Université Cheikh Anta Diop de Dakar

SPONSORED BY THE
Federal Ministry of Research, Technology and Space

****

INTERNATIONAL MASTER PROGRAMME IN ENERGY AND GREEN HYDROGEN (IMP-EGH)

****

MASTER THESIS

Speciality: Economics/Policies/Infrastructures and Green Hydrogen Technology

Assessment of potential partners for e-methanol project implementation in West Africa: Case of Côte d'Ivoire and Senegal

Presented the 15th September 2025 by:

Brou Koffi Ange Stéphane Junior

Major Supervisor	**Co-Supervisor**
Prof. Dr. Peter Letmathe	Dr Ibrahima Barry
	Benogo Mohamed TRAORE, MSc

August 2025

DEDICATION

I dedicate this thesis to my Grandmother.

You have always been there for me. Today you are no longer of this world, but I know that wherever you are, you rest in peace.

Thank you for all your sacrifices, your unconditional love, and for everything you did to make me the man I am today.

No offering can ever fully express the love and deep gratitude I feel for you

I love you forever, Mamy.

Acknowledgment

I give thanks and gratitude to God for having given me health, strength and courage during these 2 years of study.

This is the time and place for me to express my sincere thanks to all the people who, since the beginning of this hard work, have never ceased to accompany me with their invaluable advice and technical, financial and moral support in order to complete this journey and ensure the success of this work.

I would like to express my gratitude to:

• BMFTR and WASCAL for scholarship opportunity;

• Chancellor Thomas Trännapp, Vice Chancellor of the University RWTH Aachen University

• Prof. Ahmadou Aly MBAYE, Director of WASCAL GSP Senegal;

• Prof. Assane BEYE, Deputy of WASCAL GSP Senegal;

• Dr Fama GUEYE, Deputy director of WASCAL Senegal;

• Prof. Dr. Peter LETMATHE, Chair of Management Accounting and major supervisor

at RWTH Aachen University;

• Dr Ibrahima BARRY, professor at UCAD, local supervisor;

• Benogo Mohamed TRAORE, MSc, co-supervisor at RWTH Aachen University;

• Dr Khady Yama SARR, UCAD H_2 program coordinator;

• All the WASCAL and RWTH Management Accounting staff;

• All my family members;

• The entire batch H2 program especially my colleagues from UCAD specialty;

Who agreed to guide me, always with good grace, kindness and affection, along the difficult paths of research despite their multiple occupations.

Finally, I would like to thank all those who, in one way or another, contributed to the preparation of this report and whose names could not be mentioned here.

ACRONYMS AND ABBREVIATIONS

AGEDI:	Industrial Infrastructure Management and Development Agency
AHP:	Analysis Hierarchic process
ANARE:	National Electricity Regulatory Authority
ANDE:	National Environment Agency
APIX-SN:	National Agency for the Promotion of Investment and Major Works in Senegal
ANER:	National Agency for Renewable Energies
ASN:	Senegalese Association for Standardisation
ATEX:	Atmosphere EXplosibles
BAD:	African Development Bank
BNDE:	National Bank for Economic Development
CAGR:	Compound Annual Growth Rate
CCIAD-SN:	Dakar Chamber of Commerce and Agriculture - Senegal
CCI-CI:	Chamber of Commerce and Industry in Côte d'Ivoire
CDC-CI:	Côte d’Ivoire Deposit and Consignment Office
CSR:	Corporate Social Responsibility
CI-Energies:	Côte d’Ivoire Energies
CODINORM:	Côte d'Ivoire- Standardisation
CI :	Consistency index
CIE :	Ivorian Company of Electricity
CIPREL	Ivorian Company of Electricity Production
CR :	Consistency ratio
CRI:	Carbon Recycling International
CRSE:	Electricity Regulation Commission
DEEC:	Environment and Classified Establishments Department
DGE:	Directorate-General for Energy
DGH:	Directorate General of Hydrocarbons
DGPE:	Directorate General of the State Portfolio
ECOWAS:	Economic Community of West African States
ECREEE:	ECOWAS Centre for Renewable Energy and EnergyEfficiency
ESP:	Ecole superieur Polytechnique

ESRC: Electricity Regulatory Commission

FONSIS: Senegal's Sovereign Wealth Fund

GCF: Green Climate Fund

ICT: Information and Communication Technology

IMO: International Maritime Organization

INP-HB: Félix Houphouët-Boigny National Polytechnic Institute

H_2: Green Hydrogen

MCDA: Multicriteria Decision Analysis

MCDM: Multicriteria Decision Making

MEDDTE: Ministry for the Environment, Sustainable Development and Ecological Transition

MMPE: Ministry of mines, oil, and energy

MSC: Côte d'Ivoire Chipping Services

PAD: Dakar Port Authority

RFNBO: Renewable Fuels of Non-Biological Origin

SAR: African Company of Refining

SB2-4ALL: Senegalese company, Sustainable Business for ALL

SIR: Ivorian Company of Refining

SEVESO: European Union regulation on the control of major-accident hazards involving dangerous substances

TEU: Twenty-foot Equivalent Unit

WASCAL: West African Science Service Center on Climate Change and Adapted Land

LIST OF TABLES

LIST OF FIGURES

Table of Contents

ABSTRACT

Sub-Saharan Africa is accelerating its transition to sustainable energy, with green hydrogen and synthetic fuels such as e-methanol emerging as viable alternatives to fossil fuels. In this context, this research focuses on the strategic assessment of partners already active in the fuel value chain, the broader energy sector, and specifically for an e-methanol project in Côte d'Ivoire and Senegal. E-methanol production integrates renewable energy, green hydrogen, and CO_2 capture technologies, requiring effective coordination between multiple stakeholders from energy, industry, and logistics. The methodology applied is the Analytic Hierarchy Process (AHP), which enables the hierarchical ranking of potential partners based on a set of Regulatory, technical, financial, environmental, and value chain synergy criteria. The results show that the energy and fuel sectors in both countries are regulated by governmental institutions, particularly relevant ministries, along with specific national organizations. Across each segment of the e-methanol value chain, there are identified actors capable of ensuring or supporting project development. Ongoing renewable energy initiatives in Côte d'Ivoire and Senegal, expected to expand significantly before 2030, provide a favorable foundation for integrating green hydrogen and e-methanol production. This work thus supports Côte d'Ivoire and Senegal's ambition to decarbonize their energy sector and position themselves as regional leaders in climate-resilient technologies.

Keywords: E-methanol; Analysis Hierarchic Process; Partner assessment; Côte d'Ivoire; Senegal.

RESUMÉ

L'Afrique subsaharienne accélère sa transition vers l'énergie durable, l'hydrogène vert et les carburants synthétiques tels que l'e-méthanol apparaissant comme des alternatives viables aux combustibles fossiles. Dans ce contexte, cette recherche se concentre sur l'évaluation stratégique des partenaires déjà actifs dans la chaîne de valeur des carburants, le secteur de l'énergie au sens large, et spécifiquement pour un projet d'e-méthanol en Côte d'Ivoire et au Sénégal. La production d'e-méthanol intègre les énergies renouvelables, l'hydrogène vert et les technologies de capture du CO_2, ce qui nécessite une coordination efficace entre de multiples acteurs des secteurs de l'énergie, de l'industrie et de la logistique. La méthodologie appliquée est le processus de hiérarchie analytique (AHP), qui permet de classer hiérarchiquement les partenaires potentiels sur la base d'un ensemble de critères techniques, financiers, développement durable, régulations et la synergie dans la chaîne de valeur. Les résultats montrent que les secteurs de l'énergie et des carburants dans les deux pays sont réglementés par des institutions gouvernementales, en particulier les ministères concernés, ainsi que par des organisations nationales spécifiques. Dans chaque segment de la chaîne de valeur de l'e-méthanol, il existe des acteurs identifiés capables d'assurer ou de soutenir le développement de projets. Les initiatives en cours dans le domaine des énergies renouvelables en Côte d'Ivoire et au Sénégal, qui devraient se développer de manière significative d'ici 2030, constituent une base favorable à l'intégration de la production d'hydrogène vert et d'e-méthanol. Ce travail soutient donc l'ambition de la Côte d'Ivoire et du Sénégal de décarboniser son secteur énergétique et de se positionner en tant que leader régional dans les technologies résilientes au climat.

Mots clés: E-methanol; Processus d'analyse hiérarchique; Evaluation de partenaire; Côte d'Ivoire; Sénégal

Introduction

Climate change is a defining challenge of the 21st century, with consequences that are particularly severe for vulnerable regions such as West Africa. The Intergovernmental Panel on Climate Change (IPCC, 2022) identifies fossil fuel combustion for energy production, transport, and industry as the primary driver of global greenhouse gas (GHG) emissions, which contribute to rising global temperatures, extreme weather events, and ecosystem degradation. In sub-Saharan Africa, the dependence on imported fossil fuels not only contributes to environmental harm but also creates economic vulnerabilities, including exposure to volatile global oil prices (IEA, 2023b). These challenges call for an accelerated transition toward sustainable, low-carbon energy systems.

In the global search for climate-neutral solutions, synthetic fuels or e-fuels have emerged as a promising pathway to decarbonize "hard-to-abate" sectors such as heavy industry, aviation, and shipping, where direct electrification is not yet practical (IRENA & Methanol Institute, 2021). Produced through the combination of renewable electricity, water electrolysis for hydrogen production, and carbon dioxide (CO_2) capture, e-fuels can achieve near-carbon neutrality when renewable energy is used in their production process. Among them, e-methanol stands out due to its versatility: it can be used as a fuel for maritime transport, a feedstock in the chemical industry, and an energy carrier that integrates well into existing storage and distribution infrastructure (Methanol Institute, 2022).

West Africa holds considerable potential for e-fuel development, blessed with its abundant renewable energy resources, including high solar irradiation, significant wind potential along the Atlantic coast, hydropower capacity, and untapped biomass resources (ECREEE, 2022). Despite these favorable conditions, most existing studies focus on the economic and technical feasibility of renewable hydrogen and e-fuels in Africa (ECREEE ECOWAS, 2023; IRENA & Methanol Institute, 2021). However, there is a notable gap: the absence of structured stakeholder and partner assessments for implementing large-scale e-methanol projects. Given the capital intensity, technological complexity, and cross-sectoral integration required, success depends not only on technical feasibility but also on mobilizing the right partners across the value chain: regulators, producers, storage and transport operators, distributors, and financiers

This thesis addresses this gap by focusing on Senegal and Côte d'Ivoire as case studies. Both countries are particularly relevant for three reasons: they demonstrate strong political commitment to renewable energy deployment, they hold strategic coastal locations that enable integration into regional and global fuel markets through export and bunkering, and they have relatively advanced energy infrastructures and institutional frameworks to support innovation (ANARE, 2023; Kachi et al., 2023). Additionally, both countries have set ambitious national targets to diversify their energy mix and reduce dependence on fossil fuels before 2030 (ANARE, 2023; IEA, 2023a), positioning them as potential leaders in the West African energy transition.

The general objective of this thesis is therefore the selection and ranking of promising partners across the potential e-methanol value chain in Côte d'Ivoire and Senegal. To achieve this, the research is guided by three central questions:

What are the potential partners and key evaluation criteria for an e-methanol production project in Côte d'Ivoire and Senegal?

Which actors emerge as the most promising partners in Côte d'Ivoire and Senegal, and how do they compare across the value chain?

What policy and regulatory measures could encourage greater investment and partner engagement in the e-methanol sector?

To answer these questions, the study adopts the Analytical Hierarchy Process (AHP) methodology (Saaty, 1980), a multi-criteria decision-making tool that enables the hierarchical ranking of alternatives through pairwise comparisons. This method is particularly suitable in this context because it integrates technical, financial, environmental, and institutional criteria, thus ensuring a transparent and systematic evaluation of stakeholders. Data were collected primarily from secondary sources, including official government reports, regulatory authority publications, industry reports, and international organization studies, complemented by company documents and regional databases. By applying this approach, the study provides a structured mapping and ranking of potential partners across the e-methanol value chain from production to distribution. The findings contribute to both academic and policy discourse by offering a replicable decision-making framework for partner selection in green fuel projects. Moreover, they provide actionable insights for policymakers, investors, and industry stakeholders to strengthen public-private collaboration, attract targeted investments, and accelerate the deployment of e-methanol in West Africa. Ultimately, this research aims to support the development of a viable e-methanol ecosystem in Côte d'Ivoire and Senegal, contributing to both national energy security and the region's decarbonization ambitions.

Chapter 1: Literature review of e-methanol

The global trend towards renewable energies has heightened interest in the transition to green fuels. Green fuels play an important role in the energy transition, as they contribute enormously to the decarbonization of hard-to-abate sectors. Senegal and Côte d'Ivoire, with their abundance of renewable resources (solar, hydro, wind), are strategic sites for green methanol production. This literature review will examine the following key points: overview of e-methanol, wide world e-methanol context, the role of green methanol in the energy transition in Africa, the renewable energy potentials, and the e-methanol landscape of Senegal and Côte d'Ivoire.

1. Overview of e-methanol

Traditionally, methanol has been produced from syngas (a mixture of carbon monoxide and hydrogen) from fossil fuels as the feedstock (Fasihi & Breyer, 2024). Methanol (CH_3OH, conventionally indicated as MeOH) is currently regarded as one of the most significant building blocks in the chemical and pharmaceutical industries, as well as in the production of synthetic hydrocarbons. It is synthesised from a variety of carbon-containing feedstocks, including natural gas (NG), coal, biomass, and CO_2 (Mohammadi & Harandi, 2023). In light of the aforementioned, the global community has been endeavouring to identify solutions to the issue of climate change with a view to reducing its impact. This has involved a transition to renewable energy sources, as well as the utilisation of green energies and e-fuels (IPCC, 2011). The conventional demand for methanol in 2050 supplied by green methanol could grow up to reach 440-761 Mt per year (2799-4838 TWhMeOH, HHV per year) (Fasihi & Breyer, 2024). E-methanol has the potential to substitute for a significant proportion of the remaining fossil fuels used in the chemical industry. Otherwise, some platforms or bulk chemicals could also be potentially produced directly from CO_2 and H_2, resulting in a higher overall carbon and hydrogen conversion rate. This, in turn, could reduce the overall demand for sustainable CO_2 and green hydrogen, as well as green methanol, in the chemical industry. Furthermore, renewable energy is essential for H_2 and e-methanol production (Avery & Carpenter, 2025). Due to this, the declining cost of renewable electricity, especially solar photovoltaics (PV) and wind power production, will contribute relevantly to this technology (Vatankhah et al., 2025). The advancements in industrial-scale CO_2 direct air capture (DAC) with the potential to sustainably supply hydrogen by water electrolysis will make a major contribution to the e-methanol industry (Bisotti et al., 2024). In short, there are two main cases in which methanol can be considered as ‘‘green’’, bio-methanol derived from biomass feedstocks and e-methanol from renewable electricity, water, and pre-captured CO_2 (Cornils, 2020). According to Karbassi et al. (2023), curbing emissions in hard-to-abate segments is more often linked to renewable energies (RE) based energy carriers via Power-to-X (PtX) technologies rather than direct electrification. E-fuel is a potential solution to the defossilisation of the existing methanol supply and fossil fuel substitution. Furthermore, the technical feasibility of the power-to-methanol approach, together with the abundance of solar and wind resources, provide the potential to supply this elevated demand with renewable electricity-based methanol (e-methanol) Fasihi & Breyer (2024), The study's findings, as outlined in the paper, have demonstrated the viability and cost-effectiveness of producing e-methanol through the optimisation of hourly atmospheric CO_2 capture and hydrogenation. This is achieved via the utilisation of hybrid PV-wind power-to-methanol systems, exhibiting a spatial resolution of 0.451x0.451 on a global scale. The study's findings further reveal the technology mix (wind-solar) required to achieve the least cost fuel production, with the temporal scope extending from 2020 to 2050. Additionally, while the high CO_2 taxation is taken into account, or if the price of fossil methanol approximately doubled, several techno-economic and environmental studies have shown that a power-to-methanol application can be economically feasible with sufficiently low electricity prices and utilising RE to power H_2 production considerably reduces GHG emissions compared to methanol produced from a fossil source (Fasihi & Breyer, 2024). By 2040, the production cost of e-methanol will be within the market prices, suggesting that methanol supply could be defossilised at no extra cost for consumers (Fasihi & Breyer, 2024). Methanol is also partly used for gasoline blending or conversion to gasoline as a transportation fuel (Fasihi & Breyer, 2024). By 2050, the non-energetic cost of DAC declines by about 60% compared to 2030, the sharpest among all considered technologies (Fasihi & Breyer, 2024).

2. Worldwide landscape of e- methanol

The worldwide methanol production is about 90 Mt/yr (Tabibian & Sharifzadeh, 2023). Most of it (about 65 %) comes from natural gas by means of steam methane reforming, while the remainder (35 %) comes from coal through gasification processes (Mohammadi & Harandi, 2023). The production of high-demand chemical commodities such as ethylene and propylene (methanol-to-olefins), hydrocarbons (methanol-to-hydrocarbons), gasoline (methanol-to-gasoline), and aromatics (methanol-to-aromatics) has been central to research in both academia and industry (Almuqati et al., 2024; Mohammadi & Harandi, 2023). According to IRENA (2021), the global methanol market is dominated by the Asia-Pacific region with around 60% as share due to strong growth in the automotive and construction sectors, following China's leading role in methanol derivatives, North America (20%) and Europe (12%) are driven by green fuels and sustainable products, and Latin America, the Middle East and Africa about 8% overall are expected to grow through industrialisation and construction. Furthermore, the Indian government is consistently pushing the utilization of methanol in automobiles and the use of methanol in cooking fuel, which will help in promoting sustainable development as it is an eco-friendly option (Saranga et al., 2024). A capital investment of U.S. dollars to 46 million was made in order to convert around 3.6 million tons of waste into green methanol by the Netherlands (India government, 2025). This initiative is expected to provide growth opportunities for the methanol market across the European region (Mohammadi & Harandi, 2023). Global Methanol demand stood at 84.55 million tons in 2020 and is forecast to reach 135.60 million tons by 2030, growing at a healthy CAGR of 4.97% until 2030. In the past decade, the market price of conventional methanol has been mainly within 200–400 € per ton (31–63 € per $MWh_{MeOH,HHV}$). However, while e-methanol is emerging as a competitive alternative to conventional methanol and a pathway to produce e-ammonia for sustainable agriculture, a global knowledge gap remains on low-cost, large-scale production highlighting the need for cost-volume assessments (2020–2050) using optimized PV-wind systems to identify self-sufficient regions and potential trading hubs, a framework relevant for evaluating West Africa's role in future e-methanol markets (Fasihi & Breyer, 2024).

3. African landscape of e-methanol

Africa is well-positioned to play a central role in the global energy transition, blessed with immense potential in renewable resources, more than 45% of the world's renewable energy resources (IRENA, 2023), which are largely under-exploited but technically sufficient to meet domestic and export energy needs. Recent scenarios have shown that the massive use of renewable energies to cover Africa's energy demand would be optimal in terms of cost, while paving the way for the production of competitive e-fuels (Hassan et al., 2024). The development of these synthetic fuels, including e-methanol, represents a major macroeconomic opportunity, generating export revenues and skilled jobs on a large scale. Hence, most studies on Africa's e-fuel potential prioritize North Africa due to its proximity to Europe and advanced infrastructure, leaving West Africa, despite its rich solar, hydro, and biomass resources, underexplored, which underscores the need to assess countries like Senegal and Côte d'Ivoire for sustainable e-methanol production amidst growing renewable installations across the continent (Karbassi et al., 2023), Karbassi et al. (2023) posit that the integration of the Gini coefficient into renewable energy export strategies has the potential to promote broader African participation, strengthen

Europe's energy resilience, and support local renewable industries. In the preview scenario, high-potential solar PV dominates due to falling costs, while equitable scenarios increase wind power's share. These insights are crucial for assessing West Africa's role in future e-methanol production. This result suggests that high-potential solar PV combined with high-capacity wind turbines are the key technologies for achieving as regionally equitable a transition as possible at reasonable costs in Africa. The novelty is particularly evident in the combination of least-cost optimization and a minimum benefit distribution inequality objective between African countries. Indeed, Karbassi et al. (2023) have demonstrated that diversifying trade in renewable e-fuels, including e-methanol, across West African countries (except Niger) via coastal shipping routes and existing pipelines, has the potential to offer lower-cost decarbonisation benefits in comparison to Europe, where projected 2030 production costs for green hydrogen and e-fuels remain high. The strategic importance of West Africa for the competitive production and export of e-methanol was emphasised. H_2 will benefit West Africa because of its renewable natural resources: 1,956 GW of solar power, 106 GW of wind power, and 162 GW of hydroelectric power (PwC, 2023). With PtX applications, e-methanol production uses H_2; they will be able to achieve agricultural self-sufficiency through the production of green fertiliser and other agricultural products, to decarbonise sectors that are hard to abate, and finally to add value to their economy through the export of H_2. Its industrialisation will consequently reduce CO_2 emissions. According to IRENA (2023), 47% of the region's inhabitants lack electricity access, and a staggering 87% do not have access to clean cooking fuels and technologies. For projects located in areas with average long-term wholesale electricity prices at 40 EUR/MWh, the total hydrogen price would be 4.7 EUR/kg, and that is competitive with hydrogen from reforming with high carbon capture at 60 EUR/MWh gas prices. Because of the high investment costs involved in producing hydrogen, E-methanol will be beneficial for West Africa because, apart from the low cost of production, it is naturally used in industrial sectors such as chemicals, paint, plastics and other everyday products, used directly as a fuel and solvent (Sillman et al., 2025a), it is also cheaper and less inconvenient to be exported than H_2 (IRENA & methanol institute, 2021). Several techno-economic studies of e-methanol production have been done, throughout the following studies, such as Oyewo et al. (2024), which analyzed the economic viability of exporting green e-fuel, e-chemicals, and e-materials from Africa to Europe, with Africa's low-cost power-to-X products, backed by low-cost renewable electricity, mainly supplied by solar photovoltaics, is the basis for Africa's vibrant export business opportunities. Their results show that hydrogen will likely not be traded simply due to high transport costs. However, there is an opportunity for African countries to export e-ammonia, e-methanol, ekerosene jet fuel, e-methane, e-steel products, and e-plastic to Europe at low cost. Brynolf et al., (2018) demonstrate the viability of e-methanol in countries with significant renewable resources, Demirel (2015) analyzes and compares the economics and sustainability aspects of two hydrogenation processes for producing renewable methanol and ammonia by using wind-power based electrolytic hydrogen, Rahmat et al., (2023) used the in-house tool TEPET (Techno-Economic Process Evaluation Tool) to assist with the techno-economic analysis, including a sensitivity analysis regarding CO2 and H2 costs and an exergy analysis of the e-MeOH plant, Galimova et al. (2025) identified the most economically attractive methanol production locations by comparing the relative transportation costs of electricity, hydrogen, and CO_2, Bozzini et al. (2025) show the involvement the assessment of the integration of the methanol plant with various technologies for capturing and utilizing CO_2 (Direct Air Capture, Carbon Capture of flue gases, or utilizing cheap CO_2 from companies). Next, industrial, financial and technological partnerships are essential to the success of e-methanol projects, which involve complex value chains ranging from the production of renewable electricity to the chemical synthesis of the fuel. (IEA, 2021). Finally, according to Karbassi et al. (2023), the main focus of recent studies lies in North Africa and tends to disregard the 48 sub-Saharan African countries. This exclusion indicates a significant research gap, given that sub-Saharan Africa has excellent solar and wind resources for green e-fuel production, for the potential economic development in the continent.

