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ECONOMIC COMMUNITY OF WEST AFRICAN STATES (ECOWAS)

ECOWAS GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK

Imprint

ECOWAS Green Hydrogen Policy and Strategy Framework

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Partners
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NINETIETH ORDINARY SESSION OF THE ECOWAS COUNCIL OF MINISTERS

Bissau, 6 - 7 July 2023

REGULATION C/REG.1/07/2023 ON THE ADOPTION OF THE ECOWAS GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK

THE COUNCIL OF MINISTERS,

MINDFUL of Articles 10, 11 and 12 of the ECOWAS Revised Treaty as amended, establishing the Council of Ministers and defining its composition and functions;

MINDFUL of Article 28 of the ECOWAS Revised Treaty which requires Member States to coordinate and harmonize their policies and programmes in the field of energy;

MINDFUL of Decision A/DEC.3/5/82 on the adoption of the ECOWAS Energy Policy;

MINDFUL of Decision A/DEC.17/01/03 on the adoption of the ECOWAS Energy Protocol;

MINDFUL of Supplementary Act A/SA.2/07/13 on the adoption of the ECOWAS Energy Efficiency Policy;

MINDFUL of Supplementary Act A/SA.3/07/13 on the adoption of the ECOWAS Renewable Energy Policy;

MINDFUL of Supplementary Act A/SA.1/06/17 relating to the adoption of the ECOWAS Bioenergy Policy;

MINDFUL of Supplementary Act A/SA.2/06/17 on the adoption of the ECOWAS Policy on Gender Mainstreaming in Energy Access;

RECALLING the objectives of the United Nations Sustainable Energy for All SE4All goals of universal access to modern energy services by 2030, doubling the global rate of improvement of energy efficiency and the sharing of renewable energy in the global energy mix ,

CONSIDERING the Sustainable Development Goals (SDGs) adopted by ECOWAS Member States in order to ensure that the populations of the Region have access to a reliable, sustainable and modern energy for all, by 2030, with a view to satisfying their basic needs, in particular, food, health, education and job creation in rural and peri-urban areas;

RECOGNISING that population growth, urbanisation and the development of socio-economic and industrial activities require high energy consumption, which is a significant source of carbon emissions ;

CONVINCED that green hydrogen technologies offer an opportunity to build a decarbonised economy, impacting inter alia, the industry, electricity, agriculture and transport sectors ;

AWARE of the need to meet these requirements by facilitating access to technologies for the production, transport, storage, distribution and use of green hydrogen ;

AWARE ALSO of the need to remove administrative barriers of any kind to the exploitation of the many potentials of green hydrogen in the ECOWAS region;

NOTING that current and future trends in the green hydrogen market indicate a significant reduction in the price of the technologies, making them more competitive and offering opportunities for diversification of energy sources in the region ;

CONVINCED of the region's production potential, its competitive position and its determination to enter the growing global green hydrogen market;

ON THE RECOMMENDATION of the ECOWAS Ministers in charge of Energy at their meeting held in Bissau, on 24th March 2023;

UPON THE OPINION of the ECOWAS Parliament at its First Ordinary Session held in Abuja from 8th to 26th May 2023.

ENACTS

ARTICLE 1: ADOPTION

This **REGULATION C/REG.1/07/2023** hereby adopts the ECOWAS Green Hydrogen Policy and Strategy Framework herewith attached as an annex.

ARTICLE 2: PUBLICATION

1. This **REGULATION C/REG.1/07/2023** shall be published in the Official Journal of the Community by the ECOWAS Commission within thirty (30) days of its signature by the President of the ECOWAS Council of Ministers;

2. It shall also be published within the same period by each State in its Official Journal after notification by the President of the ECOWAS Commission.

ARTICLE 3: ENTRY INTO FORCE

This **REGULATION C/REG.1/07/2023** shall enter into force upon its publication.

DONE AT BISSAU, ON 7TH JULY 2023

....

H.E. SUZI CARLA BARBOSA

FOR THE COUNCIL

THE CHAIRPERSON

C/REG.1/07/2023

Foreword

This ECOWAS Green Hydrogen Policy and Strategy Framework was adopted by the 90th Ordinary Session of ECOWAS Council of Ministers, held in Bissau, Guinea Bissau on 6 and 7 July 2023. The Policy is in alignment with the new ECOWAS Energy Policy adopted the same days, which promotes the development of renewable energy and energy efficiency, with particular emphasis on the need to promote clean energy, especially the hydrogen. 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 thanks to its potential for converting renewable electrical energy into a clean chemical energy form that can easily replace conventional energy use. The prominent place of green hydrogen in the mid-and long-terms decarbonization strategies of several countries around the world is a perfecte illustration.

In addition, within the ECOWAS community, the potential in terms of renewable energies is sufficient to meet the region's energy needs and to produce green hydrogen competitively. According to reports by the International Renewable Energy Agency (IRENA), sub-Saharan Africa is the region with the greatest potential for competitive green hydrogen production in the world. It is estimated that in the most optimistic scenario, the region can produce around 35% of the total hydrogen production potential at less than $1.5 per kg of hydrogen. According to studies carried out as part of the H2 Atlas-Africa project, the ECOWAS region has almost 25% of the technical potential of the Sub-Saharan Africa region.

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 the socio-economic growth and sustainable development of all member states. It aims to achieve a regional production of at least 0.5 million tons of green hydrogen per year by 2030 and at least 10 million tons by 2050. Achieving these targets will require the installation by 2030 of nearly 4-5 GW of electrolyzer capacity with a cumulative investment requirement of around USD 3 to 5 billion and expected annual revenues of around USD 1.25 billion.

This strategic document aims to promote green hydrogen in ECOWAS member States through the development of appropriate regulatory frameworks, thereby strengthening regional integration in the sustainable energy sector with strong local content, while opening up to other regions in Africa and the world. It also gives clear indications in terms of institutional organization, certification schemes, infrastructure investment, capacity building, and research, as well as funding mechanisms. This document is perfectly aligned with the objectives of the ECOWAS Vision 2050, the 4x4 objectives of the ECOWAS Commission, and those of the ECOWAS Energy Policy. I therefore appeal to all ECOWAS member States and partners to provide strong support for the operationalization process of this Framework through the effective implementation of the ECOWAS Green Hydrogen Strategy and related Action Plans for the periods 2023-2030 and 2031-2050.

In closing, I would like to express my gratitude and thanks to all the partners who provided their support for the development of this ECOWAS Green Hydrogen Policy and Strategy Framework and the corresponding operationalization documents, including the Regional Strategy and related Action Plans. I would particularly like 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).

His Excellency, Dr Omar Alieu TOURAY
President of the ECOWAS Commission
Abuja, 6 October 2023

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List of Abbreviations

BMBF	German Federal Ministry of Education and Research
BMZ	German Ministry of Economic Cooperation and Development
CCfD	Carbon Contracts for Difference
CO2	Carbon Dioxide
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EGHDU	ECOWAS Green Hydrogen Development Unit
EREP	ECOWAS Renewable Energy Policy
EU	European Union
GDP	Gross Domestic Product
GH	Green Hydrogen
GHG	Greenhouse Gas
GW	Gigawatt
GWh	Gigawatt-hour
H2	Hydrogen
HDI	Human Development Index
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	kilowatt-hour
MW	Megawatt
MWh	Megawatt-hour
NDC	Nationally Determined Contributions
R&D	Research and Development
RE	Renewable Energy
SADC	South African Development Community
WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use

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1
Executive Summary

BACKGROUND

Globally, efforts to mitigate the effects of climate change has never been more urgent, with countries setting their Long-Term Low Emission Development Strategies. While these commitments are largely driven by the increased use of renewable resources, global decarbonization objectives are incomplete without solutions to mitigate the carbon emissions from the 'hard-to-abate' sectors such as industries and transportation.

This is one of the concerns for which **ECOWAS** has updated its Regional Energy Policy. This has made it possible to integrate changes in the international context but also in the regional context marked by significant economic, social, political, and technological changes, in order to converge towards an integrated, fair and sustainable energy development. To this end, the Policy places particular emphasis on the need to promote clean forms of energy, particularly Hydrogen.

Clean hydrogen is recognised as an energy source capable of decarbonising the industrial, transport, agricultural and power sectors. For this reason, it has been the subject of growing interest from the international community in recent years. Many countries in Europe, South and North America and Asia have developed specific policies and strategies for the production and massive use of clean hydrogen in the coming decades.

Clean hydrogen is composed of green, blue, and natural hydrogen. The interest in clean hydrogen in the ECOWAS region stems from the region's strong renewable energy, natural gas, and natural hydrogen potential. However, considering that green hydrogen is the most environmentally friendly and commercially ready form of clean hydrogen identified to this date, this policy and strategy framework will particularly focus on Green Hydrogen, while other forms of clean hydrogen will be considered at national levels.

Green hydrogen is a promising solution for decarbonization due to its potential to store renewable electric energy in a non-polluting chemical form which can easily replace conventional fuel use in industries.

The ECOWAS' renewable energy potential is sufficient to meet the region's energy needs and produce green hydrogen. According to reports from the International Renewable Energy Agency (IRENA), sub-Saharan Africa is the region with the greatest potential for competitive green hydrogen production in the world. It is estimated that in the most optimistic scenario, the region can produce about 35% of the total hydrogen production potential at less than USD 1.5 per kg of hydrogen. According to studies undertaken in the framework of the H2 Atlas-Africa project, the ECOWAS region possesses nearly 25% of the technical potential of the sub-Saharan African region.

ECOWAS region has high potential of solar power in almost all regions, however low-cost solar power is largely concentrated in the northern area. Wind potential is strongest along coastal regions, while hydropower potential is concentrated in the southern part of the region. Water availability is a critical component of green hydrogen production and fresh ground water has competing uses for consumption. As a result, desalination of sea water can be low-cost alternative. Due to the above spatial distribution of resources in the ECOWAS region, regional cross border exchange mechanisms for flow of energy, water or hydrogen are necessary to support large scale green hydrogen development.

On the demand side, ECOWAS countries currently have a limited presence of major iron and steel manufacturing industries, as well as limited production facilities for fertilizers, however the region has large reserves of iron oxides and phosphate, which combined with hydrogen or hydrogen derivatives could enable the local production of iron, steel or fertilizers. The transport sector in the region also represents an opportunity for local applications. The West African Gas Pipeline is the largest natural gas infrastructure in the region. Such industries can constitute a small demand of the total hydrogen production potential in the region. Furthermore, the Nationally Determined Contributions of the ECOWAS member states are largely aligned to long term targets to achieve carbon-neutral. Presently, the member states have a priority to stimulate economic development and improve energy access. Presently, the global costs of hydrogen and its associated costs with reconversion of electricity limit its use as a primary energy source.

However, the global demand for green hydrogen is booming, with countries setting targets and investment plans for import of green hydrogen. ECOWAS has the advantage of the presence of a large of port infrastructure and proximity to many demand centres. Targeting export markets with guaranteed green hydrogen offtakes is a critical short-term step to enable scale up of local green hydrogen ecosystem.

ECOWAS GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK

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 this extent, certain short term and long-term objectives of the framework are identified:

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. 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 climate change resilience of the region;

d. To promote sustainable industrial development;

e. Promote equitable socio-economic and gender development.

TO ACHIEVE THE ABOVE TARGETS, THE PROPOSED FRAMEWORK DIRECTS THE ECOWAS REGION AND THE MEMBER STATES TO:

1. Focus on the development of green hydrogen as an energy resource for domestic consumption as well as export.

2. Aim to be among the most competitive suppliers of green hydrogen and derivatives in the world.

3. Conduct technical assessments and facilitate homogenous regulations for green hydrogen across the ECOWAS member states.

4. Redefine targets under the ECOWAS Renewable Energy Policy to meet the renewable energy requirement for green hydrogen production.

5. Create dedicated infrastructure for green hydrogen.

6. Facilitate investments and establish financial mechanisms and incentives to minimize risks for early investors.

7. Ensure socio-economic development while mainstreaming gender.

8. Establish an ECOWAS Green Hydrogen Development Unit to monitor green hydrogen development.

9. Ensure regional and international co-operation on matters related to green hydrogen.

TARGETS

The Policy and strategy framework sets a target to reach a regional production of at least **0.5 million tonnes** of green hydrogen per year by **2030** and at least **10 million tonnes by 2050**. For the short-term target of 0.5 million tonnes, nearly 4-5 GW of electrolyser capacity is needed with a cumulative investment requirement of **~3-5 billion USD,** with expected annual revenues of nearly **1.25 billion USD per year by 2030**.

Specific targets to ensure meeting the policy and strategy framework objectives are:

- At least 3 green hydrogen clusters shall be set up in feasible locations, by 2025;
- ECOWAS should build at least 5 scalable green hydrogen production projects by 2026.

Strategy framework and Implementation Plan

In accordance with the green hydrogen policy and strategy framework, a targeted action plan is proposed herewith to address the region's short-term objectives while keeping a vision of the long-term objective of a green hydrogen economy. A phased approach to green hydrogen development is proposed to limit early mover risks and ensure appropriate adaptability to an evolving technology.

Phase I (Year 0-2)

- Developing ecosystem for green hydrogen
- National policy development
- Prerequisites for green hydrogen enabled– regulatory, technical, financial
- R&D: feasibility assessments
- Capacity Building and sensitization

Phase II (Year 2-6)

- Infrastructure development
- Research and Development: Small scale demonstration project
- Development of targeted clusters
- Financing and investment planning facilitated

Phase III (Year 6-8)

- Long term contracts secured
- International and domestic offtake operational
- Emergence of commercial scale projects

THE STRATEGIC ACTIONS PROPOSED FOR PROPER IMPLEMENTATION OF THE ECOWAS GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK ARE AS FOLLOWS:

1. At regional level establish an ECOWAS Green hydrogen Development Unit within existing institutional framework to ensure effective, dedicated and coordinated actions towards green hydrogen development and consideration. Similarly, at the national level, member states will need to develop a national level policy or modification of existing policies to include green hydrogen in accordance with the ECOWAS Green Hydrogen Policy and Strategy Framework;

2. At regional level establish a harmonious regulatory framework such as certification schemes and technical codes and standards. At national level each member country should work in close cooperation with the EGHDU for the development of national standards and should identify appropriate national agencies for the monitoring and implementation of such regulations;

3. Capacity building and sensitization efforts must be undertaken at the regional and national levels to enable public and private action;

4. At the regional level training centres should be developed to promote green hydrogen and provide training to create skilled workforce for the sector. At national level Capacity development should cover development issues such as project implementation, management, operation, and long-term sustainability;

5. Facilitate research and development on the production, handling as well as use of green hydrogen in the region;

6. Facilitating dedicated infrastructure such as hydrogen corridors for transport of energy, water or hydrogen as well as clusters for hydrogen production, desalination of water;

7. Hydrogen clusters should be given the status of 'Special Economic Zones' with various regulatory incentives like fiscal concessions on import duty, creation of value chain for Green Hydrogen;

8. Ensure financing support through appropriate financial incentives at the national level;

9. Facilitate export market development through the formulation of a dedicated hydrogen export strategy. Also supply of technology required for green hydrogen must be facilitated through technology transfer and memorandum of understandings to facilitate bilateral partnerships;

10. Facilitate local market development through appropriate promotion strategy including assessment and demonstration projects.

INSTITUTIONAL FRAMEWORK

A dedicated Institutional framework is proposed comprising of core team of experts from different institutions. A working group with representatives from these institutions will provide strategic guidance and ensure implementation of the policy goals and the strategic plan.

