Université Cheikh Anta Diop de Dakar

SPONSORED BY THE Federal Ministry of Research, Technology and Space

****

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

****

MASTER THESIS

Speciality: Economics/Policies/Infrastructures and Green Hydrogen Technology

Assessment of potential partners for e-fuels production in West Africa: Case of Mali and Côte d’Ivoire

Presented by:

Bintou TRAORE

bintoutraore7985@gmail.com / traore.bintou@edu.wascal.org

Major Supervisor	Co-Supervisors
Prof. Dr. Peter Letmathe	Dr Pape Bilal Diakhate
	Jacqueline Lorenz, MSc

September 2025

Dedication

I dedicate this master's thesis to my dear family, whose strong support, encouragement, and sacrifices have given me the strength and inspiration to complete this journey.

Acknowledgment

I sincerely thank and praise Allah for granting me health, strength, and courage throughout these two years of study.

I am equally grateful to all those who, from the beginning of this demanding journey, have offered their constant support. Their valuable advice, as well as their technical, financial, and moral contributions, making it possible to complete this work successfully.

I would like to express my gratitude to:

- BMFTR and WASCAL for scholarship opportunity;
- Dr Assane BEYE, Director 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 Pape Bilal DIAKHATE, my local supervisor at University of Dakar;
- Jacqueline LORENZ, MSc, co-supervisor at RWTH Aachen University;
- 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 extend my gratitude to all those who, in one way or another, contributed to the preparation of this report, even if their names are not mentioned here

Abstract

The transition to sustainable energy in West Africa requires innovative solutions and strategic partnerships. This research examines the prospects for e-fuels (electrofuels) investment in Mali and Côte d'Ivoire, focusing on identifying potential partners, evaluating them through a multi-criteria decision approach, comparing the two countries' readiness, and recommending supportive policies. An Analytic Hierarchy Process (AHP) framework was developed to rank potential partners (including energy companies, state agencies, and investors) based on technical capacity (27%), financial strength (45%), environmental sustainability (8%), socio-political stability (16%), and strategic fit (4%). The study finds that each country has distinct high-potential partners: for example, in Mali, renewable energy firms and state infrastructure companies such as Akuo Energy and OMAP score highly with 30% and 41% respectively, while in Côte d'Ivoire, the national refinery (SIR) with 20% and Vivo Energy (16%) emerge as leaders. The sensitivity analysis showed that partner rankings can shift when future projects and planned investments are taken into account. In Mali, Hydroma rose to first place thanks to its hydrogen and ammonia projects, while Energie du Mali (EDM SA) gained significance through new solar PV developments. In Côte d'Ivoire, Petroleum Company of Côte d'Ivoire (Petroci), SIR, and Côte d'Ivoire Energy (CIE) remained leading partners, though their order may change depending on future strategies. Comparative analysis reveals that Côte d'Ivoire currently benefits from stronger infrastructure and a more favorable investment for e-fuels . In contrast, Mali offers abundant renewable resources, but it needs to develop its energy infrastructure. Despite these differences, the two countries have complementary strengths that could support a regional e-fuels industry by combining Mali's solar potential with Côte d'Ivoire's industrial base. To seize these opportunities, the thesis recommends fostering public-private partnerships, reinforcing grid and storage infrastructure, providing financial incentives, establishing clear regulatory frameworks, and supporting investment in local skills and innovation. These measures can create a favourable environment for e-fuels, attract investment, and encourage technology transfer.

Keywords : E-fuels; Green hydrogen; Partners assesement; Analytic Hierarchy Process (AHP); Mali; Côte d'Ivoire

Résumé

La transition vers une énergie durable en Afrique de l'Ouest nécessite des solutions innovantes et des partenariats stratégiques. Cette recherche examine les perspectives d'investissement dans les e-carburants (électro carburants) au Mali et en Côte d'Ivoire, en se concentrant sur l'identification de partenaires potentiels, leur évaluation à l'aide d'une approche multicritères, la comparaison du niveau de préparation des deux pays et la formulation de recommandations politiques. Un cadre basé sur la méthode Analytics Hiérarchie Process (AHP) a été développé pour classer les partenaires potentiels (entreprises énergétiques, agences publiques et investisseurs) selon leur capacité technique (27 %), leur solidité financière (45 %), leur durabilité environnementale (8 %), leur stabilité socio-politique (16 %) et leur adéquation stratégique (4 %). Les résultats montrent que chaque pays dispose de partenaires à fort potentiel : au Mali, des entreprises d'énergies renouvelables et des sociétés d'infrastructures publiques comme Akuo Energy et l'OMAP obtiennent respectivement 30 % et 43 %, tandis qu'en Côte d'Ivoire, la Société Ivoirienne de Raffinage (SIR) avec 20 % et Vivo Energy avec 16 % se distinguent. L'analyse de sensibilité a montré que le classement des partenaires peut changer lorsque les projets futurs et les investissements prévus sont pris en compte. Au Mali, Hydroma est monté à la première place grâce à ses projets d'hydrogène et d'ammoniac, tandis qu'EDM SA a gagné en importance grâce à de nouveaux développements solaires photovoltaïques. En Côte d'Ivoire, Petroci, SIR et CIE sont restés des partenaires de premier plan, bien que leur ordre de classement puisse changer en fonction des stratégies futures. L'analyse comparative révèle que la Côte d'Ivoire possède actuellement un avantage en matière d'infrastructures et de climat d'investissement pour les e-carburants, alors que le Mali offre d'importantes ressources renouvelables mais doit développer ses infrastructures énergétiques. Malgré ces différences, les deux pays présentent des atouts complémentaires pouvant soutenir une industrie régionale des e-carburants en combinant le potentiel solaire du Mali avec la base industrielle de la Côte d'Ivoire. Pour saisir ces opportunités, la thèse recommande de mettre en place des partenariats public-privé, de renforcer les réseaux et les systèmes de stockage, d'offrir des incitations financières, d'instaurer des réglementations claires et d'investir dans les compétences et l'innovation locales. Ces mesures peuvent créer un environnement favorable aux e-carburants, attirer les investissements et encourager le transfert de technologies.

Mots-clés : e-carburants ; Hydrogène vert ; Evaluation des partenaires ; Procedure d'Analyse Hierachique (AHP) ; Mali ; Côte d'Ivoire

Acronyms and Abbreviations

AHP: Analytic Hierarchy Process

CAGR: Compound Annual Growth Rate

CIPREL: Compagnie Ivoirienne de Production d'Électricité (Ivorian Electricity Production Company)

CI : Consistency Index (also used for Côte d'Ivoire depending on context)

CIE: Compagnie Ivoirienne d'Électricité (Ivory Coast's national electric utility)

CO_2: Carbon Dioxide

CR : Consistency Ratio

DAC: Direct Air Capture (technology for removing CO_2 from air)

DryHy: "Dry Hydrogen" Project (an initiative to produce e-fuels in arid regions using solar energy and air-captured CO_2)

ECOWAS: Economic Community of West African States

EDF : Électricité de France (French multinational electric utility company)

EDM-SA : Énergie du Mali-Société Anonyme (Mali's national energy utility)

EPC: Engineering, Procurement, and Construction

EU: European Union

GCF: Green Climate Fund

H_2: Molecular Hydrogen

HVO: Hydrotreated Vegetable Oil (a type of biofuel diesel)

IEA: International Energy Agency

IPP: Independent Power Producer

IRENA: International Renewables Energy Agency

LNG: Liquefied Natural Gas

LPG: Liquefied Petroleum Gas

MMcf/d: Million cubic feet of gas per day

OMAP : Office Malien des Produits Pétroliers (Malian Petroleum Products Office)

PETROCI: Petroleum Company of Côte d'Ivoire (state oil & gas corporation)

PPM: Parts Per Million

PV: Photovoltaic

RI: Random Index

SIR: Société Ivoirienne de Raffinage (Ivorian Refining Company)

UN: United Nations

VAT: Value Added Tax

ZECI: Zola Electric Côte d'Ivoire

Lists of tables

Lists of figures

Lists of appendices

Contents

Introduction

Nowadays, the world is facing major challenges such as climate change and pollution, both largely driven by the burning of fossil fuels, which is the main source of air pollution and greenhouse gas emissions. In 2018, fossil fuels and industry were responsible for 89% of global carbon dioxide (CO_2) emissions (Solomon et al., 2022).

The energy transition is a major trend of our time, as it aims to reconcile access to clean and sustainable energy for all, while reducing greenhouse gas emissions to limit global warming to below 2 degrees Celsius, as reported in the Paris Agreement (IEA, 2023). Addressing these issues involves the adoption and encouragement of new production pathways and use of energy.

E-fuels, also known as electro-fuels, are synthetic fuels made from clean electricity, water, and CO_2 are seen as a promising solution. These fuels can significantly reduce greenhouse gas emissions (Kranenburg et al., 2020). Moreover, e-fuels can help to decarbonize hard-to-abate sectors such as aviation, shipping, and industry since they can be used in existing engines and infrastructures, making them easier to introduce compared to other clean energy options like batteries or fuel cells (Gavril, 2023).

While, production in Europe is currently limited or non-cost-effective due to insufficient high-capacity renewable energy and low full-load hours, e-fuel plants require around 3,000-4,000 operating hours per year to be cost-efficient, but many European sites only reach around 1,500 h/year (Dell'Aversano et al., 2024).

However, regions such as those in the the African contient offer enormous potential for large-scale solar and wind energy. According to the International Energy Agency, the continent hosts approximately 60 % of the world's best solar resources, yet only about 1 % of global solar PV capacity is installed there (IEA, 2023). Additionally, the cost of electricity from solar photovoltaic (PV) and wind in West Africa is much lower, making e-fuel production more economically viable (IRENA, 2021).

One example of this growing opportunity is the DryHy project, which focuses on producing green methanol in arid, sunny regions like West Africa using renewable solar energy, direct air capture (DAC) of CO_2, and high-temperature electrolysis (Selmert et al., 2025). DryHy is especially innovative because it captures not only CO_2 but also water from the air. This water is then used for electrolysis, making the process water-positive, an important advantage in dry regions.

As shown in a study by Fasihi et al. (2019), producing e-fuels in regions with high solar potential can reduce costs by over 50% compared to Europe. Even though e-fuels offer strong benefits for clean energy and economic development, as demonstrated by studies from the International Renewable Energy Agency (IRENA, 2021), the International Energy Agency (IEA, 2022), and Brynolf et al. (2018), the development and implementation of e-fuel projects in West Africa is still new. There is a lack of studies assessing the potential partners for e-fuel implementation and investment partnership or coordination between the government and companies. To move forward, it is important to identify potential partners that can support e-fuel projects. These can be companies, investors, or public institutions. As Oyewo et al. (2024) highlighted, Africa can emerge as a leader in green energy, but this will require substantial investment in infrastructure, supportive policies, and coordinated collaboration among stakeholders.

This study, titled "Assessment of potential partners for e-fuels production in West Africa" takes its foundation in the DryHy project, which aims to use CO_2 capture technology to produce e-fuels by utilizing renewable energy sources in dry environments.

The study focuses on the identification and ranking of potential partners for the production of e-fuels in West Africa, specifically in Mali and Côte d'Ivoire. These two countries have been selected due to their high solar energy potential, growing commitment to renewable energy, and strategic geopolitical positions in the region, making them pertinent examples for analysing e-fuel partnerships.

Mali has substantial solar irradiance, ranging from 6 to 7 kWh/m²/day, with sunshine lasting up to around 10 hours daily during certain periods of the year (Bagayogo et al., 2025). Côte d'Ivoire also features abundant solar resources, with average solar radiation spanning 4 kWh/m²/day in the south to 6 kWh/m²/day in the north, accompanied by roughly 6 hours of daily sunshine (Koua et al., 2015). Beyond solar power, both countries possess significant wind and hydropower potential that can further support the production of green hydrogen and e-fuels (Resort, 2023).

Importantly, Côte d'Ivoire benefits from a relatively stable political environment (Donner et al., 2024), which adds to its attractiveness as a potential strategic partner. Both countries can leverage their renewable energy resources not only to strengthen domestic energy access but also to export clean fuels to other markets (Oyewo et al., 2024a). As highlighted by Reddy et al. (2023a), green hydrogen and its derivatives (including e-methanol and e-ammonia) are poised to play a critical role in achieving a carbon-neutral economy.

The main goal of this thesis is to assess potential partners for e-fuels project implementation in Mali and Côte d'Ivoire.

To achieve the main objective, this thesis is structured around the following research questions:

- What are the potential partners for e-fuel project implementation in Mali and Côte d'Ivoire?
- Which of these partners show the strongest potential for e-fuel production, based on technical, financial, environmental, political, and strategic factors?
- How do Mali and Côte d'Ivoire compare in terms of the strengths and weaknesses for e-fuel development?
- What policy and regulatory recommendations can support the development of e-fuels and help attract investment in both countries?

This study applies the Analytic Hierarchy Process (AHP) to assess partners across multiple dimensions: technical and infrastructure capacity, economic and financial viability, environmental and sustainability factors, socio-political and regulatory conditions, and strategic partnership potential.

The findings will support the identification of potential partners and the most promising collaborators for advancing e-fuel projects in Mali and Côte d'Ivoire, contributing to the broader development of sustainable energy systems and a well-coordinated e-fuels sector in both countries as well as in West Africa.

This document is organized to provide a comprehensive understanding of the assessment of potential partners for e-fuels production in West Africa. Chapter 1 offers a literature review covering the current state of e-fuels and the renewable energy landscape in West Africa. Chapter 2 outlines the research methodology employed in this study, detailing the data sources and the application of the Analytic Hierarchy Process (AHP) as a multi-criteria decision analysis tool. Chapter 3 presents and discusses the results of the partner evaluations, while Chapter 4 concludes with a summary of the key findings and their implications.

To provide a solid foundation for the study, the next chapter reviews relevant literature on e-fuels, renewable energy resources in West Africa, and the methods used to assess potential partners in this context.

1 Chapter 1: Literature review

To establish a comprehensive background for this study, this chapter reviews the existing literature on e-fuels, the renewable energy landscape in West Africa, and frameworks for assessing potential partners in e-fuel production.

1.1 Introduction to e-fuels

E-fuels, also known as electrofuels, or synthetic fuels, are (International Transport Forum, 2023)produced by using renewable electricity to electrolyze water into hydrogen, which is then combined with captured CO_2 (to create e-diesel, e-kerosene, or e-methanol) or with nitrogen (to produce e-ammonia), resulting in synthetic liquid or gaseous fuels. (International Transport Forum, 2023). Unlike biofuels derived from biomass, which rely on plant growth to uptake carbon, e-fuels capture CO_2 directly from the air or industrial sources and hydrogen from water, and when powered by renewables, this process enables a carbon-neutral fuel cycle where the CO_2 released during combustion has already been removed from the atmosphere (London et al., 2024). Figure 1 illustrates the Different pathways for carbon-based fuel production using both fossil-based and renewable-based.

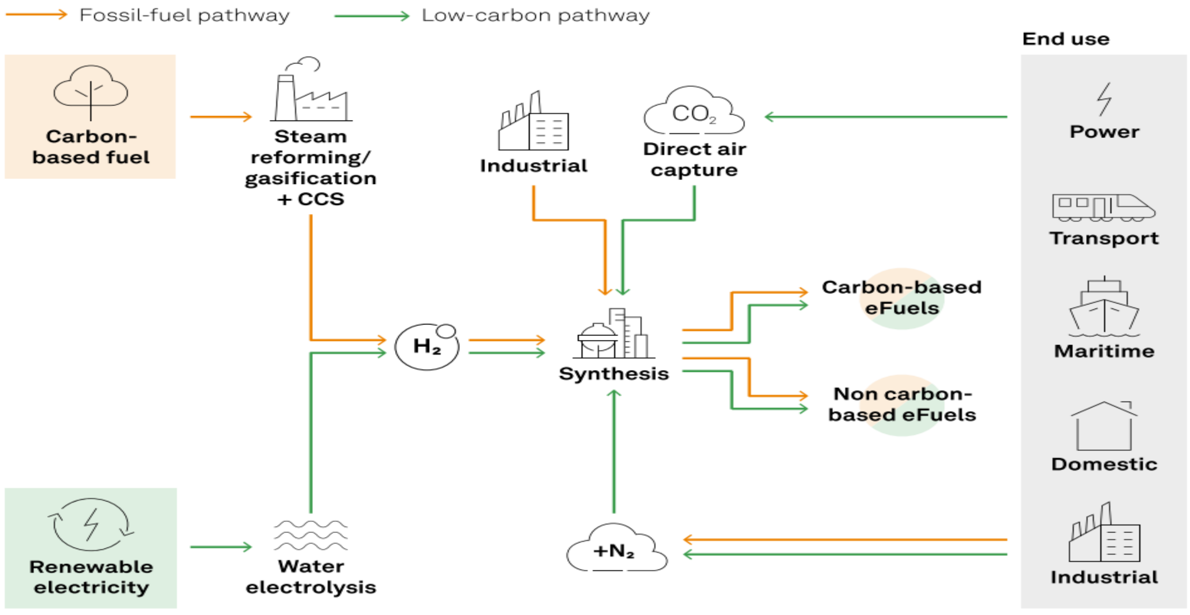


Figure 1: Fossil and renewable pathways for carbon-based fuels and end use

Notes: Carbon capture and storage (CCS); Hydrogen (H2); Nitrogen (N2).

Source: (London et al., 2024)

On the fossil-fuel pathway, carbon-based fuels undergo processes like steam reforming and gasification, often combined with (CCS), to produce hydrogen and synthesis feedstock. On the renewable pathway, renewable electricity powers water electrolysis to produce green hydrogen, while CO_2 and water are captured directly from the air using advanced (DAC) technology (specially in the case of DryHy project). The hydrogen and captured CO_2 are then synthesized into e-fuels, which can be either carbon-based (e.g., e-methanol) or non-carbon-based (e.g., e-hydrogen), and used across various end-use sectors like power generation, transport, maritime, domestic, and industrial applications. This integration of conventional and low-carbon routes highlights the flexibility and potential of combining fossil and renewable resources to produce sustainable e-fuels.

A major advantage of e-fuels is their drop-in compatibility with existing infrastructure and engines. Because they are chemically similar to conventional fossil fuels, they can be used in current internal combustion engines and distributed through today's fuel networks without major modifications (Singh et al., 2022;London et al., 2024). For instance, e-kerosene can replace jet fuel in aviation, while e-methanol and e-ammonia are suitable for use in modified ship engines. This compatibility allows a faster and more cost-effective transition by preserving the economic value of pipelines, tanks, and vehicles already in service (London et al., 2024). Using current pipelines, tanks, and engines for e-fuels enables a faster transition by preserving the economic value of existing assets. Indeed, an industry coalition emphasized that e-fuels allow the decarbonization of the 1.5 billion existing road vehicles, 27,000 aircraft, and 90,000 ships worldwide without immediate fleet replacement (Union & Africa, n.d.).

E-fuels are also gaining global interest as a solution for hard-to-abate sectors where direct electrification is not yet feasible. Heavy industry, aviation, and maritime transport require energy-dense fuels that batteries or grids cannot currently deliver, making e-fuels derived from renewable hydrogen a practical option (Reddy et al., 2023b). By converting renewable electricity into liquid or gaseous fuels, they enable the storage and transport of clean energy across time and geography, overcoming the variability of solar and wind resources (Union & Africa, n.d.). By converting intermittent renewable power into fuels that can be shipped globally, e-fuels enable high-quality renewable resources (such as desert solar or coastal wind) to be used where energy demand is highest (Union & Africa, n.d.). This strategy addresses two key challenges of the clean energy transition: it provides long-term storage for surplus renewable electricity and facilitates its distribution across regions (Union & Africa, n.d.).

Early examples of e-fuel initiatives underscore their growing importance. For instance, the Haru Oni project in Chile is a pioneering demonstration of international investment in e-fuels. This pilot plant (backed by companies like Siemens Energy and Porsche) aims to produce synthetic methanol and gasoline from wind power, water, and CO_2 captured from the air. ExxonMobil has invested in DAC technology for use at Haru Oni, underlining how major energy firms are engaging in e-fuels development (Ash et al., 2019).

Such projects illustrate the global momentum behind e-fuels as a component of carbon neutrality strategies. Governments are also formulating supportive policies: in Europe, for example, recent regulations mandate blending sustainable e-fuels into aviation fuel and allow credits for e-fuels in automotive decarbonization plans. As Oyewo et al. (2024) observed, regions with abundant renewable resources (sun-rich or wind-rich areas) are poised to become key exporters of green e-fuels, supplying global markets hungry for carbon-neutral (Nemmour et al., 2023). In fact, e-fuels represent an important pathway to extend renewable energy's reach to sectors and regions difficult to decarbonize, leveraging existing infrastructure and a growing international commitment to climate-neutral energy.

1.2 Global Demand for E-Fuels

At present, the use of e-fuels is very limited, with only pilot quantities being produced and blended. For instance, in aviation, sustainable aviation fuels (SAF), which include biofuels and synthetic fuels, accounted for less than 0.1% of total jet fuel consumption as of the early 2020s (International Energy Agency (IEA), 2023). However, projected demand for e-fuels is expected to grow rapidly in the coming decades as countries strive to decarbonize their transport and industry sectors. The IEA's analysis for a net-zero trajectory indicates that hydrogen-based fuels must supply about 36 Mtoe (416 TWh) of final energy globally by 2030, and around 307 Mtoe (3,566 TWh) by 2050 (International Energy Agency, 2023).