According to these studies, a careful study of the host country's renewable resources and its policies encouraging the development of such an industry, and the search for potential partners already involved in methanol in the country, which is the basis of our study.

4. Methanol overview in Côte d'Ivoire and Senegal, e-methanol perspective for both countries

The global energy transition towards low-carbon and sustainable solutions is placing e-fuels, or synthetic fuels, at the centre of technological and economic debates (Benamara et al., 2022). E-methanol, produced from captured CO_2 and green hydrogen from renewable energies, represents a promising alternative to fossil fuels, particularly in the maritime, industrial, and heavy transport sectors (EVOLEN, 2023). In West Africa, the value chain of fuel is from exploration and production (oil, natural gas, biomass) to refining, processing, storage, distribution, and marketing, and is still largely dominated by fossil fuels (ICAO, 2018), even though the gradual integration of renewables and green hydrogen is beginning to emerge. Côte d'Ivoire has a diversified energy mix dominated by natural gas (around 70% of electricity production) and hydroelectricity (almost 30%) (CI-Energies, 2022), as well as structured oil and gas infrastructures such as Ivorian Refining Company (DGPE CI, 2023). These assets include industrial capacity in refining and petrochemicals, access to industrial CO_2 from thermal power stations, and high solar potential (> 4.5 kWh/m²/day) conducive to the production of green hydrogen (IRENA, 2022b). Senegal, for its part, is pursuing an ambitious strategy of energy diversification with the Senegal Emerging Plan and the promotion of solar, wind and gas energy (MEPM, 2023b), and infrastructures such as the African Refining Company, the solar power plants at Bokhol and Kael, and the future offshore gas fields at Grand Tortue Ahmeyim (IEA, 2023a). Its wind and solar energy potential, favourable regulatory framework, and strategic position as a regional port hub make it a strong candidate for e-methanol. In both countries, the development of this fuel could be based on growing demand for alternatives for maritime and industrial transport (Brynolf et al., 2018), existing infrastructures for storing and transporting liquids, as well as public-private partnerships with companies already active in refining, gas, and renewable energies (Koshikwinja et al., 2025). However, challenges remain, such as the high cost of production compared with fossil fuels (Fazekas et al., 2022), the need for a clear regulatory framework, and the lack of local technical experience of Power-to-X processes. Côte d'Ivoire and Senegal offer significant potential for hosting an e-methanol project, thanks to their abundant renewable resources, their industrial infrastructure, and the possibility of integrating this sector into their existing energy value chain.

Despite their high renewable energy potential, Senegal and Côte d'Ivoire have very few academic studies or practical projects on the production of methanol or e-methanol (Mohammed et al., 2023). There are several reasons for this: firstly, the historical priority given to more mature sources such as solar, hydroelectricity and biomass (IRENA, 2023) ; on the other hand, the lack of industrial infrastructure needed to synthesis e-methanol (green hydrogen production, CO_2 capture, electrolysers) (IEA, 2021). In addition, high investment costs and the lack of a dedicated regulatory framework for e-fuels are holding back the emergence of such projects in the region. (Argus Media, 2024). In this respect, no significant initiative has been listed in international e-fuels databases for these two countries, unlike North Africa or South Africa (Argus Media, 2024). This situation highlights the urgent need for academic and strategic exploration of the subject. Firstly, Senegal and Côte d'Ivoire have a diversified energy mix, including strong solar, hydroelectric, and biomass potential. These countries are also in an industrialisation phase and have a clear political commitment to energy transition (AFREC, 2022). Senegal's National Development Strategy (Plan Sénégal Émergent) and Côte d'Ivoire's Vision 2030 include the development of renewable energies and alternative fuels (IFC, 2018; SND, 2024). However, very few studies have focused specifically on methanol or e-methanol in Côte d'Ivoire and Senegal, creating a gap that this thesis aims to fill. Then, some literature emphasises the strategic potential of methanol as a transition fuel, particularly in terms of its energy density, storage capacity and compatibility with existing infrastructures. (Methanol Institute, 2022). E-methanol is positioned as a pillar of the carbon neutrality strategy, depending on abundant and cheap renewable electricity as well as the capture of biogenic or industrial CO_2 (Wang et al., 2021). The methods used to assess potential partners are often based on multi-criteria approaches (MCDA), such as the Analytic Hierarchy Process (AHP), which takes into account various factors: technological capabilities, financial stability, sector experience, CSR commitment, etc. (Govindan et al., 2013; Saaty, 1980; San Cristóbal, 2011)

5. Empirical Review

This empirical review synthesises recent evidence (international reports, regional studies, company press releases, and port data) useful for assessing the feasibility and identifying potential partners for an e-methanol project in Côte d'Ivoire and Senegal. It focuses on four empirical pillars: availability and cost of renewable electricity; bankable CO_2 sources (industrial and biogenic); logistical and port capacities for export / bunkering; regulatory framework and market access (RFNBO certification). The following brings together the evidence observed and its interpretation for building a business case and selecting partners.

5.1. Empirical studies on the production and economic viability of e-methanol

The empirical review in this research draws on a range of technical, institutional, and sectoral sources to assess the feasibility of an e-methanol project in West Africa, particularly in Côte d'Ivoire and Senegal. The technical and economic parameters and production routes are documented in the Innovation Outlook: Renewable Methanol. (IRENA & Methanol Institute, 2021), while the H2 ATLAS-AFRICA project is highlighting the region's potential for green hydrogen (H2Atlas-Africa, 2025) and the policy framework adopted by ECOWAS (2023) (ECREEE ECOWAS, 2023). The EU Delegated Regulations (2023/1184 & 2023/1185) form the regulatory basis for RFNBO compliance (LEYEN, 2023), imposing strict additionality and temporal correlation requirements. In terms of energy, Senegal has a solid wind energy base with the Taïba N'Diaye farm (158 MW, Mainstream Renewable Power) and emerging solar initiatives, while Côte d'Ivoire has a mix dominated by hydro and gas, supplemented by utility-scale solar projects (LSD Senegal, 2023 ; (IRENA, 2022a), allowing new capacity to be contracted to supply the electrolysers. With regard to sources of CO_2, cement plants such as SOCOCIM (IFC, 2025) and CIMAF/Holcim CI in Côte d'Ivoire are concentrated industrial emitters (MEDDTE, 2022), while Compagnie Sucrière Sénégalaise (CSS) is already supplying pure biogenic CO_2 from fermentation, offering a bankable option for an initial production phase (CSS, 2025). Direct air capture (DAC) options are identified as long-term prospects but are not a priority (IRENA & methanol institute, 2021). On the logistics side, the ports of Abidjan (about 40 Mt, 1.6 M TEU in 2024, Ecofin agency (2025) and Dakar/Ndayane (issuu, 2025) offer modern export and maritime bunkering capabilities, making these hubs even more attractive. Lastly, local partnerships can rely on industrial players (SOCOCIM, CSS, CIMAF, Holcim CI), energy players (Taïba N'Diaye, SIR, Baleine/ENI-Vitol (eni, 2025)) and financial players (IFC, World Bank, ECREEE/ECOWAS), whose announcements and projects confirm the strategic interest in Power-to-X solutions and industrial decarbonisation. This empirical evidence shows that the combination of competitive renewable resources, stable CO_2 sources and high-performance port infrastructure, under a favourable regional and European regulatory framework, is creating fertile ground for the emergence of e-methanol projects in Côte d'Ivoire and Senegal.

5.2. Empirical studies on the renewable potential and export of e-fuels in Africa

Some studies, such as that by Agora Energiewende (2019), have used energy simulation models to estimate the potential for producing and exporting e-fuels from Africa to Europe. By combining climate data, land availability, and market access, their results show that West Africa, although less analyzed, has areas with high solar and biomass potential, particularly in Senegal, Mali, and Côte d'Ivoire. However, few investments have been made to date due to a lack of industrial structuring and commercial partnerships. Similar empirical research carried out by (Vaidya & Kumar, 2006) in the Indian renewable energy sector demonstrated that the AHP method combined with a sector database can identify compatible industrial partners according to a weighted ranking. To date, very few empirical studies have been published on e-methanol production in West African countries. However, secondary data from ANER (Senegal) and CI-ENERGIES (Côte d'Ivoire) provide information on: the national energy mix, green hydrogen production projects, CO_2 storage capacities, and local companies active in energy, chemicals or fuels. Public databases (e.g. company registers, energy ministry reports) can be used to construct an empirical typology of potential partners for an e-methanol project, based on criteria such as size, sector, project experience, or openness to innovation.

5.3. Methodological approaches to evaluating industrial partners

This part will show some methodologies to perform partner assessment for renewable energy projects. A variety of multi-criteria decision-making (MCDM) methodologies have been employed in the assessment of renewable energy projects and partner selection, each with its own strengths in handling complex decision contexts. For instance, PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) has been applied in project management by San Cristóbal (2011) within a fuzzy multi-criteria framework to identify the critical path of project networks. Unlike traditional scheduling methods focused only on time, PROMETHEE enabled the simultaneous consideration of multiple conflicting factors such as cost, quality, safety, and schedule. The study highlighted its effectiveness in prioritizing project activities under uncertainty, providing a more holistic basis for decision-making. Similarly, VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) has been used in renewable energy technology evaluation. For example, Gupta et al., (2023) applied it to the selection of renewable energy sources (Renewable Energy Technologies) in under developing country, Opricovic and Tzeng (2004) also applied the VIKOR approach to evaluate hydropower development alternatives in Serbia, showing how the method supports compromise solutions in cases of conflicting criteria, thus offering decision-makers flexible trade-offs between economic, social, and environmental objectives. Another widely used tool is TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), which was adopted by Madanchian and Taherdoost (2023) in the evaluation of sustainable project management practices. Their study demonstrated how TOPSIS ranks alternatives based on proximity to an “ideal solution” and distance from a “negative-ideal” solution, thus identifying optimal strategies for sustainability by integrating multiple weighted criteria into a normalized decision space. These methods demonstrate the robustness of MCDM tools in structuring decision problems in the energy and infrastructure sectors. However, compared to these techniques, the Analytic Hierarchy Process (AHP), developed by Saaty (1980), has proven particularly suitable for partner and project evaluation due to its ability to decompose complex decision-making problems into hierarchical structures and pairwise comparisons. AHP has been extensively used in renewable energy studies: for instance, Kahraman et al., (2009) applied AHP in Turkey to evaluate renewable energy alternatives, finding that it provides clear prioritization among alternatives by combining both qualitative and quantitative judgments. In the African context, AHP has been used to assess energy policy and infrastructure investment, showing its adaptability to data-scarce and uncertain environments (Mota et al., 2015). AHP (Analytic Hierarchy Process) hierarchical ranking of criteria with pairwise comparisons to obtain weights (Saaty, 1980). This method is widely used in studies to select partners, make investments, or locate industrial projects. It integrates qualitative and quantitative criteria according to a weighted hierarchy of preferences (Vaidya & Kumar, 2006). Particularly, it is well-suited for assessing potential partners in the fuel value chain of an e-methanol project due to its structured, transparent, and rigorous approach to decision-making. It also allows for the hierarchical decomposition of the problem, starting from the overall objective (partner selection) down to specific criteria and sub-criteria, making complex evaluations more manageable. Through pairwise comparisons, AHP captures both qualitative and quantitative factors, which is essential when evaluating diverse aspects such as technical expertise, financial stability, environmental compliance, and strategic alignment. Moreover, AHP incorporates a consistency check to validate the reliability of expert judgments, ensuring more objective outcomes. This is particularly important in multi-stakeholder energy projects, where partner selection can significantly impact long-term success. By supporting structured group decision-making and integrating expert opinion with measurable data, AHP offers a robust and comprehensive framework for selecting the most suitable partners in the green fuel sector. Given the focus of this research on the assessment of potential partners for e-methanol project implementation in West Africa, AHP emerges as the most relevant methodology. It allows the incorporation of expert judgments on diverse criteria such as financial capacity, technological expertise, regulatory alignment, and sustainability commitments, while maintaining transparency and consistency in the ranking process. This makes it particularly suitable for capturing the multidimensional nature of partner assessment in Côte d’Ivoire and Senegal, where both institutional and industrial actors play pivotal roles in shaping the success of future e-methanol projects.

Synthesizes existing research on climate policies, energy infrastructure, and the e-methanol production process. It also reviews methodologies for partner assessment in energy projects. The literature shows a clear gap in applying multi-criteria decision-making tools like AHP for evaluating partnerships in green fuel chains. This gap justifies the study's approach and establishes the need for a context-specific evaluation framework for Côte d’Ivoire and Senegal.

Chapter 2: Methodology

The methodological framework of this study is based on the Analytical Hierarchy Process (AHP), a multi-criteria decision-making (MCDM) technique developed by Saaty (1980). AHP is particularly suitable for complex decision contexts such as the assessment of potential partners for e-methanol project implementation, where multiple and often conflicting economic, technical, environmental, institutional, and social factors must be considered simultaneously. The strength of AHP lies in its structured hierarchy of decision criteria, pairwise comparison approach, and capacity to integrate both quantitative and qualitative judgments. This enables the evaluation and prioritization of potential partners transparently and consistently. Furthermore, AHP provides a measure of consistency in decision-makers' judgments, ensuring reliability in the outcomes. Given the strategic importance of selecting the right partners for renewable energy projects in West Africa, specifically in Côte d'Ivoire and Senegal, AHP offers a robust and systematic tool to rank and identify the most suitable partners to support the prospective e-methanol value chain.

1. Analytic Hierarchy Process (AHP)

In the following section, we will show the structure of our design, then Pairwise of the criteria, and finally, we will determine the score of the sub-criteria.

1.1. Structure the hierarchy

The AHP method will be used to evaluate potential partners in the value chain, and this will be done as follows. It should be noted that at the end of the process, it is the points (Weight* score) in percentage that will be used to evaluate our potential partners.
The method begins with the definition of the project, in our case, the e-methanol project, then the criteria are defined, and from each criterion, we will establish the sub-criteria for carrying out our evaluation. In the process, the following criteria are defined: sustainability, value chain synergy (VCs), technical capacity (Tc), regulatory & local integration (R & LI), and economic & financial viability (Ec & Fv). According to Ezbakhe and Pérez-Foguet (2021), the weight of each criterion is determined. Determining the weights means making a comparison of the criteria according to the principle of (Saaty, 1987). Then the score of each sub-criterion is determined by comparing the sub-criteria of each criterion. Finally, the weights and scores are evaluated to obtain the points for each company in the value chain.

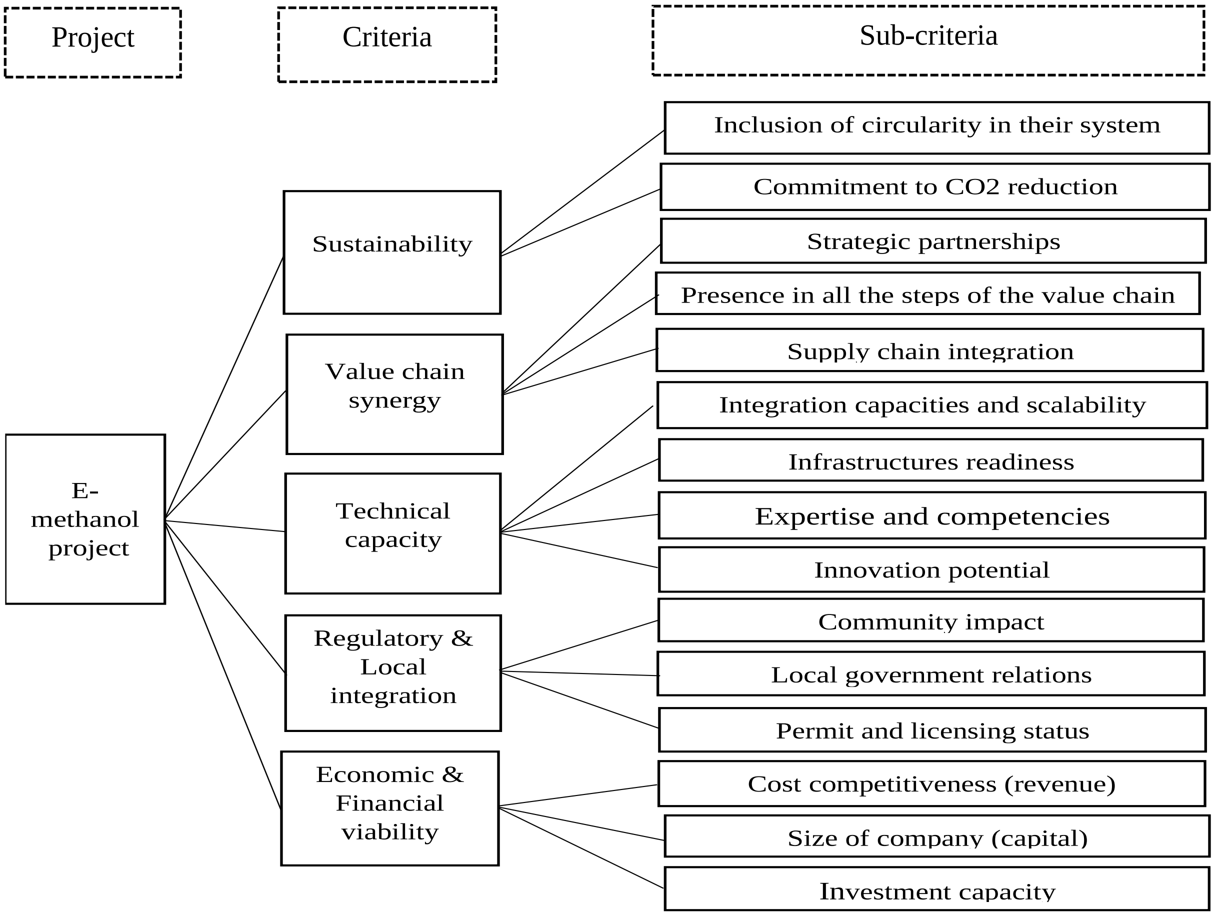

Figure 1: Criteria and sub-criteria of e-methanol project partner assessment

Source: Author

Having identified the criteria and sub-criteria (Figure 1), we will describe the components of each criterion and define the objective assigned to each sub-criterion in our work. The criteria used in our research have been employed to select a suitable renewable energy source in Turkey as a method (Ezbakhe & Pérez-Foguet, 2021). Osorio-Tejada et al., (2017), used economic, environmental, and social criteria also in their sub-criteria; they used the indicator as sustainability, regulatory, and technical capacity to find the suitable alternative fuels based on the maturity of the technologies for each application, such as electricity, compressed natural gas (CNG) and hydrogen, for urban use vehicles and liquefied natural gas (LNG) for long-haul transport in their energy production.

- **Explanation of each sub-criterion**

Table 1 below describes the criteria and sub-criteria used in this study and their explanation, and it also provides references to justify their selection.

Table 1: The content of each criterion and the meaning of each sub-criterion

Criterion	Sub-criterion	Explanation	References
Economic & financial viability	Investment capacity	Ability to finance their project (debt/equity financing)	(Mastrocinque et al., 2020)
	Size of company (Capital)	Indicates financial stability	
	Cost competitiveness	Determines profitability and market viability	
Criterion	Sub-criterion	Explanation	References
Regulatory & Local integration	Permit and licensing status	Formal approvals (environmental, construction, operational licenses)	(Akusta et al., 2024)
	Local government relations	Partnerships with municipal/regional authorities	
	Community impact	Benefits (jobs, welfare on the community) vs. disruptions (land use, pollution)	
Technical capacity	Innovation potential	R&D capability to improve processes or reduce costs.	(Mangla et al., 2015)
	Expertise and competencies	Technical skills in mastering fuel production processes	
	Infrastructure's readiness	Existing physical assets (production plants, storage, logistics)	
	Integration capacities and scalability	Ability to connect with renewable energy grids and scale production	
Value chain synergy	Supply chain integration	Coordination between raw material suppliers, production facilities, and distributors.	(Foong & Denny, 2022)
	Presence in all the steps of the value chain	Partner's ownership/control over feedstock, production, and distribution	
	Strategic partnerships	Alliances with tech providers, off-takers, or governments	
Sustainability	Commitment to CO_2 reduction	Measures how aggressively a partner contribution of greenhouse gas (GHG) emissions reduction	(NewClimate, 2024)
	Inclusion of circularity in their system	Extent to which a partner minimizes waste and reuses resources (e.g., recycling water, byproducts).	

Source: Author

The table bove shows the sub-criterion content in each criterion and the meaning or goal of each sub-criterion to assess our partners across the value chain. The importance of each criterion on the others has been determined based on the document associated.

1.2. Pairwise of the criteria

The Pairwise of the criteria consists of evaluating each criterion or sub-criterion in relation to the other based on their importance in our work. We will use Saaty's (1980) principle to perform it.