VALUE ADDITION OF DEVELOPMENT OF GREEN HYDROGEN FOR THE ECOWAS REGION

The Green Hydrogen Policy for ECOWAS region has been developed keeping in mind the value addition necessary for the region and is not focused only on export potential of Green Hydrogen to other countries. One of the clear objectives of the policy is the socio -economic development by creation of jobs in the field of green hydrogen related technologies in manufacturing, installation and construction, operations and maintenance.

RISK ASSESSMENT

The policy and strategy framework document also assess risk at various stages of implementation of ECOWAS green hydrogen policy, which can impact the intended results of the implementation framework. Appropriate risk mitigation measures have also been suggested to ensure that the policy goals are not impacted.

MONITORING AND EVALUATION MECHANISM

A robust monitoring and evaluation mechanism is suggested to ensure that the EGHDU performs in accordance with its objectives.

2 Introduction

Background

To take into account new paradigms in energy development and in anticipation of global and regional changes over the next 30 years, the ECOWAS Commission has updated the regional energy policy, which dates back to 1982.

The updated ECOWAS Energy Policy 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.

The promotion of Hydrogen in general and Green Hydrogen in particular, is an essential link in this policy in order to contribute to the more accelerated popularization of all forms of clean energy in the region. In effect, the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) has been exploring the potential to produce green hydrogen (GH) and its derivatives as energy options to decarbonize the West African economy. The H2ATLAS-AFRICA project is the first phase of a joint initiative of the German Federal Ministry of Education and Research (BMBF) and African partners in the Sub-Saharan region – South African Development Community (SADC) and Economic Community of West African States (ECOWAS) – to explore the potential of GH production using renewable energy (RE) sources within the sub-regions.

Initial technical assessments conducted under the H2ATLAS-AFRICA project indicate immense potential to produce GH in the region. However, the exploitation of this potential is still largely underdeveloped in West Africa. One of the key barriers to the development and deployment of GH is the absence of a policy and regulatory framework. It is, therefore, particularly important to formulate a comprehensive and coherent policy along with an appropriate legal and regulatory framework to encourage investment in GH both at the country and regional levels.

In this regard, the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) a specialized ECOWAS agency in charge of promoting renewable energies, is promoting the development of green hydrogen in the region through the elaboration of the ECOWAS Green Hydrogen Policy and Strategy Framework.

STRUCTURE OF THE GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK DOCUMENT

This document presents the green hydrogen development policy in the ECOWAS region and the framework of the strategy and action plan. The policy development approach to formulating this document is highlighted in Chapter 3.

The document is structured in a manner to inform the reader of the context and prerequisite information about green hydrogen and the ECOWAS region which has been considered in the development of a green hydrogen policy and strategy framework, including the strategy and action plan for the region. This context is detailed in Chapter 4 of this document.

Based on the collective understanding developed, Chapter 5 presents the Green Hydrogen Policy and Strategy Framework detailing the strategic vision and the objectives, along with specific directives and targets set for the region. Chapter 6 highlights short term and long-term objective of the policy and strategy framework. Chapter 7 and 8 respectively describes in detail guideline and target of the green hydrogen policy and strategy framework for the ECOWAS region.

The proposed strategy and action plan framework for implementation of the policy directives is explained further in Chapter 9. Specific actions are highlighted at the national and regional level to achieve the regional objectives. Chapter 10 describes the institutional framework for the ECOWAS Green Hydrogen Development Unit (EGHDU), along with its role and responsibility.

Chapter 11 describes value addition to the ECOWAS region due to green hydrogen policy and strategy framework. Chapter 12 highlights various risk that may arises during various stages of implementation of ECOWAS green hydrogen policy and strategy framework. The chapter also highlights risk mitigation measures to ensure that the policy goals are not impacted. Chapter 13 explain monitoring and evaluation mechanism that would help EGHDU to performs in accordance with its objectives.

3
Approach to Developing the Green Hydrogen Policy and Strategy Framework

Green hydrogen is emerging as an important alternate fuel and energy carrier for the future as its energy density is three times higher than that of petrol or diesel and in comparison with these fuels, it produces zero carbon emissions.

In developing a green hydrogen policy and strategy framework for the ECOWAS region, a multipronged approach has been adopted recognising the current context, issues, challenges, priorities, and socio-economic interests of the region. A regional policy presents opportunities given the diversity of resources among member countries and their unique position on the regional map and at the same time it needs to provide a strong basis and incentive for them to collaborate and benefit from their mutual strengths.

THE GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK DEVELOPED AND PRESENTED IN THIS DOCUMENT SEEKS TO ADDRESS THE FOLLOWING QUESTIONS:

1. **What is the overall vision, goal, and target for Green Hydrogen for the ECOWAS region?**

2. Where is ECOWAS at the moment, what is the current context and what are the limitations that need to be recognized?

3. What are the key issues and challenges in terms of infrastructure availability, resource availability and conflicting priorities that one must consider for green hydrogen development?

4. What should be the guiding principles for this important policy and strategy framework; and what should be the different elements such as investment promotion, institutional capacity development, financing support, research and development that will shape the future of the region for the next three decades?

4
Context of the ECOWAS Green Hydrogen Policy and Strategy Framework

The global challenge for climate change and its impact necessitates the transition towards more efficient use of energy and utilization of cleaner forms of energy. This transition along the path of decarbonisation is challenging as it must ensure that besides sustainability the other aspects of the energy trilemma – equity and security – are not compromised. Thus, as electrification and efficient energy use facilitate the journey along the low-carbon pathway, the ultimate success to reach the carbon-neutral goal would depend on the ability to cut emissions in the "hard-to-abate" sectors like carbon-intensive industries (cement, steel, etc) and transport (long-distance trucking, aviation, shipping, etc.). Such sectors are typically hard to electrify and hence alternatives to current carbon-intensive fuels need to be found.

Hydrogen is an attractive fuel as combustion or conversion of pure hydrogen does not involve any carbon emissions. If hydrogen can be produced sustainably, it can be a viable replacement option for current carbon-intensive fuels. Green Hydrogen refers to the hydrogen produced in a sustainable manner using renewable energy resources and having lower associated carbon emissions as compared to conventional process for hydrogen production like reforming.

Hydrogen can also be produced from natural gas or fossil fuels, but the standard processes involve high carbon emissions and are hence labelled 'grey hydrogen'. These carbon emissions when captured and stored, the resultant hydrogen produced is labeled 'blue hydrogen', but it is not considered attractive in the long term for global decarbonization objectives as studies show that the linked GHG emissions with carbon capture technologies are still quite significant[1]. Hydrogen can also be produced from the subsurface through chemical reactions, such hydrogen is called natural hydrogen and sometimes referred to as "white hydrogen". In such cases, the hydrogen is only extracted from the subsurface, with limited emissions in the process. The discovery of natural hydrogen was in Mali, but the overall potential for natural hydrogen for the ECOWAS is yet to be determined. As a result, green hydrogen is perceived as the preferred viable zero-carbon energy carrier to support countries in their national sustainable energy objectives.

ECOWAS has a growing economy and faces the immense challenge to build an energy infrastructure that is forward-looking and sustainable, while ensuring economic development at the desired pace. The region possesses huge renewable energy generation potential with the presence of huge solar, wind, hydropower, and biomass resources, natural hydrogen and a comprehensive renewable energy and energy efficiency policies with exploitation targets and an implementation plan. The development of the green hydrogen ecosystem in the region would complement these efforts to facilitate sustainable growth in the region, while providing a boost to sustainable development of certain industrial sectors. However, to pursue the green hydrogen development and deployment drivers, certain impediments need to be addressed quite similar to impediments associated with the development of RE in ECOWAS.

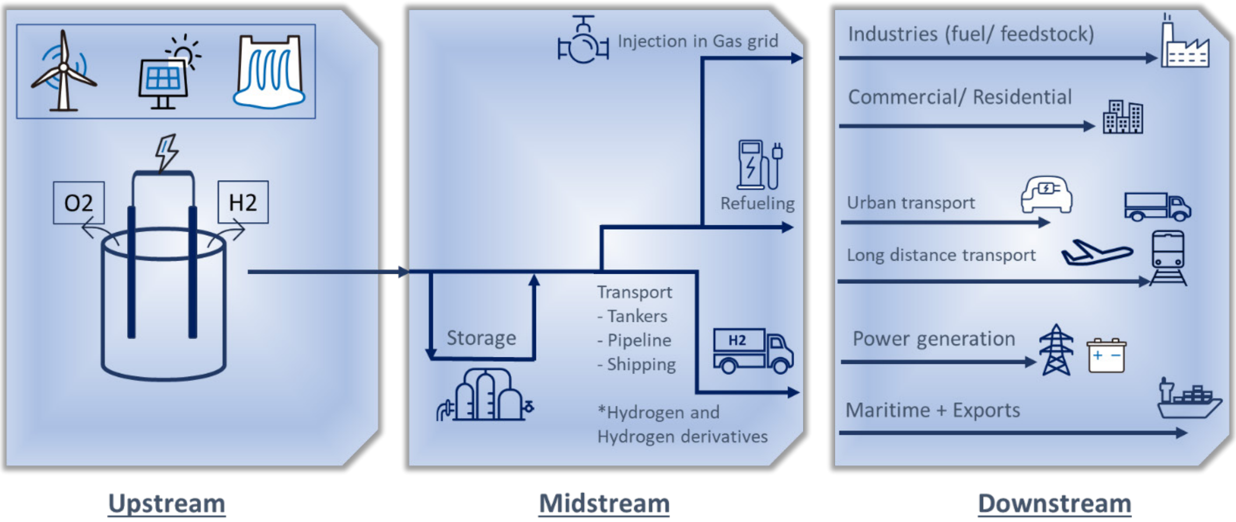
In order to identify the policy requirements for developing green hydrogen, it is necessary to understand the requirement of the region based on its prevailing situation. This chapter sets to underscore the context for green hydrogen based on the developments in the electricity sector, renewable energy and specific actions for green hydrogen in the region.

[1] - How green is blue hydrogen? Robert W. H et al, Energy Science and Engineering, Vol 9, Issue 10, August 2021 https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956

4.1 VALUE CHAIN OF HYDROGEN

While hydrogen has been used by industries for quite a while, green hydrogen is relatively new as a commercial commodity. There are various options available at each stage of production, storage and handling, and consumption which makes the value chain of hydrogen, a complex one. Each stage of the value chain presents its own sets of challenges and opportunities, unique to the region, where this energy source is deployed. The different segments of the typical green hydrogen value chain are shown below and described in detail in the following sections.

Figure 1: Schematic describing the primary segments of the value chain for green hydrogen



4.1.1 PRODUCTION OF HYDROGEN

Several technology options exist for production of green hydrogen. While large scale production is primarily achieved through electrolysis of water, production can also be conducted through gasification of biomass. Choice between different electrolyzer technology such as alkaline electrolyzers, polymer electrolyte membrane electrolyzer or solid oxide electrolyzer is guided by the cost of production and the operating parameters. The renewable energy input for electrolysis can be sourced from standalone wind, solar or renewable hybrid plants, hydropower, or other renewable energy sources for centralised or decentralised production of green hydrogen.

Conventionally, hydrogen is categorized into "colors" on the basis of its mode of production and the associated emissions with each production method. Bellow are a few key colours of hydrogen:

- **Grey:** Hydrogen produced by traditional fossil fuels based processes, without any accompanying mitigation of carbon emissions;

- **Blue:** Hydrogen produced by the traditional reforming process, accompanied by carbon capture, utilization, and storage (CCUS) solutions. However, studies have shown that the GHG emissions linked with blue hydrogen are quite high despite reduction in CO2 emissions because of emissions of methane gas ;

- **Green:** Hydrogen produced through the electrolysis of water, using RE. This is the cleanest form of hydrogen;

- **Natural Hydrogen (White):** Hydrogen generated from the subsurface. Natural hydrogen has been identified in many source rocks around the world including Mali, Australia, Russia, the United states, etc. There are multiple natural hydrogen generation processes identified today (serpentinization, natural water electrolysis, radiolysis, degassing, anaerobic fermentation, rock crushing, and anaerobic corrosion). The carbon emissions from white hydrogen production are expected to be low but have yet to be confirmed.

4.1.2 STORAGE, TRANSPORTATION, AND DISTRIBUTION

As a commercial commodity, the consumption of green hydrogen is usually separate from the site of its production. As a result, an entire value chain segment on handling of green hydrogen has to be developed to store, transport, and distribute hydrogen to its target market. Various technological options have been explored and implemented globally which have been listed below briefly:

STORAGE OF GREEN HYDROGEN

• Green Hydrogen can be stored in its gaseous form, liquid form or by conversion to other fuels;

• Natural underground structures such as salt or rock caverns, aquifers, and man-made structures such as depleted oil/gas reserves resulting from mining and other activities can be used for the long-term storage of green hydrogen in a pressurized gaseous form;

• Green Hydrogen can also be stored in compressed form. Specialized high-pressure tanks (at 350–700 bar tank pressure for transport via trucks, freights, ships, etc., or at 100 – 150 bar for stationary storage) are needed to store green hydrogen in compressed form;

• Liquefaction of green hydrogen is an energy-intensive process, requiring sub-zero temperatures which consumes more than 30% of the energy content of the hydrogen. Liquefied green hydrogen can be stored at the liquefaction plant in large, insulated tanks. Newer technologies are also emerging where green hydrogen can be temporarily absorbed or adsorbed on different materials and transported in solid form.

TRANSPORT AND DISTRIBUTION OF GREEN HYDROGEN

Green Hydrogen can be transported via tankers through trucks, freight trains, ships or through pipelines. The choice of technology for transportation is determined by the distance and the volume of gas to be transported and related economics:

• Trucks (for transport of smaller volumes);

• Pipelines (for regular transport of larger volumes);

• Shipping tankers (for transport of large volumes over very long distances)

Green Hydrogen may also be transported in different modes, including:

• Gaseous pure form, via compression;

• Gaseous form blended with natural gas;

• Pure liquid form, via liquefaction, which is dispensed via liquid tankers/trucks or through ships (technology currently in nascent stage);

• Conversion to derivatives or liquid organic hydrogen carriers like ammonia, ethanol etc.

[2] How green is blue hydrogen? Robert W. H et al, Energy Science and Engineering, Vol 9, Issue 10, August 2021 https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956
[3] These are oil/gas reserves which have already been used for extraction of fossil fuels and are already equipped with the installations for injections and withdrawal of gas into the system
[4] The cryogenic temperature range has been defined as from −150 °C (−238 °F) to absolute zero (−273 °C or −460 °F), the temperature at which molecular motion comes as close as theoretically possible to ceasing completely.
[5] Adsorption and absorption are physical processes where hydrogen is physically combined on the surface or inside the volumetric bulk of the material, respectively. Unlike chemical processes, these are easily reversible.

4.1.3 END-USE APPLICATIONS

The conventional use of hydrogen has largely been limited to its use in the industries, such as, oil refining, the chemical sector, and iron and steel production. The decoupling of green hydrogen from its localized production enables use of hydrogen across multiple sectors. Broadly, such applications can be categorized into industry, mobility, commercial/ residential, and power generation. The role of green hydrogen in each sector is unique, as detailed below. It must be mentioned that the technological maturity and economic viability of these applications are currently in different stages and not all applications are market ready at this point in time.

Industry:

- Green hydrogen can provide decarbonized high heat for industrial processes and can be used as a feed stock. In many energy-intensive industries that use high-grade heat, hydrogen could be a more feasible or efficient route to decarbonization than electrification, such as, in blast furnaces during iron reduction;
- Hydrogen is primarily used to produce ammonia by the Haber-Bosch process[6], and this ammonia is then used primarily to produce fertilizers. The petrochemical industry is also a huge consumer of hydrogen, where hydrogen is used to remove contaminants such as sulfur from diesel;
- The iron and steel industry uses hydrogen primarily as a reducing gas in the production of direct reduced iron (DRI) steel. Green hydrogen can also be used as a fuel in this process, and in other industries such as glass, metal refining, and cement manufacturing.