These sectors produce a large share of global CO_2 emissions, rely on high-energy-density fuels, and have long-lasting infrastructure and vehicles (Dybiński et al., 2025). Current battery technology cannot meet the needs of long-distance aircraft or deep-sea ships, and biofuels face sustainability limits. E-fuels (such as synthetic kerosene, diesel, methanol, and ammonia) offer a key solution. According to Dybiński et al (2025), the transport sector will likely see a mix of solutions: (i) direct electrification (batteries) for light-duty and short-range, (ii) indirect electrification by hydrogen fuel cells for some applications, and (iii) non-fossil drop-in fuels like e-fuels for legacy combustion engines and long-range modes (Dybiński et al., 2025). In aviation, (SAF) mandates like the European Union's ReFuelEU plan will require e-kerosene blends of 6% by 2030 and 34% by 2040 (London et al., 2024). Because aircraft will depend on liquid hydrocarbons for decades, e-kerosene is the most realistic option for deep emission cuts. Similarly, shipping is testing e-ammonia and e-methanol as zero-carbon fuels for ocean vessels, as they work in adapted engines or fuel cells and avoid CO_2 emissions.

Green ammonia is important for decarbonizing fertilizer production, with global demand at about 185 million tonnes per year, part of which could come from e-ammonia instead of fossil sources. Green methanol, used as both a chemical feedstock and fuel, has a global demand of around 100 million tonnes and is growing. E-methane could replace fossil gas in pipelines or power plants, but its use may be limited due to lower efficiency in the power-to-gas process (International Energy Agency, 2023). Figure 2 below illustrates the projected market growth for e-fuels from 2020 to 2035, segmented by key application sectors such as automotive, marine, industrial, and others and further divided across regions including North America, Europe, Asia, Latin America, the Middle East and North Africa, and the Rest of the World.

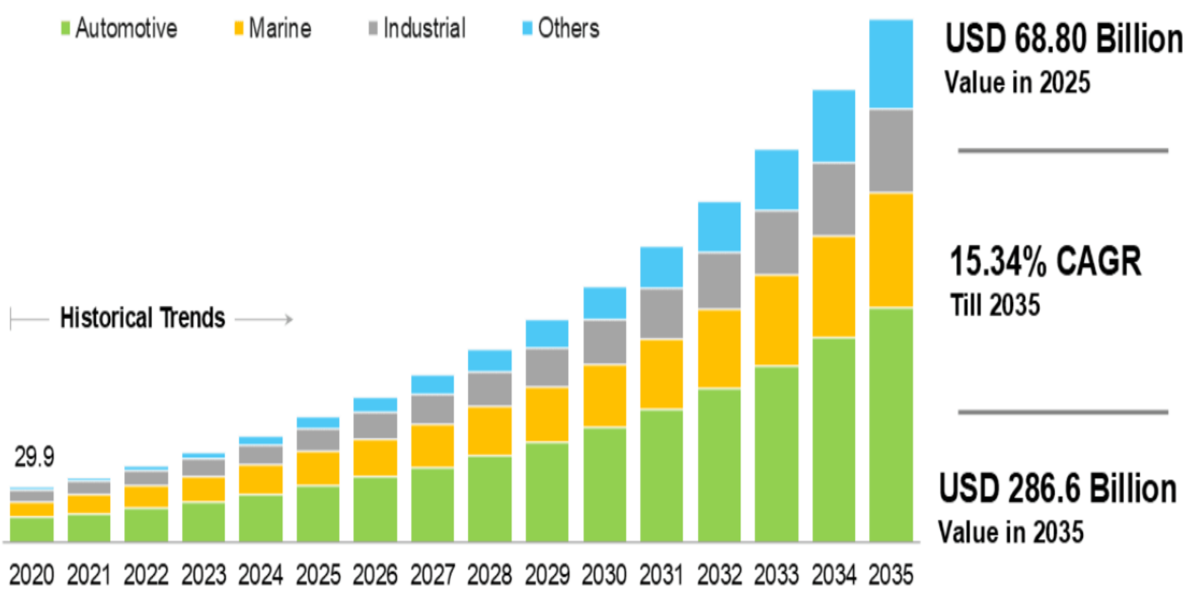


Figure 2: Market growth and segment distribution of e-fuels (2020-2035)

Source: (*E-Fuels Market Size, Share, Trends, & Insights Report, 2035*, 2025)

The chart shows steady growth with a total estimated market value reaching USD 68.80 billion by 2025 and USD 286.6 billion by 2035, reflecting a compound annual growth rate (CAGR) of 15.34% through 2035. Automotive applications dominate the market share, followed by marine, industrial, and other sectors, indicating increasing adoption of e-fuels across different industries over time. The visualization highlights the expanding economic potential and diversification in e-fuel usage.

Another demand driver is energy security and the need for clean energy imports in regions with limited renewable resources. Many industrialized countries (e.g., Japan, most of Europe) have high energy demand but constrained renewable generation potential. E-fuels offer a way for them to import renewable energy in chemical form from countries with abundant solar or wind. For example, Germany and Japan are both investing in partnerships to import green ammonia (for co-firing in power plants or shipping fuel) from countries like Saudi Arabia, Chile, and Australia. Global energy trade could thus shift from fossil fuels to e-fuels and hydrogen carriers, allowing sunbelt regions to become net exporters of energy by 2030-2040. Oyewo et al. (2024) note that Africa could emerge as an important exporter of e-fuels and e-chemicals by mid-century, supplying up to 47% of global e-fuel trade in their scenario. This would meet growing demand in energy-importing economies while creating an economic opportunity for renewable-rich developing regions (Oyewo et al., 2024b).

A Netherlands-focused study by Van Kranenburg et al. (2020) estimated that meeting the country's 2050 international transport fuel needs would require over 960 PJ of e-fuels. Producing this amount would need more than 2000 PJ of renewable electricity plus large electrolyser and synthesis capacity. This is far beyond the Netherlands' domestic renewable output, meaning imports would be unavoidable (a situation likely for many European countries). The authors conclude that a major scale-up of e-fuel production and infrastructure is essential for decarbonizing heavy transport. Even with strong deployment, a small, densely populated country would still depend on imports, making global e-fuel trade important. They also highlighted the need for close cooperation between governments, energy suppliers, fuel producers, ports, and end-users. For example, ports should plan for e-fuel production and bunkering facilities, while logistics companies and consumers must initially accept higher fuel costs to support sustainability.

1.3 Challenges in E-Fuel Development

E-fuels face a key challenge: they are highly energy-intensive and relatively inefficient. Their production process (splitting water into hydrogen, capturing CO_2, and synthesizing fuel) incurs energy losses at each stage. As a result, they require roughly six times more energy than fossil fuels. For example, meeting the EU's 2050 aviation targets could demand 380 TWh of renewable electricity, about 6% of total projected generation (London et al., 2024). In many cases, using electricity directly in batteries or motors is far more efficient. Since e-fuels return only a fraction of the renewable energy invested, their large-scale use would require a significant expansion of already limited clean power supplies (London et al., 2024).

Another major challenge is the high production cost, since e-fuels need large amounts of energy and involve complex production processes. Analyses estimate that current e-fuel production costs can be 8-10 times higher than fossil fuel equivalents (Arnaud & Cedric, 2025). Even with future improvements, they are expected to stay several times more costly over the next decade or two. For example, synthetic kerosene or diesel made from renewable electricity and CO_2 capture may cost around €2 per litter in the mid-2020s, compared to only a few cents for petroleum fuels. Costs are driven mainly by renewable electricity prices, electrolyser capacity, and CO_2 capture, especially DAC, which is still new and expensive (London et al., 2024). Green hydrogen from water electrolysis is also costly and makes up most of the production cost, so cheaper clean electricity and more efficient technology are essential. With production still at pilot scale, large investments are needed, and early output will remain limited and expensive. This means adoption may depend on strong policy support (like subsidies, carbon pricing, or fuel mandates), especially for sectors such as aviation and shipping that can pass on higher costs to customers (Arnaud & Cedric, 2025).

There are also important technological and scaling challenges. Although the main processes for producing e-fuels (such as electrolysis, Fischer-Tropsch synthesis, and methanol synthesis) are well known, expanding them to large-scale production is difficult (Nemmour et al., 2023). Supply chains for key equipment, like large electrolysers, renewable power plants, and CO_2 capture units, are still limited and may slow growth. Global electrolyser capacity and green hydrogen projects would need a huge expansion to meet the hydrogen demand for widespread e-fuel use (Nemmour et al., 2023). Carbon capture, especially DAC, is still in its early stages, and scaling it to hundreds of megatons will require major advances and investment (London et al., 2024). Current planned projects fall far short of what is needed for ambitious climate targets, showing a large gap between goals and reality. Producing e-fuels at scale may also require new renewable plants in remote areas, plus pipelines, transmission lines, or shipping facilities to move hydrogen or fuels to markets (Arnaud & Cedric, 2025). Another issue is water: most electrolysers need freshwater, so in arid regions this could compete with agriculture and human needs. New technologies for using seawater or brackish water are in development, but until they mature, water availability will limit where large-scale green hydrogen and e-fuel production can be produced sustainably (Selmert et al., 2025).

Finally, environmental and operational challenges remain even if e-fuels are successfully produced. Crucially, e-fuels do not eliminate pollutant emissions associated with fuel combustion. When burned in engines or turbines, carbon-based e-fuels emit nitrogen oxides (NOx) and other local air pollutants, much like fossil fuels (Nemmour et al., 2023). These emissions contribute to smog and respiratory problems and would perpetuate air-quality concerns, especially in urban areas or transit hubs such as airports and ports (Reddy et al., 2023b). While e-fuels are near-zero in net CO_2, the NOx and particulate matter from their combustion in internal combustion engines could still expose companies to environmental compliance issues and health impacts. Unlike full electrification (like electric vehicles), they do not remove tailpipe emissions (London et al., 2024). Some synthetic fuels may be formulated to burn more cleanly (for example, with lower sulphur or aromatic content) to reduce soot or sulphur oxides (Nemmour et al., 2023). However, NOx formation is inherent to high-temperature combustion and cannot be fully avoided, so pollutant standards will still apply (Nemmour et al., 2023).

Beyond emissions, safety and environmental risks remain. Many e-fuels are flammable or toxic. Ammonia, used as an e-fuel for shipping, is caustic and poisonous; leaks or accidents could harm workers or ecosystems (Reddy et al., 2023b). Storing and transporting large volumes will require strong safety measures. Likewise, e-methanol and e-diesel carry fire and explosion risks similar to fossil fuels. Damage to storage tanks, pipelines, or fuel ships can cause pollution similar to oil spills (Reddy et al., 2023b).

In short, e-fuels do not solve all non-CO_2 environmental issues: they shift climate impacts to production and cut CO_2 at use, but concerns about air pollution, water use, and safety remain. These combined challenges highlight that e-fuels will need major innovation, investment, and policy support to achieve their role in a low-carbon future (Selmert et al., 2025).

1.4 Potential for E-Fuel Production in West Africa

West Africa holds considerable potential for producing e-fuels, thanks to its abundant renewable resources and strategic location. Africa as a whole is increasingly recognized as a future supplier of green hydrogen and synthetic fuels due to vast solar and wind availability in many regions (IRENA, 2023). Recent energy system models suggest the continent could emerge as one of the major exporters of e-fuels by mid-century, leveraging low-cost renewable electricity to produce fuels at competitive prices (IRENA, 2022). Projections for 2050 indicate that Africa might supply up to 47% of the world's traded e-fuels and e-chemicals under ambitious transition scenarios (Oyewo et al., 2024a). Much of this potential is based on the continent's "Solar-to-X" advantage; many African locations enjoy high solar irradiance and available land, enabling extremely cheap solar power as the primary input for electrolytic hydrogen and e-fuel synthesis (Selmert et al., 2025).

West Africa, in particular, contains some of these prime resource hotspots. The Sahelian band of West Africa has intense solar radiation, averaging 5-6 kWh/m²/day across the subregion and even higher in desert areas (IRENA, 2022). This translates into very low levelized costs of electricity (LCOE) from large solar farms. A recent study finds that by 2050, Mali and northern Nigeria (both in West Africa's sun-rich Sahel) could achieve some of the lowest renewable electricity costs in the world, on the order of €14-16 per MWh (IRENA, 2022). Coastal West African countries also have strong solar potential, although it is a bit lower than in the Sahel, and they have moderate wind resources, especially in some regions and offshore areas (IRENA, 2023). With such plentiful renewable energy, West Africa could produce green hydrogen, ammonia, or synthetic hydrocarbons at attractive costs, positioning the region as a candidate for e-fuel production hubs. Furthermore, its Atlantic coastline facilitates export; e-fuels manufactured in coastal West African nations can be shipped to European or other markets relatively efficiently, similar to how fossil fuels are traded. This geographical advantage means countries like Senegal, Côte d'Ivoire, or Ghana could serve as export gateways for e-fuels produced either domestically or in neighbouring landlocked countries (Oyewo et al., 2024a). In summary, West Africa's resource endowment and location give it a strategic opportunity to participate in the emerging e-fuel economy, both to meet local energy needs and to supply global demand for clean fuels (IRENA, 2022). Some areas also offer wind potential, and the country has a unique asset: naturally occurring underground hydrogen (gold or white hydrogen). Studies suggest these reserves could yield millions of tonnes annually, providing a low-cost, carbon-free feedstock without electrolysis (Hydroma, 2022).

However, major hurdles remain. For instance, electrolysis requires significant water, which is scarce in arid climate countries such as Mali, thus making a sustainable supply essential (Selmert et al., 2025). Also, the country faces political instability and possesses weak infrastructure, which further deters investment, complicating export projects like pipelines or transmission lines (World bank, 2023). Recent hydrogen exploration efforts faced delays due to unrest and border issues (Hydroma, 2022). In short, Mali could become a competitive hydrogen and e-fuel producer, but must address water and governance challenges to realize its full potential.

Côte d'Ivoire's e-fuel potential is closely linked to its renewable energy ambitions and its position as an economic hub in West Africa. The country benefits from a diversified renewable mix: substantial hydropower already installed, strong solar potential in northern savannah areas, and some wind and biomass resources (IRENA, 2022). The government sees green hydrogen as a "key driver" of sustainable development, aiming to integrate it into power generation, transport, and industry as part of its net-zero pathway (ECREEE ECOWAS, 2023). Côte d'Ivoire targets 45% renewable electricity by 2030, up from about 30% today, through expansion of solar, hydro, and biomass (IRENA, 2022). Within this framework, the country is exploring green hydrogen production by 2030, aligned with ECOWAS goals of 0.5 million tonnes annually by 2030 (around 4-5 GW electrolysers) and 10 million tonnes by 2050 (IRENA, 2022). As one of the more stable and industrialized West African states, Côte d'Ivoire aims to attract foreign investment for large-scale hydrogen and e-fuel projects. Its coastal location enables efficient export of green ammonia, methanol, or synthetic diesel via the Gulf of Guinea, while its robust infrastructure; functioning grid with exports to neighbours, a modern port, and experience with large projects offers a competitive advantage (ECREEE ECOWAS, 2023). Policies like waiving import duties and VAT (Value Added Tax) on renewable energy equipment, and giving tax breaks on financing costs, make investing even more attractive. Challenges remain: reaching 45% renewables by 2030 will require significant capital, and solar irradiance is lower than in Mali's Sahel, meaning hydrogen costs may be higher (Oyewo et al., 2024a). Nonetheless, Côte d'Ivoire's political stability, climate commitment, and investor-friendly policies make it one of the region's most promising e-fuel locations. In the long term, successful projects here (or in neighbours like Ghana and Senegal) could showcase West Africa's capability to produce and export carbon-neutral fuels, combining Mali's vast solar potential with Côte d'Ivoire's infrastructure to strengthen the region's role in the global e-fuel supply chain.

1.5 Renewable Energy Investment Landscape in West Africa

The investment landscape for renewable energy in West Africa is characterized by enormous needs and opportunities on one hand, and persistent challenges in attracting capital on the other. The region's renewable resource base is vast; West Africa collectively has an estimated 2,000 GW of renewable energy potential (solar, wind, hydro, and others), which far exceeds the electricity needed to support its population (WREI, 2022).

Paradoxically, West Africa combines vast renewable energy potential with some of the world's lowest electrification rates. As of the early 2020s, around 220 million people in the region lack electricity access, and many connected households face high power costs (IEA, 2023) . This deficit underscores the urgent need for major investment in generation and grids to meet both development and decarbonization goals. Expanding renewables is widely regarded as the most viable route to universal access and sustainable growth (IEA, 2023; World bank, 2023). Investor interest in Africa, particularly West Africa renewable energy is showing positive momentum. In 2023, Africa attracted a record $15 billion in renewable energy investment, more than double the previous year, although still only 2.3% of global clean energy financing (Chance, 2024). This growth was driven by several large-scale projects reaching financial close across the continent.

Within Africa, West Africa is emerging as a new investment hotspot, with notable increases in renewable FDI and related job creation (EY, 2023). Recent flagship developments (such as utility-scale solar farms and a landmark green hydrogen project in Mauritania) have strengthened the region's profile as an "emerging player" in green investment (IRENA, 2022). Countries like Nigeria, Ghana, Senegal, and Côte d'Ivoire have been identified as particularly attractive markets, supported by market liberalization measures and large renewable project pipelines (World bank, 2023). This momentum aligns with initiatives like the African Development Bank's *Desert-to-Power* program, which seeks to mobilize international funding for 10 GW of solar across 11 Sahel countries, including Mali, Niger, and Senegal, by 2030. Harnessing even part of West Africa's renewable potential could both reduce energy poverty and supply global clean energy markets via exports such as green hydrogen and e-fuels, drawing continued interest from foreign investors, multilateral lenders, and regional institutions (IRENA, 2022).

Despite its renewable potential, West Africa's investment climate still faces notable hurdles. Many countries have limited project bankability due to weak public finances and debt distress. State-owned utilities often depend on subsidies and have poor creditworthiness, creating off-taker risk for independent power producers (World bank, 2023). Tariffs are frequently not cost-reflective (politically maintained below production costs) requiring subsidies that may be unsustainable. This raises the perceived risk premium for projects, driving up financing costs and deterring investors (Ernst & Young, 2023). Bureaucratic delays, unclear land rules, and underdeveloped regulatory frameworks further slow progress, though reforms are gradually improving conditions. Some countries have begun liberalizing their power markets: Nigeria has unbundled utilities, while Ghana and Côte d'Ivoire have introduced independent producers and regulatory strengthening (ECREEE ECOWAS, 2023; World bank, 2023). However, experts stress the need for tariff reform, utility restructuring, and stronger governance to build investor confidence. Risk mitigation tools (such as payment guarantees, currency insurance, and blended finance) are increasingly deployed to attract foreign capital(IRENA, 2022).

International climate finance and large-scale flagship projects signal growing momentum. The UAE-backed $34 billion green hydrogen and e-fuels project in Mauritania, launched in 2023, illustrates global interest (BloombergNEF, 2025). Masdar and partners aim to mobilize $10 billion by 2030 for African renewables, targeting 10 GW of capacity (Ernst & Young, 2023). Development banks have financed solar projects in Mali, Niger, Senegal, and Côte d'Ivoire, often through blended finance structures (World bank, 2023). If policy reforms continue and stability improves, West Africa could capture a greater share of global clean energy investment, leveraging both its growing local demand and competitive renewable resources for export.

2 Chapter 2: Methodology

To achieve our goals, we used a multi-criteria decision analysis (MCDA) to identify the most promising e-fuels production partners in Mali and Côte d'Ivoire. This methodology is a systematic approach used to assess and rank different alternatives by examining multiple criteria at the same time. It guides decision-makers in balancing various factors, such as economic, environmental, social, and technical considerations, which help to make transparent and well-informed decisions when trade-offs are involved. MCDA simplifies complex decisions by breaking them into smaller components, assigning weights to each criterion, and scoring the options to identify the most appropriate choice(s) (Effatpanah et al., 2022).

The first step was to identify the criteria and sub-criteria involved in assessing partners for a e-fuel project.

2.1 Criteria and Sub-Criteria Definition

The decision goal was to evaluate potential partners for e-fuels production. Based on a literature review and context analysis, partner evaluation must cover not only technical skills and financial strength, but also environmental responsibility, social acceptance, and alignment with national strategies (Effatpanah et al., 2022; Schöne et al., 2021). Because of this complexity, single-factor analysis is not enough. Research on energy planning highlights the need to combine technical, economic, environmental, social, and political aspects for sustainable outcomes. Similar multi-criteria methods have been applied in Asia and Africa to assess clean energy projects, using factors such as financial viability, technology reliability, environmental impacts, and resource availability (Gerard et al., 2025).

Following global practices to chose our criteria and sub-criteria, several studies have applied the Analytic Hierarchy Process (AHP) or other MCDA methods to structure complex evaluations. For example, Maruthur et al., (2015) used AHP to rank diabetes medications by weighing clinical benefits. Similarly, Chen et al., (2013) applied MCDA to assess sustainable construction systems in China, considering criteria such as environmental protection, resource efficiency, and cost management. In the agricultural sector, Poursaeed et al., (2010) employed AHP to evaluate partnership models for sustainable farming in Iran using nine sustainability-related criteria, including land consolidation, crop rotation, and reduced chemical inputs. More recently, Schöne et al., (2021) applied MCDA to fuel cells for Sub-Saharan African minigrids, analyzing economic, technical, environmental, and social criteria.

Drawing on these global practices, our case will be based on five main criteria including, technical and infrastructure capability, economic and financial viability, environmental and sustainability performance, socio-political and regulatory context, and Strategic and partnership. These five categories capture the essential dimensions of partner suitability in sustainable e-fuels projects, providing a holistic basis to compare potential partners that is adapted to West Africa but also relevant worldwide. Table 1 presents a detailed overview of the five main criteria along with their representative sub-criteria.