To evaluate the relative importance of these criteria, based on Table 2, we determine the level of importance of each criterion over the other. These elements, a_{ij} may be regarded as an estimate of the ratio $a_{ij} = \frac{W_i}{W_j}$ here, a_{ii} is the intensity of importance, W_i and W_j are the weights of each other, and W_i is important than W_j, for all decision elements. While W_j is important than W_j, which is their reciprocal, $a_{ji} = \frac{1}{a_{ij}}$

Table 2: Scales of Pairwise Comparisons

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two criteria contribute equally to the objective
3	Moderate Importance of one over another	Experience and judgment slightly favor one criterion over another
5	Essential or Strong Importance	Experience and judgment strongly favor one criterion over another
7	Very Strong or demonstrated Importance	A criterion is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme Importance	The evidence favoring one criterion over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the adjacent scale values (when a compromise is needed)	
Reciprocals	If criterion i has one of the above numbers assigned to it when compared with criterion j, then j has the reciprocal value when compared with i	

Source: Adapted from Saaty (1980)

Table 2 represents the Saaty scale of relative importance, which is the foundation of the Analytic Hierarchy Process (AHP). It provides a systematic way to compare criteria in pairs and assign numerical values to their relative importance. The scale ranges from 1 (equal importance) to 9 (extreme importance), with intermediate values (2, 4, 6, 8) allowing for compromise. The judgments are based on expert experience and reasoning: for example, if one criterion is strongly more important than another, it is given a value of 5. The concept of reciprocals ensures consistency. If criterion i is rated 5 times more important than criterion j, then j is automatically 1/5 as important as i. This scale allows subjective judgments to be quantified and structured, enabling the ranking of criteria in decision-making.

1.3. weight of the criteria

Based on the importance of the criteria, Tables 1 and 2, pairwise of the criteria are established in Table 3:

Table 3: Pairwise of the criteria

	Ec & Fv	**R & Li**	**Tc**	**VCs**	**Sust**
Ec & Fv	1	2	2	3	2
R & Li	1/2	1	1/2	4	1
Tc	1/2	2	1	3	2
VCs	1/3	1/4	1/3	1	1/3
Sust	1/2	1	1/2	3	1

Source: Author

With Ec & Fv: Economic and financial viability; R & Li: Regulatory and local integration; Tc: Technical capacity; VCs: Value chain synergy; Sust: Sustainability.

After establishing the pairwise comparisons of the criteria, the consistency ratio is determined to be CR = 0.0564 through Excel software (the details are in Appendix 1) using the formula CR $\frac{CI}{RI}$; *CI*= $\frac{\lambda max-n}{n-1}$. where *RI*: Random Inconsistency (index), CI: Consistency Index (determined through Excel software), and n: number of criteria.

This value means that the matrix A is consistence and could be used for calculation. (a CR of 0.10 or less (for n ≥ 5); for n = 2, CR= 0) According to Saaty (1980).

while the pairwise established is consistence, the square matrix A = {a_{ij}}is determined.

$$A = \begin{bmatrix} 1 & 2 & 2 & 3 & 2 \\ 1/2 & 1 & 1/2 & 4 & 1 \\ 1/2 & 2 & 1 & 3 & 2 \\ 1/3 & 1/4 & 1/3 & 1 & 1/3 \\ 1/2 & 1 & 1/2 & 3 & 1 \end{bmatrix}$$

From Table 3, the matrix A is extracted, using the matrix calculator on the website (Matrix Reshish, 2025), the matrix square of A is determined, and then Excel is used to obtain the row total and weight. (The formula for determining the total row and weights is in the appendix of the document). Repeating this exercise several times in a row and observing the approximately constant variation in the weight value ensures that the weights determined are correct and found 3 digits after the decimal point. In this study, we stopped at 3 times, which is $A^{8,}$ and the result is in Table 3.

Table 4: Weights of criteria

	Ec & Fv	R & Li	Tc	VCs	Sust	Row total	Weight
Ec & Fv	104548	194998	138060	506576	203148	1147330	0.335
R & Li	55262.2	103074	72976.2	267769	107382	606463	0.177
Tc	79170.1	147665	104548	383610	153837	868831	0.254
VCs	22025.8	41081.8	29085.9	106725	42798.8	241717	0.071
Sust	51009.8	95142	67360.7	247164	99118.6	559795	0.163
					Sum =	3424135	1

Source : Author

As explained in the previous paragraph, we stopped where we had three figures after la virgule, we obtained the most important criterion is “Financial viability” with 33.5%, followed by “Technical capacity” with 25,4% and then “regulatory and local integration” with 17.7% and “Sustainability” with 16.3%, the least importance “Value chain synergy” with 7,1. All these values are in line with the work of (Ijadi Maghsoodi et al., 2018)

1.4. Sub-criteria

For the sub-criteria, we compared the sub-criteria of each criterion with each other on the basis of the scientific documents in Table 1. The pairwise are established, using the table of pairwise, we determine the consistency ratio, and through Excel software, we determine the square of the matrix obtained. By analogy with the weight of the criteria, we obtained the scores for each sub-criterion.

1.4.1. Economic and financial viability

Tableau 5: Economic & financial viability score (CR= 0.062)

	cost comp.	Inv. cap	Size comp.	Row total	Score
Cost comp.	3	7.667	19	29.667	0.640
Inv. cap	1.267	3	7.667	11.933	0.257
Size comp.	0.511	1.267	3	4.778	0.103
			Sum	46.37778	1

Source : Author

With Cost comp.: Cost competitiveness; Inv. Cap: Investment capacity; Size comp.: Size: Size of company (Capital).

For the economic and financial viability criterion, the scores obtained for the sub-criteria are as follows: cost competitiveness about 64%, investment capacity about 25.7% and size of company (capital) about 10.3%. This matches with (Mastrocinque et al., 2020).

1.4.2. Regulatory and Local integration

Tableau 6: Regulatory & Local integration score (CR= 0.005)

	Permit lic.	Com. Imp.	Local gov. rel.	Row total	Score
Permit lic.	3	16	5.667	24.667	0.582
Com. Imp.	0.567	3	1.067	4.633	0.109
Local gov. rel.	1.6	8.5	3	13.1	0.309
			sum	42.4	1

Source : Author

With Permit lic.: Permit and licensing status; Comp. Imp.: Community impact;

Local gov. rel.: Local: Local government relations

For the regulatory and local integration criterion, the scores obtained for the sub-criteria are as follows: permit and licensing status about 58.2%, local government relations about 30.9% and community impact about 10.9%. Which matches with (Akusta et al., 2024).

1.4.3. Technical capacity

Tableau 7: Technical capacity score (CR= 0.008)

	Infra. Read.	Exp. & Comp.	Inov. Pot.	Int. Cap. & Scal	Row total	**Score**
Infra. Read.	4	7.167	12.5	22	45.667	0.483
Exp. & Comp.	2.267	4	7	12.5	25.767	0.272
Inov. Pot.	1.317	2.333	4	7.167	14.817	0.157
Int. Cap. & Scal	0.733	1.317	2.267	4	8.316	0.088
				Sum	94.567	1

Source: Author

With Infra Read: Infrastructure’s readiness; Exp. & Comp.: Expertise and competencies; Inov. Pot: Innovation potential; Int. cap & Scal.: Integration capacities and scalability

For the technical capacity criterion, the scores obtained for the sub-criteria are as follows: infrastructure’s readiness about 48.3%, expertise and competencies about 27.2%, innovation potential about 15.7% and integration capacities and scalability about 10.9%. Which matches with (Mangla et al., 2015).

1.4.4. Value chain synergy

Tableau 8: Value chain synergy score (CR = 0.026)

	Strategic partner	Supply chain	Pres. in value chain	Row total	**score**
Strategic partner	3	5.333	14	22.333	**0.559**
Supply chain	1.75	3	8	12.75	**0.320**
Pres. in value chain	0.667	1.167	3	4.833	**0.121**

		Sum	39.917	1

Source: Author

Pres. In the value chain: presence in all the steps of the value chain.
For the value chain synergy criterion, the scores obtained for the sub-criteria are as follows: strategic partner about 55.9%, supply chain about 32% and presence in all the steps of the value chain about 12.1%. Which matches with (Foong & Denny, 2022)

1.4.5. Sustainability

Tableau 9: Sustainability Score (CR= 0)

	CO_2 Reduction	Circularity	Row total	score
CO_2 Reduction	2	6	8	0.75
Circularity	0.667	2	2.667	0.25
		Sum	10.667	1

Source: Author

For the sustainability criterion, the scores obtained for the sub-criteria are such as, CO_2 reduction about 75% and circularity about 25%. Which match with (NewClimate, 2024)

Once the weight of criteria and sub-criteria scores have been established, we will go on to explore the potential value chain across Côte d'Ivoire and Senegal, which we will use to identify and rank the partners who can contribute to the development of our e-methanol project in this value chain.

2. Value chain of energy and fuel sector for a prospective e-methanol project in Côte d'Ivoire and Senegal

The establishment of a potential e-methanol value chain in Côte d'Ivoire and Senegal requires the integration of key stakeholders across the entire energy ecosystem, from regulation and production to storage, transport, and fuel distribution. Côte d'Ivoire and Senegal already host strong regulatory bodies, industrial emitters of CO_2, utilities developing renewable energies for green hydrogen, as well as established refining, storage, and distribution infrastructures. These assets provide a strategic foundation upon which the e-methanol industry can emerge, leveraging existing synergies while opening pathways for regional deployment.

The subsequent section will encompass the following elements: an examination of the energy landscape, a delineation of the roles of companies to be considered within each segment of the value chain in Côte d'Ivoire and Senegal, and the data that will be utilised for the partner assessment.

- **Data collection and AHP application**

As part of this research, we collected from reliable and institutional sources. We used official reports from the Ministries of Energy, Petroleum, Hydrocarbons, Mines, and the State Portfolio. We also used data from national energy regulation and management bodies, such as ANARE, CI-Énergies, and CIE in Côte d'Ivoire, and ANER, Senelec, and SAR in Senegal. In addition, we consulted the official websites and annual reports of companies operating in the fuel value chain, as well as the publications of regional and international organisations active in West Africa. Taken together, these sources provided a robust and relevant database to support the analysis in this dissertation. The data of each company is analyzed based on the criteria and sub-criteria established in section 1.1 of chapter 2, where the company got the criteria or sub-criteria, the weight or score is attributed. At the end, we applied the formula: $\sum$weight * score for each company; these results are used to make the diagram through Excel software.

2.1. Côte d'Ivoire

Côte d'Ivoire, located in West Africa, is a country with significant renewable energy potential that can effectively support the development of a project to produce e-methanol, a synthetic fuel produced from green hydrogen and captured CO_2 (Giz, 2025; Oyewo et al., 2024). The country benefits from abundant hydroelectric resources, already accounting for nearly 30% of its energy mix (ANARE, 2023), as well as average sunshine levels of 4 to 6 kWh/m²/day, favourable to photovoltaic solar power (Global Solar Atlas, 2025a; IRENA, 2022b). In addition, Côte d'Ivoire has strong biomass potential from agricultural residues, particularly cocoa, oil palm, cotton, and rubber, which can contribute to the production of biogenic CO_2 essential for the synthesis of e-methanol (FAO, 2023). By integrating these resources with Power-to-X technologies, the country could not only decarbonise its industrial and energy sectors, but also position itself as a future regional hub for synthetic fuels. This potential is supported by the political will expressed in the National Development Plan (PND, 2021), which aims to accelerate the energy transition.

2.2. Senegal

Senegal, at the western tip of Africa, has exceptional renewable energy potential, making it an ideal location for developing an e-methanol project. The country enjoys excellent sunshine, with average solar irradiation of between 4.2 and 6 kWh/m²/day, making it possible to develop photovoltaic solar energy on a massive scale (Global Solar Atlas, 2025b; IRENA, 2022b). Around 49% of installed renewable capacity is solar, and power stations such as Kahone, Kael, and Diass (23 MW) have already been commissioned (Ndiaye et al., 2025). Senegal has also built its first large-scale wind farm, the Taiba N'Diaye plant (158.7 MW), which accounts for almost 15% of the country's electricity (LSD, 2023). In addition, hydroelectricity, via the Manantali dam and the OMVS infrastructure, already contributes to production and could be exploited to a greater extent (ITA, 2025). Lastly, the country has biomass potential, thanks to agricultural residues, which can supply the biogenic CO_2 needed to synthesise e methanol (Pastori et al., 2021). These assets bring Senegal into line with the energy roadmap aimed at achieving around 24% renewable energy by 2030 (IEA, 2023a), through public-private partnerships (such as Scaling Solar) and international financing initiatives (JETP).

Or value chain methodology will be developed around the elements illustrated in the figure below.

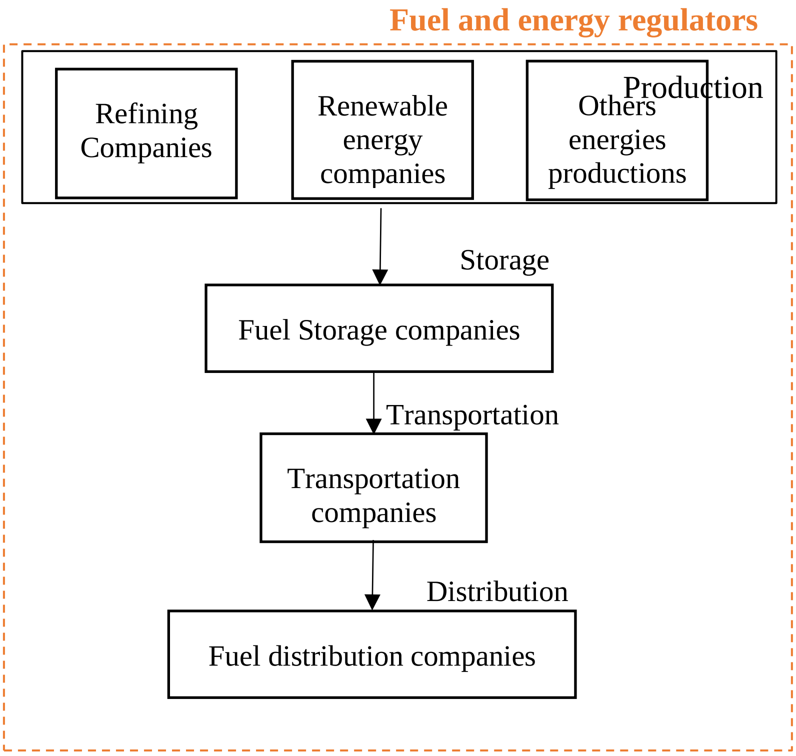

Figure 2: Value chain system boundaries

Source: Author

2.3. Definition and role of different value chain steps in Côte d'Ivoire and in Senegal

2.3.1. fuel and energy regulators

Regulators are institutions or bodies, whether governmental, public, private, national, or international, whose main mission is to supervise, monitor, and guarantee the proper operation of the strategic energy, mining, and hydrocarbons sectors. They ensure that activities in these sectors comply with the law, are fair, transparent, and technically reliable, while protecting the interests of the State, investors, and consumers. The role of regulators also includes setting technical standards, approving tariffs, managing licences, regulating markets, and sometimes resolving disputes. Their intervention is essential to ensure sustainable and balanced governance, particularly in the context of the energy transition or sensitive projects such as e-methanol production (ANARE, 2023).

2.3.2. Potential e-methanol producers

Potential e-methanol producers are industrial players active in the energy value chain, particularly in the fields of refining, renewable, thermal, or fossil fuel energy production and fuel distribution. In the case of Côte d'Ivoire and Senegal, these are companies already established in the oil, gas, and biofuels sectors, as well as electricity producers able to supply the energy needed for the electrolysis process. Their experience, industrial capacity, and existing infrastructure make them suitable candidates for developing or integrating projects to produce e-methanol, a low-carbon synthetic fuel.

2.3.3. Storage

Storage companies are structures specializing in fuel storing, conservation, and logistical management of liquid and gaseous energy products, such as crude oil, petrol, diesel, butane gas, and refined hydrocarbons. In Côte d'Ivoire and Senegal, these companies play a strategic role in energy security, building up security stocks, stabilizing supplies, and transferring products to end distributors. Their technical expertise, existing storage capacity, and infrastructure (depots, terminals, pipelines) make them key players to consider for any e-methanol production, packaging, or distribution project, which requires facilities that are compatible with liquid fuels.

2.3.4. Transport

Transport companies are those that physically transport oil and gas products, such as heating oil, gas, fuel, or petrol, within countries or between ports, industrial, and consumer areas. In Côte d'Ivoire and Senegal, these companies operate through various logistics modes: tanker trucks, rail wagons, river barges, or ships. Their role is essential in guaranteeing the continuous availability of energy products throughout the country, while complying with safety and quality standards. Their expertise in energy logistics positions them as potential partners for the future distribution of e-methanol, which, as a liquid fuel, will require appropriate and proven transport infrastructures.

2.3.5. Distribution

Distribution companies are those responsible for transporting and marketing finished oil and gas products such as fuel oil, petrol, diesel, and gas to end users throughout the country, whether in urban, industrial, or rural areas. In Côte d'Ivoire and Senegal, these companies generally have a structured network of service stations and sales outlets, and sometimes a direct delivery service for industrial or institutional customers. They play a central role in the energy supply chain, ensuring that fuel is always available on the national market. Thanks to their logistical, commercial, and regulatory capabilities, these companies could be key players in the future distribution of e-methanol.

In light of all the elements analyzed, it emerges that the e-methanol production project can rely on an ecosystem of diversified partners, intervening at different levels of the value chain, from production to distribution. However, it should be noted that the AHP (Analytic Hierarchy Process) method, used for the multi-criteria evaluation of potential partners, will not be applied to the regulatory bodies, insofar as each of these bodies performs specific standard-setting or control functions, without a competitive vocation. On the other hand, the AHP method will be used in full to analyze and rank the partners involved in the production, storage, transportation, and distribution segments, where the criteria of performance, capacity, and strategic compatibility are decisive for the success of the project.

Chapter 3: Results and discussion

This chapter presents the results of the analysis carried out as part of the evaluation of the e-methanol production project. It is organized into three main points. Firstly, the potential partners involved at the various stages of the value chain, including production, transport, storage, and distribution, are identified. These potential partners will then be ranked at each point in the value chain according to their weight (weight * score), to gain a better understanding of their potential contribution to the implementation of the project. Finally, strategic recommendations are formulated to strengthen the technical, institutional, and economic feasibility of the project, taking into account the opportunities and constraints identified in the Ivorian and Senegalese contexts.

1. Identification of partners

The identification of potential partners across Côte d'Ivoire and Senegal is a critical step in assessing the feasibility of developing an e-methanol value chain. Given the complexity of this sector, partners must be considered along the entire chain, from regulators and policymakers to industrial producers, storage and transportation companies, and distribution actors already active in the fuel and energy markets. Assessing these potential partners provides both an overview of existing capacities and a foundation for evaluating synergies, collaboration opportunities, and institutional readiness to support the deployment of e-methanol projects in the region.

1.1. Côte d’Ivoire value chain

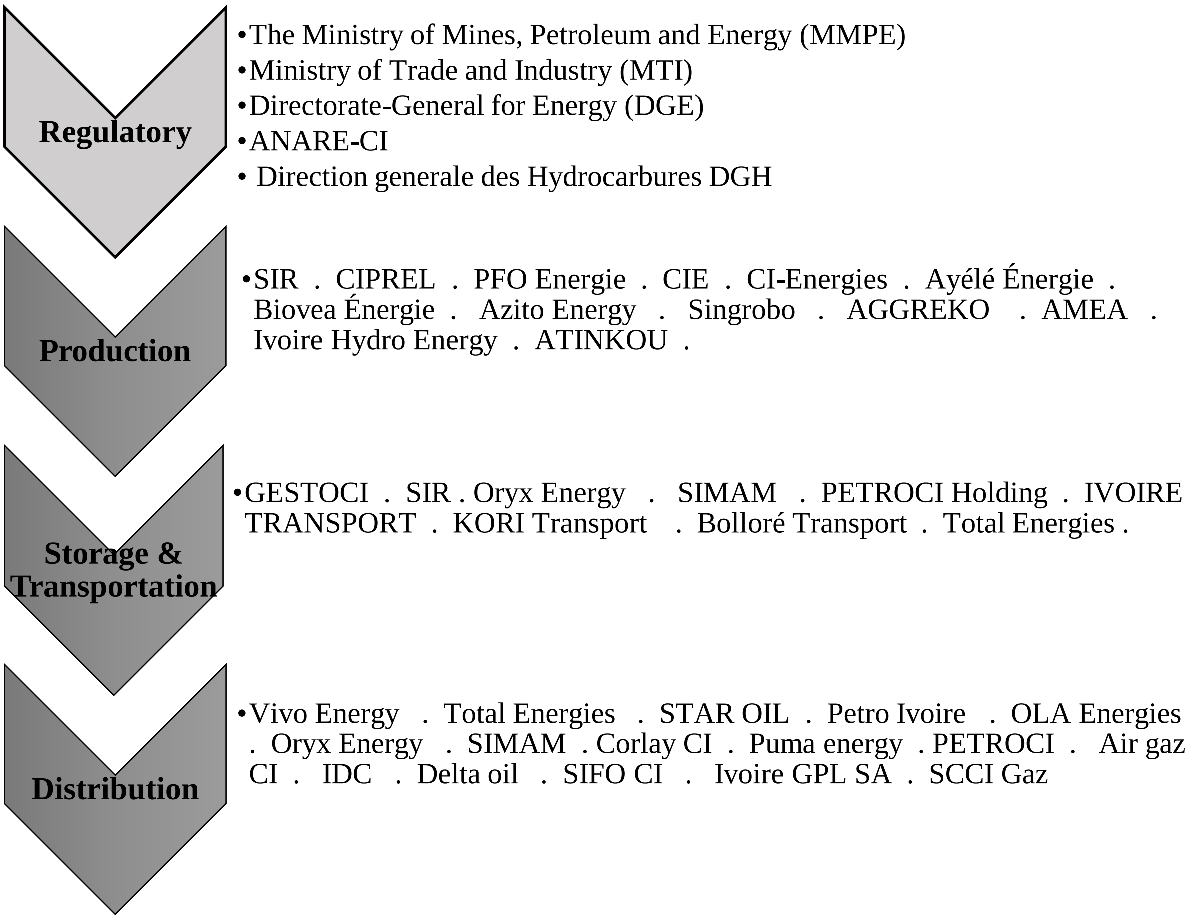

Figure 3: Potentiel value chain in Côte d'Ivoire

Source: Author using data from (ANARE, 2023; MCI CI, 2021)

The Côte d'Ivoire value chain highlights four key points as follows: energy and fuel sector regulators, potential companies whose energy production sources could support an e-methanol project, fuel oil storage and transport already existing in Côte d’Ivoire. There is a diversity of public and private partners involved at every level. The regulatory level is dominated by bodies such as ANARE-CI and the Ministry of Mines, Petroleum and Energy, Ministry of Trade and Industry, which also plays a decisive role by ensuring safety standards, import quotas, and incentives for alternative fuels (ANARE, 2023). On the production side, companies such as CI-Energies, CIE, SIR, CIPREL, AGGREKO, and international partners (e.g., AGGREKO, KARPOWERSHIP) play a central role in exploration, natural gas, biodiesel, and other cleaner fuels (Aggreko, 2025a), and heavy fuel oil (HFO), diesel, and natural gas exploring RNG (Cirolia et al., 2025). For storage and transport, we have GESTOCI, SIR, Oryx Energy, SIMAM, and PETRCI Holding, to ensure a high level of logistical reliability, and for distribution, we have Total Energies, Vivo Energy, Air gaz CI, SIFO CI, Puma Energy, Oryx Energies, PETROCI, Corlay CI, Ivoire GPL SA, OLA Energies, IDC, and SCCIZ to ensure distribution throughout the country (MCI CI, 2021)(MEPM, 2023a). This entire chain is crucial to the successful integration of e-methanol, which is a synthetic fuel made from CO_2 and green hydrogen (Sillman et al., 2025b). On the regulatory front, Côte d'Ivoire has a structured framework capable of facilitating the introduction of new fuels, provided that existing standards are adapted to incorporate the specific features of e-methanol (carbon emissions, safety, taxation) (DGPE CI, 2023; ANARE, 2023). The production segment is already well occupied by experienced players such as SIR in refining (DGPE CI, 2023), who can extend their skills to the synthesis of low-carbon fuels. Logistics, meanwhile, show satisfactory storage and transport capacity, supported by solid local companies. Lastly, the distribution network is crucial to ensuring that e-methanol is distributed quickly and safely throughout the country, and even exported.