Transport/ Mobility

- Green Hydrogen has the potential to become main fuel for transportation, as it can power fuel cells without any associated emissions. While battery powered electric vehicles are currently a more popular alternative to conventional vehicles for cleaner transport, fuel cell vehicles should be considered as a complementary option and not as a competitor, especially in long-haul heavy trucking segment. Fuel cell vehicles typically provide significantly longer ranges and their refueling times are of the same order as conventional gasoline vehicles but are typically costlier at present;
- In the short term, green hydrogen can also be used along with conventional fuels such as hydrogen enriched compressed natural gas (CNG);
- Green hydrogen is of special interest for long range vehicles such as trucks, buses, and freight trains because of its long-range capabilities and cost competitiveness. Maritime sector has an intensive use of hydrocarbon-based fuels and its replacement with green hydrogen provides a huge potential for decarbonization of this sector.

Commercial and Residential buildings

Fuel cells with green hydrogen as an input can be used in combined heat and power systems in commercial/residential sectors to improve energy access, and build system resiliency. The use of green hydrogen ensures the decarbonization of this sector, which consumes huge amount of energy, in the form of electricity for lighting, cooling and other uses, as well as fuel for space heating and power back-up.

Green hydrogen can use the gas-network infrastructure currently in place for heating and other applications, by way of blending. This limits the cost of setting up new infrastructure and is a viable short-term objective.

[6] The Haber process, also called the Haber–Bosch process, is an artificial nitrogen fixation process and is the main industrial procedure for the production of ammonia today

Power Generation and Grid services

- Stationary fuel cell technologies have demonstrated fast responses or ramp up rates, which makes them a viable option to complement renewable energy generation in grid systems. This could substitute natural gas power plants to provide ancillary support to grids in the short term due to the high prices and volatity of natural gas;
- Green hydrogen is an efficient energy storage vector that could provide power grid with a long-term energy storage option. This would mitigate the seasonal variations in renewable generation and also prevent curtailment of generation from renewable sources in peak seasons;
- Fuel cells can also been used as a back up power in the telecommunications sector and in decentralised mini-grids replacing diesel based generators.

While there are several applications that can be harnessed, it is important that the viability of these applications be examined closely in the context of long term interests of ECOWAS region. In suggesting the green hydrogen policy and strategy framework for the ECOWAS region, adequate attention has been given to this aspect as mere technical feasibility of a technology does not necessarily mean that they need to be deployed.

4.2 GLOBAL DEVELOPMENTS IN GREEN HYDROGEN

Many leading countries have announced policies or initiatives to support the development of the GH value chain (and these countries cumulatively make up 90% of the global GDP)7 . An overview of the policy level developments in the major countries/regions globally is given below:

- The US's National Clean Hydrogen Strategy and Roadmap target cost reduction for clean hydrogen by 80% to USD 1/kgH2 by 2030;
- Canada's Hydrogen Strategy (December 2020) aims for global leadership in clean supply and for a 30% share of hydrogen in end-use energy by 2050. No specific production targets are mentioned, though the Canadian strategy states a potential for 4 Mt/yr clean hydrogen production by 2030;
- As per Chile's National Green Hydrogen Strategy (2020), it aims to have 5 GW of electrolyser capacity under development by 2025, and 25 GW with committed funding by 2030;
- Colombia's Hydrogen Roadmap (2021) aims for 1–3 GW electrolysis capacity installed and 50 kt/yr of blue hydrogen produced by 2030;
- The European Union (EU) hydrogen strategy (2020) aims for at least 40 GW electrolyser capacity installed in 2030 (6 GW by 2024). As per its REPowerEU revisions (2022), it aims for 10 Mt of domestic renewable hydrogen and 10 Mt of renewable imports, by 2030. Some countries in the region (e.g., Germany) are expected to develop into large-scale importers of hydrogen, with others becoming exporters or transit hubs;
- South Africa's Hydrogen Society Roadmap (February 2021) aims for renewable hydrogen exports, targeting a 4% global market share by 2050 with a target of 1 MW electrolyser production pilots by 2024, expansion to 10 GW (2025–2030); and 15 GW capacity installed (2030–2040);

[7] LBST. (2020). International Hydrogen Strategies

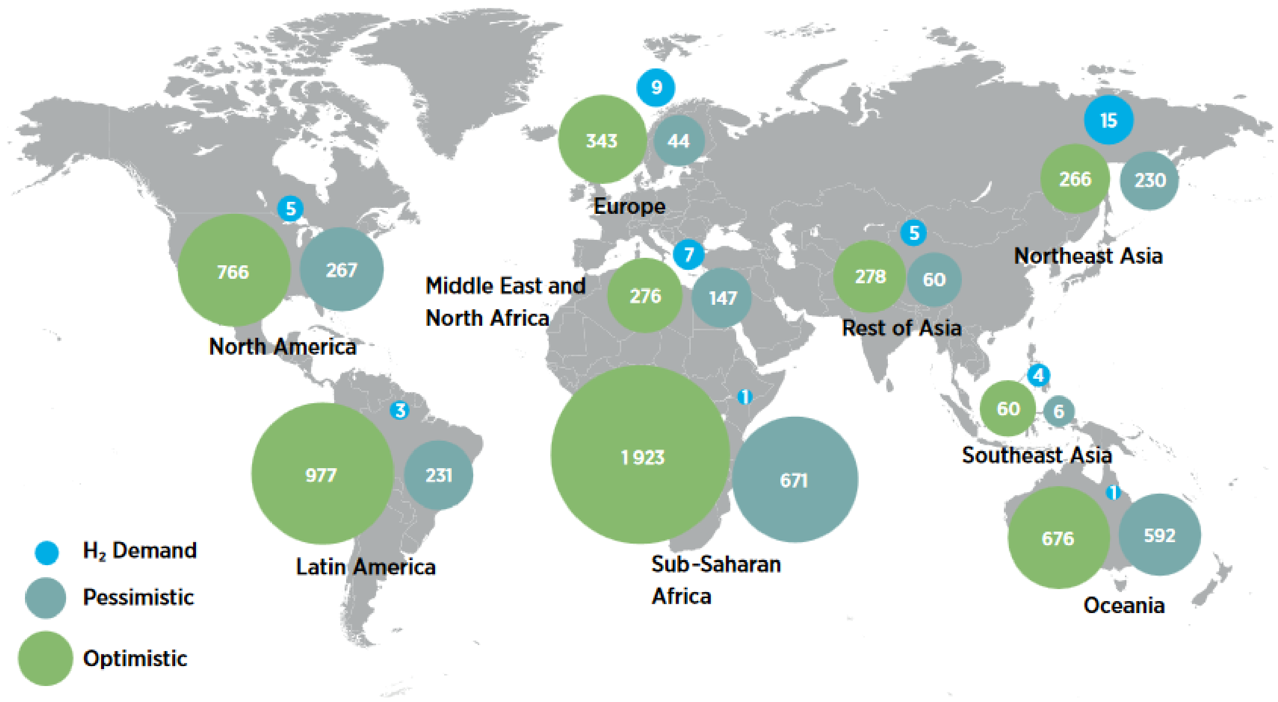
- Morocco's Green Hydrogen Roadmap (2021) targets a 4% share of global demand by 2030, prioritizing export to Europe. Domestic use plans include as raw material (feedstock) in fertilizer production, fuel for transport (freight, public transit, aviation), and green hydrogen for energy storage;
- Oman's National Hydrogen Strategy (2021) pursues blue and green hydrogen with capacity targets of 10 GW by 2030 and 30 GW by 2040. The country focuses on hydrogen for domestic use for heating in industrial processes (iron, aluminium, chemicals production), as a raw material (feedstock), and for road transport;
- The UAE's Hydrogen Leadership Roadmap (2021) targets a 25% share of the global low-carbon hydrogen/ derivatives market by 2030. It is home to the region's first solar PV / green hydrogen facility. Targets include domestic use in manufacturing (e.g., steelmaking, kerosene) and public transit. Examples of export focus include bilateral agreements with Japan, South Korea, and memoranda of understanding (MoUs) with several European countries (Austria, Germany, Netherlands);
- China's Hydrogen Development Roadmap targets 10 GW installed electrolyser capacity by 2025, at least 35 GW by 2030, and more than 500 GW by 2050;
- India's first phase green hydrogen policy (February 2022) aims to produce 5 Mt/yr of renewable hydrogen by 2030, and for 75% of hydrogen to come from renewable sources by 2050;
- South Korea's Hydrogen Economy Roadmap (2019) and Hydrogen Law (effective 2021) target a mix of grey, blue, and green hydrogen towards 2030 with a total of 3.9 Mt/yr (of which around 2 Mt/yr will be renewable hydrogen imported from overseas). For 2050, the aim is to produce 5 Mt/yr (3 Mt/yr renewable hydrogen, 2 Mt/yr low-carbon hydrogen) while importing 23 Mt/yr renewable hydrogen;
- Japan's Strategic Roadmap for Hydrogen and Fuel Cells (2019) sees hydrogen and ammonia supplying 1% of its energy demand by 2030, with hydrogen already generating electricity by then. Japan aims to import renewable or low-carbon hydrogen from overseas. A key part of its strategy is to build a comprehensive international supply chain in the manufacture, storage, transport, and use of hydrogen;
- Australia's National Hydrogen Strategy (2019) targets clean hydrogen (blue and green) production and becoming an export hub in renewable and low-carbon hydrogen and ammonia. Australia's different regions also have regional targets for hydrogen use (e.g., 10% hydrogen blending in the gas network by 2030) and production. Australia also supports the development of natural hydrogen. The country has introduced a natural hydrogen exploration permit since 2021.

While there are noteworthy policy positions taken by different countries, the policy development of ECOWAS region needs to be based on the potential for green hydrogen development duly considering the ability to produce it competitively as compared to other nations outside African region from a trade perspective. This aspect is discussed in the following sections.

Global trade potential

As per a study done by the International Renewable Energy Agency (IRENA), sub-Saharan Africa holds the greatest potential for global green hydrogen production. 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. A map of the region's potential against other global supply centres is shown below. As estimated by the H2 Atlas, 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.**

Figure 2: Technical potential for producing green hydrogen under US$ 1.5/kg by 2040 (values in EJ)



4.3 CONTEXT FOR GREEN HYDROGEN DEVELOPMENT IN ECOWAS

4.3.1 SOCIO-ECONOMIC CONDITION

The ECOWAS region is a regional political and economic union of 15 member countries located in West Africa, widely varying within the region in terms of demography and socio-economic conditions. The ECOWAS region comprises a total geographical area of 5.12 million km², occupied by a population of about 397.21 million, and has an economic output of USD 683.71 billion. This is 3.4 % of the habitable area around the world, having 5.1 % of the world population, and comprising only around 0.81 % of the global Gross Domestic Product (GDP) share. The GDP per capita of the ECOWAS countries is significantly lower than the global average of $ 10,916.10 (2020) . However, the ECOWAS economy is growing fast with the regional GDP growth rate at 3.9 % in 2020 and 4.4 % in 2021 , which is comparable to the global GDP growth rate of 3.4 % in 2020 and 2021.

4.3.2 ENERGY SITUATION IN ECOWAS

The economic growth of any region is accompanied by an increase in energy consumption. The regional population average growth rate is around 2.5 % and along with the expected regional economic growth, eelectricity consumption in the region is expected to continue to grow with a Combined Annual Growth Rate (CAGR) ranging from 4% to 6% between 2020 and 2040 according to study by IRENA. The present situation in the region with respect to energy access, organisation of the electricity sector and energy generation is further described below.

4.3.2.1 Energy Access

The region currently faces a huge disparity in providing its population with access to energy. Overall, nearly 50% of the population has access to electricity but this varies significantly from country to country and region to region. Energy access ranges from 15% of the total population of Niger to nearly 92% of the population for Cape Verde.

[8]IRENA 2022, Global hydrogen trade to meet the 1.5°C climate goal: Part III – Green hydrogen cost and potential, International Renewable
[9]Energy Agency, Abu Dhabi.
https://data.worldbank.org/indicator/NY.GDP.PCAP.CD

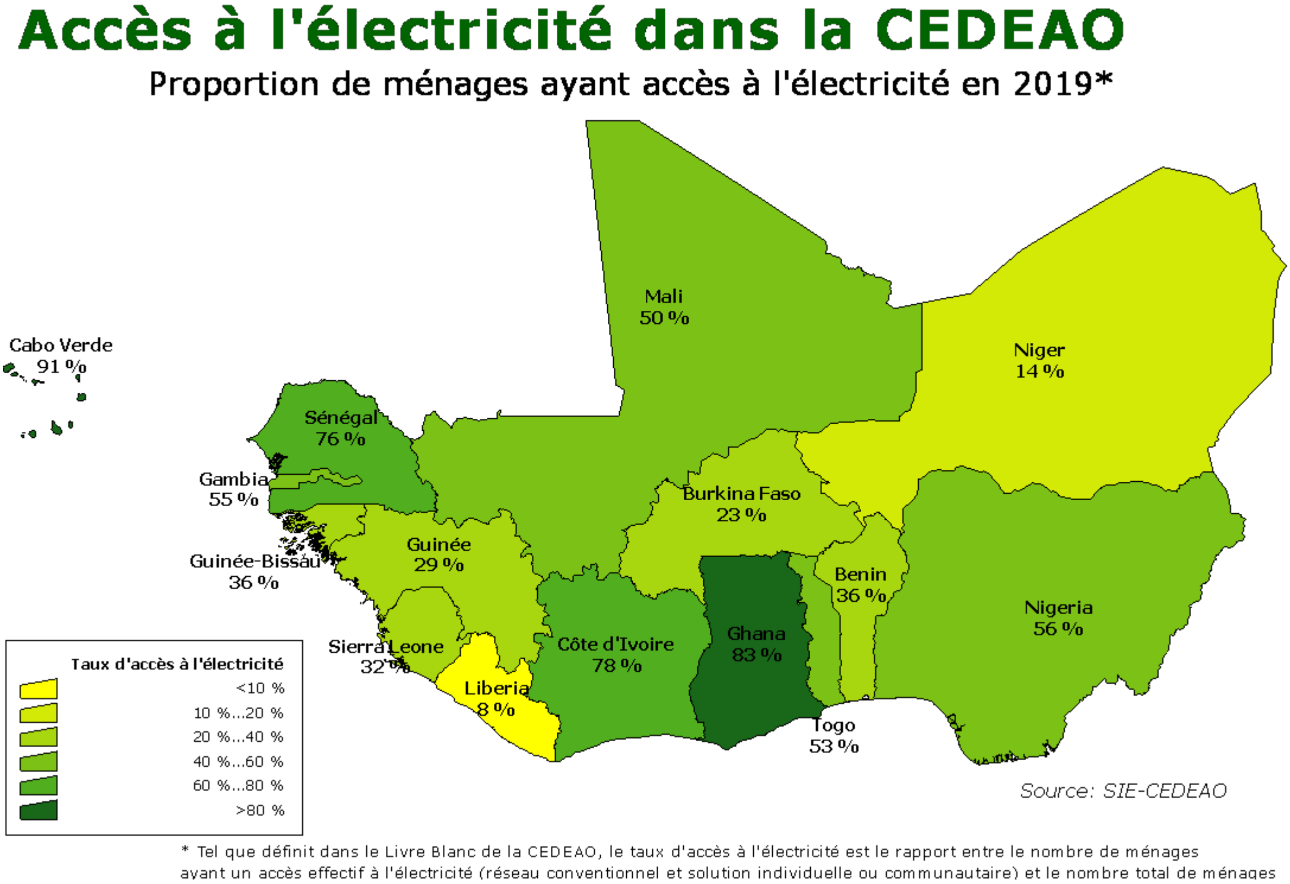


Figure 3: Variation in energy access across ECOWAS countries with an average regional energy acess of 54.3% (source: ECOWAS, 2019)[15]

Owing to the large disparity in access to electricity in the region, hydrogen development in ECOWAS becomes even more challenging as improving access remains the priority. Consequently, the principle of additionality becomes very critical in the ECOWAS context, which states that "green hydrogen should only be produced from an additional renewable energies that would not otherwise be used, and electricity that would not otherwise be consumed". The policy development needs to recognize that investments in RE for the purpose of green hydrogen should not compromise on the pace of investment in RE for improving access.