Table 1: Criteria and sub-criteria

Criteria	Sub-criteria	Justification
Technical and Infrastructure Capability	1. Integrating to Renewable Energy System	Key input for H_2 production
	2. Scalability Potential	Long-term viability
Economic and Financial Viability	1. Investment Capacity	Capital availability
	2. Cost Competitiveness	Determines market competitiveness
	3. Economic Stability	Reduces financial risks
Environmental and Sustainability	1. Carbon Footprint Reduction Potential	Benefit of e-fuels
	2. Biodiversity and Land Use Impacts	Avoid ecological damage
Socio-political and Regulatory	1. Political and Social Stability	Ensures project continuity
	2. Regulatory Framework and Permits	Fast permits obtention
	3. Government Support and Policy Alignment	Subsidies to improve viability
Strategic and Partnership	1. Existing Experience in Energy Projects	Facilitate the adaption
	2. Partnership Reliability and Reputation	Trust in the collaborators
	3. International Collaboration Potential	Access to global technologies and markets
	4. Existing Sector Partnerships (Transport, Aviation, etc.)	Facilitate supply contract

Source: Author

The main criteria and their sub-criteria were selected based on studies on sustainable energy partnerships that were cited earlier and then adapted to the specific context of Mali and Côte d’Ivoire. This adjustment involved redefining the conception of selection by retaining only the criteria most suitable for our case. The sub-criteria served as a basis for collecting data on the characteristics of each potential partner. In practice, information for each sub-criterion was obtained from secondary sources such as company websites, annual reports, and industry publications. All the necessary data were found through these sources, ensuring that the evaluation of partners build on reliable and verifiable evidence. For example, company reports gave details about technical aspects like renewable energy integration, while policy documents and news articles provided information on socio-political stability and government support.

MCDA encompasses various methods designed to evaluate and prioritize alternatives based on multiple criteria. Among these methods, the Analytic Hierarchy Process (AHP) was specifically chosen for our study due to several important advantages relevant to our context.

2.2 Analytic Hierarchy Process (AHP) Framework

AHP, originally developed by Saaty (1980), provides a structured hierarchical framework for complex decision-making involving multiple criteria (Taherdoost, 2017). It is one of the most commonly used MCDA methods for making decisions in energy and sustainability fields (Braune et al., 2009). The AHP method was chosen because of its ability to integrate both quantitative data and qualitative judgments, resulting in a transparent and traceable decision-making process (Maruthur et al., 2015a). AHP helps decision-makers allocate different weights to various factors and shows how each factor affects the final result, which improves the clarity and fairness of the ranking process. Previous studies like (Effatpanah et al., 2022), (Alamoodi et al., 2024), and (Hummel et al., 2014) have shown that AHP can make group decisions more consistent and help stakeholders understand the reasons behind the final rankings (Maruthur et al., 2015a).

The AHP method involves a series of structured steps that guide the decision-making process, from defining the goal and criteria to the determination of the final ranking of alternatives.

2.3 Steps to conduct AHP

The AHP method was implemented in five key steps, each detailed below, following standard guidelines. All calculations, including pairwise comparisons, eigenvector computations, and consistency checks, were done in Microsoft Excel using Saaty’s formulas and procedures.

2.3.1 Hierarchy Structure definition

The first step was to clearly define the decision problem and break it down into a hierarchical model. The main goal (selecting the most promising e-fuel production partner in Mali and Côte d'Ivoire) was placed at the top of the hierarchy. Below this goal, we identified five main criteria that represent the key decision factors as presented in Table 1. At the bottom level of the hierarchy, the potential partners were listed as the alternatives. This hierarchical structure reflects the standard AHP approach of problem decomposition. Figure 3 illustrates the AHP hierarchy, showing the overall goal at the top, the five criteria in the middle, and the alternative partners at the bottom.

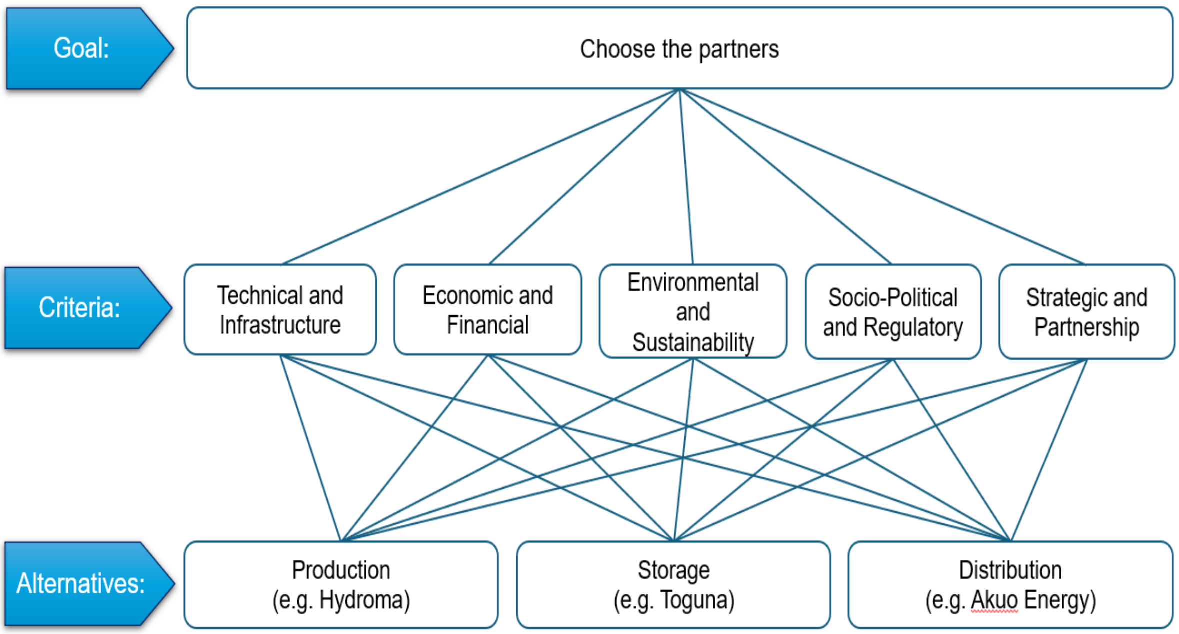


Figure 3: The hierarchy diagram

Source: Author

Organizing the decision elements in this hierarchical manner ("**goal** → **criteria** → **alternatives**") is an important part of AHP, as it simplifies a complex problem into smaller parts. This hierarchy was checked to ensure that the criteria were complete and did not overlap, following AHP guidelines (Taherdoost, 2017).

2.3.2 Construction of the Pairwise Comparison Matrix

After structuring the hierarchy, we quantified the relative importance of the five main criteria using pairwise comparisons. In this step, each criterion was compared with the others, two at a time, to decide which one is more important in relation to the overall goal. We applied Saaty's fundamental 1-9 scale of relative importance for these comparisons:

1: Equally important
2: Equally to moderately more important
3: Moderately more important
4: Moderately to strongly more important
5: Strongly more important
6: Strongly to very strongly more important
7: Very strongly more important
8: Very strongly to extremely more important
9: Extremely more important

For example, if Criterion X was judged to be "strongly more important" than Criterion Y, we gave it a score of 5 in the (X, Y) position of the matrix; in the opposite (Y, X) position, we placed the reciprocal value of 1/5. This step created a 5×5 pairwise comparison matrix A for the criteria. Table 2 shows this comparison for each criterion.

Table 2: Comparing the criteria on AHP's 9-point scale

Criteria	C1	C2	C3	C4	C5
C1	1	1/2	3	2	7
C2	2	1	5	3	9
C3	1/3	1/5	1	1/2	2
C4	1/2	1/3	2	1	5
C5	1/7	1/9	1/2	1/5	1

Source: Author

C1= Technical and infrastructure, C2= Economic and financial, C3= Environmental and sustainability, C4= Socio-political and Regulatory, C5= Strategic and Partnership

These comparisons were made using secondary data with the data indicators helping to decide which criteria are more important than others. Similar to Schöne (2021), who weighted technical, economic, environmental, and social dimensions for fuel cells in minigrids, our study justified the relative importance of criteria by aligning them with the specific requirements of e-fuel development in West Africa. This ensures that the assigned values are not arbitrary but grounded in precedent studies and regional energy realities. This step follows the AHP principle that all decision criteria must be compared in a structured way to determine their priority weights (Saaty, 1980; Taherdoost, 2017).

2.3.3 Calculation of Criteria Weights and Consistency Check

- Calculation of the criteria weights

With the pairwise comparison matrix completed, the next step was to calculate the weight of each criterion. We used the eigenvector method (the classic AHP approach) to derive the criteria weights. In practice, this step involved normalizing the pairwise comparison matrix and calculating the principal eigenvector, which represents the relative weight of each criterion (Saaty, 1980; Taherdoost, 2017). Essentially, we averaged each criterion's values (after normalizing each column of the matrix) to get an approximate priority vector. This priority vector w (with five elements for our five criteria) is the normalized eigenvector of matrix A, satisfying $AW = \lambda maxW$.

In this equation, A denotes the pairwise comparison matrix containing all judgment ratios, W is the normalized priority vector of weights for the criteria, and λmax is the maximum eigenvalue of the matrix. The relationship $AW = \lambda maxW$ reflects that the derived weights are the principal eigenvector of the comparison matrix, with λmax used to test the consistency of the judgments.

The resulting weights show how important each criterion is compared to the others. For example, if "Economic Viability" has a weight of 0.40 and "Environmental Impact" has 0.10, it means the economic factor was judged to be four times more important in this decision. Table 3 shows the priority vector calculation following all the steps and Saaty's formulas.

Table 3: Calculation of the priority vector (weights)

Criteria	C1	C2	C3	C4	C5	Total Row	Weight
C1	5	3.044	16	8.4	34.5	66.944	27%
C2	8.452	5	26.5	14.3	57	111.252	45%
C3	1.602	0.956	5	2.667	10.633	20.858	8%
C4	3.048	1.872	9.667	5	20.5	40.087	16%
C5	0.775	0.460	2.384	1.269	5	9.888	4%
					Sum:	249.029	100%

Source: Author

The result in the Table 3 hows the importance of each criterion in the decision-making process. C2 (economic and financial) has the highest weight (45%), meaning it is the most important factor. The criteria C1 (technical and infrastructure) is the second most important (27%). The other criteria C3 (environmental and sustainability), C4 (socio-political and regulatory), and C5 (strategic and partnership) have lower weights, showing they are less important in the evaluation. This result means that technical and economic factors were given the highest priority in the analysis.

After calculating the weight, we did another step, which is to square the squared pairwise comparison matrix above by repeating steps 1-3, which produces the Table 4 below. Squaring the square pairwise ensures that the results are stable and reliable. This step confirms consistency, reduces minor judgment errors, and verifies that the final weights accurately reflect the decision-maker's priorities. The process strengthens confidence in the ranking of criteria before proceeding with the analysis (Saaty, 1980). We square the pairwise matrix until the priority vector (weights) no longer changes significantly, for example, up to three or four decimal places of accuracy.

Table 4: Square the matrix again

Criteria	C1	C2	C3	C4	C5	Total Row	Weight
C1	128.695	77.341	404.130	213.984	860.867	1685.017	27%
C2	214.720	129.066	674.367	357.002	1436.540	2811.696	45%
C3	40.464	24.321	127.089	67.285	270.749	529.909	8%
C4	77.670	46.674	243.917	129.166	519.648	1017.076	16%
C5	19.325	11.616	60.701	32.137	129.329	253.107	4%
					Sum:	6296.804	100%

Source: Author

In our case, these no longer change, every criterion kept its primary weight. To complete this process in AHP, we carried out a consistency test to verify if the weights assigned are consistent

- Consistency test

The consistency test in AHP calculates the Consistency Ratio (CR) to measure whether the decision-makers' pairwise comparisons are logically consistent, ensuring the derived weights are meaningful and not the result of random judgments.

AHP checks the consistency of judgments by calculating the maximum eigenvalue λmax of the matrix and then determining the Consistency Index (CI) and Consistency Ratio (CR) (Saaty, 1980).

- Calculation of the Consistency Index (CI)

To evaluate the degree of consistency in the judgments, the CI is calculated as shown in formula (1)

$$\boldsymbol{CI = \frac{\lambda max - n}{n - 1}} \qquad (1)$$

- **λmax** is the largest eigenvalue of the comparison matrix,
- **n** is the number of criteria (n=5).

For our criteria matrix, λmax≈5.0358 giving:

$$\boldsymbol{CI = \frac{5.0358 - 5}{5 - 1} \approx 0.00896}$$

- Consistency Ratio (CR):

The CR compares the CI with the Random Index (RI), which is a standard value depending on the matrix size (Saaty, 1980). For n=5, RI=1.12. The CR is obtained using formula (2) to determine whether the level of inconsistency is acceptable.

$$\boldsymbol{CR = \frac{CI}{RI}} \qquad (2)$$

$$\boldsymbol{CR = \frac{0.00896}{1.12} \approx 0.08}$$

- Decision Rule:
  - If CR<0.10 (10%), the judgments are considered consistent.
  - If CR≥0.10, the comparisons should be reviewed and adjusted.

In our case, CR=0.08<0.10, which means the pairwise comparisons are consistent and reliable. As a result, the calculated weights can be confidently used to rank the potential partners.

The consistency test ensures that the judgments do not contradict each other. For example, if Criterion A is preferred over B, and B over C, then A should also be preferred over C in a logical way. A low CR value confirms this logic is maintained. In our study, the weights derived (e.g., C2 = 45%, C1 = 27%, etc.) are therefore valid and meaningful for the final decision. More details can be found in the Appendix *2*.

2.3.4 Scoring of the Alternatives under Each Criterion

With the criteria weights determined, the next step was to evaluate each alternative partner against each criterion. For every criterion, the potential partners (alternatives) were compared with each other to evaluate their performance on that specific factor. These comparisons were based on the secondary data collected for each partner. In practice, we built a pairwise comparison matrix for each criterion; for example, under Criterion 1, we compared partner A with partner B, partner A with partner C, partner B with partner C, and so on, using the 1-9 scale to show which partner performed better and by how much. If, for example, partner A had a much higher value (such as production capacity or financial strength) than partner B for a given criterion, we would assign a score of 7 to represent a "very strong" preference for A over B in that matrix entry. Each criterion, therefore, had its own m × m matrix of alternatives (where m is the number of partners, for instance, 4×4 if four partners were evaluated). Table 5 provides a sample of how alternatives were evaluated under one criterion.

Table 5: Example of Scoring of the Alternatives

Partner	PA	PB	PC	…	Pn	Row total	Score
PA	1	2	3		n		
PB	1/2	1	5		2n		
PC	1/3	1/5	1		3n		
…				1			
Pn	n	1/2n	1/3n		1		

Source: Author

This step produced a performance profile for each partner, giving a set of relative scores for every criterion. These scores show how well each partner satisfies that specific criterion based on the data and the pairwise comparisons.

2.3.5 Combination weights and scores to rank alternatives

In the final step, we aggregated the information from the previous steps to determine the overall ranking of the alternative partners. Each partner's local score (from Step 4) was multiplied by the weight of the corresponding criterion (from Step 3), and then all five results were added together to calculate the total composite score. This process, known as weighted summation in AHP, is often called synthesizing the results: for each partner, the total score is calculated as shown in the the formula (3).

$$\sum_{c=1}^{5}(\boldsymbol{\omega_c} \times \boldsymbol{s_{ic}}) \qquad (3)$$

Where $\boldsymbol{\omega_c}$ is the weight of the criterion**,** $\boldsymbol{s_c}$ is the score of partners $\boldsymbol{i}$ on that criterion.

This method takes into account both the importance of each criterion and how well each partner performs on them (Maruthur et al., 2015b). According to Wang et al. (2015), a typical decision analysis includes assigning weights to criteria and evaluating the alternatives to get an overall ranking. Following this approach, our calculation produced a final priority score for each partner (Wang et al., 2015).

The total score T_{sc} for the selection of the most promising partners are calculated from the above linear equation (4)

$$\mathrm{Tsc} = (\mathrm{Wc1} \times \mathrm{Sc1}) + (\mathrm{Wc2} \times \mathrm{Sc2}) + (\mathrm{Wc3} \times \mathrm{Sc3}) + (\mathrm{Wc4} \times \mathrm{Sc4}) + (\mathrm{Wc5} \times \mathrm{Sc5}) \quad (4)$$

Where Wc is the weight of criteria and Sc the Score of criteria.

The partner with the highest score is seen as the most suitable collaborator for e-fuel production based on the criteria and weights used in this study. We can find more details on the calculation of the total score in the Appendix 1.

Each step of this AHP methodology contributed to a transparent and rational decision-making process. We built a hierarchy of criteria and sub-criteria, performed pairwise comparisons to assign weights, and checked the consistency of our judgments to ensure reliability. Each partner was evaluated against all criteria, and their scores were combined using weighted summation to produce the final ranking. This structured method makes the selection process transparent, data-driven, and well-justified.

Using AHP, developed by Saaty (1980), gave us a solid framework to manage several criteria and reach a well-supported decision for the project.

2.4 Sensitivity Analysis

As part of the assessment, a sensitivity analysis was done to test how the ranking of the most promising partners in the e-fuels production chain might change over time when future projects and strategic plans are taken into account. The purpose of this step was to recognize that partner selection is not static. Companies may gain or lose relevance as a result of new investments, technological progress and/or shifts in strategy.

The sensitivity analysis was applied to the production stage of the value chain. First, future projects and investment plans of each partner were identified using secondary sources such as company announcements, annual reports and energy sector publications as for the initial assessment. These projects included planned renewable energy plants, hydrogen developments, or expansion of storage and distribution capacity.

Second, this new information (future projects) was integrated into the evaluation framework. Using the same AHP method and criteria as the baseline analysis, weights and scores were reassigned to reflect the strengthened or weakened position of each partner in light of these future projects.

Finally, the updated results were compared with the baseline ranking. This comparison highlighted how the position of some companies changed once their planned projects were considered. Thus, the sensitivity analysis not only validated the robustness of the baseline evaluation but also revealed the dynamic nature of partner selection, showing which actors are likely to become more competitive in the future.

3 Chapter 3: Results and Discussions

This chapter summarizes and discusses the main findings of this study, addressing the four objectives: identifying potential partners for e-fuels production in Mali and Côte d'Ivoire, ranking them based on defined criteria, comparing results across both countries, and providing policy and regulatory recommendations to support investment. It presents a synthesis of results, a discussion of their implications, and targeted recommendations for national and regional stakeholders.

3.1 Potential partners for e-fuel production in Mali and Côte d'Ivoire

Strong collaboration between government authorities, private companies, and international partners is necessary for the development of e-fuel projects in West Africa. This section presents the potential partners identified in both Mali and Côte d'Ivoire. The selection of potential partners presented here is based on their current activities, infrastructure, and demonstrated interest in energy projects, particularly within the e-fuels and renewable energy sector. These partners were selected through a comprehensive value chain analysis, which combines established energy development frameworks with systematic internet research to identify key actors relevant to e-fuel projects in each country.

The segmentation used in this study was adapted to fit the specific context of regional e-fuel development. The order follows the logical flow of an e-fuel project from concept to end-use, similar to the upstream-midstream-downstream model used in oil, gas, and hydrogen sectors (IDTechEx, 2023).

This distribution of partners helps guide the discussion of the results, where their roles, contributions, and selection as potential e-fuel partners will be explained in detail. Starting with regulation, followed by the suppliers, production, storage and distribution/commercialisation; below we have a clear explanation of why we selected these segments.

- **Regulation:**

The regulation segment includes government ministries, regulatory agencies, and public authorities that set the rules and policies for energy and fuel sectors. Their role is to create supportive laws, technical standards, incentives, and licensing systems for e-fuel projects. Good regulation helps lower investment risks and ensures that e-fuels fit into national energy plans, for example, by contributing to climate targets or fuel security. In West Africa, strong government support can speed up e-fuel development by linking it to broader goals like increasing energy access and growing renewable energy use.

- **Suppliers:**

The suppliers segment includes companies that provide the materials, equipment, and technology needed for e-fuel production. In West Africa, the renewable energy sector is growing, with local and international suppliers experienced in solar PV, battery storage, and related systems. These companies help use the region's strong solar resources and other renewables for e-fuel production, while also providing capacity building and maintenance to ensure project sustainability. Partnering with established suppliers in the region allows projects to benefit from existing supply chains and expertise, reducing costs and easing local implementation.

- **Production:**

The production segment refers to the entities that will actually produce the e-fuels. Their role is to design, finance, and operate the facilities that convert input electricity and feedstocks into e-fuels. In West Africa, potential producers may be existing energy companies (such as electric utilities expanding into new markets) or oil and gas firms investing in low-carbon fuels, alongside new ventures focused on green hydrogen. Their participation is essential, as they bring infrastructure, market knowledge, and alignment with national priorities like electrification and job creation. All these important components make them key players in building e-fuel capacity and supporting the region's energy transition goals.

- **Storage:**

The storage segment covers the facilities and companies involved in storing both the feedstocks and final e-fuels. This can involve tanks for hydrogen (whether compressed, liquefied, or stored in compounds) as well as tanks for liquid e-fuels such as methanol, ammonia, or synthetic diesel. It also covers related infrastructure like pipelines, depots, and terminals. In West Africa, many countries already have petroleum storage infrastructure that could be adapted for e-fuels ensuring products can be stockpiled and distributed when needed (IEA, 2023). Some operate national storage companies or public-private partnerships. Storage is a critical bridge between production and distribution. It also handles strategic reserves and safety management. Because some e-fuels, like hydrogen, are highly flammable, storage partners must have strong expertise in safety, monitoring, and logistics.