These preview results about the Côte d'Ivoire value chain show that Senegal has an energy infrastructure that is conducive to the development of an e-methanol project. The successful players identified in each link (CI-Energies, CIE, GESTOCI, Vivo Energy, Puma Energy, etc.) should be consulted as a matter of priority and integrated into the implementation of the project. Their expertise and network will make it possible to secure logistics flows and guarantee a quality of service in line with international standards. At the same time, a support strategy will need to be put in place for operators, through capacity-building mechanisms, technical partnerships, or incentives for modernisation. Finally, it will be essential to adapt the regulatory framework to recognise e-methanol as an alternative fuel, with clear rules on its production, transport, taxation, and distribution. Integrated public-private governance will be essential to ensure the sustainable success of the project and its alignment with the country's climate and energy objectives

1.2. Senegal value chain

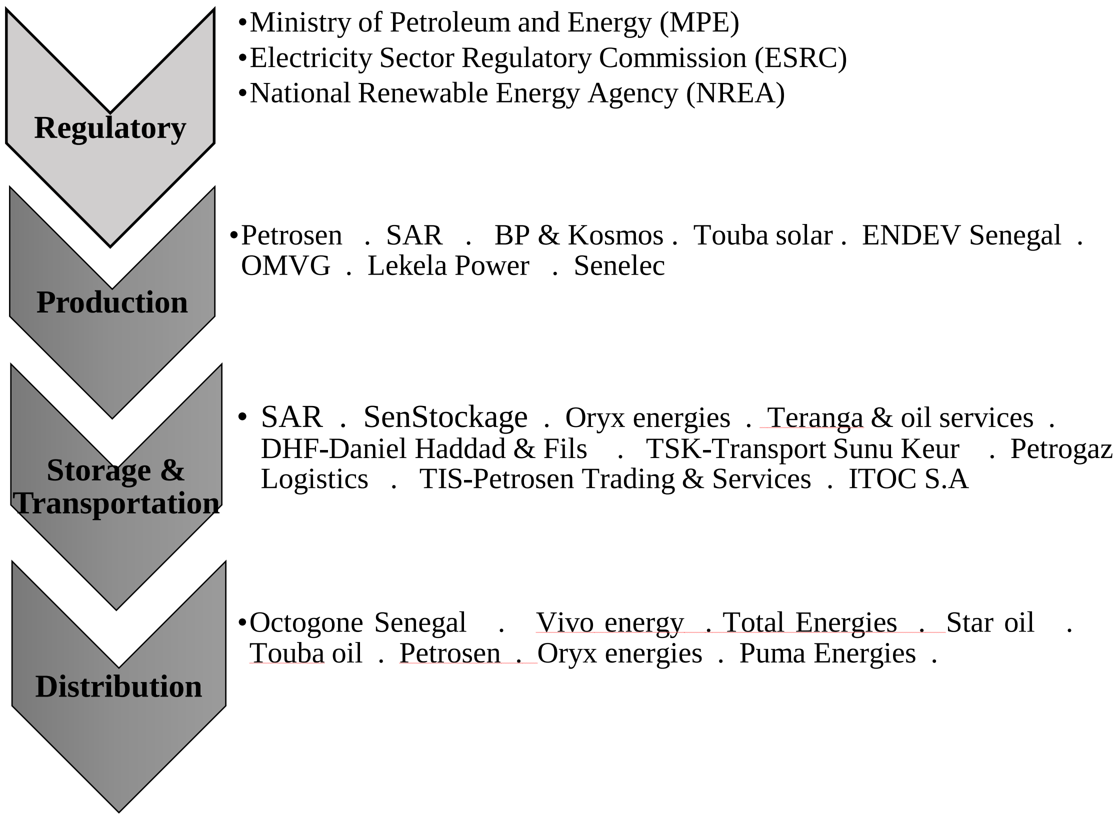

Figure 4 : Potential value chain in Senegal

Source: Author using data from (MEPM, 2021, 2022, 2023b; IEA, 2023a)

Figure 4 illustrates the value chain of the energy, oil, and hydrocarbons sector in Senegal. This segment contains: regulators, potential producers, storage agents, and the usual fuel transporters and distributors. There is a diversity of public and private partners involved at every level. At the regulatory level, we have institutions such as the Ministry of Petroleum and Energy, the Electricity Regulatory Commission (ESRC), and the National Renewable Energy Agency (NREA), which structure and oversee the sector's policies. On the production side, companies such as Petrosen, SAR, and international partners (e.g., BP, Woodside) play a central role in exploration, refining, and processing (IEA, 2023a). For storage and transport, we have TIS-Petrosen, PTL, TSK Transport Sunu Keur, DHF-Daniel Haddad & Fils, and ITOC S.A., to ensure a high level of logistical reliability, and for distribution, we have Total Energies, Vivo Energy, Petrosen, Puma Energy, Oryx Energies, and Octogone Sénégal Touba oil to ensure distribution throughout the country (MEPM, 2023a). This entire chain is crucial to the successful integration of e-methanol, which is a synthetic fuel made from CO_2 and green hydrogen (Sillman et al., 2025b). On the regulatory front, Senegal has a structured framework capable of facilitating the introduction of new fuels, provided that existing standards are adapted to incorporate the specific features of e-methanol (carbon emissions, safety, taxation) (DGPPE, 2025). The production segment is already well occupied by experienced players such as Petrosen and SAR in refining. (MEPM, 2023a), who can extend their skills to the synthesis of low-carbon fuels. Logistics, meanwhile, show satisfactory storage and transport capacity, supported by solid local companies. Lastly, the distribution network is crucial to ensuring that e-methanol is distributed quickly and safely throughout the country, and even exported.

These preview results about the Senegal value chain show that Senegal has an energy infrastructure that is conducive to the development of an e-methanol project. The successful players identified in each link (Petrosen, Total Energies, SAR, TIS, Puma Energy, etc.) should be consulted as a matter of priority and integrated into the implementation of the project. Their expertise and network will make it possible to secure logistics flows and guarantee a quality of service in line with international standards. At the same time, a support strategy will need to be put in place for operators, through capacity-building mechanisms, technical partnerships, or incentives for modernisation. Finally, it will be essential to adapt the regulatory framework to recognise e-methanol as an alternative fuel, with clear rules on its production, transport, taxation, and distribution. Integrated public-private governance will be essential to ensure the sustainable success of the project and its alignment with the country's climate and energy objectives.

2. Comparison of the companies

The following section will figure out the comparison of the companies in the potential e-methanol value chain in Côte d'Ivoire and Senegal. The results are obtained by applying the formula Point = $\sum_{i=1}^{n} Wn * qn$ (Saaty, 1980). With Wn is the weight of the criteria, qn is the score of the sub-criteria, and n is the company, the point will be obtained in percentage, which will allow the ranking. Using the weights of the criteria and the scores of the sub-criteria established in the previous chapter under point 1.1, we have:

2.1. Côte d'Ivoire

2.1.1. Potential e-methanol producers in Côte d'Ivoire

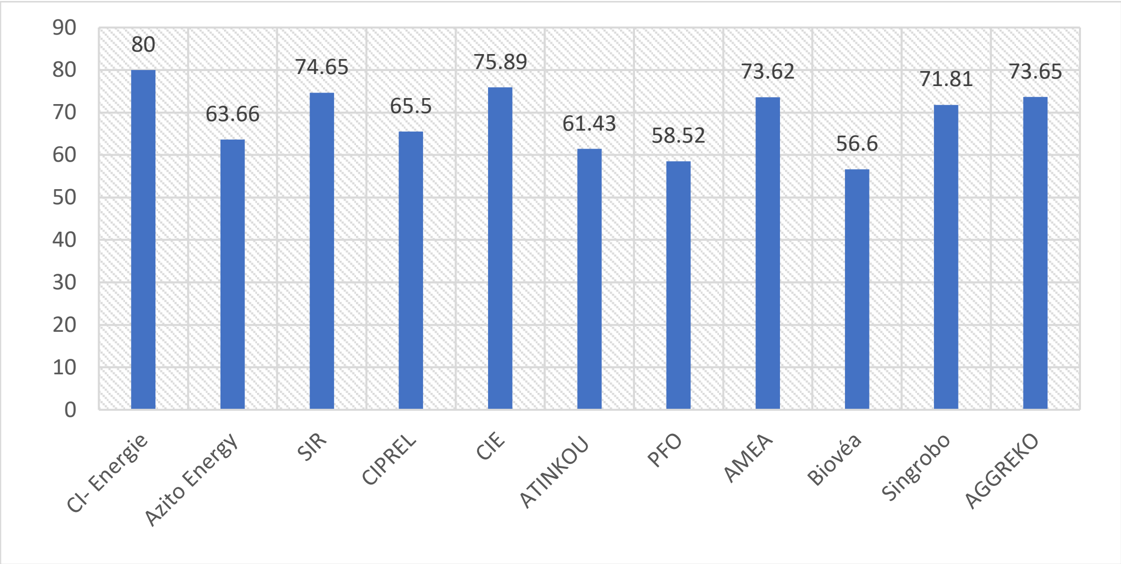

Figure 5: Potential producers in Côte d'Ivoire (%)

Source: Author using data from (CIE, 2023, 2024; ANARE, 2023)

In Côte d'Ivoire, the mapping of potential partners along the energy and fuel value chain highlights the following key actors in order of importance: CI-Energies (national electricity regulator and grid operator), CIE (Compagnie Ivoirienne d'Électricité, responsible for distribution), SIR (Société Ivoirienne de Raffinage, leading refining company), AGGREKO (independent power producer with rental and flexible energy solutions), AMEA Power (renewable energy investor), Singrobo Hydropower Project, CIPREL (Compagnie Ivoirienne de Production d'Électricité), Azito Energy, ATINKOU Energy, PFO Energy, and Biovéa Énergie (biomass-based independent power producer).

The potential companies that could be partners for the production of e-methanol in Côte d'Ivoire are ranked as follows: in first position is CI-Energie with a score 80%, because it meets all the established sub-criteria except for expertise and infrastructure readiness for the production of e-methanol, although it manages more renewable energy production companies, CI-Energies (2022), which could be favourable to the production of e-methanol. Next, we have the Compagnie Ivoirienne d'Électricité (CIE) with 75%, which meets all the sub-criteria of CI-Energie but manages fewer renewable energy companies. And SIR, with 74.65%, can be explained by the fact that it may have experience of methanol production through its experience in refining.(DGPE CI, 2023). Then AGGREKO with 73.65%, which produced its energy from thermal sources (ANARE, 2023), which is now investing in renewable energies has enabled it to occupy fourth place, Ciprel 65.5% is in seventh place, Azito Energy 63.66% is in eighth place and Atinkou is in ninth place due to its thermal energy source, AMEA (Karpowership) with 73.62% and Singrobo-houaty with 71.81% occupies fifth and sixth place as they are renewable energy production companies with capacities of 100 MW for EMEA (AMEA, 2025) and 44 MW for Singrobo-houaty (BAD, 2025). Lastly, PFO Energie (58.52%) and Biovéa (56.6%) are renewable energy projects currently under construction in Côte d'Ivoire with respective capacities of 52 MW. PFO Africa (2025) and 46 MW (Biovéa, 2025), which puts them in tenth and eleventh place in the rankings. CI-Energie's top ranking is explained by the fact that it is a public company, with a good capacity for integration in the country, responsible for the production, distribution, and marketing of electricity, and is also responsible for planning and coordinating national energy policies CI-Energies (2022), the management of hydroelectric dams such as: Ayamé 1 dam (84.21 GWh), Ayamé 2 dam (44.67 GWh), Taabo dam (838.53GWh), Buyo dam (598.07 GWh), Kossou dam (158.53 GWh), and Soubré (1475.91 GWh), Gribopolo with a capacity of 111MW throughout Côte d'Ivoire. (ANARE, 2023). These results show that CI-Energies relies mainly on natural gas and hydroelectricity, and solar energy for the bulk of its production. However, recent initiatives in the solar and biomass sectors indicate a desire to diversify, but still little focus on low-carbon production. This creates a favourable context for exploring innovative avenues such as e-methanol, using the development of renewable energies to optimise partnerships and industrial projects. CIE is ranked second because of its responsibility for production, transport, sole distributor and marketer, exporting and importing energy throughout Côte d'Ivoire. It has a share capital of FCFA 14 billion and shareholders' equity of FCFA 33.4 billion (+2.6%). In 2023, it will pay a net dividend of FCFA 1.44 billion to the State, taking into account its level of shareholding. In addition, its turnover will have increased by 8% to FCFA 257.22 billion, and the Sector's sales at the end of December 2024 will amount to FCFA 1,052.7 billion, compared with FCFA 883.6 billion at the end of December 2023, an increase of FCFA 169.1 billion (DGPE CI, 2023). In addition, the SIR in third is explained by its role, which is the refining of crude oil to obtain traditional by-products such as petrol, diesel, paraffin, LPG, and fuel oil etc. The supply of petroleum products in Côte d'Ivoire, on the other hand, methanol is generally obtained by the chemical synthesis of natural gas (methane) or by other industrial processes (biomass gasification, etc.), CO_2 + green H_2, etc.) (Motahari et al., 2024), what does not fit into the SIR value chain. AGGREKO has been ranked fourth for its technical and financial capacity in thermal energy infrastructure since 2010.(ANARE, 2023). In recent years, society has been reorienting itself towards renewable energies. (Aggreko, 2025b). In the context of the energy industry, Aggreko Côte d'Ivoire is positioned as a key player, ranking fourth according to our weight and score data. This position is underpinned by proven expertise in thermal generation and a strategic shift towards hybrid solutions. The latter, which incorporates renewable energies, particularly solar power, illustrates a proactive approach to reducing the company's carbon footprint. Aggreko is a major player in the energy sector, renowned for its expertise in the rapid deployment of power plants. Thanks to its modular infrastructures, Aggreko can supply the electricity needed for innovative processes, such as the production of e-methanol, which relies on the use of green hydrogen and the capture of carbon dioxide (CO_2). As an internationally operating entity, the company enjoys financing capacity and strategic alliances that contribute to strengthening its competitiveness. What is more, its commitment to decarbonisation is consistent with Côte d'Ivoire's energy transition objectives, making Aggreko a prime player in the development of large-scale e-methanol projects. The ranking of EMEA (Karpowership) in fifth position (73.62%) and Singrobo-Houaty in sixth position (71.81%) highlights their strategic role in the development of renewable energies in Côte d'Ivoire, making them potentially interesting players for an e-methanol production project. EMEA (Karpowership), with a capacity of 100 MW (ANARE, 2023), is gradually diversifying its energy solutions towards more environmentally-friendly technologies (EMEA, 2025), while Singrobo-Houaty, with its 44 MW hydroelectric power station (BAD, 2025), is making a direct contribution to achieving France's target of 42% of electricity coming from renewable sources by 2030. Their expertise in the production of low-carbon energy, combined with their infrastructure and operational reliability, makes them potential partners for powering the electrolysers needed to produce green hydrogen, an essential component of e-methanol. Analysis of the data shows that the performance index of PFO Energie (58.52%) and Biovéa (56.6%) is influenced by their involvement in renewable energy projects under development in Côte d'Ivoire. (Biovéa, 2025; PFO Africa, 2025). These initiatives, whose capacities are estimated at 52 MW for PFO Energie in 2025 and 46 MW for Biovéa over the same period, illustrate their commitment to sustainable development initiatives. Although these infrastructures are not yet operational, they represent potential strategic partners for an e-methanol project, given their focus on decarbonised production, which is essential for generating the green electricity required for water electrolysis and the production of green hydrogen. Their recent involvement in energy transition projects corroborates their commitment to developing a sustainable energy model. This strategic orientation positions them as players of interest for industrial collaboration in the production of e-methanol in Côte d'Ivoire. In spite of what precedes, CI-Energies, CIE, are the most powerful in terms of partners of production, and then, for the prospects, we could think of collaborating with companies like Singrobo-houaty (hydroelectric park in 2025), PFO (solar park in 2026, Biovéa (Biomass in 2026).(ANARE, 2023).

- **Sensitivity analysis based on the energy projects underway in Côte d'Ivoire**

Taking into account the renewable energy projects underway in Côte d'Ivoire, other companies will be identified and reorganised to verify their relevance and their contributions or their capacity to be potential future e-methanol production partners. In passing, we would like to point out that we will keep the same weight and score, except that we will assume that they are already in production with their assigned power, and taking into account the renewable energy power produced according to ANARE (2023), we have :

- Ivoire Hydro Energy (IHE) to commission a 44 MW hydropower plant at Singrobo in 2025
- Biovéa to commission a 46 MW biomass plant in 2026
- CI-Energies will extend the Boundiali solar power plant by 45.5 MW in 2025, the Serebou solar plant by 20 MW in 2026, and the Soubré dam by 20 MW in 2026.
- AMEA Power to commission a 40 MW solar farm in Bondoukou in 2026
- JC MONT FORT HOLDING to commission a 40 MW solar farm in Katiola in 2026
- AFRICA VIA to commission a 40 MW solar farm in Kong in 2026
- EKDS to commission a 40 MW solar farm in Tongon in 2026
- PORO POWER to commission a 50 MW solar farm in Korhogo in 2026
- KORHOGO SOLAIRE to commission a 40 MW solar farm in Binguebougou in 2026
- SCALING SOLAR will commission solar farms of 38.4 MW in Touba and 33.8 MW in Laboa in 2026.
- PFO Energies to commission a 40 MW solar farm in Ferké in 2026

By the end of 2026, the installed capacity of renewable energy will be 1,557.7 MW, with the commissioning of around ten solar power stations.

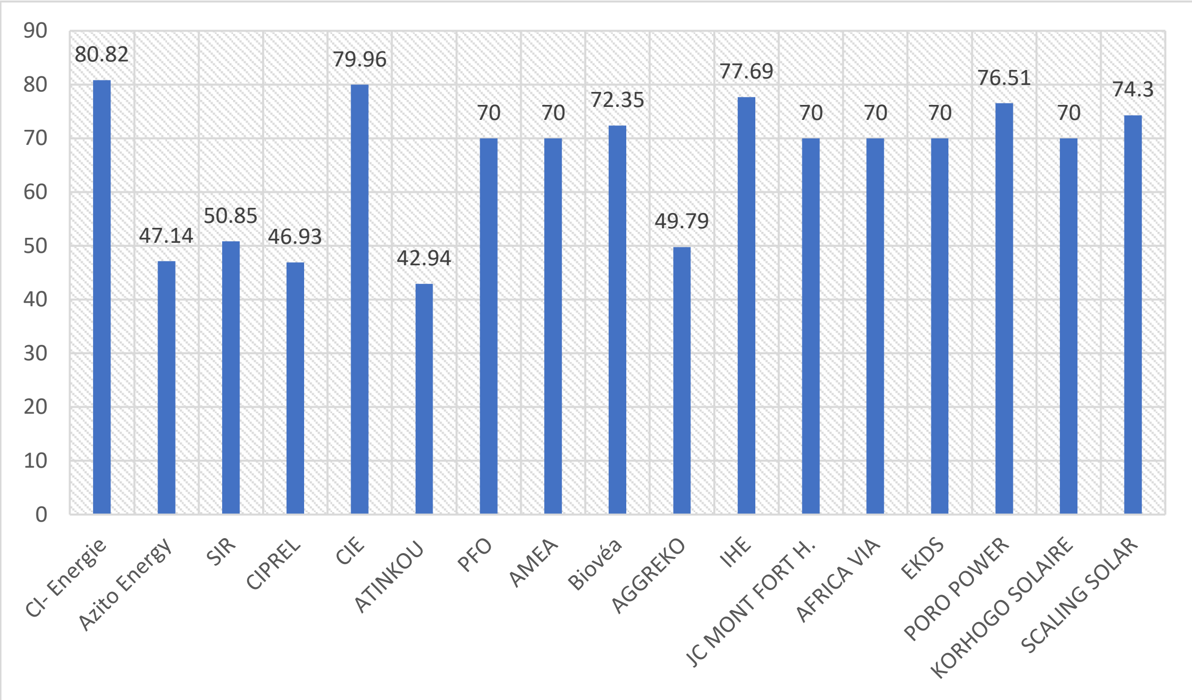

Figure 6: Potential e-methanol producers in Côte d'Ivoire by 2027 (%)

Source: Author using data from (ANARE, 2023)

Taking into account the renewable energy projects currently underway in Côte d'Ivoire, the results have enabled us to obtain the figure above, which clearly shows how Côte d'Ivoire is moving towards the energy transition. In 2027, in addition to CI-Energies and CIE, there will be companies such as Ivoire Hydro Energy, PORO Power, SCARLING SOLAR, Biovéa, and many others.