[10] https://bidc-ebid.org/en/wp-content/uploads/WEST-AFRICAN-DEVELOPMENT-OUTLOOK-JUNE-2021_WADO_EBID_2021.pdf

[11] https://www.imf.org/en/Publications/WEO

[12] https://ecowas.int/?p=54356

[13] IRENA, 2018h; Stantec, 2021a, b

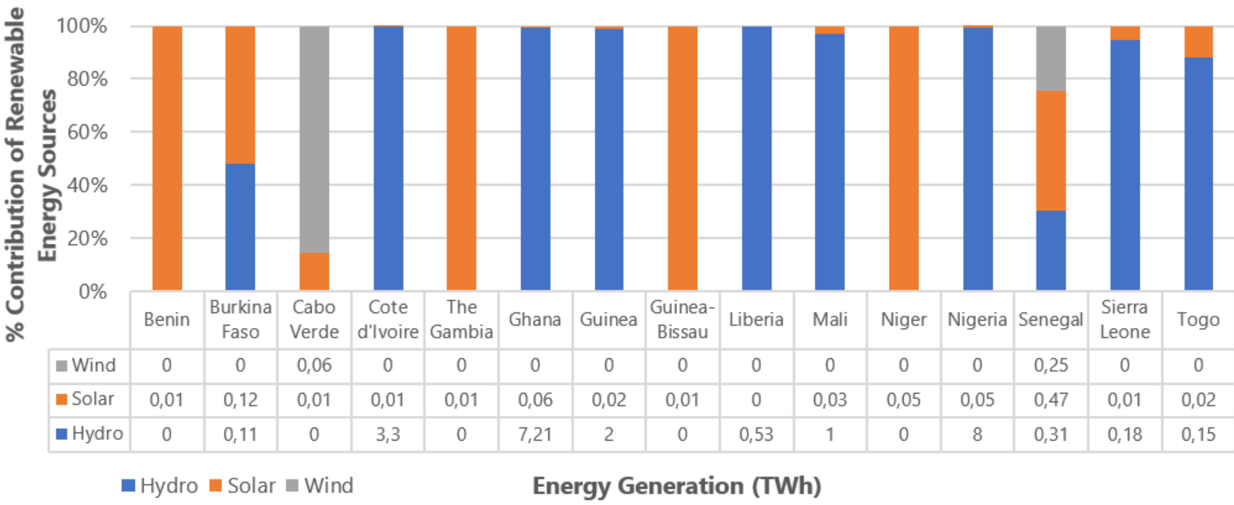
[14] https://ecowas.int/?p=54356

[15] Source: Data collected by Fichtner from member countries

4.3.2.2 Energy sources

Fossil fuels account for most of the current electricity generation in West Africa, with large shares of natural gas in Nigeria, Benin, Cote d'Ivoire, Ghana, Senegal, and Guinea. Of the current share of renewable energy generated in the region, hydropower commands a significant share. A schematic of the current share of hydro, solar and wind power generated in each ECOWAS country is shown below.

Figure 4: Representative share of different RE sources in different ECOWAS countries



	Benin	Burkina Faso	Cabo Verde	Cote d'Ivoire	The Gambia	Ghana	Guinea	Guinea-Bissau	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo
Wind	0	0	0,06	0	0	0	0	0	0	0	0	0	0,25	0	0
Solar	0,01	0,12	0,01	0,01	0,01	0,06	0,02	0,01	0	0,03	0,05	0,05	0,47	0,01	0,02
Hydro	0	0,11	0	3,3	0	7,21	2	0	0,53	1	0	8	0,31	0,18	0,15

The region has a rich RE generation potential but the nature of RE differs from region to region:

- Solar potential exists nearly everywhere;
- Wind potential is strongest along coastal areas and in the northern, drier part of the region;
- Hydropower potential is mostly concentrated in the southern part of the region, which receives the most rainfall.

As renewable energy is required for both green hydrogen production and address the needs from an electricity sector demand point of view, assessment of the status of renewable energy development in ECOWAS region is important to ensure that the predetermined priorities are not ignored or compromised. A review of status of Renewable Energy Policy and initiatives for ECOWAS region is presented in the following sections.

[16] IRENA 2020, A guide to policy making,

[17] Renewable Energy - Our World in Data

[18] IRENA Renewable Energy Statistics 2022

4.4 REGIONAL POLICY AND INITIATIVES IN RENEWABLE ENERGY

4.4.1 ECOWAS ENERGY POLICY

In accordance with the provisions of article 28 of the Revised Treaty of ECOWAS which requires Member States to coordinate and harmonize national policies and programs in the field of energy, Member States adopted in 1982 the policy of ECOWAS energy. This policy was updated in 2023 in the light of new socio-economic, political, and technological challenges.

The ECOWAS Vision 2050 in this policy is to achieve "a community with access to modern, affordable, reliable and sustainable energy services to improve living standards and socio-economic development". This vision is fully in line with the Sustainable Development Goals, international agreements on climate change (in particular the Paris Agreement of 2015 signed by Member States), the ECOWAS Vision 2050, the Agenda 2063 of the African Union, as well as the various national, regional and international commitments of ECOWAS and its Member States.

This ECOWAS Green Hydrogen Policy and Strategy Framework is in line with this vision given that the energy policy places particular emphasis on the need to promote clean forms of energy, especially hydrogen.

4.4.2 ECOWAS CENTRE FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY

The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) was established in July 2010, demonstrating the resolve of ECOWAS Member States to improve energy access, energy security, combat climate change and reduce carbon emissions. ECREEE has attained international recognition as a regional agency for the promotion of sustainable energy services. The activities of the agency cover a range of areas, including policy development, capacity building, resource assessment, knowledge management, and investment promotion. While developing a new policy for development of green hydrogen for this region, it is important to review the progress in respect of the renewable energy policy for the region and the progress against the plan for the region. This will also give insights into the constraints and challenges, if any in achievement of policy goals and targets.

4.4.3 ECOWAS RENEWABLE ENERGY POLICY (EREP)

The ECOWAS Renewable Energy Policy (EREP) was formulated in 2013 to ensure 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. The EREP takes cognizance of the efforts deployed by the West African Power Pool (WAPP) through the emergence of the regional power market. It draws upon the regional power supply concept of large bulk power generation that is distributed by the WAPP. The EREP also lays down a legal, institutional, and regulatory framework to consistently develop national and regional policies.

Targets Posed by EREP

- To increase the share of renewable energy, excluding large hydro, in the region's overall electricity mix to 10 % in 2020 and 19 % in 2030. The share, including large hydro, is 35 % in 2020 and 48 % in 2030.
- To serve around 25 % of the rural ECOWAS population with mini-grids and stand-alone systems by 2030.
- To achieve universal access to electricity in ECOWAS by 2030.

The detailed stage wise targets set by the EREP are listed below.

Target: MW installed capacity	2010	2020	2030
EREP renewable energy options in MW	0	2,425	7,606
EREP renewable energy options in % of peak load	0%	10%	19%
Total renewable energy penetration (incl. large hydro)	32%	35%	48%
Targets: GWh	**2010**	**2020**	**2030**
EREP renewable energy options – production in GWh	0	8,350	29,229
EREP renewable energy options - % of energy demand	0%	5%	12%
Total renewable energy production (incl. medium and large hydro)	26%	28%	31%
Targets: Off-grid share	**2010**	**2020**	**2030**
Off-grid (mini-grids and stand-alone) share of rural population served from renewable energy in %		22%	25%

Table 1: Targets for RE penetration in the ECOWAS region as per the EREP

Progress Against the Targets

As per data collected from member countries, and last available progress report for the year 2018, the pace of progress against the Renewable Energy Policy targets has been lagging behind. Only around half of the population had access to an electrical grid in 2018, with 52.3% of the regional population connected to the electricity grid in 2018 against the 2020 target of 65%. The member countries were also behind in meeting the renewable energy targets, with only 24% of the total installed capacity being renewable in nature in comparison to the target of 35% for 2020. The share of renewable energy generation (excluding large hydropower) was 1.1% and is significantly below the target of 5% of total energy generation proposed for 2020.

As per information collected from each member country, ECOWAS member countries have faced the following challenges in implementing its RE policy to achieve respective targets:

Technological Challenges:

- Lack of access to technology;
- Network stability and inability to store RE / Capacity issues;
- Lack of standardization;
- No e-waste disposal guidelines

Market based challenges:

- Lack of internal market;
- Limited affordability for electricity consumers

Regulatory Challenges

- Difficulties in obtaining statistics for monitoring the implementation of this policy (especially for projects initiated by the private sector);
- Limited enabling policy/ legal and regulatory environment for private sector participation;
- Policies related to Productive Uses of Electricity (PUE) are limited to the general framework of power generation, transmission and distribution. Policies to promote PUE products is lacking;
- No gender inclusive energy policies and programs.

Financing related challenges:

- Lack of access to affordable long-term finance;
- Absence of policy tools such as Renewable Energy Credit (REC) Scheme, Public Benefit Fund (PBF), Investment Tax Credits (ITC), Renewable Portfolio Standards (RPS), amongst others;
- Limited Investment capacity of local actors / Project financing / Budgetary constraints of the government.

4.4.4 SUSTAINABLE ENERGY FOR ALL (SEFORALL)

Sustainable Energy for All (SEforALL) is an international organization that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to 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 – in line with the Paris Agreement on climate.

4.4.5 WEST AFRICAN SCIENCE SERVICE CENTRE ON CLIMATE CHANGE AND ADAPTED LAND USE (WASCAL)

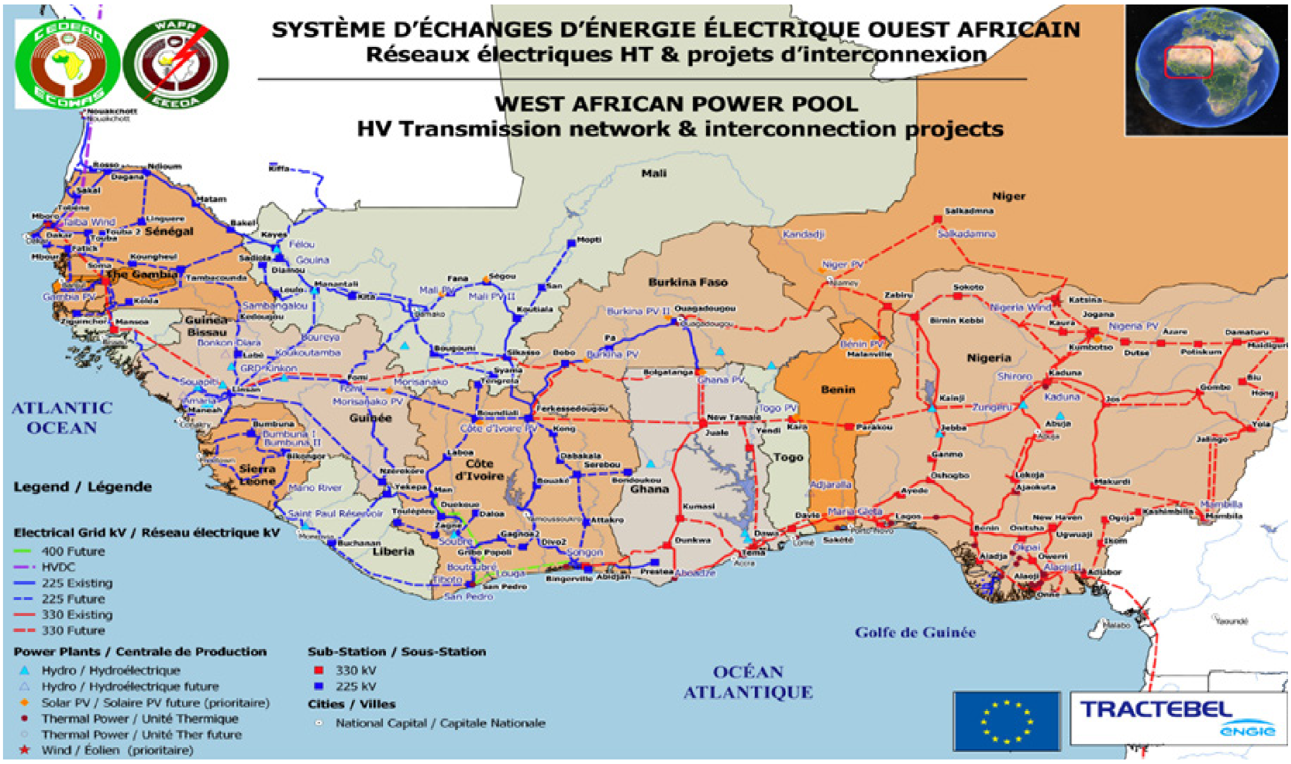
The West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) is a large-scale research-focused Climate Service Centre designed to help tackle the challenge of climate change and thereby enhance the resilience of human and environmental systems to climate change and its increased variability. It works to strengthen the research infrastructure and capacity in West Africa related to climate change and by pooling the expertise of twelve West African countries and Germany, largely funded by the German Federal Ministry of Education and Research (BMBF).

WASCAL has undertaken certain activities to promote green hydrogen including studies to assess the potential in the ECOWAS region to produce green hydrogen (GH) and its derivatives. The studies conducted by WASCAL under the H2 Atlas program is the first of its kind detailed assessment conducted in the ECOWAS region which highlight the high production potential for green hydrogen at cost competitive levels. The studies show that this potential is far superior to the regional energy demands and could also cater to a significant share of the global demand.

4.4.6 WEST AFRICA POWER POOL (WAPP)

The West African Power Pool is a cooperation of the national electricity companies in Western Africa under ECOWAS established in 2010 with the vision to integrate the national power systems into a unified regional electricity market. The WAPP aims to promote and develop infrastructure for power generation and transmission, as well as, to assure the coordination of electric power exchanges between ECOWAS Member States.

Figure 5: West Africa Power Pool (Source: ECOWAS)



The WAPP poses a significant potential to tap into the region's diversity in generation resources and costs. Development of regional electricity market to enable cross border trade of electricity will provide extra revenue for countries with surplus resources through electricity export and fulfilling demand gap for other countries at the lowest available cost. This is critical to the development of green hydrogen as availability of resources like renewable energy, land, and water is distributed non-concurrently in the region.

4.4.7 NATIONALLY DETERMINED CONTRIBUTIONS OF ECOWAS COUNTRIES

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.