- **Distribution/Commercialisation:**

The distribution and commercialisation segment covers the networks and channels that deliver e-fuels to end-users, including service stations, industrial supply, aviation, and maritime sectors. Commercialisation focuses on sales, branding, and customer outreach to build demand. In West Africa, distribution is handled by both multinationals and local firms with established retail networks. Partnering with them enables e-fuels to use existing infrastructure, manage blending with conventional fuels, and ensure quality control. Effective distribution is essential to scale e-fuels and identify the right partners by their area of intervention.

3.1.1 Potential partners in Mali

Mali's energy sector is led by a state-owned utility and supported by rural electrification programs, with new private renewable projects starting to grow. These features influence the types of potential e-fuel partners in each segment. Figure 4 below presents the e-fuel value chain in Mali, highlighting the key partners in each segment from the regulation to the distribution.

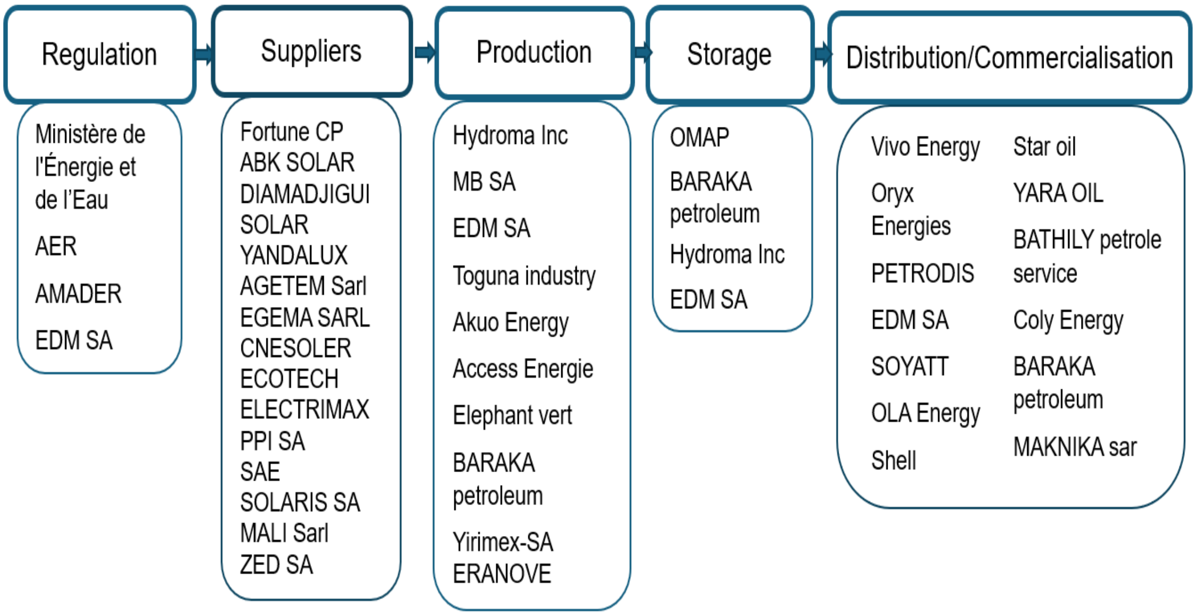


Figure 4: Value Chain with potential partners (Mali)

Source: Author

Figure 4 shows that the suppliers and distribution/commercialisation segments have the largest number of partners, indicating strong market presence and diversity in these areas. The production segment has a moderate number of partners, showing some existing capacity but also room for growth. The regulation segment includes only a few key public institutions, as expected for its role. The storage segment has the fewest partners, highlighting a clear gap in Mali's e-fuel value chain.

The following step highlights their significance in the e-fuel value chain and the specific advantages they offer that support the project's objectives.

- **Regulation**

Regulation, as the starting point of the value chain, involves key potential partners responsible for the administrative and policy aspects.

- Ministry of Energy and Water

In Mali, the Ministère de l'Énergie et de l'Eau is the main government authority for energy policy and major initiatives. It sets the overall direction for projects like e-fuels, which must align with national renewable energy targets and fuel regulations. The Ministry also plays a key role in supporting international partnerships and securing funding for the sector.

- Energy Sector Agencies (AER and AMADER)

Mali has two key agencies that promote renewable energy and rural electrification, both relevant for e-fuels. The Agence des Énergies Renouvelables du Mali (AER) works to "promote the large-scale use of renewable energies" such as solar, wind, and biomass (trade.gov, 2024b). AER is actively engaged in projects like rural solar electrification and has partnered with international donors (such as IRENA, World Bank) to implement renewable projects (Konaté, 2023). By encouraging renewable energy adoption, AER helps create the conditions needed for green hydrogen and e-fuels (since abundant renewables are a prerequisite for e-fuels).

The Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale (AMADER) focuses on improving energy access in rural and peri-urban areas. It implements rural electrification projects and regulates off-grid and private energy concessions (trade.gov, 2024b). AMADER's mission to expand access and involve the private sector means it could support pilot e-fuel projects in off-grid areas.

Together, AER and AMADER can help integrate e-fuels into Mali's energy strategy through policy support, pilot projects, and rural energy schemes.

- Énergie du Mali (EDM-SA)

Although mainly the national utility, EDM also plays a role in regulation in Mali's context because of its government ownership and strategic influence. EDM-SA is responsible for electricity generation and distribution in urban areas and operates under strong government direction, with significant subsidies and financing from regional development banks (trade.gov, 2024c). The company is also allowed to purchase power from independent producers, meaning a private e-fuel developer with a renewable plant could sell surplus electricity to EDM or use EDM's grid for stability. For any e-fuel initiative in Mali, alignment with EDM's expansion plans and the Ministry's supervision of EDM would be essential.

- **Suppliers**

Mali's potential suppliers for an e-fuel project are those companies providing solar and other renewable energy solutions, as well as technical services, since renewable electricity is the cornerstone of e-fuel production.

- Fortune CP

Fortune CP is an international renewable energy company with operations in Mali, supplying solar components and systems. Its products include solar panels, inverters, batteries, solar water pumps, mini-grid solutions, and storage systems. The company has carried out engineering design, installation, and commissioning, as well as large-scale project development such as feasibility studies, environmental impact assessments, and EPC contracts for solar farms. For example, it has been involved in developing a 20 MW solar power plant in Mali (FortuneCP, n.d.).

As a supplier, Fortune CP could provide the photovoltaic arrays and battery units needed to power electrolysers for e-fuel production. Partnering with such an experienced supplier ensures that the upstream power supply for an e-fuel is professionally delivered and maintained.

- Local Solar and Energy Integrators

In addition to Fortune CP, Mali has local companies such as ABK Solar, Diamadjigui Solar, Solaris Technologies, and Yandalux that focus on selling and installing solar energy equipment. For example, ABK Solar, based in Bamako, supplies solar panels, batteries, and solar street lights for both households and businesses, as shown in their local product advertisements (Enerdata, n.d.). These firms strengthen Mali's renewable energy supply chain on a smaller scale.

In an e-fuel project, some could be subcontracted for on-site solar installations or maintenance. Having multiple suppliers also creates competition and resilience; especially if a project requires thousands of panels and dozens of pumps or electrolysers, working with a consortium of both local and international suppliers may be the best approach.

- Engineering and EPC Contractors

Companies such as AGETEM sarl and EGEMA sarl, listed among Mali's suppliers, are engineering contractors with experience in building energy infrastructure (Enerdata, n.d.). They can manage civil works, electrical installations, and balance-of-plant construction for e-fuel facilities. For instance, installing an electrolyser unit and hydrogen storage tanks in a remote area would require engineering expertise that these local firms have developed through work on diesel power stations and telecom tower power systems in similar conditions.

Production

In Mali, potential e-fuel producers include both innovative start-ups in new fuels and established energy or industrial companies that could shift to e-fuel production or supply feedstocks.

- Hydroma Inc

Hydroma is a Canadian-Malian company and a pioneer in hydrogen energy in Mali. It was founded by a Malian entrepreneur and became the first company in the world to discover and operate a natural hydrogen well in Bourakébougou village, Mali (Hydroma, 2022). Since 2012, it has produced electricity from natural hydrogen gas, proving the concept of "white hydrogen" as an energy source (Hydroma, 2022).

The company actively develops green hydrogen projects and even plans ammonia production, with infrastructure for hydrogen storage, transport, and distribution in West Africa. Through its "West African Big Green Deal," the company shows a strong commitment to building a regional hydrogen economy and plans to construct a 100 MW hydrogen power plant by applying for funding from the UN's Green Climate Fund (GCF) (Hydroma, 2022).

Hydroma's unique expertise in both natural hydrogen extraction and electrolytic hydrogen makes it an ideal partner for Mali's e-fuels. It brings technical know-how in hydrogen production and handling the core of power-to-fuel technology and has shown its ability to implement hydrogen projects on the ground.

- Mali Biocarburant SA (MB SA)

Founded in 2007, MB SA produces biodiesel from Jatropha curcas, working with over 8,000 small farmers in Mali and Burkina Faso (Millercenterglobal, 2025). The drought-resistant shrub's seeds are pressed for oil, which is processed into biodiesel for local use, either pure or blended with diesel (Lengkeek & Verkuijl, n.d.). While biofuel differs from synthetic e-fuels, MBSA's experience in building a full local value chain (from feedstock production to fuel distribution) offers valuable lessons for e-fuel projects. Its expertise in logistics, quality control, and community engagement could also support hybrid approaches, such as using bio-derived CO_2 in synthetic fuel production (Rutz et al., 2012). MBSA has shown long-term viability and innovation, even producing biogas from residues, proving that alternative fuel companies can succeed in Mali's conditions.

- Énergie du Mali (EDM):

As the national utility, EDM could diversify into hydrogen production. Although it mainly generates power from hydro and diesel (EDM-SA, n.d.). It could develop pilot projects to produce hydrogen during off-peak hours or at remote solar mini-grids for energy storage. Green hydrogen could also replace costly diesel in its plants. EDM could offer land at existing sites and use its workforce to operate such projects.

- Toguna Agro-Industries, Elephant vert

Toguna and Elephant Vvert are the largest fertilizer producers in Mali. Both companies specialize in blending fertilizers locally, but they rely on imported chemical inputs for their production (Elephant-vert, n.d.; Toguna-agro-industries, n.d.). For an e-fuel project focusing on ammonia (which is both a fertilizer and potential fuel), Toguna could be crucial. Producing ammonia locally would reduce imports, link e-fuels to agriculture, and create economic benefits.

- International Renewable Developers

International IPPs already active in Mali, such as Akuo Energy (developer of the 50 MW Kita solar farm), Access Energie, could expand into e-fuel production (Dembélé et al., 2025). Adding electrolysers to solar farms would allow hydrogen production during peak sunlight. Their financial strength and global experience in storage and hydrogen projects would be valuable for scaling e-fuels in Mali.

- **Storage**

In Mali, storage partners will play a key role in the e-fuels value chain by taking charge of the products after they are produced. Their responsibility will be to ensure that e-fuels are safely stored, maintained in good condition, and made available for later use or distribution.

- Office Malien des Produits Pétroliers (OMAP)

OMAP is the government body responsible for storing petroleum products and maintaining security stocks. Its mission is to manage the commercialisation of petroleum products and operate the national strategic reserve. It ensures Mali has a buffer supply of fuel and can act to stabilize the market when needed (La et al., 2023).

For e-fuels, OMAP is highly relevant. If Mali produces synthetic diesel or other e-fuels, OMAP could add them to the national reserve, showing strong government support. It could also provide land at existing depots for e-fuel storage.

- Baraka Petroleum SA

Founded in 2006, Baraka Petroleum is a private Malian company active in the downstream sector, focusing on importing, transporting, and distributing petroleum products. It operates fuel depots and a fleet of trucks to supply both clients and retail stations (baraka-petroleum, 2024). As a storage partner, Baraka could use its depot facilities to store imported inputs or produced e-fuels.

Mali's fuel storage capacity is still limited but expanding, with OMAP leading new infrastructure development. An e-fuel project should make the most of existing systems to reduce costs, align with OMAP for integration into the national strategy, and work with private companies like Baraka or Hydroma for operational flexibility and cross-border logistics. A strong collaboration is very important because e-fuels need safe and stable storage before transport or sale.

- **Distribution/Commercialisation**

In Mali, fuel distribution to end-users (covering transport, households, and industry) is managed by both international companies and local businesses.

- Vivo Energy (Shell Mali) and TotalEnergies

These multinational fuel distributors operate extensive service station networks. TotalEnergies runs nearly 80 stations in Mali, while Vivo Energy (Shell) operates about 53 stations (TotalEnergies, n.d.; VivoEnergy, 2023). Both companies have corporate commitments to cleaner energy, making them likely to test e-fuel offerings and promote them to customers.

- Oryx Energies

Oryx is a Swiss-based company with a growing presence in Mali, expanding its service stations from 7 to 23 in 2016. It supplies fuels to motorists, industries, and liquid petroleum gas (LPG) users, and operates regional import terminals (OryxEnergy, 2016).

- Local Distributors (Petrodis, SOYATT)

These smaller, regionally focused companies serve specific markets and government fleets. While they run fewer stations, they are well connected locally and often reach remote areas where multinationals are absent. They could be strategic for testing e-fuel distribution in rural or specialized markets.

Mali shows potential across the e-fuels value chain. Energy companies can drive production, existing petroleum facilities could be adapted for storage, and established fuel companies offer channels for distribution. While challenges remain, these elements provide a foundation for building a future e-fuels industry that supports both domestic use and regional exports.

3.1.2 Potential partners in Côte d'Ivoire

Côte d'Ivoire has one of the most advanced energy sectors in West Africa, with a strong electricity grid that exports power to neighbouring countries and a large oil refining and distribution industry. The country aims to be a regional energy hub and is working to integrate renewable energy and new technologies like green hydrogen (GH2, n.d.). This creates favourable conditions to identify partners across the e-fuel value chain. Figure 5 presents the potential partners for e-fuel production in Côte d'Ivoire, mapped along the key segments of the value chain.

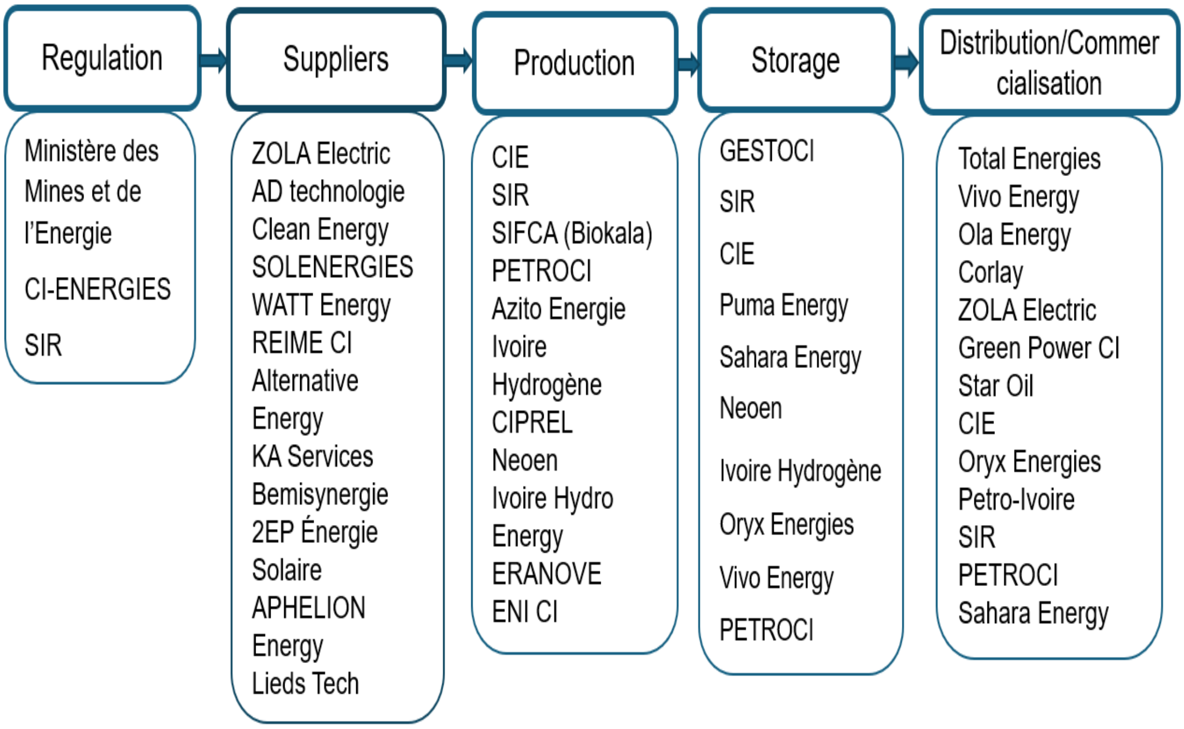


Figure 5: Value Chain with potential partners (Côte d'Ivoire)

Source: Author

Figure 5 shows that the regulation segment has the smallest number of partners, since it is mainly limited to government bodies and public institutions. The supplier segment has the largest share, reflecting the strong presence of companies providing equipment, technology, and renewable energy solutions. The production segment contains a moderate number of partners, indicating existing capacity with room for expansion. The storage segment includes fewer actors, highlighting a gap in large-scale storage infrastructure. Finally, the distribution and commercialisation segment gathers many players, showing a competitive and well-developed downstream market.

- **Regulation**
  - Ministry of Mines, Petroleum and Energy (MMPE)

The MMPE is Côte d'Ivoire's top authority for energy policy, covering fuels and electricity. It leads the push for new energy sources and has included green hydrogen in its 2030 strategy as part of the renewable energy plan. The Ministry sets national targets (45% renewables by 2030), joins regional hydrogen initiatives, and oversees major institutions (GH2, n.d.). For e-fuels, MMPE's support is vital for permits, inclusion in national plans, and access to climate finance.

- CI-Energies (Côte d'Ivoire Energies)

This state-owned company manages electricity assets and develops new generation projects for the government, while CIE operates the system. CI-Energies is key for e-fuel projects needing a grid connection or location near renewable plants (CIE.CI, n.d.). CI-Energies can help choose sites, integrate projects into grid plans, and manage government-backed pilots.

- **Suppliers**

Côte d'Ivoire has a strong base of local and international companies supplying solar, electrical, and industrial equipment. For an e-fuel project, suppliers would provide solar PV (and possibly wind in the north), electrolysers, and engineering services.

- ZOLA Electric

ZOLA Electric, formerly Off-Grid Electric, operates in Côte d'Ivoire through a joint venture with French multinational electric utility company (EDF). ZOLA supplies solar home kits with panels, batteries, and appliances on a pay-as-you-go model, aiming to reach nearly 2 million Ivorians (edf, n.d.). The company brings experience in large-scale solar deployment, logistics, and customer service, while EDF brings technical expertise and investments in larger projects like the 46 MW Biokala biomass plant (edf, n.d.). For e-fuels, ZOLA and EDF could provide modular solar and storage systems to power electrolysis in rural areas or integrate e-fuel technologies (like hydrogen fuel cells) into off-grid solutions.

- Solar PV and Equipment Companies

Local companies such as CI-Énergies new, AD Solar Technologies, Clean Energy CI, Solergies, and Watt Renewable are engaged in designing and installing solar systems for businesses and communities (Enerdata, n.d.). They could supply PV arrays, inverters, and installation services for an e-fuel plant. Some also have battery storage expertise.

- Electrical engineering suppliers

Companies like REIME Côte d'Ivoire provide and maintain electrical systems, including control systems, transformers, and substations; which are key for integrating an e-fuel facility into the grid (Enerdata, n.d.).

Production

Côte d'Ivoire's potential e-fuel production partners include major energy companies, industrial groups, and emerging ventures with strong project experience. They could provide the renewable power, CO_2 feedstock, and technical capacity needed for large-scale e-fuel production.

- Compagnie Ivoirienne d'Électricité (CIE)

CIE operates Côte d'Ivoire's electricity distribution and some generation under the Eranove group. While mainly a system operator, CIE runs hydro and thermal power plants and could adopt e-fuels for power generation (trade.gov, 2024a). Eranove has experience in large projects (such as CIPREL gas plants, 44 MW Singrobo hydro) and operates in other West African countries, offering regional synergy (trade.gov, 2024a). Their operational expertise makes them a reliable partner for running an e-fuel facility.

- Société Ivoirienne de Raffinage (SIR)

SIR, West Africa's largest refinery, could host e-fuel production by integrating hydrogen and captured CO_2 into its refining process. It already produces hydrogen for refining and could switch to green hydrogen, with any surplus used for e-fuels like methanol or synthetic diesel(ARDA AFRICA, 2025). SIR's infrastructure, technical workforce, and blending capability could ease the commercialization and distribution of e-fuels through existing channels.

- SIFCA Group-Biokala (Biovéa Project)

SIFCA, a major agro-industrial group, is building the Biovéa biomass power plant through its subsidiary Biokala (BioveaEnergy, n.d.). This plant will generate renewable electricity and produce CO_2 from biomass combustion, which could be captured for e-fuel synthesis. SIFCA's palm oil operations could also provide feedstock for biodiesel or green diesel production, aligning with national goals to add value to agricultural resources.