For this research, the sensitivity analysis will be applied exclusively to the production segment of the e-methanol value chain. This focus is justified by the availability and accessibility of data: while several studies, official reports, and company documents provide sufficient technical and economic information on potential producers, a similar depth of data could not be obtained for other segments of the value chain, such as storage, transportation, and distribution. Despite our efforts to reach stakeholders and partners through emails and calls, these actors did not respond favorably, limiting access to primary data. Consequently, concentrating the sensitivity analysis on the production segment ensures methodological rigor and reliability of results, while still offering relevant insights for assessing the feasibility of e-methanol projects in Côte d'Ivoire and Senegal.

2.1.2. Storage companies in Côte d'Ivoire

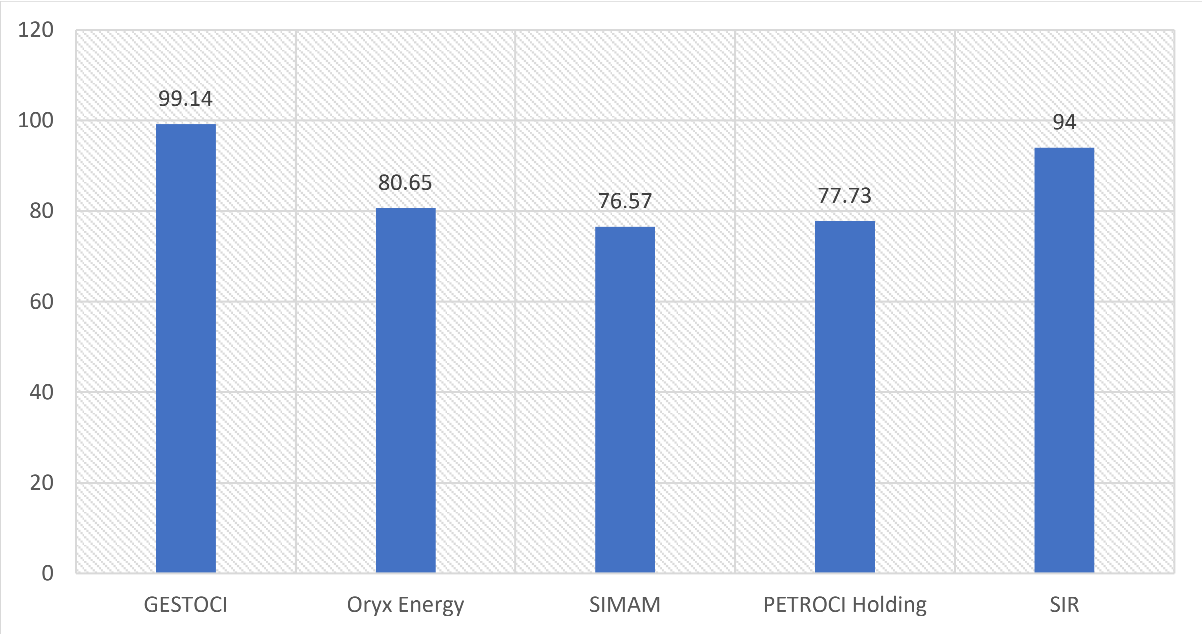

Figure 7: Fuel storage companies in Côte d'Ivoire (%)

Source: Author using data from (DGPE CI, 2023)

From the results obtained on the basis of the criteria and sub-criteria established, GESTOCI, with a score of 99.14% and SIR (94%) has the highest storage capacities, which confirms their status as historical leaders in the storage of hydrocarbons and derived products. (DGPE CI, 2023). Oryx Energy (80.65%), PETROCI Holding (77.73%), and SIMAM (76.57%) occupy intermediate positions, reflecting significant capacity, but less than the two main partners. GESTOCI (petroleum storage management in Côte d'Ivoire), the national company responsible for the strategic management of oil and fuel stocks, has modern infrastructure (depots, pipelines and petroleum terminals) adapted to the Storage of hazardous chemicals and liquids (DGPE CI, 2023), this expertise and its logistical capabilities position GESTOCI as a leading partner for the storage of e-methanol, whose physico-chemical characteristics (flammable liquid) require secure infrastructures similar to those for fuels (ANR, 2025). SIR (Ivorian Company of Refining), with a score of 94%, is the country's main refining company. It has a very high internal storage capacity due to the marketing of its products in Africa and beyond, and its logistical resources include 12 crude tanks, 72 product tanks, 02 terminals, 04 jetties, etc. (ARDA AFRICA, 2025), optimised for petroleum and chemical products (DGPE CI, 2023). This technical expertise, combined with its mastery of refining processes, makes it easy to adapt its infrastructure to the storage of methanol and its derivatives. Finally, Oryx Energy, PETROCI Holding, and SIMAM, although having a more limited capacity, have facilities adapted for the storage of hydrocarbons or various liquid products GESIP (2011) can play a complementary role in the e-methanol supply chain, particularly for secondary sites or decentralised distribution.

2.1.3. Transport companies in Côte d'Ivoire

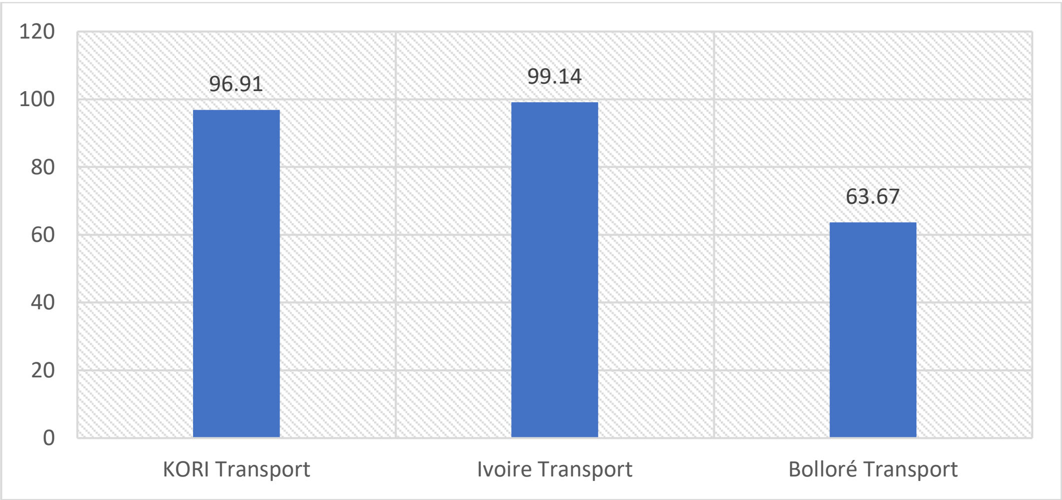

Figure 8: Fuel transportation companies in Côte d'Ivoire (%)

Source: Author using data from (DGPE CI, 2023)

Fuel transportation sector in Côte d'Ivoire, the following companies stand out as leaders in this field: Ivoire Transport (99.91%) and KORI Transport (96.91%), while Bolloré Transport (63.67%) has a lower capacity than the others. These figures reflect the differences in terms of logistics infrastructure, tanker fleet, distribution networks for the safe transport of liquid products, and their integration into the country. Ivoire Transport, with a score of 99.14%, emerged as the best-performing carrier. Its experience in the distribution of fuels and chemical products enables it to meet the safety and compliance requirements necessary for transporting methanol, a flammable liquid, due to its integration into the country and its infrastructure (Ivoire Transport, 2025). KORI Transport, the second largest partner with 96.91%, also has a specialised fleet for chemicals and fuel, making it a strategic partner for e-methanol logistics (KORI Transport, 2025). Finally, Bolloré Transport, with a score of 63.67%, remains a major partner in global logistics in West Africa, but its specific expertise in the transport of chemical products is more limited. (NDIAYE, 2021).

Ivoire Transport and KORI Transport are the priority partners for the transport of e-methanol, which requires tankers adapted to flammable liquids and a logistics chain that complies with international standards. Their infrastructure, experience in oil logistics and high level of performance make them key players in ensuring the safe distribution of methanol between production and storage sites and industrial users. Bolloré Transport could act as a secondary partner to complete the logistics or serve specific areas.

2.1.4. Distribution companies in Côte d'Ivoire

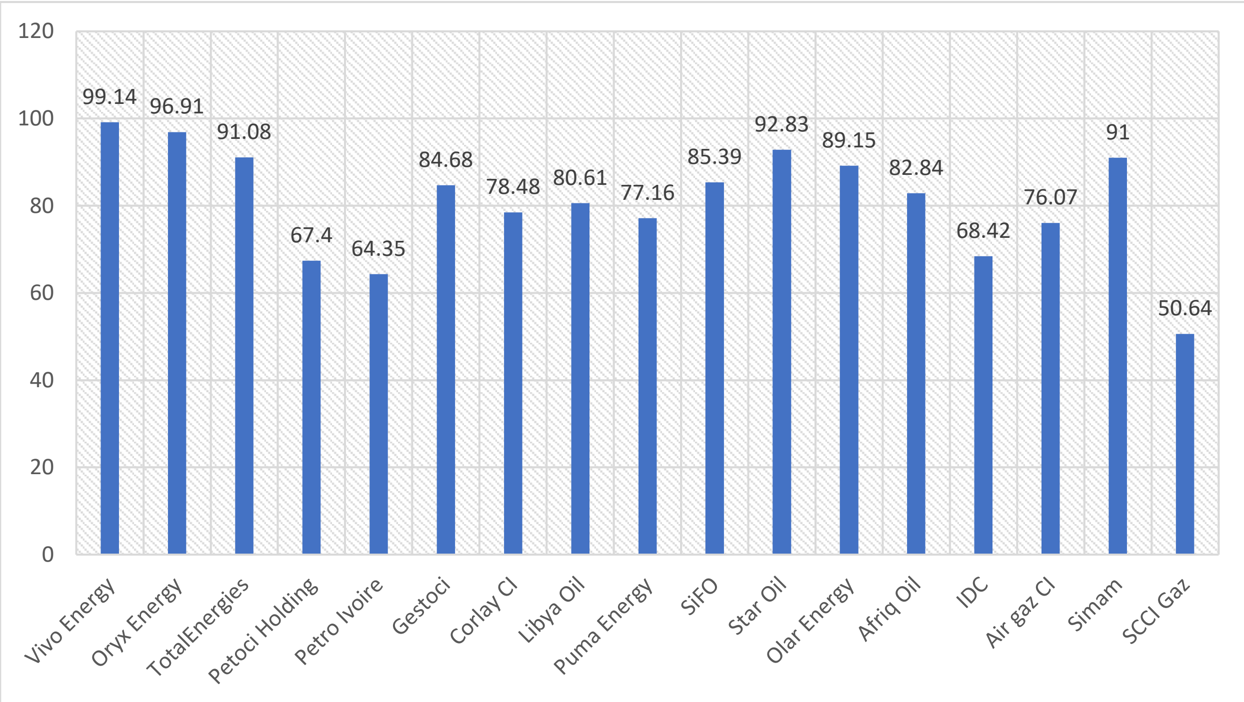

Figure 9: Fuel distribution companies in Côte d'Ivoire (%)

Source: Author using data from (MCI CI, 2021)

Based on the evaluation criteria and sub-criteria, the Distribution category reveals that Vivo Energy, with a score of 99.14%, clearly dominates the market, followed by Oryx Energy (96.91%), Star Oil (92.83%), SCCCI Gaz (91%) and Total Energies (91.08%). These companies stand out for their robust infrastructures, their integration in the country, their extensive geographical coverage and their logistical capacities adapted to the transport and distribution of flammable liquid products. Intermediate players, such as Corlay CI (84.68%), Libya Oil (80.67%) and Afriq Oil (82.84%), also have competitive capacities, albeit below those of the leaders. Conversely, Petro Ivoire (64.35%), IDC (68.42%) and above all SCCI Gaz

(50.64%) have lower levels of performance, reflecting more limited infrastructure or expertise in managing large-scale chemicals. Vivo Energy, with nearly 100% performance, has a network of modernised terminals and oil depots, as well as proven experience in handling fuels and lubricants. These technical and logistical assets guarantee its ability to integrate e-methanol distribution without heavy investment. In addition, Vivo Energy has undertaken a number of initiatives to reduce the carbon footprint of its supply chain (Vivo Energy, 2025a). Oryx Energy (96.91%) has a strong presence in West Africa and has already invested in multi-fuel infrastructures and a storage system (Oryx Energy, 2025a). Total Energies (91.08%) is a global player committed to the energy transition, with pilot projects in biofuels and alternative fuels (TotalEnergies, 2025a). These companies have integrated logistics capable of adapting quickly to a new energy carrier such as methanol. Star Oil and Ola Energy, two essential companies with scores of 92.83% and 89.15% respectively, have efficient national networks and could be strategic partners for regional or local distribution. (OLA Energy, 2025; Star Oil, 2025a). Their flexibility and intermediate size mean they are better able to adapt to the new logistics chains linked to green fuels. (OCDE, 2025). Finally, the secondary players, Corlay CI (84.68%), Libya Oil (80.67%), and Afriq Oil (82.84%), could constitute secondary allies to strengthen national coverage. On the other hand, the lower scores of Petro Ivoire (64.35%) and SCCI Gaz (50.64%) indicate that they would require technical partnerships or additional investment to meet the logistical requirements of an e-methanol project. Intending to distribute e-methanol, Vivo Energy, Oryx Energy, and Total Energies appear to be priority partners. Their expertise in the oil supply chain, their modern storage terminals, and their commitment to the energy transition give them an advantage in rapidly rolling out e-methanol on the Ivorian market. Star Oil and Olar Energy represent complementary options for regions less covered by the leaders. Finally, players such as SCCI Gaz and Petro Ivoire could play a supporting role in the longer term, provided they develop their infrastructures.

2.3. Senegal value chain

2.3.1 Potential e-methanol producers in Senegal

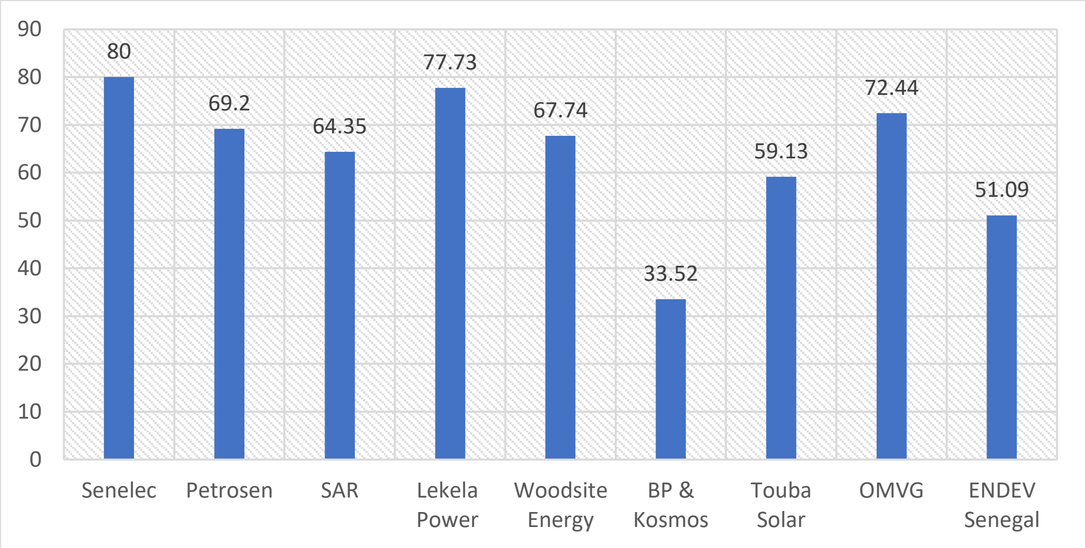

Figure 10: Potential e-methanol producers in Senegal (%)

Source: Author using data from (MEPM, 2021, 2022, 2023b, 2025)

The criteria and sub-criteria used to compile this data were analyzed. Through Figure 10, it can be seen that Senelec has the highest production capacity, with a score of 80%, followed closely by Lekela Power (77.73%). This high performance makes both partners strategic candidates for supplying the electricity needed for electrolysis, a crucial stage in the e-methanol value chain. In particular, only Lekela Power specialises in renewable energies (solar and wind) (senecaesg, 2025), which corresponds perfectly to the technical and environmental requirements of the project, guaranteeing a low-carbon energy supply (GIEC, 2011). Companies such as OMVG (72.44%) and Touba Solar (59.13%) also stand out for their focus on clean energy. (Kjellsson, 2020; Meridiam, 2025), which makes them particularly attractive as a source of energy for the e-methanol synthesis process. Their integration would strengthen the renewable aspect of the project while diversifying the sources of electricity supply. On the other hand, companies such as Petrosen (69.2%), SAR (64.35%) and Woodsite Energy (67.74%), although historically anchored in the hydrocarbons sector, offer significant industrial and logistical capacities, but they are in the refining business, which is not really favourable for e-methanol production (Petrosen, 2025; Sar, 2025; Woodsite energy, 2025). Their contribution could prove invaluable in terms of storage, distribution, and even the partial conversion of their infrastructures to sustainable uses. It is also worth noting that BP & Kosmos (33.52%) has relatively low energy production compared with the other companies. However, its position in the offshore gas sector and its links with international markets could open up prospects for financial or technological partnerships (bp, 2025). Finally, ENDEV Senegal (51.09%), although with a more modest capacity, could play a role in local development and the decentralised use of production, in particular through community access to energy and inclusive approaches. EnDev supports the country by helping to establish a commercial supply chain for improved cookstoves and facilitating access to electricity in rural areas; it thereby also enhances the electrification of social institutions as well as the productive use of clean energy (EnDev, 2025). In short, this analysis identifies the key productive forces needed to build a solid energy strategy around e-methanol. It highlights the need for an integrated partnership approach, combining conventional electricity producers (such as Senelec) and represents in 2022-2023, around 77% of the electricity produced came from fossil fuels (heavy oil), with some 8% produced from coal, and renewable energies accounted for around 23% of electricity production, broken down as follows: solar about 8%, wind about 5%, OMVG (imported under OMVS/OMVG) about 5%, and some bioenergy or waste (LowCarbonPower, 2025). Then there are the renewable energy producers (SunTaeg, Lekela Power, Hydro Africa) and the incumbents in the fossil fuel sector (SAR, Petrosen, Woodsite) in transition. This synergy is essential to ensure the technical, economic, and environmental viability of the e-methanol project in Senegal, and to help position the country as a regional player in the green energy transition. It should be remembered that none of these companies has the infrastructure or expertise to produce e-methanol to date, and even methanol is not produced in Senegal. Instead, methanol is imported as needed.

Sensitivity analysis based on the energy projects underway in Senegal

Taking into account current renewable energy projects in Senegal, other companies will be identified and reorganised to verify their relevance and their contributions or their capacity to be potential future e-methanol production partners. In passing, we would like to point out that we will keep the same weight and score, except that we will assume that they are already in production with their assigned power, and taking into account the renewable energy power produces.

- Lekela Power with the Taiba N'diaye wind farm, which has a capacity of 158.7 MW and will be extended by a further 100 MW by 2030 (Aki et al., 2023).
- Senelec in collaboration with Infinity Power will store wind energy from 2025 in Thiès, the system will be capable of storing 40 MW of electricity (AEP, 2025).
- Kaël Solaire SA manages a 25 MW solar power plant in the Diourbel region (IEA, 2023a)

- Engie, via the project company Kahone Solaire SA, has a solar power plant with a capacity of 35 MW in the region of Kaolack in Senegal. (IEA, 2023a).
- - OMVG will bring into operation a 128 MW hydroelectric power station through the Sambangalou hydroelectric project before 2030. This energy will be shared between the four OMVG member countries (Senegal, The Gambia, Guinea, and Mauritania) and is located 25 kilometres from the town of Kédougou on the border between Senegal and Guinea (pe-omvg, 2025).

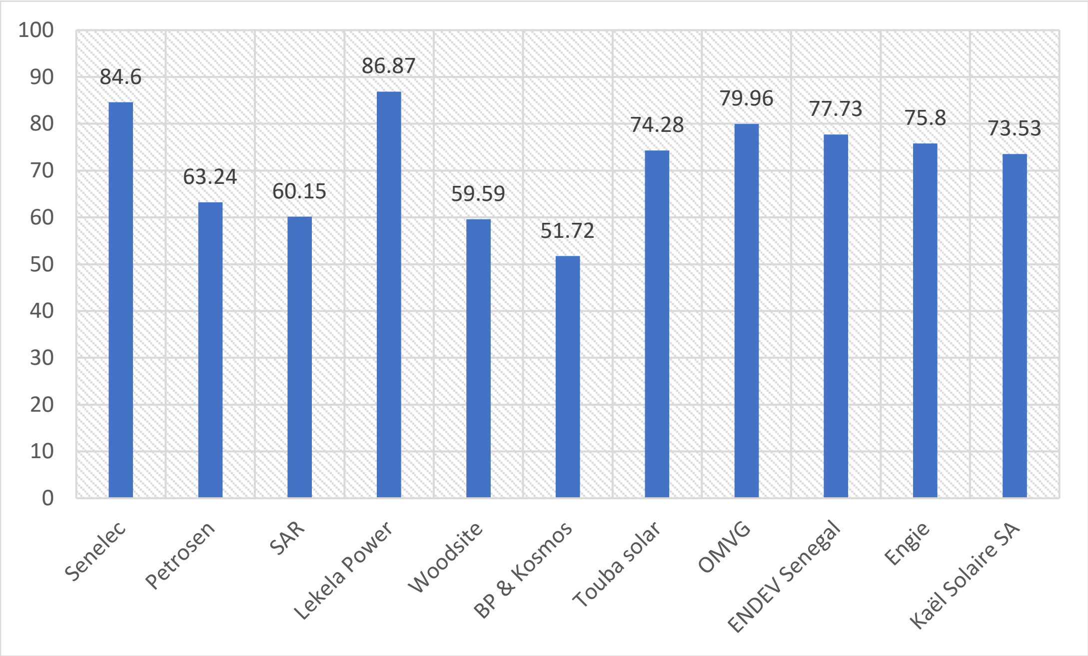

Figure 11: Potential producers of e-methanol companies in Senegal by 2030

Source: Author using data from the home page of the companies (%)

Taking into account the renewable energy projects currently underway in Senegal, the results have enabled us to obtain the figure above, which clearly shows how Senegal is moving towards the energy transition. In 2030, in addition to Lekela Power and Senelec, there will be companies such as OMVG, ENDEV Senegal, Engie, Kaël Solar, and many others.