Table 2: Summary of the potential of GHG reduction as committed by ECOWAS countries through their NDCs[19]

Country	Share of global GHG emissions	Maximum Possible emissions reduction target (Compared to BAU)
Benin	0.06%	20.15%
Burkina Faso	0.11%	29.42%
Cabo Verde	0.00%*	24%
Cote d'Ivoire	0.10%	98.95%
The Gambia	0.01%	49.70%
Ghana	0.04%	
Guinea	0.08%	49%
Guinea-Bissau	0.01%	30%
Liberia	0.05%	64%
Mali	0.09%	39%
Niger	0.09%	22.75%
Nigeria	0.73%	47%
Senegal	0.1%	40%
Sierra Leone	0.02%	25%
Togo	0.02%	50.57%
	1.51%	

** It implies negligible emissions in comparison to global emission levels*

[19] Data Compilation by Fichtner based on NDCs reported by UNFCCC

4.5 REGIONAL INITIATIVES IN GREEN HYDROGEN

4.5.1 H2 ATLAS

H2 ATLAS-AFRICA project was the first phase of a joint initiative of the German Federal Ministry of Education and Research (BMBF) and WASCAL to explore the potentials of green hydrogen production from the renewable energy sources within the region. The study considers technological, environmental, and socioeconomic conditions prevailing in different countries, assessing the available renewable energy, land, water resources and other logistic conditions that can affect green hydrogen production. The study also determines the amount of green hydrogen that can be produced in each country and the high-level cost.

Key findings

- Green hydrogen has enormous potential to make socio-economic impact

Results from H2Atlas show that the green hydrogen development in the region has a high potential for local job creation in the region.

- Land availability is not a major constraint across most of the ECOWAS region

Across the ECOWAS nations are vast land areas that are suitable for harvesting renewable energy and installing hydrogen production infrastructure. This has been assessed after considering other priority land use activities for example for farming, residential homes etc.

- Cost of electricity from renewables one of the cheapest in the world

Historically, the cost of RE is expected to continue to fall, having fallen 82% between 2010 and 2019. The ATLAS studies estimate that ECOWAS has a competitive edge in the production of green hydrogen in the international market largely due to its potential to produce RE from open field PV at less than 2 cents (Euro) per unit of energy.

- Huge technical green hydrogen production potential without impacting local energy needs

The accumulated maximum theoretical hydrogen potential of the whole ECOWAS amounts to 165,000 TWh per year. This huge potential, which is based mainly on 75% PV potential is able to meet the entire energy access needs of the region as well as have enormous export potential.

- Levelized cost of green hydrogen production in ECOWAS region.

The cost of green hydrogen production has been calculated in terms of the average levelized cost of hydrogen (LCOH) based on open-field PV and onshore wind installations. Approximately 70% of the maximum technical potential can be produced at below 2.5 EUR/kgH2 in 2050. This cost is indeed competitive when compared with current global green hydrogen production cost from around the world.

- For sustainable green hydrogen production, desalinated water instead of groundwater should be used.

Water is one of the main resources required for green hydrogen production since water is split via electrolysis to produce hydrogen and oxygen. Studies by WASCAL show that sustainable ground water is only able to support the production of 20% of the maximum technical potential of green hydrogen in ECOWAS. This clearly indicates that other fresh water sources must be explored if the full potential of green hydrogen production is to be explored. As is the common practice, desalinated seawater can be a good alternative to ground water. This adds only a marginal cost to the production cost.

- A regional cross-border resource exchange is necessary for shared benefits and optimum green hydrogen production

Low-cost renewable energy hotspots are mainly located in the north while the availability of sustainable sources of water are largely in the south of the ECOWAS region. There is therefore the need for transfer of resources (either RE or water) from one place to another. Also considering the necessity for infrastructure, an intra-regional cross-border concept that utilizes resources across neighboring nations can be a promising approach.

4.5.2 OPTIMIZING SOLAR PV FOR GREEN HYDROGEN PRODUCTION IN WEST AFRICA (PV2H)

Within the framework of the Go Green Go Africa Hydrogen Initiative, WASCAL in partnership with the German Federal Ministry of Education and Research has launched the “Optimizing Solar PV for Green Hydrogen Production in West Africa (PV2H)” project. The Project aims at providing a concrete technical response to the negative impact of dust on solar PV power plants and to propose ways to optimize the production of green hydrogen from solar PV systems under the specific climatic conditions of the Sahelian region in West Africa. The project is coupled with the feasibility study of the BIO2H study which aims to take stock of the technologies, use of the biodigester and to assess the potential for multi-scale production of green hydrogen in Burkina Faso. Based on the success of these ongoing studies, similar studies must be replicated in other countries.

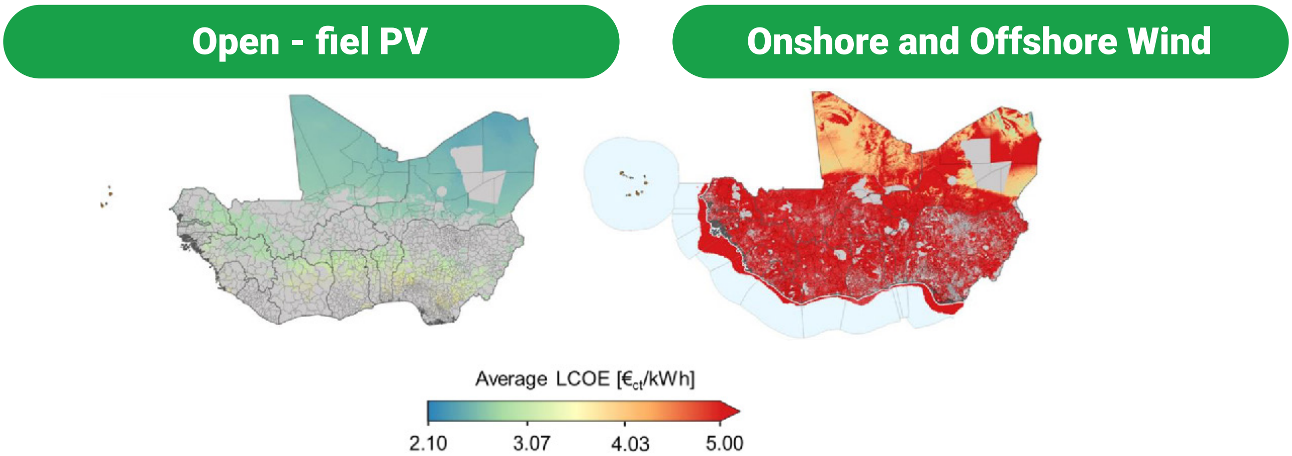
4.6 OPPORTUNITIES AND CHALLENGES FOR ECOWAS

4.6.1 RESOURCE AVAILABILITY

4.6.1.1 Renewable Energy

ECOWAS has high RE production potential for open field solar photovoltaic as well as onshore and offshore wind farms. However, open field PV plants located primarily in the northern regions provide the potential for lowest cost of generation. 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. The cheap electricity cost stems from the 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 due to poor wind conditions along the coast.

Figure 6: Resource availability in ECOWAS: RE potential (Source: H2-ATLAS)



4.6.1.2 Land and Water availability

Land and water are two limiting resources for RE and green hydrogen production in the ECOWAS region. Regions of land are co-located with RE generation sites in the north and the near south. However, the availability of fresh water required for electrolysis possesses a strong challenge with Water scarcity being a common problem in the region. It was assessed by the H2-Atlas project that cheap desalination of sea water can be explored fo the production of hydrogen production.

[20] As estimated by H2 ATLAS, WASCAL

Figure 7: Land availability assessed to be eligible for RE generation for green hydrogen (source: H2 Atlas)

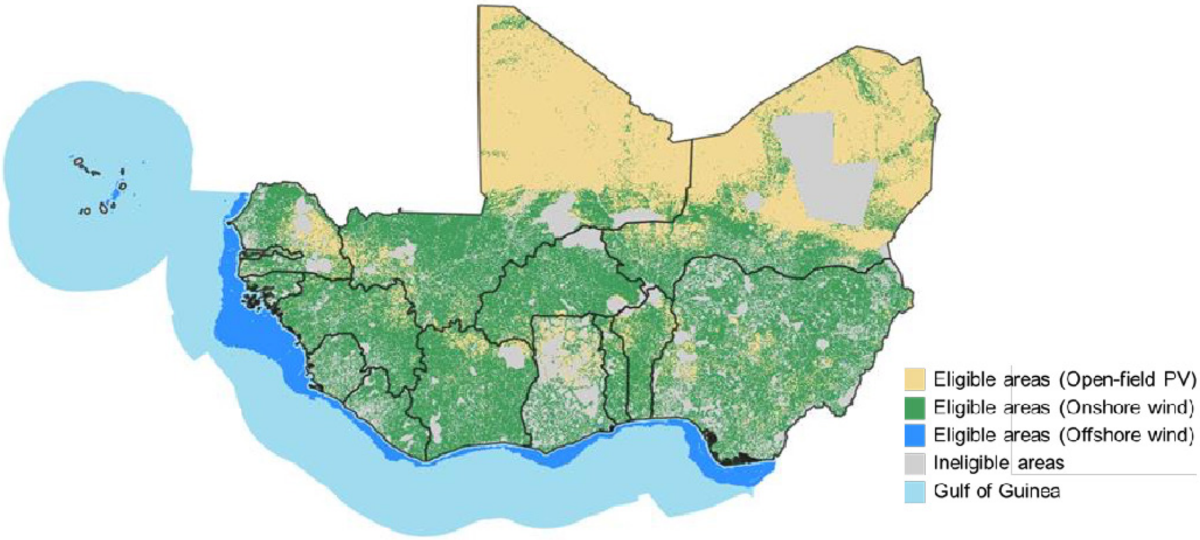
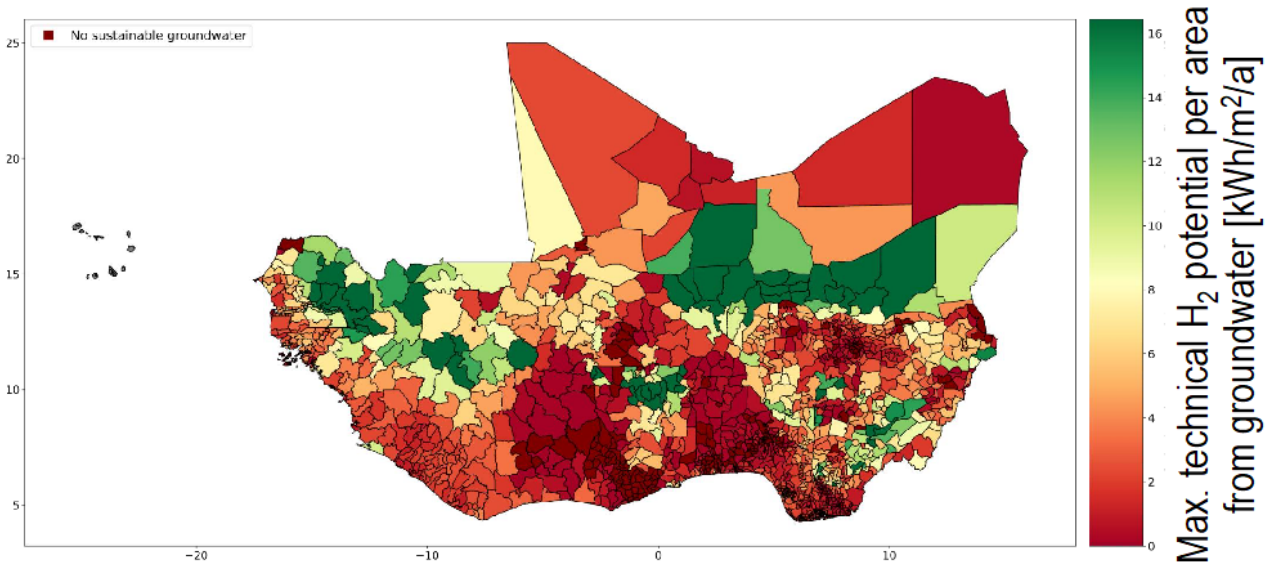


Figure 8: Constraint of ground water availability in the ECOWAS region (Source: H2 Atlas)



4.6.2 INFRASTRUCTURE AVAILABILITY

Availability of Ports

ECOWAS has the strategic advantage of a long coastline with proximity to major European countries that could facilitate competitive export of green hydrogen related commodities. Only three countries, i.e., Niger, Mali and Burkina Faso are land locked. Major ports available in the region are:

- **Benin:** Port of Cotonou
- **Cabo Verde:** Port of Praia and Port Grande of Mindelo
- **Senegal:** Port Autonome de Dakar, upcoming ports of Ndayanne, and Bargny
- **Cote D'Ivoire:** Autonomous port of Abidjan, and Autonomous port of San Pedro
- **Ghana:** Tema Port, and Takoradi Port
- **Guinea Bissau:** Port of Bissau
- **Guinea:** Autonomous port of Conakry
- The Gambia: Port of Banjul
- **Liberia:** Freeport of Monrovia, Port of Buchanan, Port of Greenville, Port of Harper
- **Togo:** Autonomous port of Lomé
- **Nigeria:** Port of Apapa, Tin Can, Lekki Deepsea, Port Harcourt, Calabar, Onne and Warri
- **Sierra Leone:** Port Queen Elizabeth 2 in Freetown, and Pepel Port.

4.6.3 PRESENCE OF LOCAL DEMAND – INDUSTRIES

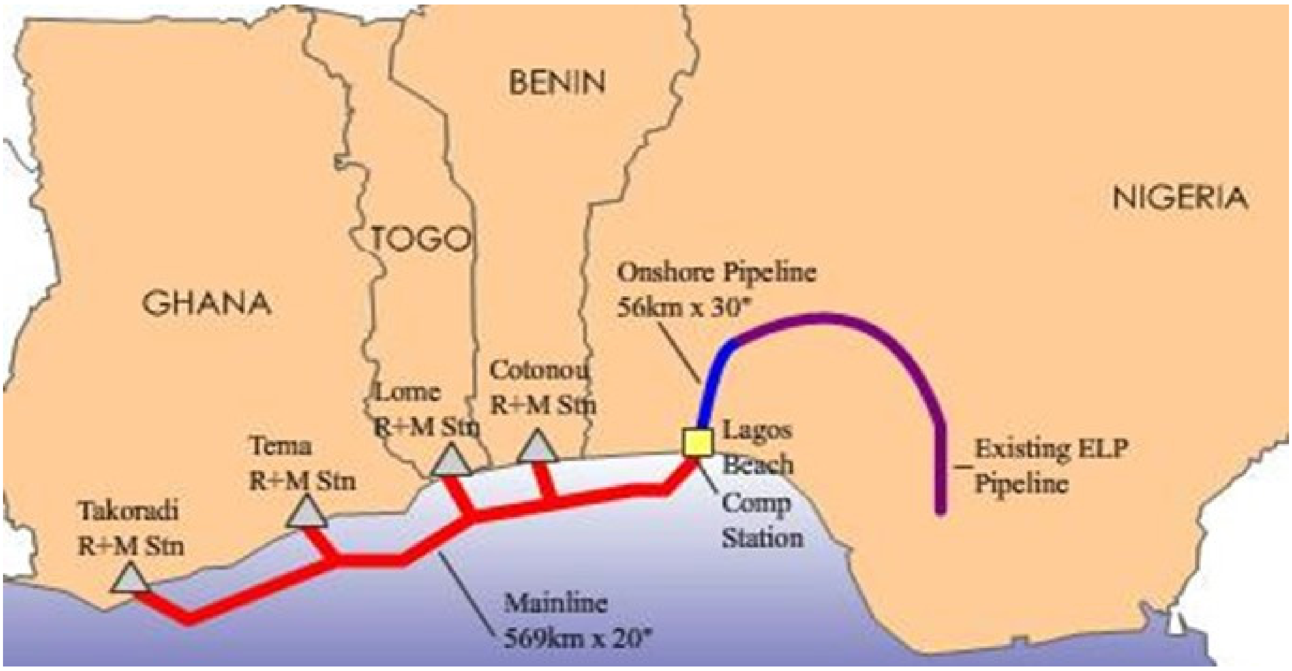
The region largely imports commodities like fertilizers, crude oil, machinery. Presence of local industries like petrochemicals, iron and steel etc are concentrated in a few countries. As per available information from different countries, the presence of hydrogen relevant sectors in the ECOWAS region is as follows:

- **Iron and Steel industry:** Iron ore industries are largely present in Liberia, Sierra Leone while smaller metal works and trading industries are present in Burkina Faso, Guinea, Gambia and Sierra Leone. Prospective projects are also upcoming in Niger.
- **Fertilizer Industry:** Mostly blending facilities are present all over ECOWAS. Production facilities are present in Senegal, Togo, Mali, Nigeria. Industries Chimiques du Senegal is the largest unit which produces nearly half a million tonne of phosphate rock. Prospective projects are also upcoming on Niger and Guinea.
- **Chemical Industry:** Chemical Industries in the region are limited to small scale pharmaceutical industries.
- **Natural gas industry:** Senegal, Nigeria, and Niger have natural gas projects while Burkina Faso is implementing a biogas production unit. West African Gas Pipeline Company Limited (WAPCo) is the largest private company that owns and operates the West African Gas Pipeline (WAGP).