- Azito Energie and CIPREL

These independent power producers run large gas-fired plants (Azito around 720 MW, CIPREL around 543 MW) (AZITOEnergy, n.d.; CIPREL.CI, n.d.). They could co-fire hydrogen or ammonia to cut emissions or install on-site electrolysers to produce green hydrogen. Their strong engineering teams and grid access position them well for hosting pilot e-fuel production units.

- Ivoire Hydrogène (iH2)

A local start-up focused on hydrogen development in Côte d'Ivoire, iH2 promotes hydrogen applications in mobility, industry, and power (Ivoireh2, n.d.). It is working on demonstration projects and training, and could lead pilot hydrogen production or mobility trials. iH2 offers local knowledge, policy engagement, and technical networking to adapt projects to Ivorian conditions.

Together, these partners could deliver an integrated e-fuel value chain (from renewable power and CO_2 capture to production).

Storage

Côte d'Ivoire is already a petroleum hub in West Africa, with large storage capacity and well-developed port facilities. These assets can support e-fuel storage and handling, although new systems may be needed for fuels like liquid hydrogen or ammonia.

- GESTOCI (Gestion des Stocks Pétroliers de Côte d'Ivoire)

GESTOCI is the national fuel storage company and the largest in West Africa, with about 400,000 m³ capacity and plans to almost double it (Halieutiques et al., 2024). It operates major depots in Abidjan and San-Pédro, storing gasoline, diesel, jet fuel, and LPG (Halieutiques et al., 2024). For e-fuels such as synthetic diesel or kerosene, GESTOCI could use existing tanks (with modifications if needed) and manage distribution. The planned 250,000 m³ expansion in San-Pédro could include dedicated e-fuel or biofuel tanks. GESTOCI also controls pipelines and trucking logistics, ensuring safe and efficient delivery (Halieutiques et al., 2024).

- SIR

The Société Ivoirienne de Raffinage has a large tank farm at the port of Abidjan for crude and refined products. It could store e-fuels on-site, making exports easier (ARDA AFRICA, 2025). Its experience with hazardous chemicals and its safety systems make it capable of handling fuels like hydrogen or methanol.

- Puma Energy, Sahara Energy

Independent storage companies, ~~they~~ manage oil terminals and could dedicate capacity to e-fuels, using Abidjan as a trade hub. Their global networks would help with imports and exports.

The collaboration with all these companies is primordial for a safe storage system in Côte d'Ivoire.

Distribution/Commercialisation

Côte d'Ivoire has a large and competitive fuel distribution network, with both multinational companies and strong local players. These partners could help deliver e-fuels to vehicles, industries, and even export markets.

- Total Energies and Vivo Energy (Shell)

They are the largest fuel retailers, each with a wide network of stations across the country. They serve both private and commercial clients. Their experience and global strategies for sustainable fuels, like Sustainable Aviation Fuel (SAF) and biodiesel, make them good partners for pilot e-fuel sales (P. Report, 2023; Vivoenergy, 2023).

- Ola Energy

Ola Energy has a smaller network but operates across francophone Africa, including Mali. They could help move e-fuels to neighbouring countries and use their depots for regional distribution.

- Corlay

It operates former mobile stations in partnership with Petroci, giving them both a local and state-backed presence (Petroci.ci, n.d.). This could make them useful for government-supported e-fuel pilot projects, such as biodiesel blends.

Other players like ZOLA Electric and Green Power CI focus on off-grid energy and could distribute e-fuels for generators or future hydrogen systems. Export routes would involve the Port of Abidjan and international shipping companies, especially if large-scale production like green ammonia targets overseas buyers.

Working with theses partners would ensure that once e-fuels are produced, they can be delivered effectively to customers and export markets. The development of e-fuel projects in Mali and Côte d'Ivoire will require strong cooperation across all parts of the value chain. The following step will discuss the selection of the most promising partners for e-fuel production in both countries.

3.2 Identification of most promising partners

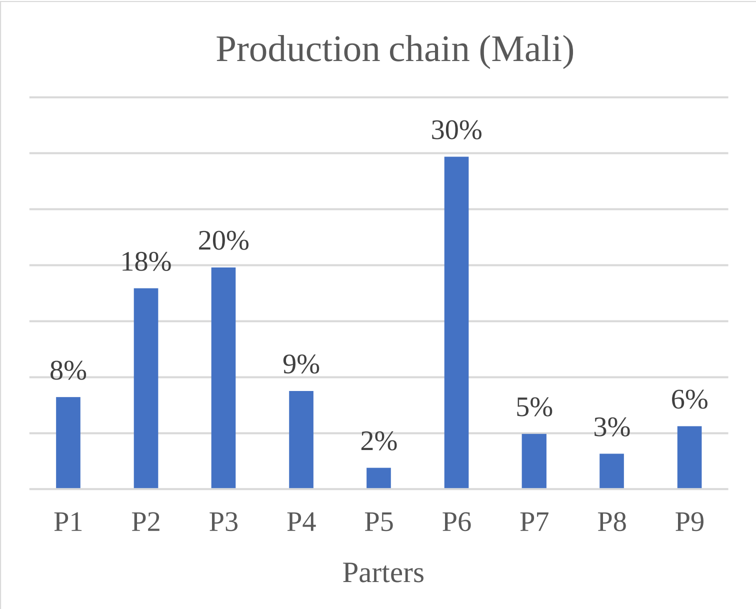
The evaluation of potential partners for e-fuel production in both Mali and Côte d'Ivoire is based on weighted criteria: technical and infrastructure capability (27%), economic and financial viability (45%), environmental sustainability (8%), strategic and partnership factors (4%), and socio-political factors (16%). The analysis focuses on the three main segments which are production, storage, and distribution, due to their strategic importance and the comparability of available data, making it possible to rank and identify the most promising partners in each country.

3.2.1 Case of Mali

Mali's e-fuel potential is driven by its growing renewable energy sector but limited by small refining capacity and high dependence on fuel imports. Assessing these actors using the weighted criteria helps identify those best placed to support Mali's e-fuel development.

- **Production chain**

The production segment in Mali is shaped by companies engaged in hydrogen, biofuels, and solar energy, forming the technical base for future e-fuel projects. Figure 6 below shows the ranking of the most promising partners for e-fuel production in Mali based on the evaluation.



P1= EDM SA (5th)

P2= Hydroma Inc (3rd)

P3= Elephant vert (2nd)

P4= Toguna industry (4th)

P5= BARAKA petroleum (9th)

P6= Akuo Energy (1st)

P7= Access Energie (7th)

P8= MB SA (8th)

Figure 6: Most promising partner for the production chain (Mali)

Source: Author

For the production chain in Mali, the promising partners are Akuo Energy (30%) following by Eléphant Vert (20%), Hydroma Inc (18%), Toguna industry (9%), EDM SA (8%), Yirimex-SA (6%), Access Energie (5%), MB SA (3%), BARAKA petroleum (2%).

Akuo Energy stands out most strongly in technical and infrastructure capacity due to its successful delivery and operation of Mali's first large-scale solar independent power producer (IPP) project, the 50 MW Kita solar farm (Dembélé et al., 2025). Commissioned fully in late 2020, this plant was the largest solar park in West Africa and a milestone for the region's renewable energy landscape (Dembélé et al., 2025). Akuo secured extensive financing with over €77 million invested (Emiliano, 2018). The company is supported by several development finance institutions and has a 28-year power purchase agreement with Mali's national utility, EDM (Dembélé et al., 2025). The plant currently supplies power to an estimated 120,000 households and demonstrates Akuo's proven ability to finance, construct, and operate highly complex renewable infrastructure under stable, long-term commercial agreements (Emiliano, 2018). This strong infrastructure foundation directly supports large-scale production of green hydrogen through solar-powered electrolysis, a core requirement for e-fuel production. Akuo Energy presence and track record in Mali also support its strategic and socio-political viability, especially as the country aims to increase electrification and transition away from climate-vulnerable hydroelectricity and costly fossil fuel imports.

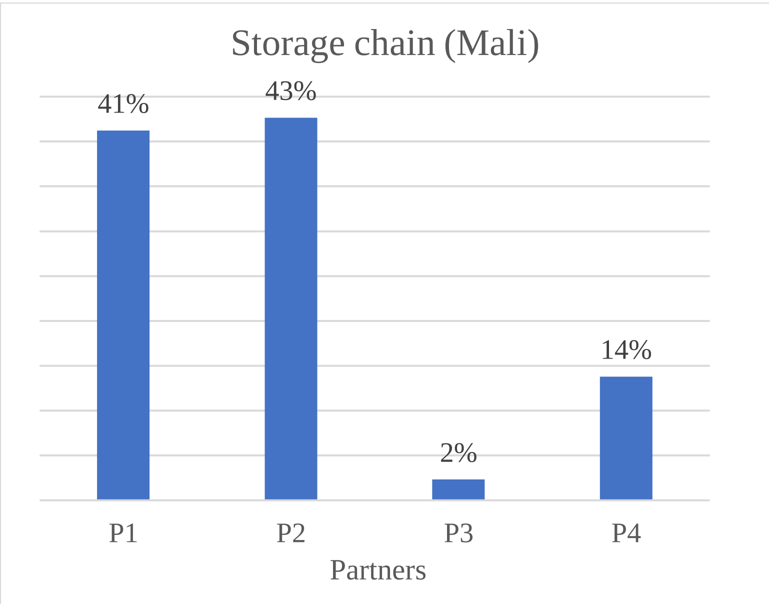
In terms of financial viability, Akuo leads as well. Its significant financial backing from multiple development banks and investor groups, continued project portfolio expansion ambitions aiming for gigawatts of renewables capacity in Africa, and demonstrated operational success mark it as a financially robust partner capable of mobilizing the substantial capital required for e-fuel plants (AkuoEnergy, 2025). Its structured financing solutions feature risk mitigation tools like debt service reserve accounts, which enhance economic stability.

In opposite to Akuo Energy, Eléphant Vert presents a different but complementary profile. Though it ranks behind Akuo in scale and financial resources, it scores well on industrial infrastructure and environmental sustainability criteria. Its large organic fertilizer plant in Ségou processes significant volumes of agricultural waste into bio-fertilizers and biogas, demonstrating expertise in biomass utilization and transformation (Hydroma, 2022). This capability is important for providing CO_2 feedstock needed for synthetic fuel (e-methanol) production, integrating agricultural biomass with clean fuel technologies. The company's strong local investment, job creation, and promotion of sustainable agricultural practices further enhance its socio-political acceptance and regulatory alignment, key for project stability. While Eléphant Vert lacks the scale and financial level of Akuo, its contribution to integrating circular bioeconomy principles with e-fuels positions make him a valuable, ecologically aligned partner.

Hydroma Inc, in its side, introduces truly innovative technical expertise unique to Mali through its pioneering discovery and exploitation of natural hydrogen wells. Since 2012, Hydroma has operated natural hydrogen energy projects and is advancing plans for green hydrogen and ammonia production (Hydroma, 2022). This expertise represents a key technical advantage in both natural and green hydrogen, being the foundation to e-fuels production. Strategically, Hydroma demonstrates vision through the “West African Big Green Deal” and pursuit of funding from the UN’s Green Climate Fund, indicating strong commitment to building a regional hydrogen economy (Lea, 2023). However, Hydroma’s current financial capacity is more limited compared to Akuo and Eléphant Vert, constraining its ability to invest at scale in large e-fuel projects. Since economic and financial viability accounts for the largest evaluation weight (45%), this financial limitation lowers Hydroma’s overall score despite its technological promise.

- **Storage chain**

Mali’s fuel storage landscape is characterized by a limited downstream sector with no oil refining industries, resulting in total fuel storage capacity of approximately 48,000 m^3 distributed over about five main depots controlled primarily by the state and a few private actors (Masami et al., 2010). Reviewing the four main partners for e-fuel storage which are: OMAP, EDM-SA, Hydroma, and Baraka Petroleum, against the evaluation criteria defined above.



P1= EDM SA (2nd)

P2= OMAP (1st)

P3= BAKARA Petrolium (4th)

P4= Hydroma (3rd)

Figure 7: Most promising partner for the storage chain (Mali)

Source: Author

In Figure 7, the ranking shows that OMAP stands out as the highest-ranked storage partner with a score of 43%. This score is due to its centralized role and legal mandate as the state-owned petroleum authority responsible for developing and managing Mali’s petroleum storage infrastructure and strategic reserves. OMAP inherited management of key state storage facilities, such as the Bamako depot with a capacity of 10,000 m³ (La et al., 2023). This direct control over national fuel reserves, combined with OMAP's regulatory authority and mission to stabilize fuel supply and conserve national security stocks, provides it with unmatched technical infrastructure capabilities and a strategic role, making it a natural focal point for integrating storage of new synthetic or e-fuels. The government-backed status and regulatory power of OMAP considerably strengthen its economic and financial viability prospects, as it can mobilize resources and coordinate logistics critical for e-fuel deployment (La et al., 2023).

Close behind OMAP, at 41% is EDM-SA. It is a state-owned electricity company, which contributes significantly to fuel consumption and storage due to the country's reliance on thermal power plants. EDM's ownership of fuel storage tanks at major electricity production sites like the Sirakoro heavy fuel oil plant support its technical infrastructure capacity for fuel storage and distribution (EDM-SA, n.d.). This makes EDM a key operational partner for e-fuel use in electricity generation, including potential blending or replacement of diesel. EDM central role in national energy security, its well-established fuel logistics system and integration with Mali electricity grid underscore its strategic importance (Guide & Sub-sectors, 2019). Although primarily focused on electricity, EDM economic and financial position as a government utility solidifies its standing, thereby justifying its second-place ranking just behind OMAP.

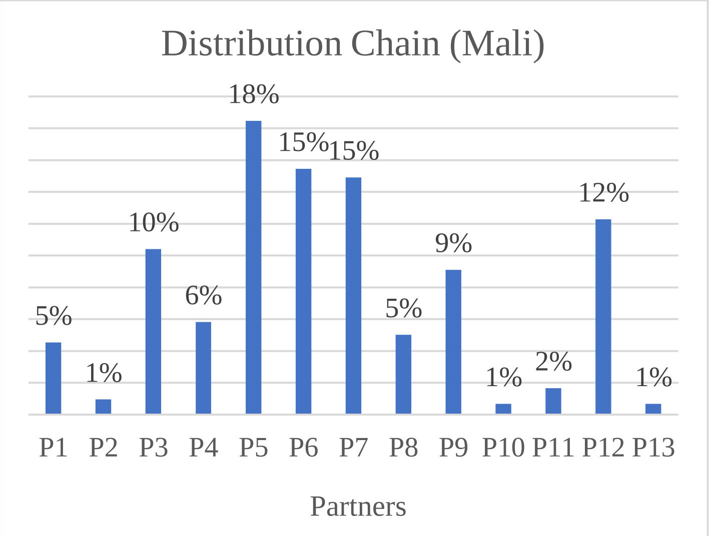
Hydroma Inc ranks third at 14% due to its unique but smaller-scale technical expertise in hydrogen energy, including natural hydrogen extraction and projects for green hydrogen and ammonia storage, transport, and distribution across West Africa (Dirk, 2025). While its storage infrastructure is more specialized and less extensive than those managed by OMAP and EDM, Hydroma's pioneering know-how in hydrogen storage positions it as vital to Mali's future e-fuel ecosystem, especially as hydrogen storage and handling are crucial to advanced synthetic fuel supply chains. Yet Hydroma's smaller scale and limited economic and financial viability in comparison to government-supported players place it below the two state agencies in rank. Its ongoing projects in geological and compressed hydrogen storage reflect important emerging capabilities that complement but do not replace traditional fuel infrastructure (Dirk, 2025).

Finally, Baraka Petroleum ranks fourth at 2%, reflecting its niche but important role as a private Malian company engaged in importing, storing and distributing petroleum products. Although it lacks large-scale tank farms like those controlled by OMAP or EDM, Baraka adds value through its agile supply chain, ability to handle special fuels and capability to deliver fuel safely to remote areas. Its limited storage capacity and smaller market share constrain its overall ranking, but its operational flexibility and logistics expertise provide useful complementary assets in Mali's distributed fuel storage sector (Clodura.ai, 2023).

Overall, the rankings reflect that OMAP and EDM's broad storage infrastructure and regulatory and operational influence dominate Mali's fuel storage ecosystem, especially regarding economic viability (45%) and strategic positioning, which constitute the largest evaluation weights. Hydroma's specialized hydrogen storage expertise offers future-oriented technical prospects essential for e-fuels but currently lacks scale and financial strength. Baraka's private sector agility supports distribution but does not compensate for limited capacity. This hierarchy underscores that Mali transition to e-fuels will rely heavily on leveraging existing state-controlled storage assets managed by OMAP and EDM, integrated with emerging hydrogen storage capabilities pioneered by Hydroma, while smaller operators like Baraka play supporting roles within the overall energy and fuel logistics landscape.

Distribution and commercialisation chain

Mali's distribution network is relatively more developed, with both local and international companies ensuring nationwide fuel supply. Figure 8 below shows the ranking of the most promising distribution partners in Mali, highlighting the percentage scores obtained by each company.



P1= EDM SA (9th)
P2= PETRODIS (11th)
P3= Coly Energy (5th)
P4= OLA Energy (7th)
P5= Vivo Energy (1st)
P6= Oryx Energies (2nd)
P7= Shell (3rd)
P8= YARA OIL (8th)
P9= Star oil (6th)
P10= BATHILY Petrole Service (12th)
P11= BARAKA Petroleum (10th)
P12= SOYATT (4th)
P13= MAKNIKA sarl (12th)

Figure 8: Most promising partner for the distribution chain (Mali)

Source: Author

The distribution partners ranking presents Vivo Energy (18%), Oryx Energies (15%), and Shell (15%) as promising companies for e-fuel distribution in Mali.

Vivo Energy sits at the top of the distribution ranking with an 18% market share, reflecting its extensive and well-established presence across Mali. As the distributor of Shell-branded fuels in the country, Vivo Energy operates approximately 39 retail service stations, covering about 23% of the national fuel market (Daly, 2018). Vivo Energy's infrastructure encompasses logistics capabilities serving both retail consumers and large industrial clients such as mines and government entities, illustrating its operational maturity and reliability. Furthermore, Vivo's expansive footprint across 23 African countries adds valuable pan-African experience and resilience (Daly, 2018). Economically, the company demonstrates strong financial conditions, underscored by its 2024 commitment (with Vitol) to invest over $550 million by 2030 in clean energy infrastructure across Africa (Vitol, 2025). These factors collectively justify Vivo Energy's leading rank, highlighting its readiness to scale e-fuel distribution through robust infrastructure, financial strength, and strategic vision.

Oryx Energies ranks second with about 15% market share, recognized for its strong logistics network and growing footprint in Mali. Since 2009, Oryx has built a retail network of 28 stations while supplying fuel to both industrial clients and retail channels, emphasizing its versatile distribution capacity (OryxEnergy, n.d.). A key advantage comes from its integrated supply chain, leveraging its own coastal fuel terminals in Senegal and Benin to ensure a reliable fuel flow into landlocked Mali. This infrastructure strengthens its ability to manage large-scale energy demands, for example, by providing fuel and lubricant supply to a 60 MW independent power plant in Mali (OryxEnergy, n.d.). The company's proven track record with industrial and retail fuel delivery, combined with its reliable logistics network, translates into strong technical capabilities and economic viability, making it a natural fit to introduce and distribute synthetic e-fuels effectively.

Although its fuels in Mali are distributed primarily through Vivo Energy's network, Shell ranked third with a 15% direct market share and a network of about 23 stations (JOHANNESBURG, 2011; OryxEnergy, 2016). Shell's global brand reputation, international standards, and established technical expertise provide significant credibility and trust in product quality, safety, and customer service. Its ongoing investments in low-carbon energy solutions position Shell as a valuable partner for synthetic fuels (S. Report & Sawan, 2025). This combination of global clean energy experience, brand strength, and extensive local presence makes Shell a highly competent and credible partner for Mali's e-fuel distribution market.

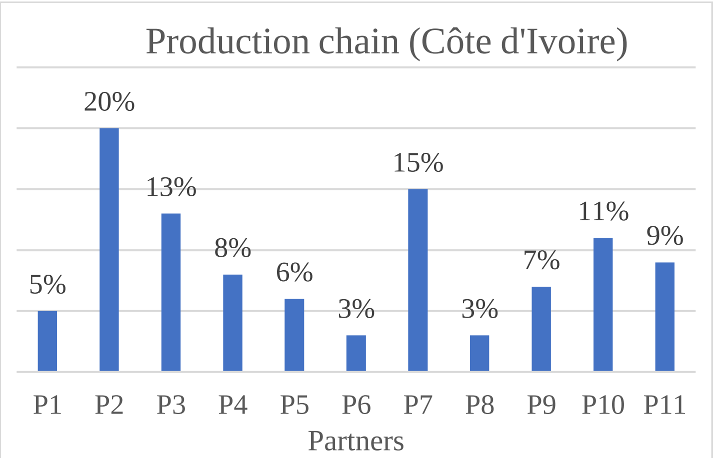
In conclusion, this ranking reflects how Vivo Energy's comprehensive infrastructure, financial condition, and pan-African experience place it at the forefront of e-fuel distribution readiness. Oryx Energies complements this with robust logistics and industrial supply capabilities, followed by Shell's credible global expertise and commitment to clean fuels. Together, these companies form a strong foundation for introducing and scaling e-fuel distribution effectively in Mali, aligning well with the weighted criteria across technical, economic, environmental, and strategic dimensions.