2.3.2. Storage companies in Senegal

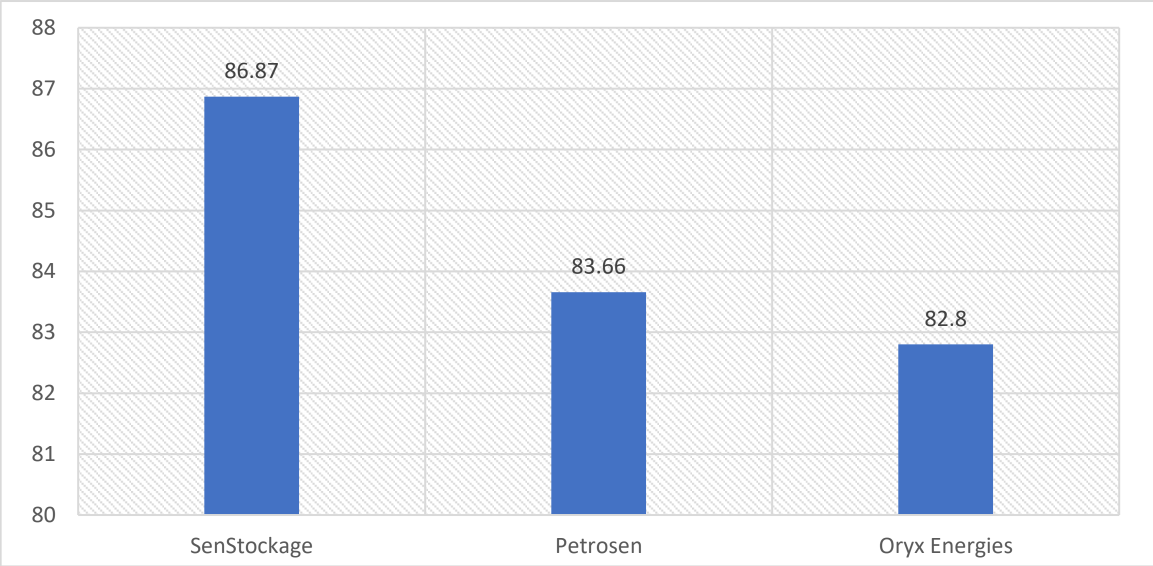

Figure 12: Fuel storage companies in Senegal (%)

Source: Author using data from (MEPM, 2022)

The results obtained from the criteria and sub-criteria established are those presented in Figure 12, a comparative assessment of the storage capacities of three companies operating in Senegal, likely to play a crucial role in the supply chain of a future e-methanol production project. As storage is a strategic component in the development of this synthetic fuel, particularly because of its volatility, its sensitivity to pressure/temperature conditions, and its role as an energy carrier, it is essential to identify partners with solid, secure, and reliable logistical capabilities (ICAO, 2018). The analysis shows that SenStockage occupies a leading position with a capacity of 86.87%, well ahead of Petrosen (83.66%) and Oryx Energies (82.8%). This high level suggests that SenStockage not only has the right infrastructure to handle large volumes of e-methanol but also operational expertise in risk management, industrial safety, and environmental compliance (Senstock, 2025). This makes it a priority partner in the deployment of a storage strategy tailored to the requirements of e-methanol. Secondly, Petrosen, a national company in the oil sector, although with a slightly smaller capacity, remains a very relevant partner. Its experience in the storage of liquid hydrocarbons, its geographical coverage of the country, and its links with the state authorities could offer significant institutional and logistical advantages, particularly in terms of regulation, customs facilitation, and long-term planning (PED, 2022). For its part, Oryx Energies, although in third place, has a solid presence in the storage and distribution of energy products in West Africa (Oryx Energies, 2025b), which could offer regional synergies if e-methanol were to be exported or integrated into cross-border value chains. All in all, Senegal already has a mature storage logistics base capable of supporting a large-scale project such as e-methanol. A targeted partnership strategy, relying on SenStockage for the core of the system, while integrating Petrosen and Oryx Energies for the diversification of sites, national logistics, and regional openness, would strengthen the robustness of the project. This storage capacity is therefore an essential lever for the industrial feasibility, security of supply, and competitiveness of Senegalese e-methanol.

2.3.3. Transport companies in Senegal

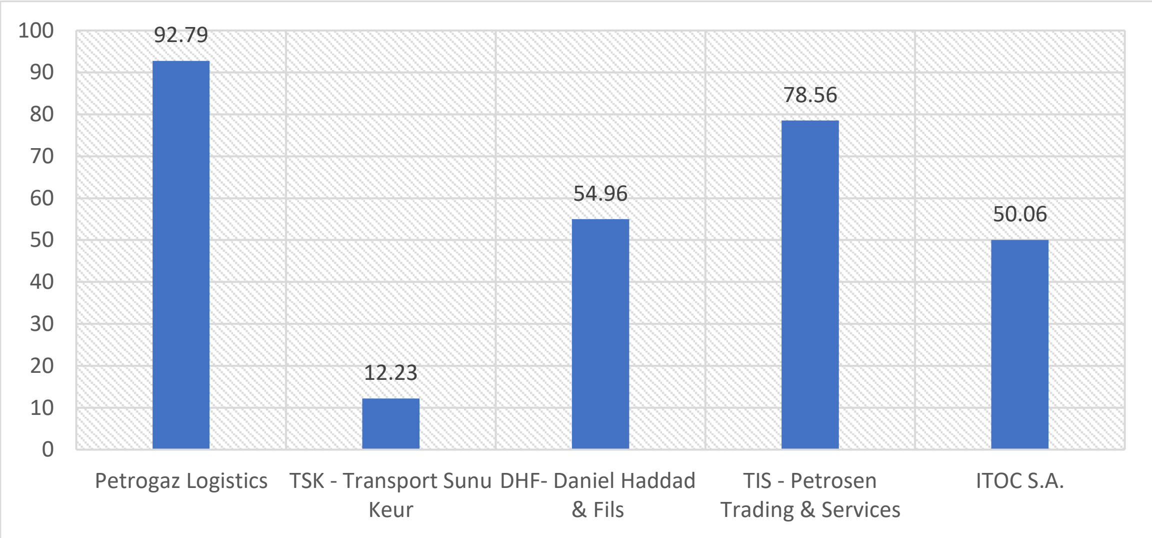

Figure 13: fuel transportations companies in Senegal (%)

Source: Author using data from (MEPM, 2021)

The results for fuel transport companies in Senegal show a marked variation in performance: Petrogaz Logistics clearly stands out with the best overall score of 92.79. Its excellent investment capacity, expertise in the transport of hydrocarbons, modern infrastructure, good integration into logistics chains, as well as its relationship with the authorities and openness to innovation, all contributed to the company's success Petrogaz Logistics (2025) makes the company an ideal partner for meeting the requirements of a green fuel like e-methanol. TIS-Petrosen Trading & Services follows with a strong institutional profile, well integrated into national energy policies. Its size, infrastructure, and public partnerships give it strategic strength (IEA, 2023a). Although slightly less competitive than Petrogaz, it is an ideal ally for long-term projects with a strong institutional scope, thanks to its roots in the state sector and its compliance with standards. DHF-Daniel Haddad & Fils, with an average score of 54.96%, benefits from good operational experience and solid relationships with oil companies. However, its lack of visible commitment to sustainability, innovation, and circularity limits its ability to carry out a green project on its own (DHF, 2025). It could nevertheless play a useful role as a support or subcontractor. ITOC S.A's performance is also average, with good infrastructures and a presence on the market, but it is not very involved in innovation or sustainable logistics. Its role would be more complementary, as part of a multi-stakeholder approach. Finally, TSK - Transport Sunu Keur performed very poorly, due to a lack of investment capacity, modern infrastructure, and logistical integration (TSK, 2025). It does not currently represent a relevant strategic partner for e-methanol. In summary, Petrogaz Logistics and TIS - Petrosen are the most viable partners, combining expertise, reliability, and strategic alignment. DHF and ITOC could be mobilised to complete the chain, while TSK is not a priority. To ensure the success of the project, it is essential to base the choice of partners on rigorous criteria of quality and logistical efficiency. Appropriate governance will also have to be put in place to guarantee the sustainability of the fuel supply chain.

2.3.4. Distribution companies in Senegal

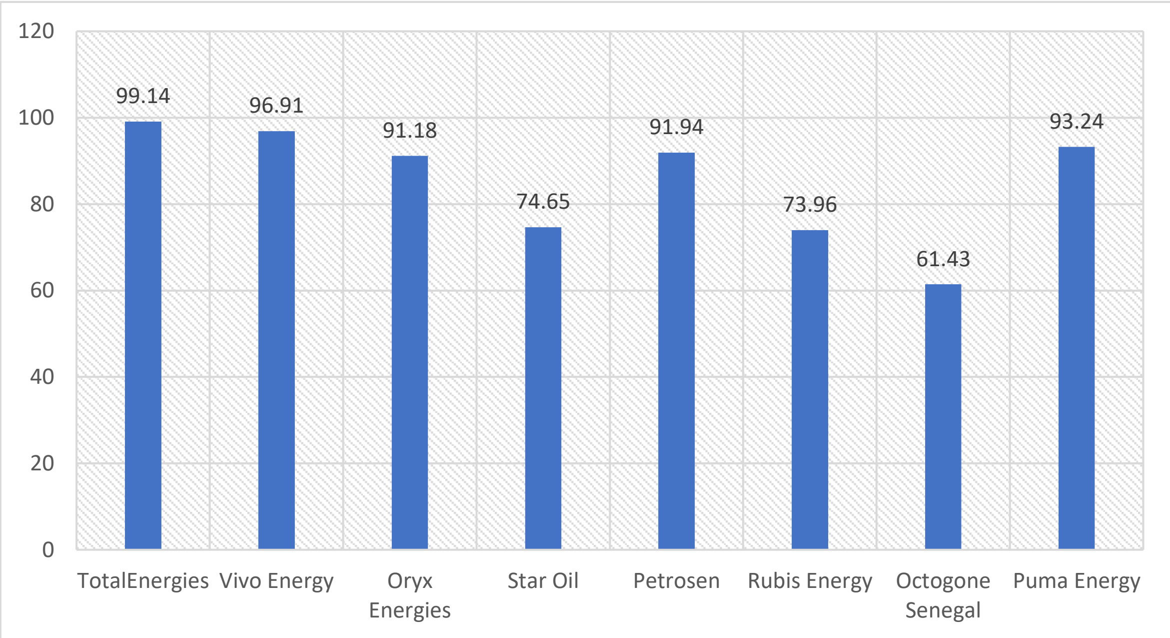

Figure 14: fuel distributor companies in Senegal (%)

Source: Author using data from (MEPM, 2023b)

The results above present the performance of eight (8) fuel distribution companies in Senegal. The scores vary considerably depending on the company. Total Energies scored the highest with 99.14, followed by Vivo Energy (96.91%), Puma Energy (93.24%), Petrosen Trading & Services (91.94%), and Oryx Energies (91.18%) (IEA, 2023a; Oryx Energies, 2024; Puma Energies, 2024; Total Energies, 2025b; Vivo Energy, 2025b). These five companies exceed the score of 90%, due to their commitment to the energy transition, their integration in West Africa and the country, and their capacity for innovation, reflecting a high level of reliability. By contrast, Star Oil (74.65 %) and Rubis Energy (73.96%) (Rubis Energies, 2025; Star Oil, 2025b), especially Octogone Senegal (61.43%) show significantly lower results, reflecting a weaker logistical performance for their lack of impact across the community, and lack of commitment to engagement in the energy transition, Specifically, Octogne Senegal specialises in trading upstream and downstream petroleum products, ensuring the supply of refined petroleum products (Octogone, 2025). This disparity indicates a significant gap in capacity and quality between the various distribution partners. In an e-methanol project, the distribution phase is crucial to ensuring that the synthetic fuel reaches end users reliably, safely, and in compliance with environmental standards. (ICAO, 2018). Companies with scores above 90, including Total Energies, Vivo Energy, and Puma Energy, demonstrate their ability to manage large-scale, complex operations. This performance may be explained by their advanced infrastructure, compliance with international standards, and market experience. On the other hand, the lower scores of Star Oil, Rubis Energy, and Octogone Senegal may reflect challenges in terms of logistics, network coverage, or compliance with safety and quality standards. These limitations could represent risks for the e-methanol supply chain. These results suggest that Total Energies, Vivo Energy, Puma Energy, Petrosen Trading & Services, and Oryx Energies are strong potential partners for the distribution of e-methanol in Senegal. They should be given priority in the project implementation strategy, particularly for areas with high demand or high logistical risks. Less successful companies could play a secondary role or be involved gradually, subject to operational upgrades. It would be advisable to set up a system for the ongoing assessment of distributors and to support the weakest through technical audits, training, or strategic partnerships. To ensure the success and sustainability of the project, the quality of distribution must remain at the heart of allocation decisions. The analysis identifies technical infrastructure, CO_2 sourcing capability, and environmental commitment as the most important criteria. Results show a diverse performance across potential partners, revealing clear leaders based on readiness and alignment with sustainability goals. The AHP model proves effective in ranking partners and providing insights for strategic collaboration. This chapter underscores how tailored evaluation can improve project outcomes and investment efficiency.

The comparative evaluation of Côte d'Ivoire and Senegal, based on the established criteria and sub-criteria for production, storage, transport, and distribution, highlights that Côte d'Ivoire could be the most suitable country for developing an e-methanol production, while also underlining the significant potential of Senegal. In terms of production capacity and partners, Côte d'Ivoire is led by CI-Energies, CIE, and taking into account the renewable energies underway, Côte d'Ivoire demonstrates a strong capacity to empower the electrolysers for e-methanol production as well as the capacity to integrate industrial CO_2 sources from cement and refining into methanol synthesis. Senegal, however, also shows high performance with Senelec and Lekela, reflecting its ability to leverage renewable electricity, particularly from wind and solar, for hydrogen production. Concerning storage capacity and potential, Côte d'Ivoire benefits from mature infrastructure and experienced operators such as GESTOCI and Bolloré, giving it a clear advantage in large-scale handling, while Senegal has made progress but remains at a comparatively earlier stage of development in this area. For transport, Côte d'Ivoire's position is reinforced by the Port of Abidjan, one of the largest in West Africa with around 40 million tons of annual throughput, supported by strong logistics partners, whereas Senegal's Port of Dakar also offers a strategic location for regional distribution and bunkering, albeit at a smaller scale. Regarding distribution, Côte d'Ivoire relies on international fuel companies and established local networks, ensuring scalability across the value chain, while Senegal equally demonstrates competitiveness through the presence of international distributors such as Total, Vivo, Puma, and Oryx, which score highly in readiness for new fuels. Taken together, the analysis confirms that Senegal performs strongly in renewable energy integration and distribution, but Côte d'Ivoire maintains superior overall readiness thanks to its stronger industrial CO_2 base, storage and transport infrastructure, and integrated partner ecosystem, making it the most advantageous country to initiate and scale an e-methanol industry in West Africa.

3. Recommendation for a favorable way to meet and attract most of the partners across the value chain in Côte d'Ivoire and Senegal

The table below outlines the development strategy for a West African e-methanol value chain, covering production, transportation, distribution, and storage for Côte d'Ivoire and Senegal. Production will depend on renewable energy for green hydrogen and industrial CO_2 capture, with key technology partners. Transportation focuses on combined rail and sea transport rather than distribution for industrial use and transport through dedicated stations and digital traceability. Storage involves regional hubs and climate financing. The strengths include the integrated model and multi-sector partnerships, although cross-border coordination and financing pose challenges. This initiative positions the region as a pioneer in the green industrialization of hydrogen and the circular carbon economy.

Value chain	Steps	Recommendation	Partner (Côte d'Ivoire)	Partner (Senegal)
Production	Development of renewable energy for electrolysis	Support the development of solar/wind farms dedicated to the production of green hydrogen for e-methanol, via long-term PPA (Power Purchase Agreement).	CI-ENERGIES, Eranove, EDF CI, DGE, Biovéa, Singrobo Power, …	SENELEC, Qair Senegal, Ten Merina, Akon Lighting Africa
	Deployment of green hydrogen projects	Propose a pilot project for green hydrogen production, preferably near industrial or mining zones, to reduce losses and optimize supply.	CIE, ZECI, CI-Energies, DGE,	NEOEN, Ecosun, SB2-4ALL, SENELEC
	Identification of CO_2 sources	Mapping industrial emissions to define available deposits.	SUCRIVOIRE, Palmci, SOLIBRA, SODEXAM, Bolloré CI (transport), MEDDTE, SIR, ENI, LafargeHolcim, Cargill	SAR, Ciments du Sahel, SDE, Sococim
	Capture of industrial and biogenic CO_2	Create partnerships with identified emitting industries to install on-site CO_2 capture units.	LafargeHolcim, SIR, ENI, SUCRIVOIRE, Cargill, SOLIBRA, Palmci,	SAR, Ciments du Sahel, SDE, Sococim
	Technology partnerships and industrial integration	Partner with international suppliers and install CO_2 + H_2 to CH_3OH conversion units in industrial and port areas to promote logistics.	INP-HB, WASCAL/CI, SGI, Haldor Topsoe, Siemens, Schneider electric, CANSOLV CO_2, CRI, Liquid Wind, Sunfire, Carbon clean	EGIS Sénégal,WASCAL/Senegal, Siemens, UCAD, ESP Dakar

Transport	Secure ground transportation	Develop national logistics (tankers adapted to e-methanol, secure rail transport)	SITARAIL, Bolloré CI, SIPROCHIM, SOTRA, ministry of transport	SCL Sénégal, Dakar Terminal, Total Sénégal
	Sea freight for international export	Work with ports and maritime players to adapt infrastructures to IMO (International Maritime Organization) e-methanol standards.	Port Autonome d'Abidjan, MSC CI, Port autonome de San Pedro, ministry of transport	Port Autonome de Dakar, DP World, CMA CGM Sénégal
	Integration into the green maritime chain	Offer local shipping companies refuelling solutions based on e-methanol (green bunkering),	Société Ivoirienne de manutention portuaire, Bolloré Africa Logistics, ministry of transport	SENTRANS, Dakar Marine Services, TotalEnergies
Distribution	Structuring national logistics	Evaluate the possibility of creating a distribution network for e-methanol by road, rail or port in partnership with logistics operators.	SIPROCHIM, Sitarail, Bolloré Africa Logistics	Dakar Terminal, SCL Sénégal, GCO
	Creation of a local distribution network	Set up e-methanol refuelling stations for industrial, heavy transport and agricultural use	PETROCI Holding, Total Energies CI; Vivo Energy, Star Oil, Total Energies, Puma Energies, ORYX Energies, Olar Energies, Petro Ivoire, etc.	Petrosen Distribution; Total Energies Sénégal Vivo Energy, Puma Energies, etc.
	Engaging with industry	Target potential industrial users for direct use (chemicals, fertilizers, biofuels, etc.)	Olam, SIFCA, Compagnie Ivoirienne de Production d'Alcool (CIPA), COTIPLAST	Indorama, ICS, Takamoul
	Direct sales to manufacturers	Identify industrial zones with high energy requirements for direct	SIFCA, Olam, IVOIRE COTON, Unilever CI, COTIPLAST,	ICS, Takamoul, Industries Chimiques du Sénégal

		integration of e-methanol into processes (ceramics, chemicals, textiles).		
	Development of long-term contracts	Negotiate secure supply contracts with major groups to amortize investment in infrastructure	Ministry of Trade and Industry, CCI-CI, AGEDI CI,	Ministère Industrie, CCIAD -SN, APIX Senegal
	Creation of digital traceability platforms	Set up a digital platform to monitor the quality and traceability of e-methanol in the network	Orange CI, Smart Africa, ANSUT, MTN CI, MOOV CI, etc.	Sonatel, ADIE Sénégal, Orange Senegal
	Raising awareness among customs and regulatory authorities	Initiate a dialogue with customs and ministries to define tariff codes, standards and taxation for e-methanol	Direction Générale des Douanes, Ministère de l'Énergie, ANARE, MMPE, DGH.	Senegalese customs, Ministry of Oil and Energy, CRSE
Stockage	Audit of existing infrastructures	Audit the compatibility of current facilities with the storage of alternative fuels (SEVESO and ATEX standards).	Total CI Dépôts, SDS, PETROCI, GESTOCI, Petroci Holding, SIMAM, etc.	Total Sénégal Dépôts, SENTRAK, Petrosen T&S
	Reinforcing technical standards	Work with national agencies to define e-methanol storage safety and certification standards.	ANDE, AGEDI, CODINORM,	DEEC, APIX, ASN
	Land and environmental security	Identify industrial sites compatible with SEVESO or equivalent standards.	AGEDI, Ministry for the Environment, ANDE	APIX, DEEC, Ministère Environnement
	Blended finance	Mobilize international climate resources and national banks to co-finance storage infrastructures.	Fonds Vert Climat, BOAD, CDC-CI, BAD	GCF, FONSIS, BAD, BNDE

The development of an e-methanol value chain in Côte d'Ivoire and Senegal requires not only the identification of technical opportunities but also the creation of favorable conditions to mobilize and attract strategic partners across production, transport, storage, and distribution. The recommendations outlined in the table above highlight several entry points for such engagement.

At the production stage, both countries possess strong renewable energy potential, with Côte d'Ivoire relying on hydro and gas-based infrastructure complemented by growing solar projects, while Senegal has already operationalized large-scale wind and solar farms such as Taïba N'Diaye and Bokhol. To convert this renewable capacity into competitive hydrogen for e-methanol, the establishment of dedicated Power Purchase Agreements (PPAs) with utilities such as CI-Energies and Senelec is crucial. Pilot hydrogen projects near industrial clusters (cement, sugar, mining) would minimize transmission losses and optimize CO_2 sourcing. Partnerships with industrial emitters (cement, sugar, oil and gas, breweries) create an immediate pathway for biogenic and industrial CO_2 capture, which is critical to bankability. In addition, collaboration with universities (UCAD, INP-HB) and technology suppliers (Haldor Topsoe, Siemens, etc.) would ensure knowledge transfer and capacity building, reducing the current gap in local technical expertise on Power-to-X (PtX) technologies.