WAPCo is an international Company transporting Natural Gas in Nigeria, Benin, Togo and Ghana through the West Africa gas pipeline (WAGP). The pipeline also offers the potential for transporting hydrogen. It is the starting point for the recently launched Nigeria-Morocco Pipeline project, which could potentially be further extended to Europe. If constructed as "hydrogen-ready", the WAGP could be repurposed for the export of hydrogen from West African countries. However, its success will depend on the interests of the Nigerian and Moroccan governments.

Figure 9: Presence of fertilizer industries in ECOWAS (Source: Africafertilizer.org)

Figure 10: West African Gas Pipeline Authority (WAPGA)[21]

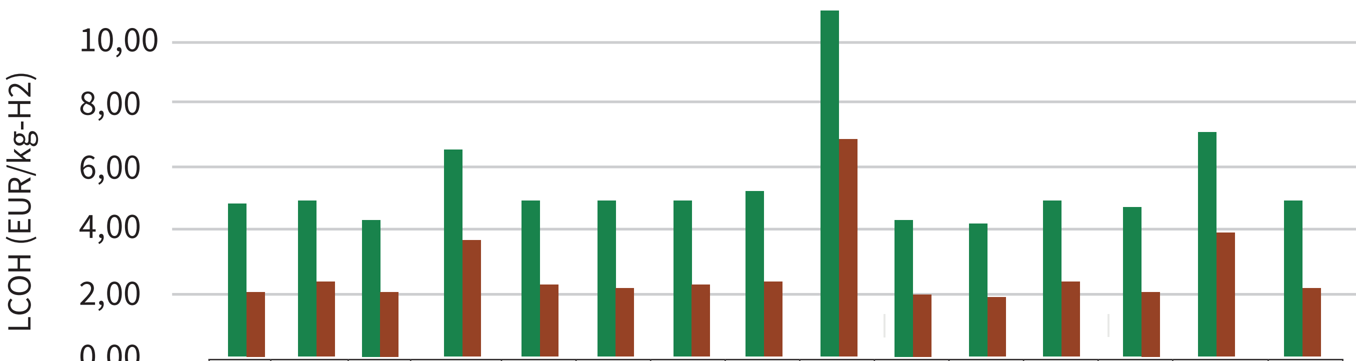


4.6.4 COST OF PRODUCTION OF HYDROGEN

The cost of production of hydrogen was assessed by WASCAL for the base year 2020 as well the forecasted cost for 2050. The levelized cost of hydrogen (LCOH) varies significantly from country to country as shown below[22].

low cost of renewable energy in the region. However, water availability in the region and lack of gas handling infrastructure or access to off takers (local or international) could be a barrier. Hence, supporting infrastructure development to transport energy or resources to other favourable regions remains key to overcome the challenge of cost-effective green hydrogen development in the region.

Figure 11: The present and forecasted average cost of hydrogen (LCOH) for ECOWAS Countries



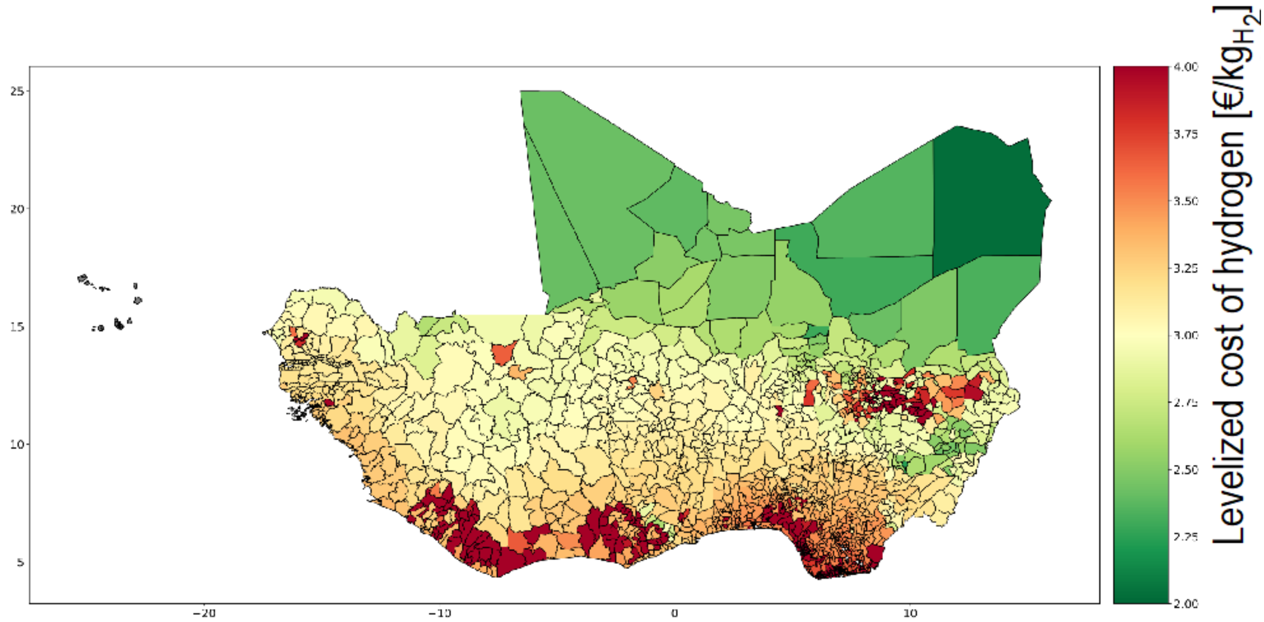
	Benin	Burkina Faso	Cabo Verde	Côte d'ivoire	The Gam-bia	Ghana	Guinea	Guinea Bissau	Liberia	Mali	Niger	Nigeria	Sene-gal	Sierra Leonne	Togo
Avg LCOH (2020)	4,90	5,00	4,40	6,60	5,00	5,10	5,00	5,30	10,80	4,40	4,30	5,00	4,80	7,10	5,00
Avg LCOH (2050)	2,90	2,50	2,20	3,80	2,40	2,30	2,40	2,50	6,90	2,10	2,00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

As per the H2 Atlas studies, West Africa alone could produce approximately 120,000 TWh of green hydrogen per year at a price of less than \$2.63/kg, assuming no water constraints. However, the cost of transporting hydrogen hampers this competitiveness.

Maritime shipping, considered the most cost-effective for distances over 3,000 km, would add an estimated \$1 to \$2.75/kg. For shorter distances, the cost of pipeline transport could be considerably lower, estimated at \$0.18/kg per 1,000 km for new hydrogen pipelines and \$0.08 for retrofitted gas pipelines.
The regions marked green in the figure above have the potential to produce hydrogen at the cheapest costs. This is largely dictated by the

[21] Map source: ECOWREX
[22] H2 Atlas

Figure 12: Site wise potential Levelized cost of green hydrogen (Source: H2-ATLAS)



4.7 CONSIDERATIONS FOR ECOWAS GREEN HYDROGEN POLICY AND STRATEGY FRAMEWORK

The clear observations and implications from a high-level review of the energy and economic situation of ECOWAS is as follows:

- Improving energy access will continue to remain a priority for the ECOWAS region;
- Among the sources of energy for energy access in rural areas, the demands on renewable energy for electrification of households will continue to remain high;
- The achievement of the targets set for renewable energy are below expectations and the pace of renewable energy investment needs to be improved;
- Development of green hydrogen needs to keep in view the socio-economic context, the national interests as well as priorities of ECOWAS member countries and it would be worth examining the costs and benefits of introducing GH into the economy of these countries.

Based on the earlier-mentioned opportunities, it is evident that ECOWAS has the maximum opportunity to produce green hydrogen at competitive costs owing to its renewable potential. A summary of the region's readiness for green hydrogen production is shown below.

Table 3: Green hydrogen production assessment of ECOWAS countries

	RE resources			Water availability	Port infrastructure availability	Readiness for green hydrogen production
	PV	Wind	Hydro			
Benin	Yes	Yes	Yes	Water could be made available through desalination	Autonomous Port of Cotonou	Medium
Burkina Faso	Yes	Yes		Land locked, dependent on ground water availability		Medium
Cabo Verde	Yes	Yes		Entire water requirement through desalination facilities	Port of Praia and Port Grande of Mindelo	High wind and solar potential
Côte d'Ivoire			Yes	Water could be made available through desalination	Autonomous port of Abidjan, and Autonomous port of San Pedro	Medium
The Gambia	Yes	Yes		Water could be made available through desalination	Port of Banjul	Medium
Ghana	Yes	Yes	Yes	Major desalination centre at Accra	Port of Tema, and Port of Takoradi	High, RE and water availability
Guinea			Yes	Water could be made available through desalination	Autonomous port of Conakry	Medium
Guinea-Bissau			Yes	Water could be made available through desalination	Port of Bissau	Medium
Liberia			Yes	Water could be made available through desalination	Freeport of Monrovia, Port of Buchanan, Port of Greenville, Port of Harper	Medium
Mali	Yes	Yes	Yes	Land locked, dependent on ground water availability,		Medium, presence of natural hydrogen
Niger	Yes	Yes	Yes	Land locked, dependent on ground water availability		High

	RE resources			Water availability	Port infrastructure availability	Readiness for green hydrogen production
	PV	Wind	Hydro			
Nigeria	Yes	Yes		Water could be made available through desalination	Port of Apapa, Port of Tin Can, Port Lekki Deepsea, Port of Port Harcourt, Port of Calabar, Port of Onne and Port of Warri in Lagos	High
Senegal	Yes	Yes	Yes	Water could be made available through desalination	Port Autonome de Dakar Ndayanne (under construction) Bargny (under construction)	High
Sierra Leone	Yes		Yes	Water could be made available through desalination	Freetown and Pepel Port	High
Togo			Yes	Water could be made available through desalination	The port of Lomé	Medium

When looking at green hydrogen consumer markets, there is the currently existing hydrogen market, on the one hand, and the potential future hydrogen markets on the second hand.

Considering the existing market, the primary accessible consumer markets of green hydrogen are likely to be outside ECOWAS's boundaries. There is limited existing consumption of green hydrogen and derivative consumption locally due to the absence of large-scale presence of hydrogen consuming industries, lack of availability of hydrogen technologies and high costs.

However, when looking at potential future consumption markets in the region, for countries that are endowed with iron ore or phosphate and potassium minerals, or countries that have a strong need for clean long haul transport solutions, there is a potential for local hydrogen uptake. Such potential can contribute to the development of value adding industrial and transport sectors in the region. The presence of existing hydrogen relevant industries is summarised below.

These facilities present the opportunity to produce green products by use of green hydrogen and retrofitting required in the process for such usage. However, the economics of such production would impact the competitiveness of the products in the local market. A possibility is to consider making such investments in pilot facilities to produce green products for the purpose of export and this needs to be validated by specific feasibility studies duly considering the demand for such products in the international market.

The potential for future local consumption will have to be further analysed at national levels as part of the national action plans.

Table 4: Summary of industrial potential of different industries in ECOWAS region (source: Fichtner compilation)

	Presence of fertilizer production	**Presence of Chemical Industry**	**Presence of Iron and steel industry**	**Presence of Petrochemical/ Natural Gas industry**
Benin	*No existing production, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*
Burkina Faso	*TBC*	*TBC*	*Construction and metal works*	*Some developments in biogas production*
Cabo Verde	*TBC*	*small scale pharmaceutical*	*TBC*	*TBC*
Côte d'Ivoire	*No existing production, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*
The Gambia	*No existing production, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*
Ghana	*No existing production, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*
Guinea	*Evolving*	*No existing industry, yet in the country*	*Growing industry*	*No existing industry, yet in the country*
Guinea-Bissau	*No existing production, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*
Liberia	*TBC*	*TBC*	*Iron ore and steel production units*	*TBC*
Mali	*No existing production, yet in the country, but phosphate potential confirmed*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*
Niger	*No existing production, yet in the country but Prospective projects*	*Prospective projects*	*Prospective projects*	*SORAZ refinery for LPG production*
Nigeria	*Large*	*Large*	*Large*	*Large*
Senegal	*Phosphate production*	*Industries Chimiques du Senegal (ICS)*	*Future projects Iron ore and steel production units*	*Tortue Ahmeyim liquefied natural gas (LNG) and Yakaar-Teranga, projects led by BP in Senegal*
Sierra Leone	*No existing production, yet in the country*	*No existing industry, yet in the country*	*Prospective projects*	*Prospective industry*
Togo	*No existing production, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*	*No existing industry, yet in the country*

5
Strategic Vision of the ECOWAS Green Hydrogen Policy and Strategy Framework

To position the ECOWAS 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 ECOWAS Member States.

6
Objectives of the ECOWAS Green Hydrogen Policy and Strategy Framework

The overall objective of the ECOWAS Green Hydrogen Policy and Strategy Framework is to establish a legislative and regulatory environment conducive to the development of a green hydrogen economy. In this context, the ECOWAS Green Hydrogen Policy and Strategy Framework is developed with the aim of achieving the following short-, medium- and long-term objectives.

6.1 SHORT- AND MEDIUM-TERM OBJECTIVES

In the short term till 2030, the policy aims to fulfil the following objectives:

1. Promote the development of an enabling and facilitating environment for establishment of green hydrogen industries by creating awareness, capacity, and suitable legislative framework.
2. Undertake demonstration projects within the region in collaboration with relevant agencies and Member States.
3. To develop strategic long-term roadmap for development of green hydrogen consumption within the region.
4. To promote investments in supporting infrastructure required for green hydrogen investments.
5. To establish strategic partnerships for investments, technology supply and financing with private and governmental agencies.

6.2 LONG TERM OBJECTIVES

In the long term, the ECOWAS Green Hydrogen Policy and Strategy Framework aims to fulfil the following objectives:

1. To become a competitive supplier of green hydrogen in the world.
2. Improve the share of sustainable energy in the region through facilitation of green hydrogen as an energy resource.
3. To improve the energy security and climate change resilience of the region.
4. To promote sustainable industrial development.
5. Promote equitable socio-economic and gender development.

7 Guidelines on ECOWAS Green Hydrogen Policy and Strategy Framework

To achieve the objectives as stated above, the ECOWAS Green hydrogen policy and strategy framework promotes the uses of green hydrogen as a new energy source.

1. The ECOWAS region shall focus on the development of green hydrogen as an energy resource for domestic consumption as well as export

Green hydrogen herewith shall refer to the hydrogen produced through the electrolysis of water using renewable sources of energy, including through sustainable bio-based processes. The green hydrogen defined shall be associated with process having lower associated carbon emissions compared to best available technologies as determined by appropriate regulations from time to time, in line with international definitions.