3.2.2 Case of Côte d'Ivoire

Compared to Mali, Côte d'Ivoire has a stronger energy sector, with established players in hydrogen, biomass, and solar projects. Storage benefits from public and private facilities, including those linked to refining. Distribution is competitive, with nationwide networks run by multinational and local firms. Applying the weighted criteria highlights the most capable partners for advancing e-fuel production, storage, and distribution.

- **Production chain**

Côte d'Ivoire's production segment includes established industrial players and new investors in hydrogen, biomass, and solar, supported by a strong energy infrastructure. The Figure 9 shows the ranked of the selecting partner for the production of e-fuel.



P1= CIE (9th)
P2= SIR (1st)
P3= PETROCI (3rd)
P4= SIFCA (Biokala) (6th)
P5= Azito Energie (8th)
P6= CIPREL (10th)
P7= Neoen (2nd)
P8= Ivoire Hydro Energy (11th)
P9=NERANOVE (7th)
P10= ENI CI (4th)
P11= Ivoire Hydrogène (5th)

Figure 9: Most promising partner for the production chain (Côte d'Ivoire)

Source: Author

In Cote d’Ivoire, SIR holds the top position with 20% due in large part to its commanding technical infrastructure and financial comeback. As Côte d’Ivoire’s only oil refinery, SIR processes about 100,000 barrels per day and is undergoing a €2 billion upgrade to install new desulphurization units and reformulate gasoline, moving decisively toward cleaner fuel production (EcofinAgency, 2025; EnergyCapital, 2025). These improvements not only make SIR the clear technical leader but also set the stage for incorporating synthetic e-fuels into its portfolio. On the financial front, SIR has recovered from earlier setbacks and by 2022 posted record profits of 125 billion CFA (Sow, 2025). Its government-backed expansion includes a $5.1 billion project with Yaatra Ventures to build a second refinery at 170,000 barrels per day, ultimately targeting a national capacity of 270,000 barrels per day and solidifying its place as a regional production hub (EcofinAgency, 2025). This scale, healthy financials, state support and experience with large partnerships together justify its top ranking.

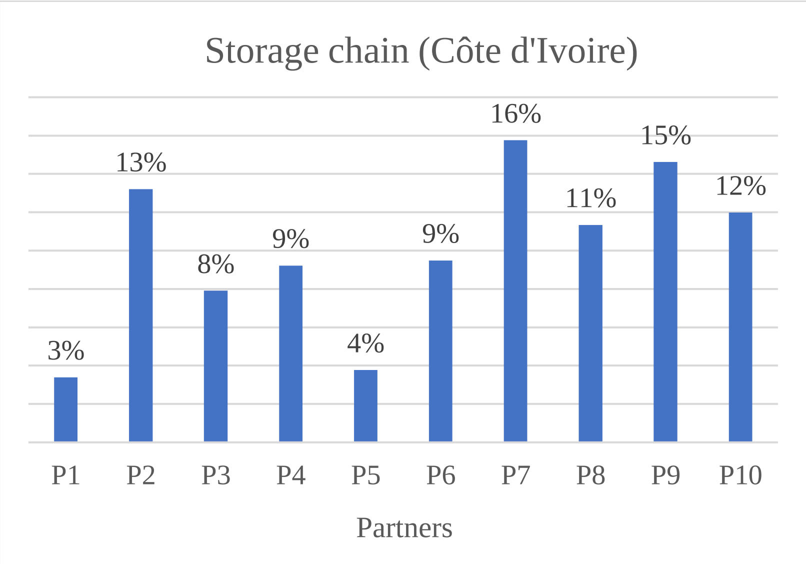
In the second place comes Neon with 15%. Excelling particularly on environmental and technical grounds. As a global leader in renewable energy, Neoen specializes in developing massive solar, wind and storage projects (the backbone technologies for green hydrogen and, by extension, e-fuel production). In 2025, Neoen targets to exceed 10GW of total installed renewables capacity internationally, investing over €5.3 billion in expansion (Neoen, 2025b). The company has a proven track record with over €300 million in annual EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortisation) (Neoen, 2025a), indicating strong financial stability to support the capital-intensive investment of hydrogen or synthetic fuels. Importantly, Neoen’s business model is aligned solely with renewable technologies, so any partnership for e-fuel would guarantee a genuinely green, decarbonized product. These environmental credentials, along with robust technical expertise in power infrastructure, make Neoen an ideal provider of clean energy for Côte d’Ivoire’s e-fuel ambitions.

PETROCI, ranking third with a score of 13%, is Côte d’Ivoire’s national oil and gas company. It demonstrates strength in both technical infrastructure and national strategy. PETROCI operates across the energy chain, and the operator of critical gas pipelines like the 80km Foxtrot line (Petroci.ci, n.d.; Sanogo, 2025). These assets mean that PETROCI has hands-on experience with large-scale production, processing and infrastructure for both oil and natural gas, which are important technical assets for any e-fuel initiative, particularly those involving hydrogen or carbon capture. While its finances are partly dependent on state resources and joint venture partners, PETROCI is prioritized in public energy policy with dedicated funding running into the hundreds of millions of dollars through 2030 (FrenchNews, 2025). This strategic role ensures PETROCI can back large-scale, state-aligned e-fuel projects, even if not at the same scale of financial robustness as SIR.

These rankings underscore the importance of proven infrastructure, financial capacity and forward-thinking environmental strategies. SIR leads for its scale, upgrades and financial strength, positioning it as the anchor for national e-fuel expansion. Neoen offers support for renewable energy and sustainability value, essential for fully green e-fuel. PETROCI, with strong technical and strategic alignment, brings vital energy capabilities. Collectively, these organizations demonstrate why they are Côte d’Ivoire’s most promising production partners for driving the e-fuel transition.

- **Storage chain**

Storage facilities are more extensive, combining public and private assets, many linked to the refining industry. A different group of top partners was selected, focusing on companies with strong capabilities in logistics, and fuel management. The following Figure 10 shows the rank obtained after the AHP was applied.



P1= CIE (10th)

P2= SIR (3rd)

P3= Sahara Energy (8th)

P4= Neoen (7th)

P5= Ivoire Hydrogène (9th)

P6= Oryx Energies (6th)

P7= Vivo Energy (1st)

P8= PETROCI (5th)

P9= Puma Energy (2nd)

P10= GESTOCI (4th)

Figure 10: Most promising partner for the storage chain (Côte d’Ivoire)

Source: Autor

As for the ranking of the partners for the storage part, the evaluation shows that Vivo Energy as in Mali, Puma Energy and Société Ivoirienne de Raffinage (SIR) are the top partners for fuel storage in Côte d’Ivoire.

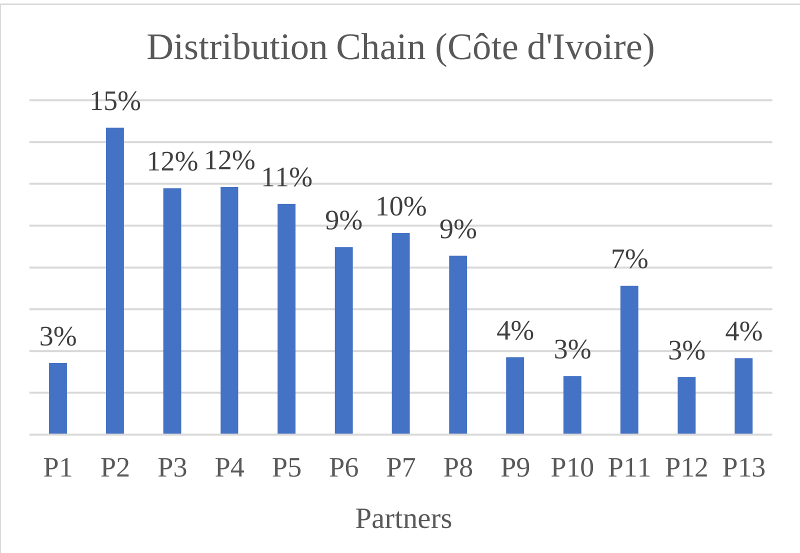
Vivo Energy leads as a great player in Côte d'Ivoire storage and supply chain, due to its strong infrastructure and extensive logistical capabilities. As the marketer of Shell fuels, vivo manages substantial storage depots (with inherited facilities like the Vridi petroleum terminal in Abidjan) that store gasoline, diesel, kerosene and aviation fuels. Its infrastructure supports around 190 retail stations and a diverse set of bulk consumers ranging from industrial firms to airlines (MarketScreener, 2022). Technically, the company's fuel storage systems are modern and well-maintained, benefiting significantly from Shell's global expertise and operational standards. Economically, Vivo's strong balance sheet, significant revenue scale (amounting to billions of USD in Côte d'Ivoire alone) and backing by major commodity trader Vitol provide robust financial viability, enabling it to maintain large inventories and invest in infrastructure expansion (Dabafinance, 2025). Strategically, Vivo's stable regulatory relationships, socio-political importance in preventing fuel shortages, and collaborative ownership structure (with Vitol and Helios) make it a trusted and powerful partner able to support national fuel security and future e-fuel storage projects (Trafigura, 2023).

Puma Energy, a major midstream operator, owns the largest petroleum storage terminal in Côte d'Ivoire with a capacity of approximately 159,100 m^3 (PumaEnergy, n.d.). This advanced facility includes multiple tank farms, a large surface capable of accommodating very large tankers and technology designed to minimize environmental impact through safety features and waste treatment (Trafigura, 2023). Puma infrastructure enables to store diverse petroleum products and services not only in domestic markets but also acts as a regional hub to landlocked neighbours. The company's financial viability is reinforced through ownership by Trafigura (Trafigura, 2023), which guarantees access to global supply chains and financing. Puma Energy's strategic position was further solidified through the acquisition of 80% of Petroci's fuel distribution business, underscoring the confidence placed in by Ivorian authorities (Palmer & Place, 2024). This combination of technical capability, environmental safeguards, financial backing and government support places Puma Energy as a leading storage chain partner fit to accommodate emerging e-fuel needs.

SIR complements this group as both the national oil refining company and a critical storage entity. Holding one of the most advanced refinery complexes in West Africa, SIR operates extensive crude oil and refined product storage tanks on site in Abidjan. Its refinery processes about 100,000 barrels per day and is undergoing an expansion and upgrade to produce cleaner fuels that meet Euro 5 (European regulations limiting vehicle emissions and fuel pollutants) and AFRI 6 standards, which require ultra-low sulphur fuels (maximum 10 ppm sulphur) across Africa to reduce air pollution (EcofinAgency, 2025). This technical expertise includes well integrated logistics infrastructure such as pipelines connecting major consumption centers. Financially, SIR has recovered strongly from past difficulties, posting record profits in recent years supported by government ownership and restructuring that positions it for new investment aligned with national interests (Sow, 2025). Environmentally, SIR is actively implementing technologies to reduce emissions and sulphur content in fuels, meeting stringent international standards (Brelsford, 2021). Socio-politically, SIR's state-controlled status, local workforce, and strategic importance (Maher, 2025), further bolster its reliability and long-term viability as a storage and refining partner for e-fuels.

In summary, the ranking reflects a balance where Vivo Energy's diverse and modern storage infrastructure, deep financial resources, and socio-political stability lead the field, followed by Puma Energy's world-class terminal facilities, environmental focus, and strong government partnerships. SIR's integrated refining and storage capabilities, combined with its improving financial health and sustainability efforts place it solidly as a top partner for Côte d'Ivoire's fuel storage chain. These companies collectively demonstrate the technical capacity, financial robustness and strategic positioning needed to start Côte d'Ivoire's transition to e-fuels. The Figure 11 show the raking of those partners.

- **Distribution/commercialisation chain**



P1= CIE (11th)
P2= Total Energies (1ST)
P3= Ola Energy (3rd)
P4= Vivo Energy (2nd)
P5= Star Oil (4th)
P6= Corlay (6th)
P7= Oryx Energies (5th)
P8= Petro-Ivoire (7th)
P9= SIR (10th)
P10= PETROCI (12th)
P11= Sahara Energy (8th)
P12= ZOLA Electric (13th)
P13= Green Power CI (9th)

Figure 11: Most promising partner for the distribution chain (Côte d'Ivoire)

Source: Author

The ranking and suitability of top fuel distributors in Côte d’Ivoire show that TotalEnergies, Vivo Energy and Ola Energy as most promising partners.

TotalEnergies, the largest retail network, holds the leading position in the distribution chain with about 190 service stations nationwide (TotalEnergy, n.d.). This extensive infrastructure gives TotalEnergies important level and capacity for fuel distribution across Côte d’Ivoire. The company has demonstrated robust financial performance, reporting revenues of approximately 631 billion XOF in 2024 with an 8% rise in net profits from the prior year (Dabafinance, 2025). It also invests in modernization and expansion of its outlets to meet rising fuel demand and integrates renewable energy initiatives such as solar projects and solar solutions at its stations, reinforcing its commitment to sustainability (TotalEnergy, n.d.). Strategically, TotalEnergies benefits from longstanding presence in the country and strong relationships with the government and local communities. Notably, it was entrusted by Ivorian authorities to lead a major LNG import terminal project, highlighting its critical role in the country’s energy infrastructure (TotalEnergy, n.d.). These combined factors across infrastructure, financial strength, environmental focus and strategic alignment justify TotalEnergies top ranking for e-fuel distribution.

Vivo Energy, operating under the Shell brand in Côte d’Ivoire since 1927, closely follows TotalEnergies in market share and distribution capacity with a score of 12%. Vivo Energy maintains a robust technical and infrastructure profile, managing over 170 service stations with a wide national footprint (MarketScreener, 2022). Financially, the company benefits from the backing of the multinational Vitol Group, enabling solid economic viability and operational scale (Pie, 2019). Vivo Energy emphasizes continuous improvement in supply and customer service, reflecting strategic resilience and adaptability. Its long-term presence and deep community ties contribute to strong socio-political stability and regulatory compliance. Additionally, Vivo actively engages in corporate social responsibility initiatives (Vivoenergy, 2023), enhancing its social license to operate in the country. These attributes collectively support Vivo Energy’s position as a promising partner capable of efficiently distributing e-fuels throughout Côte d’Ivoire.

Ola Energy ranks next as a dynamic pan-African downstream operator with a substantial network of service stations. Though smaller than TotalEnergies and Vivo, Ola Energy is financially stable, supported by the Libyan Africa Investment Portfolio sovereign fund and has shown consistent profit growth (LybianExpress, 2025). Technically, Ola is committed to upgrading infrastructure, including investing millions of dollars in new stations and renovations, reflecting growth-oriented technical capability (Yedder, 2021). Its sustainability approach is forward-looking, incorporating zero-carbon strategies by installing solar panels at fuel stations and exploring electric vehicle charging solutions. Ola also promotes cleaner cooking fuels (LPG), aligning with broader social and environmental goals. These efforts enhance Ola Energy's environmental and socio-political credentials, making it a promising partner in the evolving e-fuel distribution landscape (Yedder, 2021).

In summary, TotalEnergies leads primarily due to its expansive and modern distribution infrastructure, strong financial performance, sustainability investments and strategic government partnerships. Vivo Energy's nearly equivalent infrastructure scale, solid financial backing and longstanding market presence position it as an equally strong contender for e-fuel distribution. Ola Energy, while smaller, brings growing technical capacity, financial viability and proactive sustainability initiatives. Together, these companies control the majority of Côte d'Ivoire's fuel distribution market and form a solid foundation to support the introduction and scaling of e-fuel distribution across the country.

3.3 Sensitivity analysis

The sensitivity analysis was conducted to see how the ranking of the most promising partners in the e-fuels production chain could change over time when future projects and strategies are considered. Partner selection is not static, as companies may strengthen or weaken their position with new investments, technological progress, or strategic choices. By including these future developments, the analysis provides a dynamic view that helps decision-makers anticipate which actors could gain competitiveness. This complements the earlier evaluation of current partner capacities in Mali and Côte d'Ivoire and focuses on the production chain, the most critical step where renewable electricity is converted into hydrogen or synthetic fuels.

3.3.1 Analysis of the production chain in Mali

In Mali, the sensitivity analysis shows that the ranking of production chain partners can change when future projects are considered. Some companies that were not leading in the initial evaluation become more competitive due to their planned investments and strategic initiatives, while others lose their position. This highlights how the most promising partners in Mali may shift over time. Figure 12 presents the projected shares and updated ranking of these partners based on their expected activities.

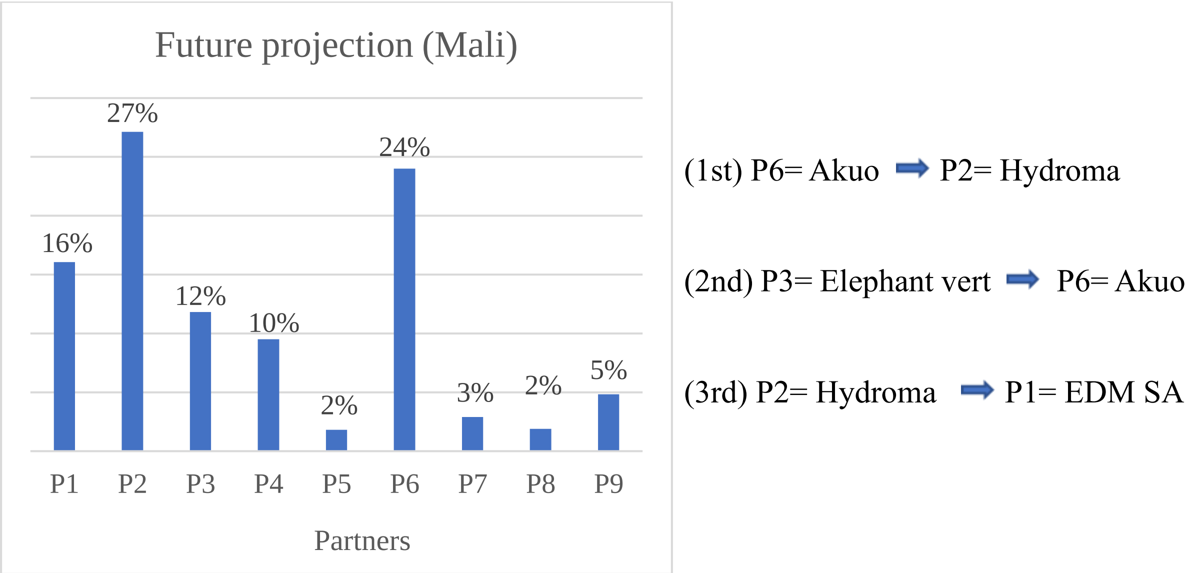


Figure 12: Sensitivity analysis of production chain in Mali

Source: Author

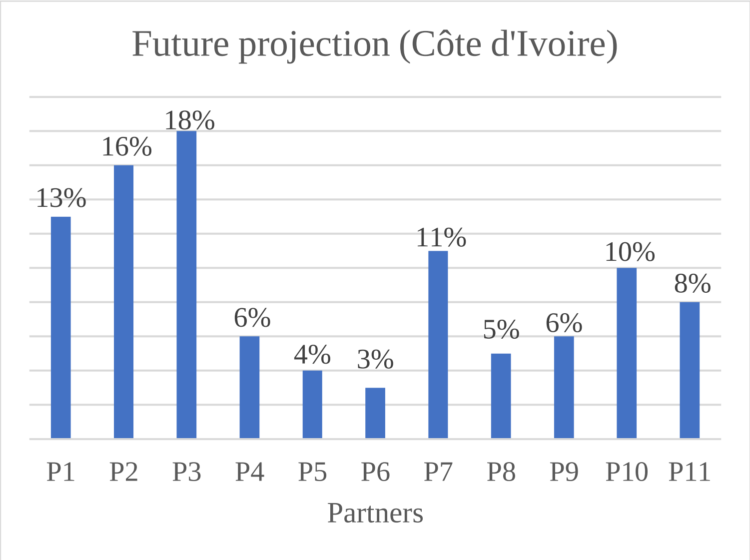
The results show that the initial top three (Akuo Energy, Elephant vert, and Hydroma) do not remain in the same order once future projects are taken into account. In the projection, Hydroma takes first place with 27% thanks to its planned 100 MW hydrogen power plant and wider hydrogen and ammonia projects for local and export markets (Hydroma, 2022). Akuo Energy follows with 24%, supported by its delivered 50 MW capacity and its target of 1 GW of renewable energy in Africa (AkuoEnergy, 2025). EDM SA rises to third place with 16% due to large solar PV projects, including a 200 MW plant with Rosatom and two additional 100 MW parks with Chinese and Emirati backing (EDM-SA, n.d.).

These results confirm that the most promising partners can change over time, as companies with ambitious future investments gain stronger positions. For Mali, this highlights the importance of flexible, forward-looking strategies in building e-fuels partnerships.

3.3.2 Analysis of the production chain in Côte d'Ivoire

For Côte d'Ivoire, the sensitivity analysis tests how future investments and strategies could affect the ranking of production partners. The results indicate that strong players with established infrastructure and international links are likely to reinforce their role in the sector.

Figure 13 illustrates these projections and highlights how the most promising partners may change when future plans are taken into account.



(1st) P2=SIR ➡ P3=PETROCI

(2nd) P7= Neoen ➡ P2= SIR

(3rd) P3= PETROCI ➡ P1=CIE

Figure 13: Sensitivity analysis of production chain in Côte d'Ivoire

Source: Author

The results show that the initial top three (SIR, Neoen, and PETROCI) do not remain in the same order once future projects are taken into account. In the projection, PETROCI takes first place with 18%, driven by the Baleine offshore development with Eni, which is ramping up domestic gas supply (about 70 MMcf/day for power) and improving the bankability of downstream e-fuel projects (Petroci.ci, n.d.). SIR follows with 16%, supported by ongoing refinery upgrades (Euro-5/AFRI-6 compliance) and the government's plan for a new around 170,000 barrel/day refinery, keeping SIR central in fuel logistics and potential future co-processing (SIR, n.d.). CIE rises to third with 13% thanks to grid expansion and the connection of new solar and hydro Independent Power Producers (IPPs) under its supervision, aligned with the national target of 45% renewables by 2030 (CIE.CI, n.d.; Energie.gouv.ci, 2023).