For storage, existing petroleum depots (GESTOCI, Petroci, Petrosen, Total) must be audited and upgraded to SEVESO and ATEX standards to ensure safe e-methanol handling. Here, blended finance mechanisms involving national banks, regional institutions (BOAD, FONSIS), and climate funds (Green Climate Fund, AfDB) could play a catalytic role. In parallel, collaboration with national standardization agencies (CODINORM, DEEC, and ANDE) would enable the definition of storage and handling protocols, coupled with training programs to build local expertise in fuel safety, certification, and environmental management.

For transport and logistics, the strategic positioning of Abidjan, San Pedro, and Dakar ports offers significant opportunities for integration into the global green maritime fuel chain. Adaptation of port infrastructures to IMO e-methanol standards and the creation of green bunkering services would make these hubs attractive for international shipping lines, reinforcing their competitiveness. Partnerships with operators like Bolloré Africa Logistics, SITARAIL, CMA CGM, and DP World would enable secure ground and maritime logistics. However, capacity building in fuel safety handling and certification standards will be required for local logistics operators to align with international norms.

In the distribution segment, collaboration with established fuel distribution companies (Total Energies, Vivo Energy, ORYX, Petroci, Petrosen, etc.) provides a ready platform to scale e-methanol distribution for industry and transport sectors. To ensure market penetration, awareness campaigns targeting industrial users (fertilizer, chemicals, agro-industry) will be necessary, alongside the negotiation of long-term offtake agreements with large industries. Furthermore, leveraging ICT platforms (Orange CI, Sonatel) to create digital traceability systems for e-methanol could enhance transparency, build investor confidence, and strengthen compliance with EU RFNBO certification requirements.

Finally, across all stages of the value chain, capacity building is indispensable. Both Côte d'Ivoire and Senegal face limitations in local expertise in hydrogen, CO_2 capture, and PtX technologies. Thus, structured partnerships with academic institutions, regional centers (WASCAL, ECREEE), and private technology providers must be pursued to create knowledge transfer platforms, technical training, and professional certification programs. This ensures not only the availability of partners but also the development of local capacity to sustain long-term operations. A favorable way to meet and attract partners involves combining industrial partnerships, financial innovation, regulatory adaptation, and capacity building. By aligning renewable energy deployment with CO_2 capture opportunities, upgrading infrastructure to international standards, and engaging existing fuel distributors, Côte d'Ivoire and Senegal can establish themselves as early movers in the African e-methanol value chain.

This final chapter outlines concrete actions for policymakers, investors, and stakeholders. It recommends enhancing institutional frameworks, incentivizing sustainable practices, and fostering public-private partnerships. It also calls for replication of the methodology in similar contexts. The chapter closes by reinforcing the strategic role of e-methanol and green hydrogen in Côte d'Ivoire's and West Africa's energy transition.

Conclusion

This thesis has examined the strategic selection and ranking of potential partners for the development of an e-methanol value chain in Côte d'Ivoire and Senegal. The general objective of this research was to assess the investment potential and identify key stakeholders and prospective partners for the development of an e-methanol value chain in Côte d'Ivoire and Senegal, from production to commercialization and export. To achieve this, several specific objectives were defined: to identify and map the stakeholders across the e-methanol value chain; to analyze the infrastructures and policies supporting e-methanol integration; and to assess and rank potential partners for project implementation.

The methodology adopted was the Analytical Hierarchy Process (AHP), which enabled a structured, multi-criteria evaluation of potential partners. This choice was motivated by AHP's ability to integrate both qualitative and quantitative criteria, ensuring consistency in decision-making across diverse factors, such as financial viability, regulatory and government relationships, technical capacity, sustainability, and value chain synergy. The analysis was complemented by a sensitivity analysis applied to the production segment, based on available data from prospective energy projects in both countries. This enabled us to test the robustness of the results and to acknowledge that, while our findings are based on the weights and scores we established, different assumptions in future studies could lead to slightly different outcomes.

In terms of data, the study relied mainly on secondary sources, including official reports from ministries, regulatory agencies, company annual reports, and international organizations. Despite efforts to collect primary data through emails and calls to companies in the value chain, responses were limited, which constrained the empirical depth of the research. This limitation was mitigated by data from diverse secondary sources, ensuring a consistent and reliable foundation for the analysis.

The identified research gap lies in the fact that, while several studies address the economic feasibility and technical potential of hydrogen and e-methanol production in West Africa, there is a notable absence of research assessing the partners and stakeholders critical to the success of such projects.

The results obtained show that currently, there are no methanol production companies in either Côte d'Ivoire or Senegal. Industries using methanol rely entirely on imports, mainly from Western markets. However, both countries possess abundant renewable energy resources, positioning them strongly for e-methanol production. The study successfully mapped and ranked potential partners: in Côte d'Ivoire, promising producers include CI-Energies, CIE, CIPREL, and Azito Energy; storage partners include GESTOCI, SIR, and ORYX Energies; transport partners include Ivoire Transport and KORI Transport; distributors include Vivo Energy, Total Energies, and ORYX Energies; and Bolloré Transport represents a potential export partner. In Senegal, producers include Senelec, Lekela Power, and Taiba N'Diaye wind farm; storage actors include Petrosen, SenStock, and ORYX Energies; transport companies such as Petrogaz Logistics and TIS-Petrosen Trading & Services; and distributors such as Vivo Energy, ORYX Energies, and Total Energies. Regulators in both countries, such as ANER, CRSE, and ANARE-CI, will also play a pivotal role in enabling project implementation.

The implications of these results are significant: by leveraging existing industrial infrastructures, regulatory frameworks, and abundant renewable energy resources, Côte d'Ivoire and Senegal have the capacity to position themselves as early movers in the e-methanol industry in West Africa. Establishing such a value chain would not only support national energy transitions but also provide competitive advantages in regional and global clean fuel markets, particularly for maritime transport decarbonization.

Nevertheless, the study faced limitations, particularly the difficulty of accessing primary data directly from companies, which restricted the analysis to secondary information and reduced the opportunity for in-depth case-specific validation. The reliance on secondary data also implies that the results are bounded by the quality and availability of existing reports and statistics.

For future research, it is recommended to complement this study with direct interviews and field surveys involving key stakeholders across the value chain, from production to export. Additionally, economic modeling of investment requirements, life-cycle emissions assessments, and comparative analyses with other PtX (Power-to-X) pathways would further enrich the understanding of e-methanol's role in the regional energy transition.

In conclusion, this thesis demonstrates that Côte d'Ivoire and Senegal present a promising environment for the deployment of an e-methanol value chain. While the absence of current production underscores the novelty of such a project, the abundance of renewable resources, combined with the presence of relevant partners and regulators, provides a solid foundation for project development. By bridging the existing knowledge gap on stakeholder assessment, this research makes an important contribution to the debate on sustainable fuels in West Africa and offers practical insights for policymakers, investors, and industry partners seeking to advance the region's energy transition.

References

AEP. (2025, August 1). *SENEGAL: in Thiès, Infinity Power will store wind energy from Taïba N'Diaye from 2025 | Africa Energy Portal*. https://africa-energy-portal.org/news/senegal-thies-infinity-power-will-store-wind-energy-taiba-ndiaye-2025?utm

AFREC. (2022). *Africa Energy Balance & Indicators 2022*.

Aggreko. (2025a, July 13). *Renewable Energy Project Solutions | Aggreko US*. https://www.aggreko.com/en-us/sectors/renewable-energy-project-solutions?utm

Aggreko. (2025b, July 25). *Industrial Power & Temperature Control Solutions | Aggreko CI*. https://www.aggreko.com/en-ci

Agora Energiewende. (2019). Agora Energiewende (2019): European Energy Transition 2030: The Big Picture. Ten Priorities for the next European Commission to meet the EU's 2030 targets and accelerate towards 2050. *Agora Energiewende*, 104. https://www.agora-energiewende.de/fileadmin/Projekte/2019/EU_Big_Picture/153_EU-Big-Pic_WEB.pdf

Aki, K., Martin, V., & Juliette, G. (2023). Sénégal renouvelable Résumé. *Sénégal Renouvelable*, 13.

Akusta, E., Ari, A., & Cergibozan, R. (2024). Barriers to renewable energy investments in Turkiye: A fuzzy AHP approach. *Renewable Energy*, *240*(December 2024), 122161. https://doi.org/10.1016/j.renene.2024.122161

Almuqati, N. S., Aldawsari, A. M., Alharbi, K. N., González-Cortés, S., Alotibi, M. F., Alzaidi, F., Dilworth, J. R., & Edwards, P. P. (2024). Catalytic production of light Olefins: Perspective and prospective. *Fuel*, *366*(February). https://doi.org/10.1016/j.fuel.2024.131270

ANARE. (2023). *RAPPORT*. 1–172.

ANR. (2025, July 28). *Le e-méthanol, vecteur de décarbonation de l'industrie chimique ? - PEPR Spleen*. https://www.pepr-spleen.fr/2025/03/20/le-e-methanol-vecteur-de-decarbonation-de-lindustrie-chimique/

ARDA AFRICA. (2025, July 28). *Société Ivoirienne de Raffinage - Accueil | ARDA AFRICA*. https://arda.africa/societe-ivoirienne-de-raffinage/?utmda

Argus Media. (2024). *European Natural Gas-Winter 2024-25 Preview*. *September 2024*.

Avery, G., & Carpenter, A. (2025). Supply Chain Energy and Greenhouse Gas Analysis Using the Materials Flows Through Industry (MFI) Tool: Examination of Alternative Technology Scenarios for the U.S. Chemical Sector. *Journal of Advanced Manufacturing and Processing*, *7*(3). https://doi.org/10.1002/amp2.70012

BAD. (2025, July 25). *Côte d'Ivoire - 44 MW Singrobo - Ahouaty Hydropower Project - MapAfrica - African Development Bank Group*. https://mapafrica.afdb.org/en/projects/46002-P-CI-FAB-001

Biovéa. (2025, July 25). *LA CENTRALE BIOMASSE - Biovea Energie*. https://biovea-energie.com/la-centrale-biomasse/#biomasse-approvisionnement

Bisotti, F., Hoff, K. A., Mathisen, A., & Hovland, J. (2024). Direct Air capture (DAC) deployment: A review of the industrial deployment. *Chemical Engineering Science*, *283*(October 2023), 119416. https://doi.org/10.1016/j.ces.2023.119416

Bozzini, M. M., Signorelli, M., Moioli, E., & Manenti, F. (2025). Techno-Economic-Assessment of the Methanol Synthesis from Captured Co2 and Modular Nuclear Power-Based Electrolysis. *Journal of CO2 Utilization*, *101*(July), 103186. https://doi.org/10.1016/j.jcou.2025.103186

bp. (2025, August 1). *Qui nous sommes | Sénégal*. https://www.bp.com/fr_sn/senegal/home/who-we-are.html

Brynolf, S., Taljegard, M., Grahn, M., & Hansson, J. (2018). Electrofuels for the transport sector: A review of production costs. *Renewable and Sustainable Energy Reviews*, *81*(July 2016), 1887–1905. https://doi.org/10.1016/j.rser.2017.05.288

CI-Energies. (2022). Rapport de gestion 2022. *RAPPORT DE GESTION*, 18. https://www.cinergies.ci/rapport-de-gestion-exercice-2022/

CIE. (2023). Rapport Annuel 2023 du CIE. *Rapport Annuel 2023 Du FMI*.

https://doi.org/10.5089/9798400240478.011

CIE. (2024). *Rapport d ' activités Rapport d ' activités*. 1–19.

Cirolia, L. R., Ray, C., & Hendricks, R. (2025). Coastal encounters with electrical hybridity: Karpowership in Africa's energy transition. *Sustainability Science*, *Silver 2014*. https://doi.org/10.1007/s11625-024-01624-0

Cornils, B. (2020). Green Methanol. *Catalysis from A to Z*, 2–4. https://doi.org/10.1002/9783527809080.cataz07521

CSS. (2025, August 17). *Home - CSS*. https://www.css.sn/en/

Demirel, Y. (2015). Technoeconomics and Sustainability of Renewable Methanol and Ammonia Productions Using Wind Power-based Hydrogen. *Journal of Advanced Chemical Engineering*, *5*(3). https://doi.org/10.4172/2090-4568.1000128

DGPE CI. (2023). Rapport Annuel Rapport Annuel. *DGPE*, 1–191.

DGPPE. (2025, July 28). *Adoption de la loi d'orientation relative au SNP - Bienvenue sur le portail officiel de la DGPPE | Direction Générale de la Planification et des Politiques Economiques*. https://dgppe.sn/adoption-de-la-loi-dorientation-relative-au-snp/

DHF. (2025, August 4). *Historique - Transport Daniel Haddad & Fils*. https://www.dhfsa.com/historique/

Ecofin agency. (2025, August 17). *Port of Abidjan Handles 1.6 Million TEUs in 2024, Almost Double 2022 - Ecofin Agency*. https://www.ecofinagency.com/finance/2702-46447-port-of-abidjan-handles-1-6-million-teus-in-2024-almost-double-2022

ECREEE. (2022). *Regional Progress Report*. 10. https://ecowrex.org/dashboard/page/resource

ECREEE ECOWAS. (2023). *Economic Community of West Ecowas Green Hydrogen Policy and Strategy Framework*. 1–52.

EMEA. (2025, July 25). *Powership Project*. https://karpowership.com/project-ivory-coast

EnDev. (2025, August 1). *Senegal - EnDev*. https://endev.info/countries/senegal/

eni. (2025, August 17). *Eni and Vitol to strengthen collaboration in West Africa*. https://www.eni.com/en-IT/media/press-release/2025/03/eni-and-vitol-to-strengthen-collaboration-in-west-africa.html

EVOLEN. (2023). *Note de synthèse sur les électro-carburants. Cartographie, propriétés, synthèses et usages*.

Ezbakhe, F., & Pérez-Foguet, A. (2021). Decision analysis for sustainable development: The case of renewable energy planning under uncertainty. *European Journal of Operational Research*, *291*(2), 601–613. https://doi.org/10.1016/j.ejor.2020.02.037

FAO. (2023). FAO Country Profiles:Côte d'Ivoire. *FAO Publications Catalogue 2023*. https://doi.org/10.4060/CC7285EN

Fasihi, M., & Breyer, C. (2024). Global production potential of green methanol based on variable renewable electricity. *Energy and Environmental Science*, *17*(10), 3503–3522. https://doi.org/10.1039/d3ee02951d

Fazekas, A., Bataille, C., & Vogt-Schilb, A. (2022). *Atteindre la prospérité sans carbone: comment les gouvernements peuvent mettre en oeuvre 15 transformations essentielles*. *October*. https://shs.hal.science/halshs-03787651/

Foong, & Denny. (2022). A systematic approach for synthesis and optimisation of sustainable oil palm value chain (OPVC). *South African Journal of Chemical Engineering*, *41*(December 2021), 65–78. https://doi.org/10.1016/j.sajce.2022.05.001

Galimova, T., Karjunen, H., Lassila, J., Satymov, R., & Breyer, C. (2025). Techno-economic analysis of e-methanol infrastructure choice for the case of Finland. *Energy*, *334*(July), 137531. https://doi.org/10.1016/j.energy.2025.137531

GESIP. (2011). *Guide De Lecture De La Reglementation Sur Le Stockage Et Le Chargement / Dechargement De Liquides Inflammables Partie Stockage (1432 a) Arrete 1432a Du 3 Octobre 2010 Modifie Par L ' Arrete Du 10 Fevrier 2011 (Hors Titre Vi - Defense Incendie)*. *2011*, 1–115.

GIEC. (2011). Rapport spécial sur les sources d'énergie renouvelable et l'atténuation du changement climatique. *O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P.*

Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer et C. von Stechow, 26 p.

giz. (2025). African Green Hydrogen Report. *African Green Hydrogen Report*.

Global Solar Atlas. (2025a, August 7). *Global Solar Atlas*. https://globalsolaratlas.info/map?r=SEN&c=8.102739,-7.437744,7&s=7.989737,-5.567946&m=site

Global Solar Atlas. (2025b, August 7). *Global Solar Atlas*. https://globalsolaratlas.info/map?r=SEN&c=12.529169,-21.665039,5

Govindan, K., Rajendran, S., Sarkis, J., & Murugesan, P. (2013). Multi criteria decision making approaches for green supplier evaluation and selection: A literature review. *Journal of Cleaner Production*, *98*, 66–83. https://doi.org/10.1016/j.jclepro.2013.06.046

Gupta, P., Mehlawat, M. K., & Ahemad, F. (2023). Selection of renewable energy sources: a novel VIKOR approach in an intuitionistic fuzzy linguistic environment. In *Environment, Development and Sustainability* (Vol. 25, Issue 4). Springer Netherlands. https://doi.org/10.1007/s10668-022-02172-2

H2Atlas-Africa. (2025, August 17). *Objectifs du projet - H2Atlas-Africa*. https://www.h2atlas.de/fr/Objectifs-du-projet

Hassan, Q., Viktor, P., J. Al-Musawi, T., Mahmood Ali, B., Algburi, S., Alzoubi, H. M., Khudhair Al-Jiboory, A., Zuhair Sameen, A., Salman, H. M., & Jaszczur, M. (2024). The renewable energy role in the global energy Transformations. *Renewable Energy Focus* , *48*(January), 100545. https://doi.org/10.1016/j.ref.2024.100545

ICAO. (2018). *Burkina faso Étude de faisabilité sur le*.

IEA. (2021). World Energy Outlook 2021. *IEA Publications*, 1–386. www.iea.org/weo

IEA. (2023a). *Sénégal 2023 - Revue de la politique énergétique*. www.iea.org

IEA. (2023b). *World Energy Outlook.* 1–355.

IFC. (2018). Unlocking Private Investment. *Unlocking Private Investment*, *November*.

https://www.ifc.org/wps/wcm/connect/3bacce14-0e4d-4f79-9cc8-e6d70a15407d/IFC-Cote_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES&CVID=mhF-kt3

IFC. (2025, August 17). *Disclosure - Sococim Low Carbon Cement II*. https://disclosures.ifc.org/project-detail/ESRS/50290/sococim-low-carbon-cement-ii-

Ijadi Maghsoodi, A., Ijadi Maghsoodi, A., Mosavi, A., Rabczuk, T., & Zavadskas, E. K. (2018). Renewable Energy Technology Selection Problem Using Integrated H-SWARA-MULTIMOORA Approach. *Sustainability*, *10*(12), 4481. https://doi.org/10.3390/su10124481

The India government. (2025, July 24). *Methanol Economy for India: Energy Security, Make in India, and Zero Carbon footprint*. https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=174919

IPCC. (2011). IPCC, 2011: Summary for Policymakers. In: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. In *Cambridge University Press*. https://doi.org/10.5860/CHOICE.49-6309

IPCC. (2022). Africa. In *International Lawyer* (Vol. 52). https://doi.org/10.9774/gleaf.978-1-907643-09-5_3

IRENA. (2022a). *Agence internationale pour les énergies renouvelables*. www.afdb.org

IRENA. (2022b). International Renewable Energy Agency RENEWABLE ENERGY STATISTICS 2022. In *Irena*. www.irena.org

IRENA. (2023). *Scaling Up Renewable Energy Investments*. 0–13. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Oct/IRENA_Coalition_Scaling_up_investment_West_Africa_2023.pdf

IRENA & Methanol Institute. (2021). *INNOVATION OUTLOOK RENEWABLE METHANOL in partnership with*. www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jan/IRENA_Innovation_Renewable_Methanol_2021.pdf?rev=ca7ec52e824041e8b20407ab2e6c7341

issuu. (2025, August 17). *Port Autonome de Dakar by Business Excellence Magazine - Issuu*.

https://issuu.com/business-excellence/docs/issuu-_pad_-_be_mag-2023

ITA. (2025, August 7). *Senegal - Energy*. https://www.trade.gov/country-commercial-guides/senegal-energy

Ivoire Transport. (2025, July 28). *Ivoire Transport Côte d'Ivoire*. https://ivoiretransport.ci/activites?lang=en

Kachi, A., Voss, M., Grandpré, J. de, & Marquardt, M. (2023). Renewable Senegal. *NewClimate Institute*, *June*, 1–72. https://newclimate.org/resources/publications/renewable-senegal

Kahraman, C., Kaya, I., & Cebi, S. (2009). A comparative analysis for multiattribute selection among renewable energy alternatives using fuzzy axiomatic design and fuzzy analytic hierarchy process. *Energy*, *34*(10), 1603–1616. https://doi.org/10.1016/j.energy.2009.07.008

Karbassi, V., Trotter, P. A., & Walther, G. (2023). Diversifying the African energy system: Economic versus equitable allocation of renewable electricity and e-fuel production. *Applied Energy*, *350*(August), 121751. https://doi.org/10.1016/j.apenergy.2023.121751

Kjellsson, J. (2020). Senegal River Basin. *Transboundary Water*, 1–6.

KORI Tansport. (2025, July 28). *KORI Transport | Gas transport in Côte d'Ivoire*. https://en.koritransport.com/

Koshikwinja, P. M., Cavana, M., Sechi, S., Bochiellini, R., & Leone, P. (2025). Review of the hydrogen supply chain and use in Africa. *Renewable and Sustainable Energy Reviews*, *208*(March 2024). https://doi.org/10.1016/j.rser.2024.115004

LEYEN, U. VON DER. (2023). La commission. *Acta Endoscopica*, *34*(3), 487. http://link.springer.com/10.1007/BF03003901

LowCarbonPower. (2025, August 1). *Senegal Electricity Generation Mix 2023 | Low-Carbon Power Data*. https://lowcarbonpower.org/region/Senegal?utm

LSD Senegal. (2023). *The Taiba N'Diaye Wind Farm in Senegal: Renewable Energy for*

Whom? THE TAIBA N'DIAYE WIND FARM IN SENEGAL: Renewable Energy for Whom? www.re-course.org.