2. The region shall aim to be among the most competitive suppliers of green hydrogen and its derivatives in the world

It is assessed that the region has enough RE potential to meet the global demand for green hydrogen. The region must strive to leverage its potential and maximise its presence in the international green hydrogen markets, while ensuring equitable socio-economic growth and energy security within its boundaries.

3. ECOWAS region will conduct necessary technical assessments and facilitate development of homogenous supporting regulations for green hydrogen sector

The primary stage towards achieving the above target is to enable the development of green hydrogen as an energy commodity in the region. This includes the setting up of relevant codes, standards, and regulatory systems including a certification system. These systems must be developed in a regional context while ensuring compatibility with international requirements to unlock the global targets. These policies will be developed in a homogenous manner across all the countries to enable development of cross border projects among member countries.

4. ECREEE should redefine targets under the ECOWAS Renewable Energy Policy

Existing targets within the EREP were developed with the objective of harnessing renewable energy potential to meet the energy demands of the region. Given that new and dedicated renewable energy investments will be required for green hydrogen production, the targets set under the EREP should be reviewed, reassessed, and redefined periodically.

5. ECOWAS will create dedicated infrastructure to cater to green hydrogen

Production of green hydrogen using renewable energy must not compete with the development of Renewable Energy to cater to growing energy demands of the region in a sustainable manner as guided by the ECOWAS Renewable Energy Policy. The renewable energy projects set up for green hydrogen shall be eligible to avail benefits under the EREP and appropriate incentives shall be decided for sale of excess generated power from RE set up for green hydrogen. To bridge the regional disparity in the availability of resources such as RE, water, land and port availability, the Region will undertake necessary assessments to establish dedicated infrastructure corridors for easy transport of water, power, or hydrogen.

6. ECOWAS will facilitate investments and establish incentives to minimize risks for early investors:

In an emerging sector like green hydrogen, investors must make decisions regarding the technology, service providers, market players etc while the development of markets cannot be precisely forecasted. As a result, to offset this risk, the ECOWAS Green Hydrogen Policy and Strategy Framework encourages member countries to provide incentives for early movers with a sunset clause so that these early movers can remain competitive with market entrants in a developed market.

7. Socio-economic development while mainstreaming gender:

ECOWAS Green Hydrogen Policy and Strategy Framework aims to stimulate socio-economic growth through the creation of jobs in the field of green hydrogen related technologies in a wide range of activities such as manufacturing, installation and construction, operation, and maintenance etc. The development of all these activities must be done through specific institutional frameworks while ensuring that equitable opportunities are created for both sexes and guaranteeing equal access to opportunities.

8. Institutional Framework

For achieving the above-mentioned targets and implementing the said directives, a coordinated action is needed at the regional level. An ECOWAS Green Hydrogen Development Unit shall be established for promoting regional cooperation of each country in the development of green hydrogen sector. The Unit would be integrated within ECREE working in close cooperation with WASCAL, the Ministry of Energy, other relevant Ministries from each member state and any other regional body as may be relevant.

9. ECOWAS member states will co-operate on matters related to green hydrogen

The policy targets and directives require co-operation amongst a wide range of interconnected segments from energy and water to land, industry, and infrastructure. The distribution of resources is not homogenous within the ECOWAS region. For example, the highest RE potential is in the northern land locked countries, while the availability of water and transportation infrastructure is more readily available near the southern sea facing regions. This necessitates greater cooperation amongst the member nations. The ECOWAS Green Hydrogen Policy and Strategy Framework shall be a guiding document to align respective country actions to a common objective. Each member must prepare its individual policy and strategy framework after assessing the technical potential and the economic feasibility of green hydrogen development in the region.

8
Targets of the ECOWAS Green Hydrogen Policy and Strategy Framework

H2 Atlas highlights that by using wind and solar energy, ECOWAS countries could produce up to 165,000 tera-watt hours of green hydrogen annually, 120,000 tera-watt hours of which could already be produced for less than 2.5 euros per kilogram compared with 7-10 euros/kg in Germany23.

To underscore the above policy directives, taking into account the demand from end use sectors, ECOWAS region will target to reach a regional production of at least 0.5 million tonnes of green hydrogen per year by 2030 and at least 10 million tonnes by 2050.

To achieve this production target, it is estimated that the region will need to have an installed electrolyser capacity of 4-5 GW. Assuming a current electrolyser CAPEX of 800-1000 USD/kW2[4], this would require a cumulative investment of up to 3-5 billion USD by 2030. Assuming a competitive hydrogen cost of USD 2.5/ kg of H2, it is likely to result in annual revenues of ~ 1.25 billion USD per year by 2030.

Specific targets to ensure meeting the policy and strategy framework objectives are:

- At least 3 green hydrogen clusters shall be set up in feasible locations, where multi-sectoral demand for green hydrogen can be explored on a pilot basis, without building expensive new infrastructure by 2025.
- ECOWAS should build at least 5 scalable green hydrogen production projects by 2026 in these clusters.

The progress against the policy targets shall be reviewed for any changes required recognising the achievements and developments, particularly in view of the long-term targets for 2050.

[23] Page 4: https://www.mdpi.com/1996-1073/15/7/2304/htm
[24] IRENA 2020, Cost of production of green hydrogen

9
Strategy and Action Plan Framework

A framework and targeted action plan is proposed herewith to address the region’s short-term objectives while keeping a vision of the long-term objective of a green hydrogen economy. This framework will be the subject of a Regional Green Hydrogen Development Strategy in the ECOWAS region.

9.1 GUIDING PRINCIPLE FOR DEVELOPMENT OF GREEN HYDROGEN

The strategy framework for the implementation of the ECOWAS Green Hydrogen Policy and Strategy Framework is developed on the following principles:

Implementation principles			
1. Collaborative Approach	2 Capacity Building	3. Adaptability	4. Limiting Risk for Early Movers

- **Collaborative approach:** The policy highlights the need for collaboration and cooperation between member states of ECOWAS to enable the regions competitiveness in green hydrogen, and to ensure each country can benefit from the development of green hydrogen in the region. Constitution of ECOWAS Green Hydrogen Development Unit is a step in this direction and the activities of EGHDU will guide the deliberation and implementation of green hydrogen policy and strategy for the countries;
- **Capacity building:** For a new and emerging sector like green hydrogen, it is necessary to develop capabilities within the region to make the region green hydrogen. This would include development of resources within the region for informed decision making and improving the employability of its population;
- **Adaptability:** Green hydrogen production technology, including sustainability standards and norms, is constantly evolving in the global context. Costs will decrease as commercial production increases. The ECOWAS Green Hydrogen Policy and Strategy Framework sets a target for 2030, but it is expected that there will be global and regional developments that will impact the targets of the framework. Therefore, the implementation strategy will be adaptive in nature;
- **Limiting risk for early movers:**

  High initial costs and limited demand and the early nature of the regulatory environment is expected to be a barrier for investment by local and international players. The implementation strategy shall specifically address this through risk limiting measures as mentioned in the subsequent strategy framework.

9.2 PHASED IMPLEMENTATION APPROACH

To minimize the risks associated with the development of new technology like green hydrogen, a phased approach must be adopted for the ECOWAS region, to minimize the early mover risks. The stagewise approach to implementation is illustrated as follows:

Phase I (Year 0-2)

- Developing ecosystem for green hydrogen
- National policy development
- Prerequisites for green hydrogen enabled– regulatory, technical, financial
- R&D: feasibility assessments
- Capacity Building and sensitization

Phase II (Year 2-6)

- Infrastructure development
- Research and Development: Small scale demonstration project
- Development of targeted clusters
- Financing and investment planning facilitated

Phase III (Year 6-8)

- Long term contracts secured
- International and domestic offtake operational
- Emergence of commercial scale projects

9.3 STRATEGIC ACTIONS

9.3.1 ESTABLISHING AN EFFICIENT INSTITUTIONAL FRAMEWORK

Regional Actions

At the institutional level, the ECOWAS Green Hydrogen Policy and Strategy Framework makes the provision for a unit within ECREEE for the development of green hydrogen. The proposed ECOWAS Green Hydrogen Development Unit (EGHDU) must be well integrated within the existing institutional framework relating to the energy sector.

A working Group will be formed to discuss matters related to green hydrogen. Based on the consensus of the Working Group, EGHDU may change the configuration of the Group, depending on the need or requirement.

National Actions

The EGHDU will guide the respective Member States in the development of their own National Green Hydrogen Framework (national action plans) in line with the ECOWAS Green Hydrogen Policy and Strategy Framework or amend existing frameworks and/or policies to include the green hydrogen, after an appropriate assessment of their technical potential and specific requirements and challenges.

All Member States entrust existing official national bodies or institutions with the functions and competence to develop and implement an appropriate legislative framework to promote green hydrogen.

9.3.2 ESTABLISHING A HARMONIOUS REGULATORY FRAMEWORK

Regional Actions

Green hydrogen development requires the establishment of various supporting regulations relating to the use, safety, and handling of hydrogen. Specific regulations are also required to differentiate green hydrogen from hydrogen and to monitor its production such as regulations relating to guarantee of origin certification and additionality.

A guarantee of origin (GO) system evaluates all the emissions related to the production and transport of hydrogen, to determine its green nature. Typically, they should account for the effect of grid-connected electrolysers on the overall grid mix and ensure the temporal and geographical correlation between production and consumption of renewable energy .

The EGHDU shall undertake the following actions:

- Undertake the development of a

regional certification mechanism in accordance with internationally acceptable standards;

- Implement pilots for the certification scheme and develop a strategy for scale up;
- Establish regional standards for use, storage, and transportation consistent with internationally established standards.

National Actions

Each member country shall work in close cooperation with the EGHDU in the development of national standards and shall identify appropriate national agencies for the monitoring and implementation of such regulations. The countries shall also review their NDCs considering Green Hydrogen to support a move towards a net-zero economy especially in hard-to-abate sectors.

9.3.3 CAPACITY BUILDING AND SENSITIZATION

Regional Level Actions

To enable public and private action at the national and local level, sensitization of the key decision-making stakeholders must be conducted to enable them to understand and evaluate the technological and commercial value of projects in green hydrogen.

Towards this the EGHDU shall:

- Identify relevant training centres in the region as Centres of Excellence for Green Hydrogen with a pool of resources at the regional level for promotion including awareness raising, training and Research and Development of Green Hydrogen;
- Prepare, in close coordination with WASCAL, a capacity building roadmap that includes workshops and national open forums to promote green hydrogen and understand major challenges and inhibitions of investors in each country, which will be considered in the development of the national level frameworks/policies/action plan;
- Identify the need to further strengthen the education programmes with an aim to develop local future capable work force and introduce doctorate level programmes and specialization activities ranging from manufacturing, research, and development to financing and policy making;
- Identify, select, and equip relevant agencies to help create skilled workforce for the sector;
- Support development of homogenous training material on green hydrogen business development shall also be carried out targeting relevant stakeholders for entrepreneurs, investors, financing institutions.

National Actions

At the national level, actions on capacity building shall complement the regional level actions. Towards this objective, EGHDU shall support the following:

- Capacity development at the national level which shall cover development issues such as project implementation, management, operation, and long-term sustainability; hence, it shall be conducted for national decision makers and field operators.
- Organisation of training of clean technologies national officials and regulatory authorities.
- Introduction of renewable energy curricula including green hydrogen topics at the national universities and technical institutes assisted by the regional network.
- Introduction of practical renewable energy courses at the national training centres including utility training centres, if relevant which are open to trainees from the private sector.
- Training of national craftsmen and electricians essential for implementation of green hydrogen projects.
- Attention to gender issues should be increased throughout the implementation of the actions.

[25] Crone, Friese and Löchle, 2020

9.3.4 RESEARCH AND DEVELOPMENT

Regional Actions

To support Research and Development, EGHDU shall

- Collaborate with WASCAL or any other relevant research institutions to expand the scope of conducting research on Green Hydrogen/derivatives and its applications in industries
- Explore, with support from WASCAL or any other relevant institution, access to grant funding from international funding agencies to promote green hydrogen research in the region
- Focus on framework agreements to coordinate R&D programmes, focus on creation of value chains and joint R&D activities through WASCAL or any other relevant research institution
- **Develop pilots on each of the following broad fields:**
  - Green Hydrogen blending in chemical and natural gas industries;
  - Use of green hydrogen in decarbonizing mining activities;
  - Use of green hydrogen for urban transport in densely populated cities;
  - Other use of green hydrogen as deemed fit for undertaking a pilot, subsequently.

9.3.5 FACILITATING INFRASTRUCTURE DEVELOPMENT

Regional Actions

In the early stages of development of green hydrogen, it is important to minimize costs and mitigate risks
by localized development of manufacturing and demand centres. Based on the resource availability in the

ECOWAS region, few regional clusters can be identified:

- Regions for cheap low cost RE generation located primarily in the north of ECOWAS region;
- Regions with sufficient water availability along the coastline;
- Regions with the availability of port infrastructure and/or presence of local fertilizer or natural gas industries.

H2 Atlas developed by WASCAL provides the primary high-level assessment on the potential of green hydrogen production in the ECOWAS region. For commercial realisation of such projects, dedicated assessments need to be undertaken to determine the suitable regions for green hydrogen clusters.

The region through the EGHDU shall facilitate feasibility studies, with the support of development agencies and international governments, on the following aspects.

- Hydrogen Corridors: Considering the spatial variation in the availability of the resources, development of dedicated infrastructure corridors for the transmission of energy, water and hydrogen must be assessed link production clusters with the RE and port related clusters;
- Clusters for production of Green Hydrogen/derivatives for application in local industries in the form of co-location clusters/hubs.
- Large scale desalination: Water resource availability is a challenge in most parts of ECOWAS region. Assessments should be carried out for large-scale desalination plants in the vicinity of identified cluster locations that can serve water requirements for green hydrogen production as well as other industries and other consumption needs. Furthermore, these identified clusters must be favourably supported through regulatory and financial incentives. These clusters will be given the status of 'Special Economic Zones' with the following regulatory incentives:
  - Facilitate right of way clearance procedure for the development of green hydrogen related corridors;

- The region can review the possibility for fiscal concessions like import duty concession for import of equipment required to develop the corridor.

- Develop a mechanism through which excess power from Renewable Energy projects, which are set up to provide power to electrolyser plants, are sold to relevant agencies at competitive price provided there is connectivity;
- Identify infrastructure requirement for creation of value chain for Green Hydrogen and estimate cost for the development of infrastructure, such as, creation of pressure vessel storage near the ports and coordinate with International and Regional agencies to tap resources;
- Assess the feasibility on Intra regional and inter regional pipelines to transport Green Hydrogen for export and for local consumption in the longer run.

9.3.6 FINANCING SUPPORT

As an emerging market, it is important to provide financial support to the development of green hydrogen through appropriate financial incentives that facilitate investments by local and international private and public entities. Some guiding activities to be undertaken by the region and member countries are given below:

- Member states will introduce appropriate fiscal incentives to promote green hydrogen development and facilitate investment;
- Create instruments for financing the development of Green Hydrogen based initiative;
- Review policies for private sector investments and include green hydrogen as a prospective sector and supporting ancillary industries.

9.3.7 MARKET DEVELOPMENT

9.3.7.1 Dedicated Export focus

The EGHDU, in consultation with the Working Group, shall work towards developing export-oriented production units considering that Green Hydrogen production will be export oriented in the first phase. Towards this, EGHDU shall:

- Develop hydrogen export strategy to inform business case for green hydrogen (including derivatives) export;
- Supply of technology required for green hydrogen must be facilitated through technology transfer and memorandum of understandings with other import-centric countries and facilitate bilateral partnerships for supply of green hydrogen;
- Develop Regional incentive mechanism for cost effective import till the year 2027 and subsequently incentivize local production of equipment till the 2030.