The results indicate that the most promising partners can change over time, resulting in stronger positions for companies with ambitious future investments. The importance of flexible and forward-looking strategies when developing e-fuel partnerships for Côte d'Ivoire cannot be overstated.

3.4 The comparative analysis of Mali and Côte d'Ivoire regarding their potential partners for e-fuels production

Following the identification and ranking of potential partners for e-fuel production in Mali and Côte d'Ivoire, this section presents a comparative analysis of the two countries. The aim is to assess their overall readiness and capability to develop a viable e-fuel sector, beyond individual company performance. The comparison is structured around eight key factors that influence e-fuel development: infrastructure and scale, financial resources, green innovation, government and policy support, partner diversity, strategic partnerships, distribution capabilities, and storage capabilities. These factors were selected to provide a balanced view of both the technical-operational capacity and the enabling conditions necessary for establishing a viable e-fuel sector. Table 6 below summarises the comparison, offering a side-by-side view of both countries across these factors.

Table 6: Comparative Summary

Factor	Mali	Côte d'Ivoire	Source
Infrastructure and Scale	-56% electrification; -No refinery; -Limited infrastructure	-97% electrification; -Largest regional refinery; -Strong hub	IEA (2023); ARDA Africa (2025)
Financial Resources	-Relies on aid and climate finance; -Small capital base	-Attracts large investments; -Profitable energy sector	Emiliano (2018); ARDA Africa (2025)
Green Innovation	-Natural hydrogen; -Small biofuel projects	-Green hydrogen strategy; industrial -Scale projects	Hydroma (2022); Biovea Energy (n.d.)
Government and Policy	Supportive policies but limited capacity	-Clear targets; -Strong funding and regional engagement	Ministry of Energy Mali (2024); MMPE (2024)
Partner Diversity	Few actors; gaps in some segments	Broad mix of public, private, and global players	Author's analysis (2025)
Strategic Partnerships	-Mainly donor-led; -Small-scale pilots.	-Large joint ventures; -Global corporate links.	World Bank (2023); EDF (n.d.)
Distribution	-Small network; -Landlocked.	-Extensive network; -Port access for exports.	TotalEnergies (2024); Vivo Energy (2023)
Storage	Very limited capacity.	Largest in West Africa; expanding.	GESTOCI (2024)

Source: Author

The comparison shows that, Mali, while rich in renewable resources and demonstrating innovative approaches such as natural hydrogen and community-based biofuels, faces structural challenges including limited infrastructure, smaller financial capacity, and early-stage storage systems. These constraints mean that Mali's e-fuel potential is more dependent on targeted external investment, technology transfer, and phased development

Côte d'Ivoire currently holds a stronger position for large-scale e-fuel development, supported by robust infrastructure, diversified partnerships, significant storage and distribution capabilities, and a well-funded policy framework. These advantages make it capable of quickly integrating e-fuels into its existing energy system and exporting to the region.

The two countries have strengths that complement each other; Côte d'Ivoire can provide the infrastructure and capacity needed for quick e-fuel deployment, while Mali offers strong renewable resources and innovative projects that can support long-term growth.

The comparative analysis highlights both the differences and the complementarities between both countries, providing a clear basis for identifying areas where targeted interventions can strengthen their readiness for e-fuels.

3.5 Recommendations for policy and regulatory frameworks to support e-fuels investment

The following section presents policy and regulatory recommendations designed to attract investment, reduce risks, and create a supportive environment for the development of a competitive e-fuel sector in both countries. Table 7 presents a summary of the key policy and regulatory recommendations.

Table 7: Recommendations for supporting e-fuels investment

Recommendation	Key Action	Main Benefit
Build a robust and diversified consortium	Partner government, local firms, international investors	Share risks, combine expertise
Strengthen technical and infrastructure capacity	Invest in renewables, grid, storage, transport	Reliable production, attract investors
Ensure financial resilience	Offer incentives, guarantees, blended finance	Reduce risks, increase funding
Align with sustainability and innovation	Link to climate goals, promote pilot projects	Green image, modern technology use
Create supportive policies and stakeholder trust	Clear rules, fast permits, community engagement	Stable environment, social acceptance
Pursue international partnerships	Sign MoUs, secure tech transfer, export deals	Access to markets, funding, expertise
Integrate the supply chain	Connect production, storage, and distribution	Lower costs, secure fuel delivery
Support R&D and Capacity building	Fund research, train local experts	Local skills, innovation, self-reliance

Source: Author

The recommendations presented in Table 7 highlight the multi-dimensional approach needed to develop a viable e-fuels sector in West African region specially, in Mali and Côte d'Ivoire. Together, they address technical, financial, institutional, and human capacity challenges identified in this study. Developing a strong e-fuels sector in West Africa requires action in several areas.

Diversified consortia of governments, local firms, and international partners are key to share risks and combine expertise. Mali and Côte d'Ivoire need stronger grids and storage despite good renewable potential. Financial incentives and blended finance can attract investors, while aligning e-fuels with climate goals promotes innovation. Supportive policies, stakeholder engagement, and international partnerships can reduce risks, bring funding, and open export opportunities. Supply chain integration, R&D, and workforce training will lower costs, speed adoption, and build long-term competitiveness. Establishing specialized training centers, integrating e-fuels modules into university and technical training programs, and encouraging knowledge transfer through international partnerships would help ensure that the workforce can meet the technical requirements of this emerging sector. To operationalize these priorities, the following actions are recommended:

- Governments: set clear regulations, simplify permits, offer fiscal incentives, and ensure land, infrastructure, and grid access.
- Companies and investors: form public-private partnerships and expand renewable, storage, and distribution infrastructure.
- Regional bodies (like ECOWAS): harmonize e-fuel standards and promote cross-border projects linking resources and infrastructure.
- Development partners: provide concessional finance, risk guarantees, pilot project support, and training for skills and regulatory reforms.

Combined, these measures will attract investment, improve readiness, and make e-fuels part of West Africa's clean energy future

4 Conclusion

The transition to sustainable energy is essential for West Africa's economic and environmental future. Among the emerging solutions, e-fuels offer a way to decarbonize sectors such as transport, industry, and power generation while promoting regional energy security.

This study aimed to assess the potential for e-fuels production in Mali and Côte d'Ivoire by identifying potential partners across the e-fuels value chain. Using the Analytic Hierarchy Process (AHP) based on five key criteria: technical and infrastructure capability (27%), economic and financial viability (45%), environmental and sustainability factors (8%), socio-political and regulatory stability (16%), and strategic partnership potential (4%), the identified partners were ranked. Moreover, the comparison of the investment environment and the performance of both countries was carried out in order to formulate recommendations to support e-fuels projects and attract investment.

The formulated research questions are addressed and interesting findings are as follow:

Firstly, the analysis identified a diverse range of organizations and companies in both countries capable of supporting e-fuel projects. Some partners stand out for their technical expertise and infrastructure, while others facilitate project compliance with regulatory and socio-political requirements, thereby expediting permits and implementation.

Secondly, the evaluation of identified partners shows that in Mali, Akuo Energy (30%) emerges as the leader in production, OMAP (43%) in storage, and Vivo Energy (18%) in distribution. While in Côte d'Ivoire, SIR (20%) leads production, Vivo Energy (16%) heads storage, and Total Energies (15%) dominates distribution. These rankings reflect the institutions' strengths across the identified evaluation criteria. Akuo Energy stands out due to its strong renewable energy portfolio and ambitious expansion targets, OMAP benefits from its extensive storage infrastructure, and Vivo Energy is supported by its established distribution network. Similarly, SIR's refining capacity and ongoing upgrades secure its lead in production, Vivo Energy's nationwide facilities reinforce its role in storage, and TotalEnergies' international experience and local presence strengthen its position in distribution..

The sensitivity analysis confirms that rankings are not fixed; they shift when credible future projects are taken into account. In Mali, Hydroma rises to first place because of its planned hydrogen and ammonia projects, while EDM SA improves with the addition of large solar capacity. In Côte d'Ivoire, Petroci, SIR, and CIE remain the leading partners, but their order becomes sensitive to the timing and progress of future strategies. These changes, however, are only possible if the announced projects are successfully implemented. If such projects are delayed or not realized, the competitive advantage of these partners may weaken. This underlines that the baseline reflects current capacity, while the sensitivity analysis highlights potential future competitiveness, making it necessary to revisit partner evaluations as projects advance.

Further, the comparative analysis between the countries highlights that Côte d'Ivoire has stronger infrastructure and investment readiness, whereas Mali offers abundant renewable resources but requires significant technical and financial reinforcement.

From these findings, recommendations are formulated to ease e-fuels project developments in the region. Diversified partnerships between governments, local firms, and global players are essential to share risks and expertise. Despite strong renewable potential, Mali and Côte d'Ivoire need better grids and storage. Blended finance, supportive policies, and international collaboration can attract investment, reduce risks, and boost exports. Integrating supply chains, investing in R&D, and training workers will lower costs and drive long-term competitiveness.

Additionally, the complementarity between both countries will be great: Mali's low-cost renewable potential can supply e-fuel production, while Côte d'Ivoire's industrial base can handle processing and exports. Geography also strengthens this synergy, as landlocked Mali can benefit from Côte d'Ivoire's access to ports, enabling efficient export of e-fuels to international markets. Together, they could establish a regional e-fuels hub capable of meeting both domestic and global demand. Beyond this regional perspective, the research also provides a replicable decision-making framework for evaluating strategic partners in emerging clean energy sectors.

This study has several limitations that should be considered when interpreting its results. The Analytic Hierarchy Process (AHP) relies partly on expert judgment, which introduces a degree of subjectivity in the weighting and scoring of criteria. Additionally, much of the data used for evaluating potential partners came from secondary sources, such as literature reviews, company reports, and publicly available statistics. While these sources were selected for their reliability, they may not fully reflect the most recent or internal company data. Furthermore, some companies did not disclose complete technical or financial information, which required the use of proxy indicators or estimates.

However, future research could address these gaps by collecting primary data through interviews with companies, policymakers, and investors. It could also expand the analysis to more West African countries for regional comparison and cross-border opportunities. Adding techno-economic modelling would give cost and performance estimates, while dynamic modelling could integrate investment timelines and policy changes to strengthen sensitivity analysis and forecast the long-term evolution of e-fuel value chains.

Declaration of the Use of Artificial Intelligence in Scientific Theses

Bintou Traore — 20230C6WY

Surname, First name — Matriculation Number

I hereby certify that I have written this thesis independently and,

A. with the help of ☒

B. without the help of ☐

an artificial intelligence (AI) program, such as: ChatGPT, DALL-E2, Stable Diffusion, Looka, etc.

If option A has been ticked, the following declaration is also required:

☐ I declare that all AI programs used for this work have been carefully cited in the text and in the bibliography. The screenshots and usage information have also been presented in detail in the appendix "AI-generated content".

☒ I declare that for this document AI assistance was undertaken solely for grammatical improvements. No citations were provided for text generated by an AI, as no content was created or significantly modified.

I have reviewed all the inclusions and modifications made with the assistance of AI in this thesis and take full responsibility for the accuracy of the content.

Dakar, 11-09-2025

Place, Date

Signature

Bibliography

AkuoEnergy. (2025). *Completion of the Akuo Group's acquisition by Ardian and appointment of Bruno Bensasson as CEO _ Akuo*.

Alamoodi, A. H., Al-Samarraay, M. S., Albahri, O. S., Deveci, M., Albahri, A. S., & Yussof, S. (2024). Evaluation of energy economic optimization models using multi-criteria decision-making approach. *Expert Systems with Applications*, *255*(PD), 124842. https://doi.org/10.1016/j.eswa.2024.124842

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

Arnaud, A., & Cedric, S.-J. (2025). *Regional e-fuel sectors are on the verge of industrialization*. *April*.

Ash, N., Sikora, I., & Richelle, B. (2019). Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile. *Environmental Defense Fund …*. https://doi.org/10.13140/RG.2.2.26479.38566

AZITOEnergy. (n.d.). *Le projet Azito Energie – AZITO ENERGIE*. https://baraka-petroleum.com/about/

Bagayogo, I., Sanogo, S., & Traoré, I. (2025). Evaluation of the Solar Photovoltaic Potential for Electrification of Rural Areas off the National Grid in Mali. *Computational Water, Energy, and Environmental Engineering*, *14*(02), 77–96. https://doi.org/10.4236/cweee.2025.142005

baraka-petroleum. (2024). *Baraka Petroleum – Les hydrocarbures notre Business*. https://baraka-petroleum.com/about/

BioveaEnergy. (n.d.). *Accueil - Biovea Energie*. https://biovea-energie.com/la-centrale-biomasse/#projet-biovea

BloombergNEF. (2025). Energy Transition Investment Trends 2025 - Report Summary. *Tracking Global Investment in the Low-Carbon Transition*. https://about.bnef.com/insights/finance/energy-transition-investment-trends/

Braune, I., Pinkwart, A., & Reeg, M. (2009). Application of multi-criteria analysis for the evaluation of sustainable energy systems—A review of recent literature. *… of Energy, Water and Environment …*, *May*. https://www.researchgate.net/profile/Matthias-Reeg/publication/237144775_Application_of_Multi-Criteria_Analysis_for_the_Evaluation_of_Sustainable_Energy_Systems-A_Review_of_Recent_Literature/links/0046352039b8c972c5000000/Application-of-Multi-Criteria-Ana

Brelsford, R. (2021). *Rystad Energy_ Global FLNG capacity to more than triple by 2030 _ Oil & Gas Journal*.

Chance, C. (2024). *Energy Transition Investment Trends 2024*. *February*.

https://www.cliffordchance.com/content/dam/cliffordchance/briefings/2024/02/energy-transition-trends-2024.pdf

Chen, W., Kamara, J., & Cai, Y. (2013). *The Role of Multi-criteria Decision Techniques for Sustainable Construction of Chinese Residential Buildings*.

CIE.CI. (n.d.). *Compagnie Ivoirienne d'Electricité - L'entreprise - Notre Présentation - CIE en bref*. https://www.cie.ci/entreprise/presentation/cie-en-bref

CIPREL.CI. (n.d.). *Accueil _ CIPREL*. Compagnie Ivoirienne de Production d'électicité. https://ciprel.ci/about/

Clodura.ai. (2023). *Baraka Petroleum - Overview, Competitors, expertise in fuel import, storage, distribution; 200-truck fleet for nationwide deliverya*.

Dabafinance. (2025). *Dabafinance - TotalEnergies Côte d'Ivoire Unit Annual Profit Jumps 8_*. https://www.dabafinance.com/fr/nouvelles/le-benefice-annuel-de-l-unite-cote-d-ivoire-de-totalenergies-augmente-de-8-percent

Daly, J. (2018). *Vivo Energy PLC Annual Report &Accounts 2018*. lubricants to commercial and domestic,customers

Dell'Aversano, S., Villante, C., Gallucci, K., Vanga, G., & Di Giuliano, A. (2024). E-Fuels: A Comprehensive Review of the Most Promising Technological Alternatives towards an Energy Transition. *Energies*, *17*(16), 1–43. https://doi.org/10.3390/en17163995

Dembélé, Y., Bonkaney, A. L., Sanogo, S., Kumar, N., Tischbein, B., & Madougou, S. (2025). Performances Analysis of On-Grid-Tied Large-Scale Solar PV Plant in Mali: A Case Study in Kita. *Smart Grid and Renewable Energy*, *16*(02), 35–56. https://doi.org/10.4236/sgre.2025.162003

Dirk, S. (2025). *Can white hydrogen revolutionise clean energy and aviation fuels_*. https://green.simpliflying.com/p/can-white-hydrogen-revolutionise

Donner, S., Hartmann, H., & Steinkamp, S. (2024). Côte d ' Ivoire. *BTI 2024 Country Report*.

Dybiński, O., Szabłowski, Ł., Martsinchyk, A., Szczęśniak, A., Milewski, J., Grzebielec, A., & Shuhayeu, P. (2025). Overview of the e-Fuels Market, Projects, and the State of the Art of Production Facilities. *Energies*, *18*(3). https://doi.org/10.3390/en18030552

E-Fuels Market Size, Share, Trends, & Insights Report, 2035. (2025). https://www.rootsanalysis.com/e-fuels-market/request-sample

EcofinAgency. (2025). *Côte d'Ivoire Secures $5*. https://www.ecofinagency.com/news-industry/1905-46870-cote-d-ivoire-secures-5-1bn-commitment-from-yaatra-for-refinery-project#:~:text=Raphael Souanga%2C SIR's Director of,Saharan Africa

ECREEE ECOWAS. (2023). *Economic Community of West Ecowas Green Hydrogen Policy and Strategy Framework*. 1–72.

edf. (n.d.). *Off-grid for access to low-carbon electricity _ EDF Ivory Coast*.

EDM-SA. (n.d.). *ENERGIE DU MALI _ Energie du Mali - SA*.

Effatpanah, S. K., Ahmadi, M. H., Aungkulanon, P., Maleki, A., Sadeghzadeh, M., Sharifpur, M., & Chen, L. (2022). Comparative Analysis of Five Widely-Used Multi-Criteria Decision-Making Methods to Evaluate Clean Energy Technologies: A Case Study. *Sustainability (Switzerland)*, *14*(3). https://doi.org/10.3390/su14031403

Elephant-vert. (n.d.). *Mali subsidiary - Eléphant Vert*. https://www.azitoenergie.com/le-projet-azito-energie/

Emiliano, B. (2018). *Akuo Energy secures financing for Mali's second solar park – pv magazine International*.

Enerdata. (n.d.). *Mali Energy Market Report | Energy Market Research in Mali*. https://www.enerdata.net/estore/country-profiles/mali.html

Energie.gouv.ci. (2023). *Ministère Mines, Pétroles et Energies : Site officiel*. https://www.energie.gouv.ci/apropos/mission-organisation

EnergyCapital. (2025). *Ivory Coast to Build New 170,000 BPD Refinery*. Energy Capital and Power. https://energycapitalpower.com/ivory-coast-to-build-new-170000-bpd-refinery/#:~:text=The project forms part of,with a feasibility study completed

Ernst & Young. (2023). *A Pivot to Growth - EY Attractiveness Africa*. *November*.

Fasihi, M., Efimova, O., & Breyer, C. (2019). Techno-economic assessment of CO 2 direct air capture plants. *Journal of Cleaner Production*, *224*, 957–980. https://doi.org/10.1016/j.jclepro.2019.03.086

FortuneCP. (n.d.). *Mali - Fortune CP*. https://fortunecp.com/projects/

FrenchNews. (2025). *La Côte d'Ivoire vise 200*. Xinhuanews, French News. https://french.news.cn/20250620/dd4fc343936448ba97df22712dd64503/c.html#:~:text=La Côte d%27Ivoire vise 200,pour les

Gavril, J. (2023). *EMBA Mobility Transformation E-fuels' worldwide production potential* [ACADEMY FOR CONTINUING EDUCATION]. www.tcpdf.org

Gerard, P., Rafiee, A., Alvarado, M. M., Mahdi, O., Kaya, H. F., & Khalilpour, K. (2025). The Africa-Europe Energy Interconnection: Assessing Green Hydrogen Suppliers for France. *The Lancent Pschch*, 1–35.

GH2. (n.d.). *Côte d'Ivoire _ Green Hydrogen Organisation*.

Guide, C., & Sub-sectors, L. (2019). *Mali - Energy* (pp. 1–4).

Halieutiques, R., Halieutiques, R., Faso, B., Leuven, K. U., Terres, G., & Faso, B. (2024). *Rapport Annuel Rapport Annuel*. 1–64.

Hummel, J. M., Bridges, J. F. P., & IJzerman, M. J. (2014). Group decision making with the analytic hierarchy process in benefit-risk assessment: A tutorial. *Patient*, *7*(2), 129–140. https://doi.org/10.1007/s40271-014-0050-7

Hydroma. (2022). Hydrogen production leader in Africa. In *Hydroma Inc*. https://hydroma.ca/

IDTechEx. (2023). *Hydrogen Economy 2023-2033_ Production, Storage, Distribution & Applications_ IDTechEx*.

IEA. (2023). Africa Energy Outlook 2022: World Energy Outlook Special Report (Revised in 2023). International Energy Agency (IEA). *World Energy Outlook Special Report*, 250. https://www.iea.org/reports/africa-energy-outlook-2022%0Ahttps://iea.blob.core.windows.net/assets/220b2862-33a6-47bd-81e9-00e586f4d384/AfricaEnergyOutlook2022.pdf

International Energy Agency. (2023). *The 2023 World Energy Outlook*. 355.