Madanchian, M., & Taherdoost, H. (2023). A comprehensive guide to the TOPSIS method for multi-criteria decision making. *Sustainable Social Development*, *1*(1), 1–6. https://doi.org/10.54517/ssd.v1i1.2220

Mangla, S. K., Kumar, P., & Barua, M. K. (2015). Prioritizing the responses to manage risks in green supply chain: An Indian plastic manufacturer perspective. *Sustainable Production and Consumption*, *1*(March), 67–86. https://doi.org/10.1016/j.spc.2015.05.002

Mastrocinque, E., Ramírez, F. J., Honrubia-Escribano, A., & Pham, D. T. (2020). An AHP-based multi-criteria model for sustainable supply chain development in the renewable energy sector. *Expert Systems with Applications*, *150*, 113321. https://doi.org/10.1016/j.eswa.2020.113321

Matrix Reshish. (2025, May 20). *Matrix Calculator - Reshish*. https://matrix.reshish.com/

MCI CI. (2021). *Stations service 1*.

MEDDTE. (2022). *Le Ministère de l ' Environnement , du Développement Durable et de la Transition Ecologique en collaboration avec Rapport National d ' Inventaire pour la Côte d ' Ivoire au titre de la Convention -Cadre des*.

MEPM. (2021). *Elaboration d ' un plan directeur pour le développement du secteur pétrolier et gazier au Sénégal Rapport intermédiaire QED , PwC Advisory ,*.

MEPM. (2022). *Un Peuple - Un But - Une Foi MINISTERE DE L ' ENVIRONNEMENT , DU DEVELOPPEMENT DURABLE ET DE LA TRANSITION ECOLOGIQUE MINISTERE DU PETROLE ET DES ENERGIES DIRECTION DE L ' ENVIRONNEMENT ET DES ETABLISSEMENTS CLASSES DIRECTION DES HYDROCARBURES GES-PETROGA*.

MEPM. (2023a). *« Elaboration d ' un Plan d ' investissement de la Transition é nerg é tique juste (JET) au S é n é gal » Plan d ' Investissement de la Transition*.

MEPM. (2023b). Rapport Annuel 2023 du FMI. *Rapport Annuel 2023 Du FMI*, 1–34. https://doi.org/10.5089/9798400240478.011

MEPM. (2025, July 15). *Missions du Ministère - Ministère des Energies, du Pétrole et des Mines*. https://energie.gouv.sn/missions-du-ministere/

Meridiam. (2025, August 1). *Senegal Advances Sambangalou Hydropower Plant*. https://energycapitalpower.com/senegal-advances-sambangalou-hydropower-plant/

Methanol institute. (2022). Carbon Footprint of methanol. *Carbon Footprint of Methanol*, *January*, 1–67. www.methanol.org/wp-content/uploads/2022/01/Carbon-Footprint-of-Methanol-studio-Gear-Up-Full-Presentation.pdf

Mohammadi, R., & Harandi, M. H. (2023). Methanol to Olefin (MTO) Value Chain Management. *New Applied Studies in Management*, *6*(1), 7–17.

Mohammed, B. U., Wiysahnyuy, Y. S., Ashraf, N., Mempouo, B., & Mengata, G. M. (2023). Pathways for efficient transition into net zero energy buildings (nZEB) in Sub-Sahara Africa. Case study: Cameroon, Senegal, and Côte d'Ivoire. *Energy and Buildings*, *296*(June), 113422. https://doi.org/10.1016/j.enbuild.2023.113422

Mota, P., Gil Pascoal, A., & Bo, K. (2015). Diastasis Recti Abdominis in Pregnancy and Postpartum Period. Risk Factors, Functional Implications and Resolution. *Current Women s Health Reviews*, *11*(1), 59–67. https://doi.org/10.2174/157340481101150914201735

Motahari, S., Moorjani, S. F., & Rahimpour, M. R. (2024). Methanol Production: A Comprehensive Review of Processes, Catalysts, and Reactors. In *Comprehensive Methanol Science: Production, Applications, and Emerging Technologies: First Edition, Volume 1-4* (Second Edi, Vol. 2, Issue December). Elsevier. https://doi.org/10.1016/B978-0-443-15740-0.00067-7

Mustapha Benamara, Chafia Bessalem, Arnaud Diemer, & Cécile Batisse. (2022). Les Transitions Energetiques À L'Horizon 2030 Et 2050, Le Retour En Grace Des Scenarios Et De La Prospective. *Revue Francophone Du Développement Durable*, *March*.

Ndiaye, F. A., Aidara, M. C., Sene, D., Drame, O., & Ndiaye, M. L. (2025). Analysis of real performance and seasonal prediction of a 23 MWp grid-connected photovoltaic plant in Senegal: Case of Diass. *Energy for Sustainable Development*, *85*(January), 101660. https://doi.org/10.1016/j.esd.2025.101660

NDIAYE, H. H. O. (2021). *BOLLORE TRANSPORT & LOGISTICS CÔTE D ' IVORE*.

NewClimate. (2024). *GREEN HYDROGEN FOR SUSTAINABLE DEVELOPMENT The Role of Multilateral Development Banks REPORT*. https://newclimate.org/

OCDE. (2025). Examen de l'OCDE sur la résilience des chaînes d'approvisionnement. In *Examen de l'OCDE sur la résilience des chaînes d'approvisionnement*. https://doi.org/10.1787/efc0e1c0-fr

Octogone. (2025, August 5). *Trading et distribution - Octogone*. https://dev.octogonegroupe.com/en/secteurs-activites/trading-et-distribution/

OLA Energy. (2025, August 1). *OLA Energy – We keep you going*. https://olaenergy.com/

Olah, G. A., Goeppert, A., & Prakash, G. K. S. (2009). *George A. Olah, Alain Goeppert, and G. K. Surya Prakash Beyond Oil and Gas: The Methanol Economy*.

Opricovic, S., & Tzeng, G. H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. *European Journal of Operational Research*, *156*(2), 445–455. https://doi.org/10.1016/S0377-2217(03)00020-1

Oryx Energies. (2024). *Your energy partner of choice in Africa*. https://oryxenergies.com/uploads/pdf/OE_Corporate Brochure_Intermediary_28052024_EN_aw_Digital.pdf

Oryx Energies. (2025a, July 28). *Côte d'Ivoire - Oryx Energies*. https://oryxenergies.com/fr/notre-implantation/cote-ivoire

Oryx Energies. (2025b, August 4). *Senegal - Oryx Energies*. https://www.oryxenergies.com/en/country/senegal

Osorio-Tejada, J. L., Llera-Sastresa, E., & Scarpellini, S. (2017). A multi-criteria sustainability assessment for biodiesel and liquefied natural gas as alternative fuels in transport systems. *Journal of Natural Gas Science and Engineering*, *42*, 169–186. https://doi.org/10.1016/j.jngse.2017.02.046

Oyewo, A. S., Lopez, G., ElSayed, M., Galimova, T., & Breyer, C. (2024). Power-to-X

Economy: Green e-hydrogen, e-fuels, e-chemicals, and e-materials opportunities in Africa. *Energy Reports*, *12*(August 2024), 2026–2048. https://doi.org/10.1016/j.egyr.2024.08.011

Pastori, M., Udias, A., Cattaneo, L., Moner-Girona, M., Niang, A., & Carmona-Moreno, C. (2021). Bioenergy Potential of Crop Residues in the Senegal River Basin: A Cropland–Energy–Water-Environment Nexus Approach. *Sustainability 2021, Vol. 13, Page 11065*, *13*(19), 11065. https://doi.org/10.3390/SU131911065

pe-omvg. (2025, August 2). *D'UN CHANTIER À L'AUTRE Sambangalou, enfin le bout du tunnel | Site Web du Projet Energie OMVG*. https://www.pe-omvg.org/node/166

PED. (2022). Rapport final. *Europe and the Dollar in the World-Wide Disequilibrium*, 340–348. https://doi.org/10.1163/9789004633995_020

Petrogaz Logistics. (2025, August 4). *PETROGAZ LOGISTICS – Oil Transport & Logistics*. https://petrogazlogistics.com/

Petrosen. (2025, August 1). *Groupe Petrosen – L'énergie pour le développement durable*. https://www.petrosen.sn/

PFO Africa. (2025). *CENTRALE SOLAIRE FERKE SOLAR - PFO Africa*. https://pfoafrica.com/projets/centrale-solaire-ferke-solar/

PND. (2021). *Ministère du Plan et du Développement PLAN NATIONAL DE DEVELOPPEMENT*. 1–197.

Puma Energies. (2024). *Energising communities*. *June*, 1–126. https://pumaenergy.com/wp-content/uploads/2025/03/Puma-Energy-Integrated-Annual-Report-2024.pdf

PwC. (2023). *Accelerating renewable energy investment in West Africa*. https://www.pwc.com/m1/en/publications/documents/accelerating-renewable-energy-investment-in-west-africa.pdf

Rahmat, Y., Maier, S., Moser, F., Raab, M., Hoffmann, C., Repke, J. U., & Dietrich, R. U. (2023). Techno-economic and exergy analysis of e-methanol production under fixed operating conditions in Germany. *Applied Energy*, *351*(July), 121738. https://doi.org/10.1016/j.apenergy.2023.121738

Rubis Energies. (2025, August 5). *Présentation of Rubis Energie - Energies and bitumen distributor*. https://www.rubisenergie.com/en/company/presentation/

Saaty, R. W. (1987). The analytic hierarchy process-what it is and how it is used. *Mathematical Modelling*, *9*(3–5), 161–176. https://doi.org/10.1016/0270-0255(87)90473-8

San Cristóbal, J. R. (2011). Multi-criteria decision-making in the selection of a renewable energy project in spain: The Vikor method. *Renewable Energy*, *36*(2), 498–502. https://doi.org/10.1016/j.renene.2010.07.031

Sar. (2025, August 1). *Sar – Societé africaine de raffinage*. https://www.sar.sn/

Saranga, H., Roy, S., & Chowdhury, S. (2024). Charting a sustainable future: Transformative policies for India's energy, agriculture, and transport sectors. *IIMB Management Review*, *36*(1), 21–38. https://doi.org/10.1016/j.iimb.2024.02.005

senecaesg. (2025, July 26). *Lekela to Build a Large Battery Storage Plant in Senegal - Seneca ESG*. https://senecaesg.com/insights/lekela-to-build-a-large-battery-storage-plant-in-senegal/

Senstock. (2025, August 1). *SENSTOCK | Sénégalaise de stockage*. https://senstock.sn/

Sillman, J., Ylä-Kujala, A., Hyypiä, J., Kärri, T., Tuomaala, M., & Soukka, R. (2025a). Feasibility assessment of e-methanol value chains: Temporal and regional renewable energy, costs, and climate impacts. *Applied Energy*, *391*(April). https://doi.org/10.1016/j.apenergy.2025.125887

Sillman, J., Ylä-Kujala, A., Hyypiä, J., Kärri, T., Tuomaala, M., & Soukka, R. (2025b). Feasibility assessment of e-methanol value chains: Temporal and regional renewable energy, costs, and climate impacts. *Applied Energy*, *391*(March). https://doi.org/10.1016/j.apenergy.2025.125887

SND. (2024). *VISION SÉNÉGAL 2050 - Stratégie nationale de Développement 2025-2029 1*. 1–135.

Star Oil. (2025a, July 31). *Accueil | Star Oil*. https://staroilgroup.com/

Star Oil. (2025b, August 4). *Nos produits et services | Star Oil*. https://www.staroilgroup.com/en/nos-produits-et-services

Suntaeg Energy. (2025, July 26). *ABOUT US | SUNO*. https://www.suntaegenergy.com/en/about-us/

Tabibian, S. S., & Sharifzadeh, M. (2023). Statistical and analytical investigation of methanol applications, production technologies, value-chain and economy with a special focus on renewable methanol. *Renewable and Sustainable Energy Reviews*, *179*(February), 113281. https://doi.org/10.1016/j.rser.2023.113281

TotalEnergies. (2025a). *TotalEnergies - More Energy , Less Emissions*. *March*.

TotalEnergies. (2025b, August 5). *Nos solutions solaires dédiées aux professionnels | v2mssenegal*. https://totalenergies.sn/nos-solutions-solaires-dediees-aux-professionnels

TSK. (2025, August 4). *À propos | Transport Sunukeur*. https://www.tsk.sn/blank-1

Vaidya, O. S., & Kumar, S. (2006). *Analytic hierarchy process: An overview of applications*. European Journal of Operational Research. https://doi.org/10.1016/j.ejor.2004.04.028

Vatankhah Ghadim, H., Haas, J., Breyer, C., Gils, H. C., Read, E. G., Xiao, M., & Peer, R. (2025). Are we too pessimistic? Cost projections for solar photovoltaics, wind power, and batteries are over-estimating actual costs globally. *Applied Energy*, *390*(April), 125856. https://doi.org/10.1016/j.apenergy.2025.125856

Vivo Energy. (2025a, July 15). *Sustainability | Vivo Energy*. https://www.vivoenergy.com/en/sustainability

Vivo Energy. (2025b, August 5). *Sustainability | Vivo Energy*. https://www.vivoenergy.com/en/sustainability

Wang, F., Harindintwali, J. D., Yuan, Z., Wang, M., Wang, F., Li, S., Yin, Z., Huang, L., Fu, Y., Li, L., Chang, S. X., Zhang, L., Rinklebe, J., Yuan, Z., Zhu, Q., Xiang, L., Tsang, D. C. W., Xu, L., Jiang, X., … Chen, J. M. (2021). Technologies and perspectives for achieving carbon neutrality. *Innovation*, *2*(4). https://doi.org/10.1016/j.xinn.2021.100180

Woodsite energy. (2025, August 1). *Sangomar Oil Field Development | Senegal Offshore Oil & Gas*. https://www.woodside.com/what-we-do/operations/sangomar

Annex

Annex 1: Methodology

Table: Criteria (weight)

	Ec & Fv	R & Li	Tc	VCs	Sust
Ec & Fv	1	2	2	3	2
R & Li	1/2	1	1/2	4	1
Tc	1/2	2	1	3	2
VCs	1/3	1/4	1/3	1	1/3
Sust	1/2	1	1/2	3	1
sum	2.833333333	6.25	4.333333333	14	6.333333333

With Ec & Fv: Economic and financial viability; R & Li: Local integration; Tc: Technical capacity; VCs: Value Chain synergy; Sust: Sustainability

Table: Determination of the consistency ratio

	Ec & Fv	R & Li	Tc	VCs	Sust	Average	Lemda
Ec & Fv	0.352941176	0.32	0.461538462	0.214285714	0.315789474	0.332910965	5.223063443
R & Li	0.176470588	0.16	0.115384615	0.285714286	0.157894737	0.179092845	5.153702188
Tc	0.176470588	0.32	0.230769231	0.214285714	0.315789474	0.251463001	5.252846744
VCs	0.117647059	0.04	0.076923077	0.071428571	0.052631579	0.071726057	5.105903143
Sust	0.176470588	0.16	0.115384615	0.214285714	0.157894737	0.164807131	5.165220256
sum	1	1	1	1	1		5.252846744

Table 2 Random Inconsistency index (Saaty,1980)

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.46	1.49

With n: number of criteria; and RI: Random inconsistency index

CI	RI	CR
0.063211686	1.12	**0.056439005**

Table: square of A: A

	Ec & Fv	R & Li	Tc	VCs	Sust	Row total	Weight
Ec & Fv	5	10.75	7	26	11	59.75	**0.33489**
R & Li	3.083	5	3.833	14	5.333	31.25	**0.17515**
Tc	4	7.75	5	21.5	8	46.25	**0.25922**
VCs	1.125	2.167	1.625	5	2.25	12.1667	**0.06819**
Sust	2.75	4.75	3.5	13	5	29	**0.16254**
					sum =	178.417	**1**

Table: $A^2 * A^2$

	Ec & Fv	R & Li	Tc	VCs	Sust	Row total	**Weight**
Ec & Fv	145.645833	270.333333	191.958333	704	281.833333	1593.77	**0.33507**
R & Li	76.5833333	143.520833	101.333333	371.916667	149.416667	842.771	**0.17718**
Tc	110.083333	205.083333	145.645833	531.5	213.708333	1206.02	**0.25355**
VCs	30.6180556	57.0416667	40.3055556	148.770833	59.4305555	336.167	**0.07067**
Sust	70.7708333	132.354167	93.5833333	343.25	137.833333	777.792	**0.16352**
					sum =	4756.52	**1**

Table: A^8

	Ec & Fv	R & Li	Tc	VCs	Sust	Row total	**Weight**
Ec & Fv	104547.841	194997.993	138059.654	506575.951	203148.391	1147330	**0.33507**
R & Li	55262.1655	103073.7	72976.2488	267768.747	107381.73	606463	**0.17711**
Tc	79170.1363	147665.293	104547.841	383610.42	153837.221	868831	**0.25374**
VCs	22025.8267	41081.7642	29085.9499	106724.559	42798.8423	241717	**0.07059**
Sust	51009.793	95142.0456	67360.7474	247163.809	99118.6024	559795	**0.16349**
					Sum =	3424135	1

Annex 2: Table the score of the sub-criteria

Table: Pairwise criterion Economic & Financial viability

	cost comp.	**inv. Cap.**	**size comp.**
cost comp	1	3	5
inv. Cap.	1/3	1	3
size comp.	1/5	1/3	1
sum	1.533333333	4.333333333	9

Table: Consistency ratio of Economic & financial viability

	cost comp.	**inv. Cap.**	**size comp.**	**average**	**lemda**
Cost comp	0.652173913	0.69230769	0.555555556	0.63334572	3.071973401
inv. Cap.	0.217391304	0.23076923	0.333333333	0.260497956	3.032968775
size comp.	0.130434783	0.07692308	0.111111111	0.106156324	3.011201867
sum	1	1	1		3.071973401

CI	RI	CR
0.035986701	0.58	**0.062046035**

Table: Economic & financial viability score

	cost comp.	Inv. Cap	size comp.	Row total	Score
Cost comp	3	7.66666667	19	29.66666667	**0.639674173**
Inv. cap	1.26666667	3	7.66666667	11.93333333	**0.257307139**
Size comp.	0.51111111	1.26666667	3	4.777777778	**0.103018687**
			Sum	46.37777778	**1**

Table: Pairwise of technical capacity

	Infra. Read.	Exp. & Comp.	Inovat. Pot.	Scal & Int. cap.
Inf. Read.	1	2	3	5
Exp. & Comp.	0.5	1	2	3
Inovat pot.	1/3	1/2	1	2
Scal. & Int. cap.	1/5	1/3	1/2	1
sum	2.033333333	3.833333333	6.5	11

Table: Consistency ratio of technical capacity

	Infra. Read.	Exp. & Comp.	Inovat. Pot.	Scal & Int. cap.	average	Lemda
Infra. Read.	0.491803279	0.52173913	0.461538462	0.454545455	0.482406581	4.021428996
Exp. & Comp.	0.245901639	0.260869565	0.307692308	0.272727273	0.271797696	4.020930947
Inovat. Pot.	0.163934426	0.130434783	0.153846154	0.181818182	0.157508386	4.004765182
Scal & Int. cap.	0.098360656	0.086956522	0.076923077	0.090909091	0.088287336	4.011017802
sum	1	1	1	1		4.021428996

CI	RI	CR
0.007142999	0.9	**0.007936665**

Table: Technical capacity score

	Infra. Read.	Exp. & Comp.	Inovat. Pot.	Scal & Int. cap	Row total	Score
Infra. Read.	4	7.166666667	12.5	22	45.66666667	**0.482904**
Exp. & Comp.	2.266666667	4	7	12.5	25.76666667	**0.272471**
Inovat. Pot.	1.316666667	2.333333333	4	7.166666667	14.81666667	**0.15668**
Scal & Int. cap	0.733333333	1.316666667	2.266666667	4	8.316666666	**0.087945**
				Sum	*94.56666667*	***1***

Table: Pairwise of the criterion (Regulatory & Local integration)

	Permit lic	**Com. Imp.**	**Local gov. rel.**
Permit lic	1	5	2
Com. Imp.	1/5	1	1/3
Local gov. rel.	1/2	3	1
sum	1.7	9	3.3333

Table: Determination of the consistency ratio of Regulatory & Local integration

	Permit. Lic.	**Com. Imp.**	**Local gov. rel.**	**average**	**lemda**
Permit lic.	0.588235294	0.555555556	0.6	0.581263617	3.006371814
Com. Imp.	0.117647059	0.111111111	0.1	0.109586057	3.001192843
Local gov. rel.	0.294117647	0.333333333	0.3	0.309150327	3.003523608
sum	1	1	1		3.006371814

CI	**RI**	**CR**
0.003185907	0.58	**0.005492943**

Table: regulatory & local integration score

	Permit lic.	Com. Imp.	Local gov. rel.	Row total	**Score**
Permit lic.	3	16	5.666666667	24.66666667	**0.581761006**
Com. Imp.	0.566666667	3	1.066666667	4.633333333	**0.10927673**
Local gov. rel.	1.6	8.5	3	13.1	**0.308962264**
			sum	42.4	1

Table: Pairwise of the criterion (value chain synergy)

	Strategic partner	**Supply chain**	**Pres. In value chain**
Strategic partner	1	2	4
Supply chain	1/2	1	3
Pres. In value chain	1/4	1/3	1
Sum	1.75	3.333333333	8

Table: consistence ratio determination of value chain synergy

	Strategic partner	**Supply chain**	**Pres. In value chain**	**Average**	**lemda**
Strategic partner	0.571428571	0.6	0.5	0.557142857	3.02991453
Supply chain	0.285714286	0.3	0.375	0.320238095	3.018587361
Pres. In value chain	0.142857143	0.1	0.125	0.122619048	3.006472492
Sum	1	1	1		3.02991453

CI	**RI**	**CR**
0.014957265	0.58	**0.025788388**

Table: value chain synergy score

	Strategic partner	Supply chain	Pres. In value chain	Row total	**score**
Strategic partner	3	5.33333333	14	22.3333333	**0.55949896**
Supply chain	1.75	3	8	12.75	**0.31941545**
Pres. In value chain	0.66666667	1.16666667	3	4.83333333	**0.12108559**
			Sum	39.91666667	1

Table: Pairwise of the criterion (sustainability)

	CO_2 Reduction	**Circularity**
CO_2 Reduction	1	3
Circularity	1/3	1
Sum	1.333333333	4

Table: consistence ratio determination of sustainability criterion

CI	RI	CR
0	0	0

Table: sustainability score

	CO_2 Reduction	Circularity	Row total	**score**
CO_2 Reduction	2	6	8	**0.75**
Circularity	0.66666667	2	2.66666667	**0.25**
		Sum	10.66666667	1