9.3.7.2 Local Market Development

- Assessment of local market potential for green hydrogen and its derivatives by Member States;
- Develop green hydrogen promotion strategy to identify business cases;
- Signing up of bilateral agreements with relevant agencies or industries for investment to bolster demand at the local level.

10 Institutional framework

A dedicated Institutional framework is proposed comprising of core team of experts from different institutions as highlighted in Fig 13 below. The choice of institutions is based on their authority, roles and functions in the ECOWAS region, their expertise and capabilities using which they can make important contributions to the development of the green hydrogen sector. Besides specialist institutions, this will also include representations from different countries which will ensure adequate participation for promoting regional cooperation of each country in the development of the green hydrogen sector.

A Working Group with representatives from these institutions will provide strategic guidance and ensure implementation of the policy goals and the strategic plan. The proposed structure and role of the Working Group is shown below:

Figure 13: Core institutions for the formation of Institutional framework

- ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)
- ECOWAS Regional Electricity Regulatory Authority (ERERA)
- West Africa 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
- National level representatives (Ministeries in charge of Energy ...)
- West Africa Economy and Monetary Union (WAEMU)
- West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)

Roles and Responsibilities of the EGHDU

The ECOWAS Green Hydrogen Development Unit (EGHDU) would be responsible for the following activities:

- Support the development of National Green Hydrogen Policy and Strategy Frameworks or National Action Plans in line with the ECOWAS Green Hydrogen Policy and Strategy Framework;
- Implementing R&D activities in close coordination with specialised research bodies including WASCAL
- Conduct Periodic review of policy targets and progress against targets;
- Revisit policy targets every five years in line with regional and global developments in green hydrogen or at shorter intervals under exceptional circumstances;
- Identify and collaborate with specialised agencies to develop regulations pertaining to safety, certification, specifications, and standardization;
- Develop harmonious framework for regulations;
- Develop training and capacity building programs required for skill development in GH sector;
- Coordinate effectively with all partner institutions within EGHDU and leverage their strengths for the beneficial development of Green hydrogen sector in ECOWAS region;
- Interact and collaborate with industry to understand developments, investment interests, skill development requirements, technology collaborations, financing support necessary and facilitate requirements from Governments;
- Support development of frameworks and institutional mechanisms at national levels to facilitate investments in member countries.

Meetings and Periodicity

The EGHDU and its members must meet periodically to discuss and work in accordance with a predefined agenda to ensure that the performance is closely monitored and objectives are met. The periodicity of meeting should be at least once a year for which the agenda shall be circulated in advance along with the Minutes of the previous meeting so that participants can come with appropriate preparation and ensure meaningful contributions to the meetings.

11
Value Addition of Development of Green Hydrogen for the ECOWAS Region

The ECOWAS Green Hydrogen Policy and Strategy Framework has been developed keeping in mind the value addition necessary for the region and is not focused only on export potential of Green Hydrogen to other countries. The Policy directives clearly focus on development of green hydrogen as an energy resource for domestic consumption as well as export. For this, the definition of green hydrogen includes hydrogen produced through electrolysis of water using renewable energy including through sustainable bio- based processes.

The short and medium- term objectives include development of a strategic roadmap for development of green hydrogen consumption within the region. This is likely to begin with setting up demonstration projects for various projects in in the industry or transport or storage or mini grids. Such projects will establish the technical feasibility of green hydrogen applications, build capacity for project implementation and operation, albeit on a demonstration scale and provide access to know how.

In the transport sector, it is suggested that green buses using green hydrogen be introduced on a pilot scale in urban areas to demonstrate the impact of CO2 reduction. Such pilots and its success is expected to give tremendous confidence for scaling up the projects on commercial scale in future and will be a significant value addition of green hydrogen in the regional and local economy.

One of the clear objectives of the policy is the socio -economic development by creation of jobs in the field of green hydrogen related technologies in manufacturing, installation and construction, operations and maintenance. This is a clear value addition of green hydrogen sector in the region.

In building the infrastructure and ecosystem required for development of green hydrogen, there will be a significant boost to the local industry, core sectors like cement, steel and ancillary industry supporting green hydrogen in an indirect manner.

The strategic actions identify capacity building as a priority and several programs will be rolled out for education, skill development and training in order to create a skilled work force in the region keeping local employment in view. Training programs will also be focused on creating entrepreneurs and opportunities for research and development keeping in view the long- term requirements of green hydrogen sector.

Besides export focus, there is emphasis on local market development which includes assessment of local market potential for green hydrogen and its derivatives, development of promotion strategies, identifying business case and signing up bilateral agreements for investment to bolster demand at the local level.

These strategic actions and their intent clearly underline the value addition identified under the Policy and Strategic Plan for the ECOWAS region.

12
Risk Assessment

At different stages of the implementation of the Green Hydrogen Policy and Strategy Framework for the ECOWAS region, certain risks may impact on the expected results. These potential risks are listed below according to the project concept, the size of the investment required and past experiences. While analyzing the risks, the constraints and benefits of public and private delivery systems has been considered. Appropriate risk mitigation measures were also suggested to ensure that the policy objectives would be met. Concerted and proactive efforts on risk mitigation will help to achieve the expected results.

Table 5: Implementation Constraints and risks in the implementation of the green hydrogen projects

No	Implementation constraints and Likely Risks	Likely Consequence of Risks	Risk Reduction Measure
1	Delay in Announcement of National Policies for Green Hydrogen Development	• Delay in start of the green hydrogen projects • Shortfall in achievement of targets announced under the Regional Green Hydrogen Policy	Early development of national policies and consensus of policy proposals
2	Lack of adequate budgets leading to weak incentive structure for investment in green hydrogen sector	Weak investment sentiment in Green hydrogen sectors	Adequate consultation with private sector during the national policy finalisation stage
3	Inadequate skilled workforce in ECOWAS countries	Weak investor interest in investment in ECOWAS countries	Design and implementation of skill development programs
4	Delays in provision of land for projects Competing demand and need for land	Delays in project implementation	Constitution of Nodal agency for allotment of land. Objective evaluation of land use with long term benefits
5	Delay in providing clearances for green hydrogen projects	Delays in project implementation	Constitution of nodal agency for expediting clearances
6	Delays in developing and providing local infrastructure around ports, pipelines for transportation, transmission corridor for clean electricity	Delays in project implementation	Creating budgets in advance in National budgets for GH investment for investment in common infrastructure.
7	Inability to become the most competitive producer and supplier strategy	Weak interest in procurement in international markets	Developing a strategy for competitive production for exports which is well coordinated and conceptualised and offtake agreements are discussed in advance. Concessional Financing support for green hydrogen projects to help them compete in international markets Developing large pool of talent and skilled workforce in West Africa

13
Monitoring and Evaluation Mechanism

A robust monitoring and evaluation mechanism would help in ensuring that the EGHDU performs in accordance with its objectives. Therefore, in its initial meetings, the EGHDU's agenda must include the development and an agreement on the framework for monitoring and evaluation mechanism wherein specific Key Performance Indicators (KPIs) are set along with Management Information System (MIS) reports in order to capture necessary information on various activities, tasks, planned for the month or quarter for the tasks to be performed by the EGHDU and actual performance vis a vis the plan.

The MIS formats and reports shall be ratified by the Working Group and adopted for implementation. These reports should be presented at every quarterly meeting of the EGHDU discussed.

14
Annexure

Nationally Determined Contributions of ECOWAS countries

- **BENIN**

  • For the coming years, the measures envisaged in the revised NDC, in the energy, agriculture and waste sectors are likely to contribute to reducing cumulative GHG emissions (excluding land use, land-use change and forestry) by approximately 48.75 Mt E CO2 compared to the benchmark scenario, i.e., a reduction of around 20.15% over the 2021-2030 period.
  • The commitment is ambitious given its reduction targets focus on sectors key to economic development, particularly energy and agriculture.

- **BURKINA FASO**

  • Burkina Faso has set a quantifiable emissions reduction target of 29.42% by 2030. Adaptation actions could also lead to a reduction of 30.76%.
  • Designed with participation of youth and women, the NDC highlights the co-benefits of climate action with links to adaptation.
  • Monitoring and evaluation are a focus as the country moves forward with its National Adaptation Plan for the medium- and long-term view.

- **CABO VERDE**

  • Under its revised NDC, Cabo Verde comprehensively increased the scope and ambition of its mitigation goals while also enhancing their focus on adaptation, climate justice and gender equality, transparency, and good governance.
  • The small island state has committed to an emissions reduction target of 18% below business-as-usual by 2030, or 24% with international support.
  • The country aims to achieve a net-zero economy by 2050.

- **COTE D'IVOIRE**

  • In its updated NDC, Côte d'Ivoire commits to reducing its greenhouse gas emissions by 30.41% by 2030 relative to business as usual, or 98.95% with international support.
  • With additional mitigation measures in the Food and Land Use sector and the inclusion of new greenhouse gases, Côte d'Ivoire significantly raises its climate ambition, resolutely committing to carbon neutrality from 2030.
  • In terms of adaptation, the country aims to reduce vulnerabilities and increase climate resilience across five priority sectors: agriculture, Food and Land Use, water, health, and coastal zones.

- **THE GAMBIA**

  • With its revised NDC, The Gambia aspires to achieve net-zero emissions by 2050
  • The revised NDC sectoral coverage has been extended to include all greenhouse (GHG) emissions including the entire Agriculture, Forestry and Other Land Use (AFOLU) sector
  • The revised NDC projects a Business as Usual (BAU) scenario projection to 6,617 Gg of CO2 equivalent in 2030 and proposes a mitigation level of around 3327 Gg of CO2 equivalent.
  • The Gambia extended the sectoral coverage to include all greenhouse gas emissions, including forestry and waste.
  • The adaptation section was also strengthened, including for vulnerability analysis, envisaged adaptation action and financial needs.

- **GHANA**

  • With more ambition across sectors and the inclusion of new greenhouse gases, Ghana raised its target to cut emissions by 64 MtCO2e by 2030.
  • Ghana commits to implementing unconditional actions that would result in 24.6 MtCO2e, and conditional actions which have the potential to reduce emissions by 39.4 MtCO2e by

2030.
• The updated NDC lists 47 ways in which the country will mitigate and adapt to climate change, with each examined for its socioeconomic outcomes, job prospects, funding, number of beneficiaries and gender responsiveness.

- **GUINEA**

• From its initial NDC's conditional target to reduce greenhouse gas emissions by 13%, Guinea moved to a 17% reduction target with unconditional contributions across sectors, potentially reaching 49% by 2030 by including land-use and forestry.
• Alongside their mitigation efforts, Guinea outlined enhanced adaptation goals, articulated clearer links with other national strategies and policies, and examined gender and youth inclusion along with the Sustainable Development Goals.

- **GUINEA-BISSAU**

• Guinea-Bissau defined its first quantified target for reducing greenhouse gas emissions, committing to a reduction of 30% by 2030 with support and an unconditional target of reducing emissions by 10%.
• The NDC sets out a vision for low-carbon and climate-resilient development in line with the country's economic and social progression.
• As well as linking climate action to the Sustainable Development Goals, the updated NDC reflects concerns for women's empowerment and gender equality.

- **LIBERIA**

• While its first NDC was entirely conditional upon international support, Liberia's updated NDC includes an unconditional 2030 target to reduce emissions by 10% below business-as--usual.
• Aligned with the National Adaptation Plan and development plan, the revised NDC contains new sectors and elaborated adaptation measures including steps to integrate gender and youth considerations into planning.
• The NDC also aligns the country's climate action with the Sustainable Development Goals.

- **MALI**

• Under its revised NDC, Mali committed to reducing greenhouse gas emissions by 31% for energy, 25% for agriculture, 39% for land use and forestry, and 31% for waste sectors by 2030 compared to business-as-usual – an overall increase on their first NDC submitted in 2015.
• The updated NDC also integrates gender considerations and aligns with the Sustainable Development Goals.
• It also provides a detailed plan for monitoring, reporting and verifying NDC progress.

- **NIGER**

• Niger enhanced its adaptation and mitigation ambition and updated its NDC based on new estimates in the agriculture, forestry, and other land use and Energy sectors and new climate projections.
• The country committed to conditional mitigation targets for the agriculture, forestry, and other land use sector of 14.60% by 2025 and 22.75% by 2030 compared to business as usual and introduced unconditional contributions of 4.50% and 12.57% by 2025 and 2030 respectively for this sector.
• Niger also introduced an unconditional pledge to cut greenhouse gas emissions in the Energy sector by 11.20% by 2025 and 10.60% by 2030 relative to business-as-usual, as well as reductions conditional on support of 48% and 45% for the same target years.

- **NIGERIA**

  • Nigeria's updated NDC reiterated the country's unconditional economy-wide target to reduce emissions by 20% relative to business-as-usual by 2030, increasing its conditional target from 45% to 47%.
  • While the targets appear similar to those of the initial NDC, revised baseline conditions – based on more accurate economic growth projections – mean that they represent a rise in ambition.
  • Updates include an analysis of the potential of Nature-Based Solutions (NBS) to contribute to mitigation efforts and the integration of the water and waste sectors to the adaptation component.
  • The NDC now also integrates gender concerns and youth engagement.

- **SENEGAL**

  • Senegal's NDC has an unconditional and conditional target, depending on international aid. It is based in a BAU scenario taking into account 2010 as base year.
  • Senegal posits its mitigation by establishing 2025 as middle point and 2030 as the end point. In the reference year, a projection of emissions to 2025 (32648,6097 GgCO2eq) and 2030 (37761,1405 GgCO2eq) were foreseen; (ii) In the unconditional scenario, Senegal proposes reductions of 5% (30987 GgCO2eq) and 7% (35106 GgCO2eq) respectively to 2025 and 2030 emissions; (iii) In the conditional scenario, the goals are bolder, reaching 23,78% (24883,0564 GgCO2eq) in 2025 and 25,53% (26611,0057 GgCO2eq) in 2030.
  • The country aims to go an extra mile with international aid mainly in the electricity sector, outlining an unconditional achievement of a cumulative installed solar capacity of 235 MW, 150MW in wind power, 314 MW in hydroelectricity in 2030 and presents a conditional one of an additional solar capacity of 100 MW, 100 MW in wind power, 50 MW of biomass, 50 MW of CSP, by 2030. Moreover, Senegal has a wider goal to reach 999 MW in renewable energies (conditionally) and invest to switch carbon intensive fuels to natural gas in dual thermal power stations (fuel oil / gas), which will bring the total installed 600 MW of natural gas between 2025 and 2030.

- **SIERRA LEONE**

  • In its updated NDC, Sierra Leone defined a progressive path forward for cutting greenhouse gases emissions from 2005 levels: 5% by 2025, 10% by 2030, and 25% by 2050.
  • Unlike the initial NDC which had only conditional commitments, the updated NDC set unconditional mitigation contributions, also providing more detail on each sector's trends, strategies and goals, with quantifiable targets.
  • Sierra Leone also expanded their adaptation targets and have sought alignment with the Sustainable Development Goals.

- **TOGO**

  • Adding new greenhouse gases while increasing mitigation targets across sectors, Togo almost doubled their economy-wide emissions reduction target in their updated NDC, from 11.14% to 20.51%, relative to business-as-usual by 2030, with another 30.06% conditional on support.
  • With an estimated 69% of rural households living below the poverty line, adaptation and development remain key priorities under Togo's NDC, with targets including 100% rural electrification by 2030.
  • The adaptation component also provides information on the progress made since the first NDC and includes new activities and measures. The updated NDC also aligns with the Sustainable Development Goals.

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