International Energy Agency (IEA). (2023). The Role of E-fuels in Decarbonising Transport. *Reports*. https://www.iea.org/reports/the-role-of-e-fuels-in-decarbonising-transport

International Transport Forum. (2023). *The Potential of E-fuels to Decarbonise Ships and Aircraft Corporate Partnership Board Report*. https://www.itf-oecd.org/sites/default/files/docs/potential-efuels-decarbonise-ships-aircraft-v2.pdf

IRENA. (2021). Making the breakthrough: Green hydrogen policies and technology costs. In *International Renewable Energy Agency, Abu Dhabi*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Green_Hydrogen_breakthrough_2021.pdf?la=en&hash=40FA5B8AD7AB1666EECBDE30EF458C45EE5A0AA6

IRENA. (2022). Global Hydrogen Trade to Meet the 1.5°C Climate Goal: Technology Review of Hydrogen Carriers. In *International Renewable Energy Agency*. https://www.irena.org/publications/2022/Apr/Global-hydrogen-trade-Part-II

IRENA. (2023). *IRENA (2023), Renewable energy statistics 2023, International Renewable Energy Agency, Abu Dhabi.* www.irena.org

Ivoireh2. (n.d.). *iH2 - Ivoire Hydrogène - Hydrogène Vert, Hydrogène Blanc*.

JOHANNESBURG, R. (2011). *Shell to sell Africa downstream stake for $1 billion _ Reuters*. https://www.reuters.com/article/us-shell/shell-to-sell-africa-downstream-stake-for-1-billion-idUSTRE71I1NO20110219/

Konaté, J. (2023). *AER-Mali _ Des résultats satisfaisants malgré une insuffisance budgétaire - Le Continent*. La Tribune Du Continent.

Koua, B. K., Koffi, P. M. E., Gbaha, P., & Touré, S. (2015). Present status and overview of potential of renewable energy in Cote d'Ivoire. *Renewable and Sustainable Energy Reviews*, *41*, 907–914. https://doi.org/10.1016/j.rser.2014.09.010

La, D. E., General, S., & Gouverne, D. U. (2023). Journal officiel. *Andrologie*, *10*(1), 119–120.

https://doi.org/10.1007/bf03035230

Lea, A. (2023). *Hydroma talks up Mali's subsurface hydrogen potential _ Latest Market News*. Argus.

Lengkeek, A., & Verkuijl, H. (n.d.). *Commercial Jatropha biodiesel production with small-scale farmers*. http://worldagroforestry.org/sites/default/files/grp1_workshops/Trees for Farmers/G. Poster exercise/Posters/Ard Lengkeek.pdf

London, T. E., Paris, G. M., Paris, P. G., Ferraris, V., Tim, M., Oslo, A., & Paris, L. L. (2024). *E-fuels: A Challenging Journey To A Low-Carbon Future*.

LybianExpress. (2025). *Ola Energy accelerates growth with sharp rise in annual profit*.

Maher, H. (2025). *Côte d'Ivoire's SIR speeds up its transition - Africa Business+*.

MarketScreener. (2022). *Vivo Energy Cote d'Ivoire SA_ Shareholders Board Members Managers and Company Profile _ CI0000000246 _ MarketScreener*.

Maruthur, N. M., Joy, S. M., Dolan, J. G., Shihab, H. M., & Singh, S. (2015a). Use of the analytic hierarchy process for medication decision-making in type 2 diabetes. *PLoS ONE*, *10*(5), 1–11. https://doi.org/10.1371/journal.pone.0126625

Maruthur, N. M., Joy, S. M., Dolan, J. G., Shihab, H. M., & Singh, S. (2015b). Use of the analytic hierarchy process for medication decision-making in type 2 diabetes. In *PLoS ONE* (Vol. 10, Issue 5). https://doi.org/10.1371/journal.pone.0126625

Masami, K., Bill, M., Fred, S., Sanjoy, R., Robert, M., & Bacon, R. (2010). *Petroleum Product Markets in Sub-Saharan Africa*. https://www.esmap.org/sites/default/files/esmap-files/Rpt_SSA_downstream_sector_SSA_Petroleum_Products_Jan_2010.pdf#:~:text=2, sector on a concession basis

Millercenterglobal. (2025). *Mali Biocarburant SA - Miller Center for Global Impact*. Santa Clara University Center of Distinction.

Nemmour, A., Inayat, A., Janajreh, I., & Ghenai, C. (2023). Green hydrogen-based E-fuels (E-methane, E-methanol, E-ammonia) to support clean energy transition: A literature review. *International Journal of Hydrogen Energy*, *48*(75), 29011–29033. https://doi.org/10.1016/j.ijhydene.2023.03.240

Neoen. (2025a). *Neoen is reporting 2024 results in line with its expectations and reiterating its targets for 2025*. *December 2024*, 1–18.

Neoen. (2025b). *The New Global Leader in Renewable Energy*.

OryxEnergy. (n.d.). *Mali - Oryx Energies (lubricants to commercial and domestic,customers)*. https://www.oryxenergies.com/en/country/mali#:~:text=lubricants to commercial and domestic,customers

OryxEnergy. (2016). *Oryx Energies inaugurates 16 new service stations in Mal*.

Oyewo, A. S., Lopez, G., ElSayed, M., Galimova, T., & Breyer, C. (2024a). Power-to-X Economy: Green e-hydrogen, e-fuels, e-chemicals, and e-materials opportunities in Africa. *Energy Reports*, *12*(July 2024), 2026–2048. https://doi.org/10.1016/j.egyr.2024.08.011

Oyewo, A. S., Lopez, G., ElSayed, M., Galimova, T., & Breyer, C. (2024b). Power-to-X Economy: Green e-hydrogen, e-fuels, e-chemicals, and e-materials opportunities in Africa. *Energy Reports*, *12*(November 2023), 2026–2048. https://doi.org/10.1016/j.egyr.2024.08.011

Palmer, J., & Place, U. M. (2024). *Energising communities*.

Petroci.ci. (n.d.). *PETROCI HOLDING Côte d'Ivoire*.

Pie, K. (2019). *Vivo Energy Côte d'Ivoire strengthens its presence in the Ivorian market - Africa Business Communities*.

Poursaeed, A., Mirdamadi, M., Malekmohammadi, I., & Hosseini, J. F. (2010). The partnership models of agricultural sustainable development based on multiple criteria decision making (mcdm) in iran. *African Journal of Agricultural Research*, *5*(23), 3185–3190.

PumaEnergy. (n.d.). *Renewable and Lower Carbon Energy - Puma Energy*.

Reddy, V. J., Hariram, N. P., Maity, R., Ghazali, M. F., & Kumarasamy, S. (2023a). Sustainable E-Fuels: Green Hydrogen, Methanol and Ammonia for Carbon-Neutral Transportation. *World Electric Vehicle Journal*, *14*(12). https://doi.org/10.3390/wevj14120349

Reddy, V. J., Hariram, N. P., Maity, R., Ghazali, M. F., & Kumarasamy, S. (2023b). Sustainable E-Fuels: Green Hydrogen, Methanol and Ammonia for Carbon-Neutral Transportation. *World Electric Vehicle Journal*, *14*(12), 29. https://doi.org/10.3390/wevj14120349

Report, P. (2023). *TotalEnergies - More Energy , Less Emissions*. *March*.

Report, S., & Sawan, W. (2025). *Chair ' s message*. 2024–2025.

Resort, S. (2023). *Role of hydropower in West African Power Pool (WAPP) interconnected network ESMAP Hydropower Development Facility HYDRO 2023 Conference*.

Rutz, D., Janssen, R., & Energies, W. I. P. R. (2012). Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability Global-Bio-Pact Meeting , Workshop and Study Tour in Mali. *Renewable Energy*, *4*, 1–12.

Saaty, T. L. (1980). What is the Analytic Hierarchy Process? In *Mathematical Models for Decision Support* (pp. 109–121). https://doi.org/10.1007/978-3-642-83555-1_5

Sanogo, F. (2025). *Ivory Coast's Energy Future in Focus_ PETROCI CEO to Speak at AEW 2025 - African Energy Week Cape Town _ AEC Week*. African Energy Chamber.

Schöne, N., de Rochette, F., & Heinz, B. (2021). When More Than Money Talks: Multi-Criteria Decision Analysis of Fuel Cells for Sustainable Power Supply in Sub-Saharan Minigrids. *Renewable Energy and Sustainable Development*, *7*(1), 5–25. https://doi.org/10.21622/RESD.2021.07.1.005

Selmert, V., Paschalidis, L., Kruse, N., Dirkes, S., Kretzschmar, A., Jerome, G., Jung, C., Xu, L., Beltermann, N., Tempel, H., Peters, R., Samsun, R. C., & Eichel, R. A. (2025). Overcoming the energy-water nexus in dry regions - water-positive production of green hydrogen carriers and base chemicals: the DryHy project - technical aspects. *Sustainable Energy and Fuels*, *9*(7), 1672–1682. https://doi.org/10.1039/d4se01783h

Singh, H., Li, C., Cheng, P., Wang, X., & Liu, Q. (2022). A critical review of technologies, costs, and projects for production of carbon-neutral liquid e-fuels from hydrogen and captured CO2. *Energy Advances, 9,* 580–605. https://doi.org/10.1039/d2ya00173j

SIR. (n.d.). *Société Ivoirienne de Raffinage, de l'energy pour l'avenir*.

Solomon, C. G., Salas, R. N., Malina, D., Sacks, C. A., Hardin, C. C., Prewitt, E., Lee, T. H., & Rubin, E. J. (2022). Fossil-Fuel Pollution and Climate Change — A New NEJM Group Series. *New England Journal of Medicine*, *386*(24), 2328–2329. https://doi.org/10.1056/nejme2206300

Sow. (2025). *Côte d'Ivoire_ TotalEnergies sells its stake in SIR to African investors - Or Noir Africa*. Ornoirafrica.Com.

Taherdoost, H. (2017). Decision Making Using the Analytic Hierarchy Process (AHP); A Step by Step Approach. *International Journal of Economics and Management Systems, 2,* 244–246. https://ssrn.com/abstract=3224206http://www.ahooraltd.comhttp://www.hamta.org

Toguna-agro-industries. (n.d.). *TOGUNA AGRO*.

TotalEnergies. (n.d.). *TotalEnergies in Mali _ TotalEnergies*.

TotalEnergy. (n.d.). *TotalEnergies in Côte d'Ivoire _ TotalEnergies*.

trade.gov. (2024a). *Côte d'Ivoire - Energy/Country Commercial Guide*. Energy. https://www.trade.gov/country-commercial-guides/cote-divoire-energy#:~:text=As of 2021%2C Côte d,MW) generated by hydroelectric dams.

trade.gov. (2024b). *Mali - Energy-AER*. International Trade Administration, U.S. Department of Commerce,.

trade.gov. (2024c). *Mali - Energy-EDM*. International Trade Administration, U.S. Department of Commerce,.

Trafigura. (2023). *Puma Energy announces Q2 2019 results ::* https://www.pumaenergy.com/press-releases/2019/08/28/puma-energy-announces-q2-2019-results/

Union, E., & Africa, S. (n.d.). *5 Key Demands for a Global Scale-Up of E- Fuels Production*.

Van Kranenburg, K., Van Delft, Y., Gavrilova, A., De Kler, R., Schipper, C., Smokers, R., Verbeek, M., & Verbeek, R. (2020). E-fuels: towards a more sustainable future for truck transport, shipping and aviation. *Tno, July*, 1–36. www.tno.nl

Vitol. (2025). *Vitol and Vivo Energy to invest $550+ million in infrastructure to support clean cooking in Africa - Vitol*.

Vivoenergy. (2023). *Côte d'Ivoire _ Vivo Energy*.

VivoEnergy. (2023). *Mali _ Vivo Energy*.

Wang, J. Q., Peng, J. J., Zhang, H. Y., Liu, T., & Chen, X. H. (2015). An Uncertain Linguistic Multi-criteria Group Decision-Making Method Based on a Cloud Model. *Group Decision and Negotiation*, *24*(1), 171–192. https://doi.org/10.1007/s10726-014-9385-7

World bank. (2023). *Scaling Up Energy Access for Green, Resilient, and Inclusive Development in Western and Central Africa*. https://www.worldbank.org/en/results/2023/11/17/scaling-up-energy-access-for-green-resilient-and-inclusive-development-in-western-and-central-africa

WREI. (2022). *Accelerating renewable energy investment in West Africa*. 1–29. https://www.pwc.com/m1/en/publications/documents/accelerating-renewable-energy-investment-in-west-africa.pdf

Yedder, O. Ben. (2021). *Future of retail stations is electric, says OLA Energy chief of strategy*. African Business

Appendix 1: Scoring of the Alternatives under Each Criterion (final scoring)

Production chain in Mali												
	Wc1	Sc1	Wc2	Sc2	Wc3	Sc3	Wc4	Sc4	Wc5	Sc5	Total score	Rank
P1	27%	16%	45%	7%	8%	1%	16%	3%	4%	13%	8%	5
P2	27%	38%	45%	11%	8%	17%	16%	2%	4%	23%	18%	3
P3	27%	6%	45%	24%	8%	34%	16%	27%	4%	1%	20%	2
P4	27%	10%	45%	11%	8%	2%	16%	6%	4%	1%	9%	4
P5	27%	2%	45%	2%	8%	1%	16%	1%	4%	2%	2%	9
P6	27%	23%	45%	37%	8%	25%	16%	24%	4%	27%	30%	1
P7	27%	1%	45%	1%	8%	10%	16%	15%	4%	22%	5%	7
P8	27%	1%	45%	2%	8%	4%	16%	9%	4%	4%	3%	8
P9	27%	3%	45%	4%	8%	6%	16%	13%	4%	7%	6%	6
											100%	

P1= EDM SA

P2= Hydroma Inc

P3= Elephant vert

P4=Toguna industry

P5= BARAKA

P7= Access Energie

P8= MB SA

P9= Yirimex-SA

Wc= Weight of criteria

Sc= Score of criteria

Storage chain in Mali												
	Wc1	Sc1	Wc2	Sc2	Wc3	Sc3	Wc4	Sc4	Wc5	Sc5	Total score	Rank
P1	27%	70%	45%	34%	8%	20%	16%	24%	4%	44%	41%	2
P2	27%	20%	45%	56%	8%	6%	16%	63%	4%	44%	43%	1
P3	27%	2%	45%	2%	8%	3%	16%	2%	4%	2%	2%	4
P4	27%	7%	45%	8%	8%	70%	16%	11%	4%	10%	14%	3
										Sum	100%	

P1= EDM SA

P2= OMAP

P3= BARAKA petroleum

P4= Hydroma Inc

Distribution/Commercialisation Chain in Mali												
	Wc1	Sc1	Wc2	Sc2	Wc3	Sc3	Wc4	Sc4	Wc5	Sc5	Total score	Rank
P1	27%	3%	45%	1%	8%	8%	16%	14%	4%	2%	5%	9
P2	27%	1%	45%	1%	8%	1%	16%	1%	4%	1%	1%	11
P3	27%	14%	45%	7%	8%	5%	16%	14%	4%	16%	10%	5
P4	27%	6%	45%	7%	8%	2%	16%	5%	4%	6%	6%	7
P5	27%	27%	45%	17%	8%	20%	16%	8%	4%	9%	18%	1
P6	27%	21%	45%	17%	8%	5%	16%	8%	4%	9%	15%	2
P7	27%	3%	45%	25%	8%	13%	16%	5%	4%	25%	15%	3
P8	27%	6%	45%	4%	8%	13%	16%	2%	4%	3%	5%	8
P9	27%	3%	45%	4%	8%	27%	16%	24%	4%	9%	9%	6
P10	27%	1%	45%	1%	8%	1%	16%	1%	4%	1%	1%	12
P11	27%	2%	45%	1%	8%	2%	16%	2%	4%	2%	2%	10
P12	27%	14%	45%	12%	8%	3%	16%	14%	4%	16%	12%	4
P13	27%	1%	45%	1%	8%	1%	16%	1%	4%	1%	1%	12
										Sum	100%	

P1= EDM SA
P2= PETRODIS
P3= Star oil
P4= OLA Energy
P5= Vivo Energy
P6= Oryx Energies
P7= Shell
P8= Coly Energy
P9= SOYATT
P10= BATHILY petrole service
P11= BARAKA petroleum
P12= YARA OIL
P13= MAKNIKA Sarl

Production Chain in Côte d'Ivoire												
	Wc1	Sc1	Wc2	Sc2	Wc3	Sc3	Wc4	Sc4	Wc5	Sc5	Total score	Rank
P1	27%	9%	45%	5%	8%	5%	16%	9%	4%	9%	5%	9
P2	27%	24%	45%	11%	8%	2%	16%	15%	4%	16%	20%	1
P3	27%	1%	45%	2%	8%	1%	16%	15%	4%	16%	13%	3
P4	27%	3%	45%	11%	8%	3%	16%	14%	4%	10%	8%	6
P5	27%	13%	45%	5%	8%	6%	16%	4%	4%	3%	6%	8
P6	27%	9%	45%	5%	8%	6%	16%	4%	4%	3%	3%	10
P7	27%	4%	45%	18%	8%	22%	16%	2%	4%	6%	15%	2
P8	27%	2%	45%	2%	8%	11%	16%	5%	4%	3%	3%	11
P9	27%	13%	45%	9%	8%	6%	16%	14%	4%	9%	7%	7
P10	27%	18%	45%	31%	8%	14%	16%	14%	4%	21%	11%	4
P11	27%	1%	45%	1%	8%	25%	16%	3%	4%	4%	9%	5
										Sum	100%	

P1= CIE
P2= SIR
P3= PETROCI
P4= SIFCA
P5= Azito Energie
P6= CIPREL
P7= Neoen
P8= Ivoire Hydro Energy
P9= ERANOVE
P10= ENI CI
P11= Ivoire Hydrogène

Storage Chain in Côte d'Ivoire												
	Wc1	Sc1	Wc2	Sc2	Wc3	Sc3	Wc4	Sc4	Wc5	Sc5	Total score	Rank
P1	27%	1%	45%	1%	8%	7%	16%	11%	4%	4%	3%	10
P2	27%	24%	45%	5%	8%	2%	16%	24%	4%	24%	13%	3
P3	27%	1%	45%	3%	8%	1%	16%	32%	4%	34%	8%	8
P4	27%	2%	45%	11%	8%	32%	16%	4%	4%	1%	9%	7
P5	27%	1%	45%	1%	8%	23%	16%	7%	4%	1%	4%	9
P6	27%	17%	45%	7%	8%	11%	16%	2%	4%	10%	9%	6
P7	27%	4%	45%	32%	8%	3%	16%	1%	4%	2%	16%	1
P8	27%	11%	45%	17%	8%	4%	16%	1%	4%	6%	11%	5
P9	27%	7%	45%	24%	8%	16%	16%	1%	4%	16%	15%	2
P10	27%	32%	45%	2%	8%	1%	16%	17%	4%	1%	12%	4
										Sum	100%	

P1= CIE

P2= SIR

P3= Sahara Energy

P4= Neoen

P5= Ivoire Hydrogène

P6= Oryx Energies

P7= Vivo Energy

P8= PETROCI

P9= Puma Energy

P10= GESTOCI

Distribution/Commercialisation Chain in Côte d'Ivoire												
	Wc1	Sc1	Wc2	Sc2	Wc3	Sc3	Wc4	Sc4	Wc5	Sc5	Total score	Rank
P1	27%	1%	45%	1%	8%	10%	16%	10%	4%	2%	3%	11
P2	27%	19%	45%	17%	8%	7%	16%	8%	4%	8%	15%	1
P3	27%	15%	45%	11%	8%	5%	16%	13%	4%	10%	12%	3
P4	27%	13%	45%	15%	8%	10%	16%	4%	4%	3%	12%	2
P5	27%	9%	45%	15%	8%	7%	16%	6%	4%	11%	11%	4
P6	27%	12%	45%	8%	8%	7%	16%	8%	4%	9%	9%	6
P7	27%	10%	45%	10%	8%	7%	16%	10%	4%	7%	10%	5
P8	27%	8%	45%	9%	8%	6%	16%	9%	4%	5%	9%	7
P9	27%	1%	45%	2%	8%	13%	16%	7%	4%	9%	4%	9
P10	27%	1%	45%	1%	8%	5%	16%	5%	4%	14%	3%	12
P11	27%	6%	45%	8%	8%	6%	16%	8%	4%	9%	7%	8
P12	27%	2%	45%	2%	8%	5%	16%	5%	4%	10%	3%	13
P13	27%	2%	45%	2%	8%	12%	16%	8%	4%	4%	4%	10
										Sum	100%	

P1= CIE

P2= Total Energies

P3= Ola Energy

P4= Vivo Energy

P5= Star Oil

P6= Corlay

P7= Oryx Energies

P8= Petro-Ivoire

P9= SIR

P10= PETROCI

P11= Sahara Energy

P12= ZOLA Electric

P13= Green Power CI

Appendix 2: Calculation of the consistency test

- ***Consistency Index (CI)*** $$CI = \frac{\lambda max - n}{n-1}$$

$$\lambda max = (5.0603 + 5.0609 + 5.0335 + 5.0206 + 5.0038)/5$$

$$\lambda max \approx 5.0358$$

$$CI = (5.0358 - 5)/4$$

$$CI = 0.00896$$

- **Consistency Ratio (CR)** $$CR = \frac{CI}{RI}$$

$$CR = 0.00896/1.12$$

$$CR = 0.08$$

- CR=0.08 If CR < 0.10 (10%), the judgments are consistent.
- If CR ≥ 0.10, the comparisons might be inconsistent and should be reviewed.

Criterion	(A·w)i	wi	λi= (A·w)i/wi
C1	1.3522	0.2672	**5.0603**
C2	2.2523	0.4454	**5.0609**
C3	0.4251	0.0844	**5.0335**
C4	0.8158	0.1625	**5.0206**
C5	0.2030	0.0405	**5.0038**

C→criteria

Standard value based on matrix size n						
n	1	2	3	4	5	6
RI	0	0	0.58	0.9	1.12	1.24

RI: Random Index