technology transfer framework.
Facilitating Infrastructure Development	Feasibility study of Green hydrogen clusters	The establishment of green hydrogen clusters may be restricted due to negative environmental impact.	Engage with environmental authorities and communities to implement carbon tax or other alternatives
	Feasibility study on Port and Gas Pipeline	The development or restructuring of port infrastructure and pipelines for bulk green hydrogen transport may not be viable.	Conduct detailed financial modelling, risk assessments, and sensitivity analysis to assess the financial viability of the project.
	Development of Special economic zone/ clusters	Design/construction fault-Failure to meet performance quality/ quantity-and sufficient utilities are not available for petrochemical complex.	Select experienced developer and include penalty clauses in the contract.
Financing Support	Fund Mobilization	Economic and financial market volatility can impact the availability of financing and the cost of capital for projects.	Introduce guarantees and insurance to reduce risks and make GH2 projects more attractive to investors.
	Development of Green Hydrogen Sovereign Fund Framework Development of Green Hydrogen Sovereign Fund Framework	Developing a fund can be challenging and may risk mismanagement of resources or disputes among stakeholders.	Include clear governance structures, decision-making processes, and accountability mechanisms to ensure transparency and responsible management.
	Soliciting Investments	Increase in interest rates, project and O&M cost due to WPI and CPI increase	To be covered in concession agreement. This risk is to be borne by developer through hedging or other means. Capex is fixed price contract. O&M escalation payable as per WPI/CPI indexing

Market Development	Long Term Contract	Long-term contracts may be affected by market fluctuations, changing prices, or shifts in global energy demand, potentially impacting the profitability of the projects.	Implement hedging mechanisms and price index clause within contracts to mitigate the impact of market volatility by stabilizing prices and revenue.
	Development of Export Market	There is no offtake risk (Export Market) leading to loss of revenue	Long term contract, Take or pay type of contracts, Government to Government contracts
		Regional/Domestic Market: Cost of application leads to project unviability	Creation of viability gap fund promoting applications in hard to abate sectors in the region/nations at the outset along with defining a sun set clause for the applicability of the fund.
	Participation in International tender, open bidding	Differences in political stability, legal frameworks, and regulatory environments in foreign countries can impact the success and stability of long-term contracts.	Evaluate geopolitical stability by engaging local experts understanding regulatory and legal requirements of respective countries. Include dispute resolution mechanisms and clear exit strategies for addressing geopolitical and regulatory risks.
	Local demand aggregation	Inadequate or underdeveloped technologies and infrastructure can hinder the adoption and utilization of GH2 in industries.	Long term O&M contract with the technology suppliers, Local manufacturing of equipment.

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